

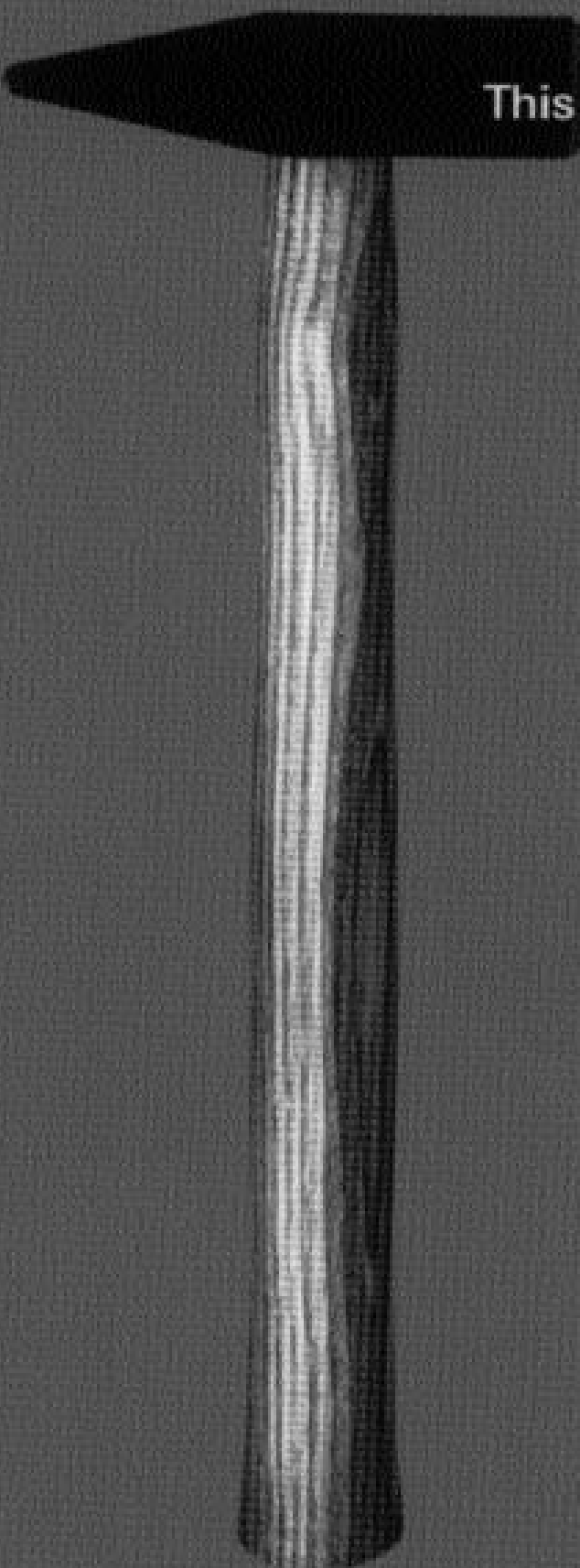
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NATURAL DISASTER MANAGEMENT



NATURAL DISASTER MANAGEMENT

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This hammer is a risk

A hammer is the symbol *par excellence* of an everyday risk. Nothing embodies more fittingly the thin dividing line between a successful hit and a throbbing thumb. The hammer, like no other tool, constantly tempts us to underestimate its hazard potential. No matter how placid, harmonious and well-formed it pretends to be, it strikes mercilessly: knocks holes in all the wrong places, always bends nails with the final stroke, and lurks on the rung of the ladder, ready to drop onto your foot at the last minute. The hammer – allegedly a harmless implement – is thus revealed in its true colours: it is, in reality, a tool for virtuosos only. But even they have their problems when it's a question of hitting the proverbial nail on the head. They would be well advised to rely on their flashes of inspiration and leave the hammer on the shelf ...

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NATURAL DISASTER MANAGEMENT

A presentation to commemorate the
International Decade for Natural Disaster Reduction (IDNDR)
1990–2000

Edited by Jon Ingleton



TUDOR ROSE

1999

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We are grateful for the support and co-operation of many individuals and organisations who have volunteered their time and effort without remuneration. Sincere thanks are given to Terry Jeggle, whose enthusiasm and commitment has made the publication of Natural Disaster Management possible.

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STATEMENT BY THE SECRETARY-GENERAL

Almost daily, we are reminded of the threat of natural disasters. We cannot stop the forces of nature, but we can and must prevent them from causing major social and economic disasters.

Natural disasters profoundly affect our efforts to achieve sustainable development. By their powerful impact on the supply of primary commodities, they disrupt market stability, leading to steep declines in national revenue. In many developing countries, five per cent of gross national product may be lost to natural disasters each year.

We can no longer afford, financially or socially, to rely only on the expectations of emergency relief when disaster strikes. Much greater attention must be paid to preventive strategies aimed at saving lives and protecting resources and assets before they are lost. The programme for the International Decade on Natural Disaster Reduction, adopted by the United Nations General assembly in 1989, has taken up this battle, combining resources, advanced scientific and technological development, information dissemination, human resource management and risk assessment in an integrated package. Agencies of the United Nations system such as the World Meteorological Organization, UNESCO and the World Bank have been particularly active in contributing their technical expertise.

As the International Decade for Natural Disaster Reduction comes to a close, it is essential that the aims of this initiative are continued. As more and more countries incorporate disaster prevention policies into national development plans, they are trying to enlist the help of educators, non-governmental organisations, civil society institutions and private sector enterprises. Indeed, prevention begins with information. This publication will make an important contribution by encouraging the widest possible partnership, communication and exchange of information among all groups of society and all nations to ensure a sustained commitment to a safer world, a world more resilient to the impact of natural hazards and disasters.



Kofi Annan
Secretary-General of the United Nations

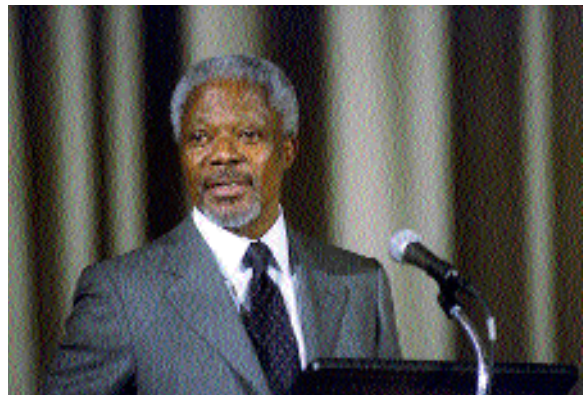
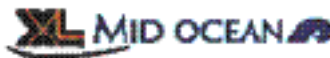
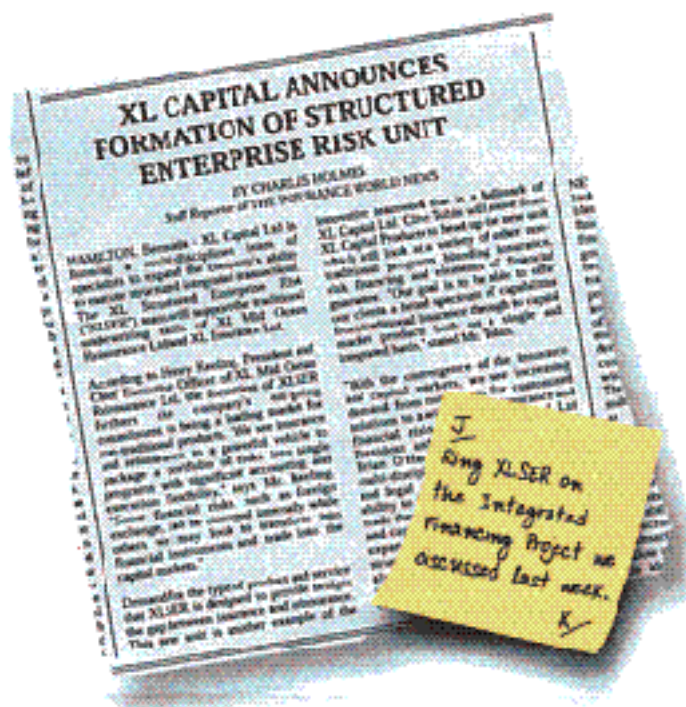


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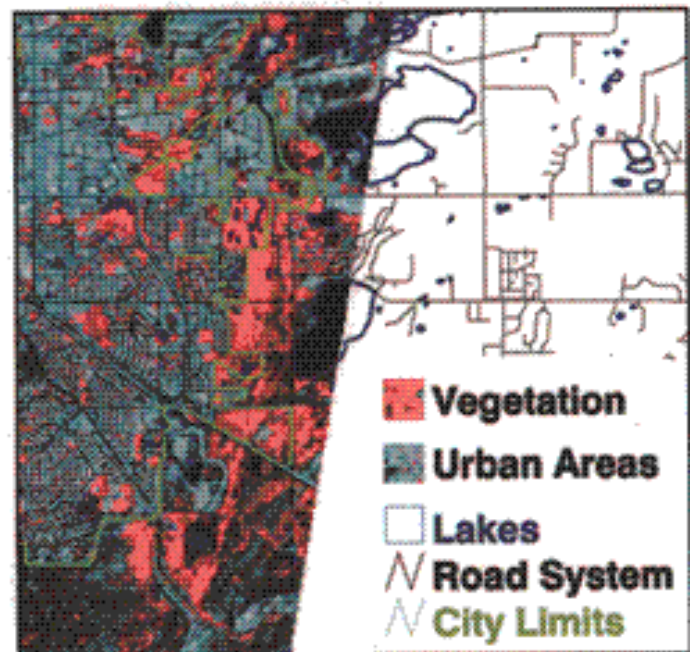
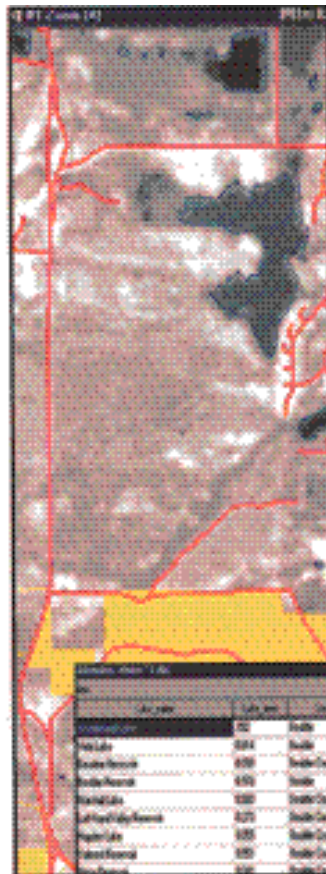
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Editor's Foreword

I have lost count of the number of times that, upon introducing the title of this book, *Natural Disaster Management*, the response has been a raised eyebrow of scepticism or even a short burst of laughter. One might forgive the postman's comment 'rather you than me', but when corporate and organisational leaders tried to convince me that we were fighting a lost cause, the incredible need for this book became only too apparent. Even more alarming is that the efforts of the International Decade for Natural Disaster Reduction have had to overcome this inherent cynicism many more times over, and magnified to many degrees.

However, for every sneer there has also been someone with the vision and belief that an initiative like this can be truly worthwhile, and that with patience, effort and downright bloody-mindedness, visible and tangible success can be found. One only has to scan the pages of this book to see that many of these visionaries have contributed their time and effort for, without exception, no financial gain, to share their experiences and pass on the lessons they have learned in our pursuit of managing natural disasters. This should inspire hope and belief in us all. Why? Because we can manage natural disasters. Depending on the hazard, its occurrence may be inevitable, but in every single case, the hazard need not lead to disaster. We need not build communities on floodplains, or construct fragile structures in earthquake prone regions, and we can educate our communities on how to preserve their lives and property when an extreme natural event takes place. In publishing this book, our simple aim is that more individuals are better prepared.

The opportunities for you, the reader, to gain from those whose unique position has enabled them to contribute to this book would not exist were it not for a small selection of brave organisations who have invested financial resources into making this book happen. We are delighted that they are able to profile their products and services within these pages and hope they benefit from doing so. We are also indebted to those governments who have embraced the IDNDR and taken positive action in the effort to achieve its lofty goals. In addition to the wealth of contributors that are listed in the following contents pages, we have received the support of more individuals, too numerous to mention, whose help and advice have combined to increase the worth of this book. It is with deep regret that I learned that one of our most dedicated supporters and a proactive member of our Editorial Advisory Board, Mohammed El-Sahb, IAPSO Commission of Natural Marine Hazards, passed away some months before the completion of *Natural Disaster Management*. We are proud to dedicate this book to his efforts towards our common goal.

As a genuinely collaborative piece of work, *Natural Disaster Management* may not ease the reader through its chapters with the uniform and consistent turn of phrase of a single author text. Rather, the rich diversity of authors has resulted in a book that probably does not lend itself to being read from cover to cover in a single attempt. This is a strength, not a weakness, as it offers a rare chance to view the same problem from many different perspectives, at the same time helping us to understand the varied, and sometimes conflicting, set of challenges that are faced by different communities throughout the globe. I hope that, whatever path you tread through this book, you take away something useful.



Jon Ingleton
Editor

Preface

As the twentieth century comes to a close, the subject of disaster reduction is at an important point on the world agenda. Especially important are the respective roles for facing the challenges which it poses for our professions and our societies. Perhaps 'poised' is not too strong a word to describe the position in which too many countries find themselves, as they face the risks of natural hazards in the near future. After the wide-ranging disaster experiences of recent years, more countries recognise now, more fully than before, that the risk of disasters is too important to be consigned only to planning eventual emergency relief measures. However, the seeming demands to employ disaster reduction measures can also appear, at first glance, to be so sweeping in their implications that they may easily deter us from taking methodical steps that can lead to long-term commitments.

By reflecting on the past ten years of the global initiative of the International Decade for Natural Disaster Reduction, we should recall what the United Nations General Assembly emphasised in its founding resolution of the IDNDR (UNGA, 1989). There, it emphasised the importance of adopting an integrated approach for disaster management in all its aspects to initiate a process towards a global culture of prevention. It is now even more evident ten years after the IDNDR resolution that the escalating costs of natural disasters cannot continue to be tolerated, or absorbed. Several highly visible, recent natural disasters such as Hurricane Mitch in Central America, the effects of smoke, fire and haze on three continents, the worst floods in over a hundred years in China, and the global effects of El Niño provide a foretaste of perhaps more severe, and possibly more frequent, disasters that we can expect in the future.

No country in the world will be devoid of the risk of natural hazards, but it will be up to each one of them to decide what measures are necessary, feasible, and affordable to embrace acceptable levels of protection against social and economic disasters. However that cannot, or should not, be accomplished in isolation. As the Yokohama Strategy stated in its Introduction, '...each country bears the primary responsibility for protecting its own people, infrastructure and other national assets from the impact of natural disasters, and accepting in the context of increasing global interdependence, concerted international co-operation and an enabling international environment are vital for the success of these national efforts' (*Yokohama Strategy*, 1994). We have all, through increasing contact and shared concerns, come a long way in raising awareness of an issue which can no longer be ignored. Much also remains to be accomplished, together.

With burgeoning cities around the world, disregard for the continuing demands that rapidly growing societies place on the natural and physical environments on which they depend, and the elusive achievement of sustainable development which many emerging economies seek, hazard awareness and risk management practice will have to be incorporated into national planning processes. Demonstrated practical experience, expanding scientific knowledge, and advances in technological applications also provide us with the abilities and the resources to reduce our exposure to risks.

If we are to protect the social resources and economic assets of our societies, we must embrace prevention as a public value. It requires a broad awareness, passed between generations, and a collective discipline embodied in numerous trades and professions. While sympathies may result from a humanitarian imperative, success can only be realised through practical means of reducing human vulnerability, safeguarding the environment, and seriously pursuing the fundamental principles of sustainable development. Disaster prevention does not respond to an event; it is rather a process. It proceeds, over time, sustained by the informed decisiveness of political commitment, the investment of resource allocations, and the application of knowledge tested by experience.

We have to look resolutely towards the future as we develop policy instruments which can motivate communities to accept the fact that expenditure which protects infrastructure of even greater value constitutes a positive investment. New organisational relationships become both necessary and possible, as the functions of hazard awareness and disaster prevention are recognised as being multi-dimensional, involving many skills and abilities. Modern communications and the explosion of information access around the world provides the basis for rapid and extensive exchange of ideas and experience. The early warning of threats becomes more possible than it has ever been before. All of these are opportunities, but only if we seize them.

First there has to be a common recognition of mutual interests in protecting collective resources, livelihoods, infrastructure, and assets that we call a society. Partnership becomes essential. Effective risk management for the future can only proceed if it is multi-sectoral, but yet integrated in the comprehensive planning and resource allocation that characterises all public effort. To be sustained, this will call for on-going commitments to the assessment of hazards and vulnerabilities, the fullest application of prevention measures where feasible, the informed use of preparedness arrangements where necessary, and the availability of effective and rapid response in the case of need. However, the misplaced reliance on the latter needs of responding to the effects of a disaster alone, without first seeking to prevent loss and damage in the first place, raises serious questions as to responsible governance.

For all of these reasons, I have the greatest appreciation that *Natural Disaster Management* has sought to demonstrate the number/diversity of hazard awareness and risk management efforts being pursued around the world. This volume admirably serves to demonstrate what is being accomplished in furthering the original objectives of IDNDR, as well as the promises for even greater opportunity in achieving disaster prevention in the future. The publication of this book has been a productive partnership, between the publisher, the IDNDR Secretariat and over one hundred authors — to achieve a common aim of demonstrating the practicality of efforts to reduce the likelihood of natural disasters. The articles demonstrate both the feasibility and the reach necessary to work towards a safer 21st century.

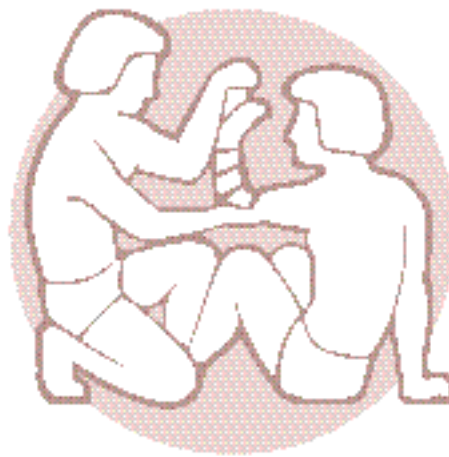
Most importantly though, I believe that the real story of successful natural disaster management is that it is a composite effort of many people doing their daily work, learning from their individual mentors, and teaching their students or successors. Information has been shared between colleagues, and among organisations. As the following articles demonstrate abundantly, all of the people described are necessarily attentive to hazards and dedicated to their professional roles in reducing risks. They are not waiting for something to happen first, or relying on it not happening at all. They have made their personal investments. They are doing it now.



Philippe Boullé
Director, IDNDR Secretariat



Philippe Boullé, Director, IDNDR Secretariat, Switzerland



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I

INTERNATIONAL CO-OPERATION AND COMMITMENT

THE WHITE HOUSE

WASHINGTON

April 7, 1999

As the International Decade for Natural Disaster Reduction draws to a close, we must share the knowledge and experience we have gained through this initiative if we are to build on its success in saving lives and reducing suffering.

As all of us know from tragic experience, no part of our world is immune from natural disasters. Floods, hurricanes, earthquakes, fires, and other forces of nature continue to threaten property and lives across the globe. We cannot prevent most natural disasters, but it is the duty of every nation to pool its resources to develop and implement new ways to reduce the loss of life and property when these disasters do occur.

By sharing effective methods of preparedness and promoting a greater awareness of the social and technological advances we have made in disaster prevention, we can help mitigate the often tragic and always destructive effects of natural disasters. In order to be successful, however, these solutions must be supported by national governments and implemented at the community level. For example, here in the United States, the Federal Emergency Management Agency has been working through its initiative, Project Impact, to advise local communities about disaster prevention and mitigation efforts that have been successfully introduced and implemented in other parts of our country. The U.S. Agency for International Development also works with national governments, community groups, and non governmental organizations to support disaster planning preparedness and mitigation activities overseas.

As we applaud both the goals and the achievements of the International Decade for Natural Disaster Reduction, I urge individuals and communities across America and around the world to learn more about the importance of disaster prevention and preparedness. Working together, we can build a brighter, safer future for all our people.





STATEMENT BY THE SECRETARY-GENERAL, WORLD METEOROLOGICAL ORGANIZATION

Various statistics compiled by the United Nations system, the insurance industry, and many national committees for the International Decade for Natural Disaster Reduction (IDNDR), confirm that about 80 per cent of losses to natural disasters are attributed to meteorological or hydrological events. Tropical cyclones alone account for an annual average of about 20,000 deaths and about US\$ 6 billion in damage globally. During the 1990s, major floods in China, the United States and several other countries in Asia, the Americas and Europe, caused significant loss of life and economic devastation worth tens of billions of dollars.

Therefore, for any nation at risk from meteorological and hydrological events, the highest priority for saving lives and reducing damage to property is an adequate warning system and its complementary effective emergency response procedures. The longer in advance a warning can be given about potentially damaging conditions, the easier it will be to mitigate and reduce its impact. Combating natural disasters is therefore a major activity in many countries, among several sectors of society, and indeed among many national, regional and international organisations. Of particular concern to the World Meteorological Organization (WMO), which is a specialised agency of the United Nations system, are disasters that are meteorological and hydrological in origin, such as tropical cyclones, droughts, floods, tornadoes and extreme temperatures.

Since its establishment in 1950, WMO has focused, through the Meteorological and Hydrological Services of its 185 Member countries, on continually strengthening its networks for non-stop real-time observations and monitoring of the atmosphere in all parts of the world. A unique system for the rapid global exchange of data, forecasts and warning information is the cornerstone for this activity. Specialised technical and scientific centres and training institutions have been established throughout the world, supporting national services in the provision of timely warnings against floods, droughts and other severe weather events. Special attention is placed on strengthening the capacities of developing countries, particularly those where tropical cyclones are a major threat. An array of meteorological satellites provides continuous monitoring of all tropical ocean basins where these devastating storms originate. The improved capabilities over the years have led to a major reduction in the loss of human life as a result of these natural disasters.

During the Decade, we have seen catastrophic floods and droughts in many parts of the world caused by the El Niño phenomenon. Major scientific advances, particularly during the decade, in the understanding of the El Niño and the ability of Meteorological Services to predict its occurrence up to a year in advance, mean that in these cases, governments and concerned organisations can now take early mitigation measures, which have significant social and economic benefits.

I commend the great overall international efforts that made the Decade a success. While the Decade will end soon, the continued collaboration of scientific and technical agencies, such as WMO, and disaster management agencies, will remain key to successful natural disaster reduction in the future.

A handwritten signature in black ink, appearing to read 'Godwin Obasi', written over a set of horizontal lines.

Godwin Obasi
Secretary-General, World Meteorological Organization



STATEMENT FROM THE DIRECTOR-GENERAL OF UNESCO

As we embark upon a new century and millennium, natural hazard prevention is set to play a prominent role in global efforts to reduce human suffering and damage to natural built environments. The safety and well-being of many communities depend on decisions made, not made or postponed in coping with natural phenomena. The possibility of irreversible changes to the global environment is very real. In consequence, natural disasters may increase in terms of frequency, complexity, scope and destructive capacity.

Disasters strike industrialised and developing countries alike. yet the capacity of people to cope with disasters is often drastically diminished in the poorer countries. Poverty, increasing migration and concentration of population, inadequate infrastructures, often added to social dislocation caused by wars and conflicts, make many countries unprepared for catastrophes.

There is a relationship between natural disasters and threats to peace. There can be no certainty of peace and security when disasters and crisis loom. Coping with hazards—whether natural or attributable to human activity—is one of the greatest challenges of the 21st Century.

The basic problem is how to prevent hazards from triggering large-scale disasters. The answers are often known yet seldom applied. The disastrous effects of natural phenomena will only be eliminated, reduced or stabilised when prevention becomes a priority and cities, settlements, infrastructure, and houses are made safer. The overriding necessity for a global culture of prevention is clear: a culture which compels us to stop increasing exposure of humankind and property to nature's violent forces.

Disaster reduction is both possible and feasible. While we cannot prevent an earthquake or hurricane from occurring, we can apply the scientific knowledge and technical know-how that we already have to increase the earthquake- and wind-resistance of houses and bridges, to issue early warnings and organise proper community response to such warnings. The extent to which society puts this knowledge to effective use depends firstly upon the political will of its leaders at all levels. The culture of prevention must thrive both at the national and the neighbourhood level.

A disaster strategy which consists in putting emphasis solely on relief and response is short-sighted and not cost-effective. The alternative is clearly to develop a shift in emphasis from post-disaster reaction to pre-disaster action and anticipation. An important aspect of a preventive strategy is to educate, organise and motivate the people of communities at risk. The United Nations Educational, Scientific and Cultural Organization (UNESCO), is committed, in the follow-up to the Decade, to encourage further the human resource development within those communities. The Organization will continue to provide the intellectual setting linking the natural, social and human sciences with education, culture, communication, and information, thereby integrating many of the ingredients for disaster reduction programmes.

I commend the way this book brings together specialists from different fields and encourages the crystallisation of key ideas for the purpose of reducing losses stemming from natural hazards. We already know much about these hazards and about the ways and means to avoid or reduce many of their effects. Success in significantly reducing disasters is within our reach. Now is the time to act, for tomorrow is always too late.

Federico Mayor
Director-General, UNESCO



MESSAGE FROM THE PRESIDENT OF THE FEDERATIVE REPUBLIC OF BRAZIL

By its nature, the IDNDR reflects the United Nations' renewed concern with the condition of individuals and peoples, rather than with more abstract political interests of states. The poor and socially-disadvantaged groups in developing countries are the least equipped to cope with natural disasters and are therefore the most affected. The loss of life, property damage, and social and economic disruption which result from natural disasters require practical measures on the part of public authorities, as well as the exchange of information among scientists and decision-makers from the countries engaged in this endeavour. According to the guidelines agreed upon in December 1989, when this programme was launched, specific attention should be given to education, training and the development of technical knowledge targeted at the assessment, prediction and mitigation of natural disasters. Also, a consensus was reached as to the necessity of establishing appropriate infrastructure in each country, through demonstration projects and programmes of technology transfer. Since any territory can be damaged by such unfortunate phenomena, mutual assistance can be beneficial to both developing and developed countries.

Although natural disaster reduction involves a great deal of co-ordination within the world's scientific community, it presents an essential political character, namely the need of policy co-ordination among governmental, non-governmental agencies and the private sector, with a view to mitigating the social consequences of natural disasters and promoting a more effective use of the available resources. Secretary-General Kofi Annan, with the assistance of the Under Secretary-General for Humanitarian Affairs, Mr Sergio Vieira de Mello, playing a key role in articulating the activities and research of UN operational agencies, non-governmental organisations and civil society. In this context, community participation in this campaign should be encouraged, providing the organisations involved in this effort with greater insight into the individual and collective perception of development and risk, as well as a clearer understanding of the cultural characteristics of each society and of their interactions with the physical and natural environment. Moreover, local communities would bring to light their traditional knowledge, practices and values in the form of low-cost alternatives to existing technologies.

Success in the prevention and reduction of natural disasters is closely related to the pursuit of sustainable development policies. Therefore, nations should incorporate preparedness against these phenomena into their social and economic agendas, in order to ensure efficient and continuous implementation of the principles set forth at the beginning of this decade and confirmed during the meetings concerning this matter held under the auspices of the United Nations. In light of the current economic difficulties faced by many developing countries, disaster prevention and mitigation should benefit from development projects financed by multilateral financial institutions, including the regional development banks.

Even in a world of increasing interdependence and concerted international co-operation, each country ought to bear the primary responsibility for the protection of its citizens and their properties, its infrastructure and other national assets from the physical impact and moral traumas of natural disasters. This position does not derive from a conservative notion of sovereignty, but from the evidence that each state can provide a more immediate and effective response to events which occur inside their own jurisdiction. International co-operation, including from non-governmental organisations, can, however, play a most welcome role in several specific circumstances.

In conclusion, the Decade has produced some very inspiring results for the international community. Though some points of the strategy deserve careful consideration and reassessment, such as the establishment of training programmes and the use of the media resources, a number of positive results have been achieved so far. Among these results, it is worth mentioning the improvement of technical co-operation at local, regional and international levels, as well as the creation of a multilateral structure capable of coordinating the resources of sovereign states and non-governmental organisations, with a view to mitigating the effects of natural disasters. I therefore congratulate the United Nations and other institutions which have dedicated themselves to the successful development of this initiative, whose continuation in the next decade would be a blessing for the peoples affected by natural disasters.



Fernando Henrique Cardoso
President of the Federative Republic of Brazil





MESSAGE FROM THE PRIME MINISTER OF AUSTRALIA

Australia has been committed to the International Decade for Natural Disaster Reduction since its inception by the United Nations on 22 December 1989. We have supported, in particular, the need for a strong focus on disaster reduction and on associated regional co-operation.

During the 1990s Australia has been subject to some significant disasters which have profoundly affected many people and have also drawn the nation together in collective grief and action. While we have strong capabilities to respond to disasters, our attention has been increasingly focused on prevention and mitigation so that we can reduce pain and suffering of individuals and damage to property and the environment.

Although disaster prevention is our vision, we realise that some disasters will always occur. The effect of disasters can, however, be minimised by co-operative programmes involving government, industry, research institutions, communities and individuals. Government initiatives and leadership are important, but by themselves are insufficient to foster a culture of prevention which will lead to concerted action. I believe that there is a need for a strong partnership approach in combating the effects of both natural and man-made disasters.

Such partnerships must also extend internationally. Natural perils, such as tropical cyclones and volcanic ash, do not respect national boundaries. There is a clear need for concerted international effort to forecast, monitor and manage hazards, to share information, to transfer technology and ideas, and to help each other as good neighbours. Australia has been active in working with other nations, particularly those located in our region, to raise the levels of disaster awareness and associated capabilities.

The Decade has provided an important national, regional and international focus on disaster prevention. Although there have been significant advances, there is still much to do. The future is to build on the successes in disaster prevention which have been achieved in the 1990s and to ensure that the focus does not diminish. Australia is firmly committed to this challenge.

A handwritten signature in black ink, appearing to read 'John Howard'.

John Howard
Prime Minister of Australia





MESSAGE FROM THE PRIME MINISTER OF NEW ZEALAND

The International Decade for Natural Disaster Reduction has been a timely opportunity for the world community to review the threats that natural hazards present and the ways in which, nationally, regionally and in the global family, we may prepare for them. New Zealand welcomed the Decade in 1989 and I welcome this book commemorating the conclusion of the Decade.

For New Zealand, the Decade was particularly well-timed. It began as we were reshaping our public sector for the challenges of the coming century, and had just completed reforms of local government. We were thus encouraged by the issues highlighted in the work of the Decade to take full account of the potential for natural disasters in the reforms we had in hand.

The Decade has also coincided with a number of events, such as the Pinatubo eruption and the Great Hanshin-Awaji Earthquake, which have clear lessons for us in New Zealand. The enhanced feeling of community amongst the nations taking part in the projects and meetings of the Decade has helped make learning easier, as well as encouraging the offering and receiving of help across international boundaries.

The Decade has encouraged more systematic thought about the full cycle of emergency management, from risk reduction through readiness to response and then recovery. It is clear that we must have this full array in mind rather than be prepared only to pick up the pieces and rebuild after the event.

Finally the Decade has called itself into question in an interesting and positive way. While natural disasters remain more frequent and devastating than technological or anthropogenic ones, the interplay of natural and technological or human factors has been highlighted in many of the Decade's documents and discussions. This might not have happened except for the rigor and honesty of the work the Decade has encouraged.

The Decade is ending but the work continues. New Zealand looks forward to playing its part in the ongoing regional and global efforts to protect lives and property from natural disasters.

A handwritten signature in black ink, appearing to read 'Jenny Shipley'.

Jenny Shipley
Prime Minister of New Zealand





MESSAGE FROM THE PRIME MINISTER OF JAMAICA

The end of the International Decade for Natural Disaster Reduction this year, on the eve of 2000, provides the unique opportunity for us to take the principles and achievements of the Decade into a new century. The Decade has provided a solid base on which global common approaches to disaster reduction and prevention can be built. The 21st Century allows us to strengthen our approach to disaster reduction and to demonstrate the fact that prevention and mitigation ultimately provide the best method for reducing the enormous cost of disasters.

Jamaica has been integrally involved in the Decade since 1990. It was among the initial countries to name an IDNDR focal point, and has commemorated IDNDR day each year. Membership of the Scientific and Technical Committee provided the opportunity for input to the Decade steering process. We have also hosted two major conferences in 1993 and 1996.

More important though, is the fact that we have sought to integrate the Decade's targets into the country's comprehensive disaster management programmes. The past ten years have seen significant progress in hazard mapping, input of hazard-related information into development planning, review and upgrade of appropriate contingency plans, public awareness and information dissemination, and development and refining of warning systems. In particular, installation of community-based flood warning systems has been a priority.

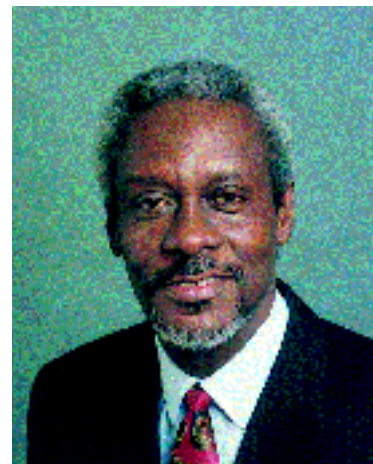
The drafting of a national hazard mitigation policy is the latest in a series of activities intended to focus national efforts on disaster prevention and mitigation, and by so doing to reduce the effect of disasters on our population and economy. However, the effect of hurricanes on our islands over the past ten years, the Monserrat volcanic crisis and the near miss of Hurricane Mitch this year, remind us that we cannot be complacent and decrease our vigilance. Jamaica remains committed to the concept 'prevention pays'.

The country has also benefited enormously from the technical information and expertise, as well as public awareness material that has been made available during the Decade. This global exchange of information and expertise has been one of the most successful aspects of the IDNDR, and it is hoped that this level of exchange will continue.

Though much has been achieved, much remains to be done if we are to realise the vision of the Yokohama Conference — 'A Safer World for the 21st Century'. Let us hope that the lessons and achievements of the past ten years will be carried forward and will serve to inform global approaches to disaster management in the next century.

A handwritten signature in black ink, appearing to read 'P. J. Patterson'.

P. J. Patterson
Prime Minister, Jamaica



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MESSAGE FROM THE PRIME MINISTER OF FINLAND

The International Decade for Natural Disaster Reduction is coming to an end. The issue is however more topical than ever. Disasters resulting from natural hazards are on the increase. The intensity and the devastating effects of natural catastrophes have clearly shown the necessity to intensify international co-operation for disaster reduction.

For Finland, the Decade has meant an opportunity to contribute the international efforts within the framework of IDNDR and beyond. The Intergovernmental Conference on Emergency Telecommunications, ICET 98, which was held in Tampere, Finland from the 16 to 18 June, 1998 has been one of the major events of the Decade. Tampere gave birth to a new Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations. The Convention establishes an international framework to facilitate the provisions and use of telecommunication resources and to foster co-operation for disaster mitigation and relief. The Tampere Convention reflects the new kind of willingness and readiness of the international community to tackle the vital issue of providing timely assistance when disaster strikes.

Ten years have gone by since UN resolution 44/236 was adopted and the Decade was launched. Much has already been achieved but many more efforts are needed. Finland has always welcomed and supported the objectives of the Decade. Finland will be ready for her part to further the international co-operation beyond the year 2000 in order to reduce the loss of life and property damage caused by natural disasters. We hope this book, which commemorates the conclusion of the Decade, will also encourage the international community to intensify all efforts in disaster reduction.



Paavo Lipponen
Prime Minister, Finland

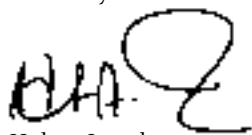
MESSAGE FROM THE PRIME MINISTER OF THE COMMONWEALTH OF THE BAHAMAS

A decade is a significant period to give sustained effort to an issue. While much has been done to heighten public awareness of the various natural threats to mankind during the International Decade for Natural Disaster Reduction (IDNDR), the devastation that can be caused by natural phenomena, particularly in smaller states, requires that the matter receives ongoing international focus.

The principal benefit of the IDNDR was that it generated a bias for action. The information exchanged by the world community showed that undertaking appropriate measures in a timely manner could reduce the effect of shifts in the earth's crust, the incursion of water or strong winds. Human populations occupy regions which are subjected to natural occurrences that disrupt the social fabric, and although population relocation may not always be a viable option, making regions safer through the provision of information and improvement in the physical environment has been an IDNDR goal.

As the Decade comes to a close the full integration of the lessons taught into national development efforts is a requirement. The emphasis of the Decade has been disaster prevention and this can only be attained by consciously putting into place, as development proceeds, those measures which will ensure that populations are safe and economic setbacks minimised.

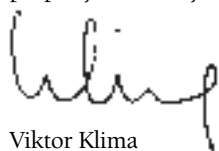
The future before the world is one in which the challenges posed by natural threats will not be reduced, but because of the IDNDR the ability to meet those challenges will be very much improved.



Hubert Ingraham
Prime Minister, Commonwealth of the Bahamas

MESSAGE FROM THE FEDERAL CHANCELLOR OF THE REPUBLIC OF AUSTRIA

Natural disasters will continue to threaten life and property—insurers even observe a trend that these dangers are increasing. However, there have been advances in managing the effects of natural disasters, emphasised by the outgoing International Decade for Natural Disaster Reduction. I hope that your efforts in documenting these achievements will help to strengthen relationships in this field between professionals throughout the world and develop co-operation agreements aimed at reducing the loss of life and property caused by natural disasters.



Viktor Klima
Federal Chancellor, Republic of Austria



MESSAGE FROM THE PRESIDENT OF THE REPUBLIC OF ZIMBABWE

Sub-Saharan African countries have experienced prolonged droughts in the 1980s and 1990s. In most cases these extreme events were accompanied by outbreaks of pests, diseases and mass movement of people in search of food. Such a scenario describes the disasters that our people are exposed to regularly. Fresh in my memory is the experience of 1991–92 drought during which economies in Southern Africa Development Community were at the point of total collapse. This resulted in the diversion of huge resources from economic development programmes towards the acquisition of food stocks for man and animals (domestic and wildlife). Both human and financial resource capacities in African countries are limited and least able to respond to such disasters.

The establishment of the International Decade for Natural Disaster Reduction gave our small economies some hope. At a global level a lot has indeed been achieved. However, Zimbabwe still needs support to improve her capacity to better prepare for such adverse events. To date, Zimbabwe has benefited from the establishment of the Southern African Regional Climate Outlook Forum that has been instrumental in producing seasonal climate forecasts with active stakeholder participation. The skills developed over the last three years to a level that the products can be used as a useful guide for early warning for drought preparedness. In addition, the regional Drought Monitoring Centre established in Harare in the early 1980s continues to provide the nation with valuable inputs. Given the limited resources in Africa generally, it is my wish that efforts must be put in place to strengthen these institutions to better co-ordinate disaster management at local, regional and continental levels. To achieve this goal, development of early warning capabilities must be given special attention.

Zimbabwe believes that the IDNDR has prepared roadmap for the world to follow in the next millennium. The challenges that lie ahead, from the possible impact of climate change and the interactions of global economies, would demand closer co-operation among nations in future. Given the numerous outstanding programmes in Africa, Zimbabwe would welcome the establishment of a fully funded follow up programme for the IDNDR under the UN regular budget.

A handwritten signature in black ink, appearing to read 'R. Mugabe'.

Robert Mugabe
President, Republic of Zimbabwe



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II

INTRODUCTION



The Financial Impact of Disaster

Dr Gerhard Berz, Munich Reinsurance Company, Germany



Photo: Thomas Loster, Munich Re

Major flooding in Munich, Germany, 1993

NATURAL CATASTROPHES are responsible for more frequent and greater losses worldwide. Over the past four decades, the frequency of natural catastrophes has tripled, inflation-adjusted economic losses have multiplied by a factor of nine and insurance losses by a factor of fifteen. The main causes are increasing urbanisation, the settlement in and industrialisation of highly exposed regions, the vulnerability of modern technologies and also anthropogenic changes in the environment. The estimates of future loss potentials, which attain dimensions not known in past history for a number of realistic catastrophe scenarios, give particular cause for concern.

In spite of these unfavourable loss trends, the insurance industry still offers a broad spectrum of covers against natural catastrophes but, at the same time, attempts to motivate its clients to make significant contributions toward loss prevention/avoidance. Furthermore, the industry is going to great lengths to determine its own loss potentials through implementation of modern geoscientific methods. Much progress has also been made in the recent flood risk analysis in central Europe. In spite of the fact that, already today, there is growing evidence of significant influences, the problem remains of assessing the consequences of future climatic change on the frequency and intensity of extreme atmospheric events.

Over about the last two decades now, the insurance industry has become increasingly worried about the rapid growth of the claims burden from natural catastrophes. Since most of these losses have been caused by extreme atmospheric events like windstorms, floods, droughts and hailstorms, suspicion soon arose that the environmental and climatic changes observed worldwide are contributing significantly to the trend of catastrophes. Even if these connections have not yet been scientifically substantiated, there is no doubt about the plausibility and, at the same time, about the explosive effects of this hypothesis. Applying the prevention principle, economic and political plans must therefore include the aspect of further aggravation of the catastrophe trend being set by the predicted climatic changes and compare this with the costs of effective avoidance strategies.

Disaster trends

The claims burdens resulting from natural disasters have taken on dramatic dimensions, particularly in recent years and particularly for the insurance industry. Table 1 lists all the natural disasters in the past few decades which have cost the insurance industry more than US\$ 1 billion. Before 1987, only one event, Hurricane Alicia in 1983, reached this figure. Since 1987, however, there have been 18 such events in total, 16 of which occurred since 1990

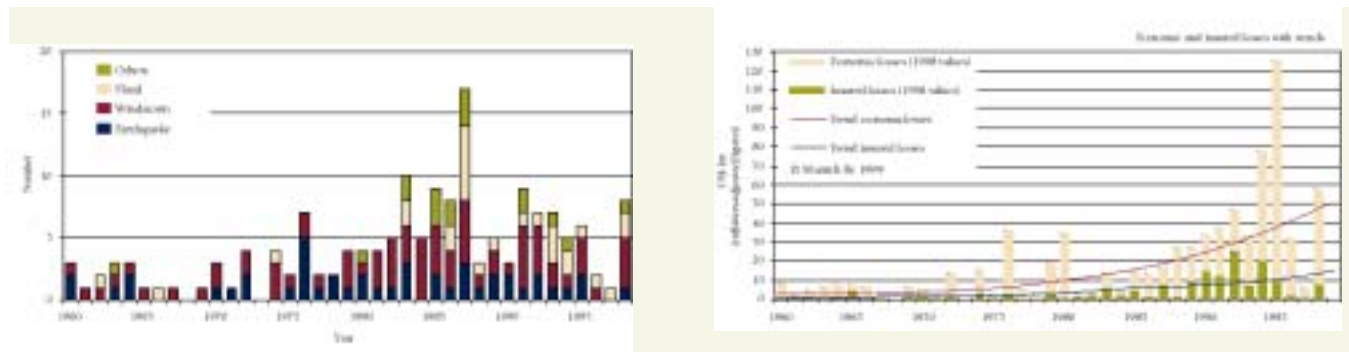


Figure 1: Since the 1960s, large-scale natural catastrophes have increased significantly both in number and in the scope of economic and insured losses (inflation-adjusted figures)

alone. Hurricane Andrew heads the list by a long way, causing insured losses in the region of US\$ 20 billion, although the figure would have been several times higher if Hurricane Andrew had achieved two direct hits in Miami and New Orleans, rather than a 'double miss'. The situation was very similar as regards the earthquake in California in 1994, which likewise only hit the edge of the Los Angeles district. Despite insured losses in excess of US\$ 12 billion, this event can be regarded as just a 'warning shot', or a 'grazing shot' at most, like the Kobe earthquake in Japan in 1995. These two earthquakes are the only disasters in the list which were not of atmospheric origin.

The natural disaster trend since 1960 (Figure 1) very clearly reveals the dramatic increase in catastrophe losses in the last few years — a development which will already result in annual claims burdens from major natural disasters in the region of US\$ 25 to 50 billion (in today's values) by the end of this decade. The increase compared to the 1960s, which amounted to a factor of three for the economic losses and five for the insured losses in the 1980s, has since — ie. in the last ten years — exploded to factors of nine and 15, respectively. These figures refer to so-called 'major' natural disasters. The remaining natural hazard events, of which the Munich Re records roughly 600–700 per year all over the world, increase the total claims volume to at least double, (Munich Re, 1999a).

Without doubt, this increase in claims is largely, if not predominantly, caused by increasing values and insured liabilities, particularly in heavily exposed conurbation areas. Moreover, natural disasters show time and again that the loss susceptibility of buildings and infrastructures has tended to rise, rather than fall, despite tighter building regulations and advanced technical developments. Hurricane Andrew and the earthquakes in California and Japan are very clear evidence of this fact.

Climate change

At the same time, however, there are increasing signs that the emerging climate change is having an ever greater influence on the frequency and intensity of natural disasters. On the one hand, there are the major windstorm disasters of recent years that have set new loss records almost every year while, on the other hand, there are countless flood, tempest, drought and forest-fire disasters that today seem to be occurring more often than even before.

However, the second IPCC report (*Intergovernmental Panel on Climate Change*, 1996) still considers that there is no proof of a connection between global warming and the accumulation or intensification of extreme atmospheric events. In the meantime, however, analyses of observation series and model calculations have produced numerous new indications that the probabilities

of various meteorological parameters reaching extreme values have already changed substantially or will yet do so. The following are a few examples:

The anticipated continued increase in the average temperatures causes an extraordinarily steep rise in the probability of extremely high temperatures. For instance, the consequence of a rise of 1.6°C in the summer mean-temperatures in central England, which is expected to occur there by about the year 2050, is that a heat wave summer, as in 1995 — which was a 75-year event according to the temperature distribution for 1961 to 1990 — could then occur every three years on average. Similarly, the temperature series for Berlin indicates that the highest temperature observed in this century (39°C) will have a nine times higher probability of being exceeded at the end of the next century. We are today in no way prepared for the heat waves that this will entail, meaning that substantial adaptation costs and losses are to be expected.

In central Europe, the winters have become far wetter and the summers dryer in recent decades. More precipitation falls as rain instead of snow in winter, and the majority runs off the surface, meaning that the run-off quantities increase, as reflected in the series of measurements from the catchment area of the Rhine and also the accumulation of flood disasters, such as those in December 1993 and January 1995. A recent study predicts a substantial increase in the probability of critical rainfall volumes being exceeded. Warming also increases the capacity of the air to absorb water vapour, and thus the rainfall potential. In combination with intensified convection processes, this leads to increasingly frequent and more extreme heavy rainfall events. These are already responsible for a major proportion of the flood damage occurring today.

Milder winters, which have in the meantime become typical in central Europe, reduce the snow-covered areas above which stable cold high-pressure systems used to develop as a barrier against the cyclones approaching from the Atlantic. As a result, the barrier is often weak, or shifted far to the East, meaning that a series of devastating windstorms, as happened in 1990, can no longer be regarded as rare and exceptional phenomena, shown in Figure 2 (*page 15*). The wind records of representative German weather stations show a marked increase in the number of windstorm days in recent decades.

As yet, there is no definitive confirmation of a trend observed in the North Atlantic towards more frequent and more extreme cyclones, ie. an increase in actual windstorm activity. The findings to date concerning the connection between warming and tropical cyclone activity are equally controversial and contradictory. This development could become a question of survival for many

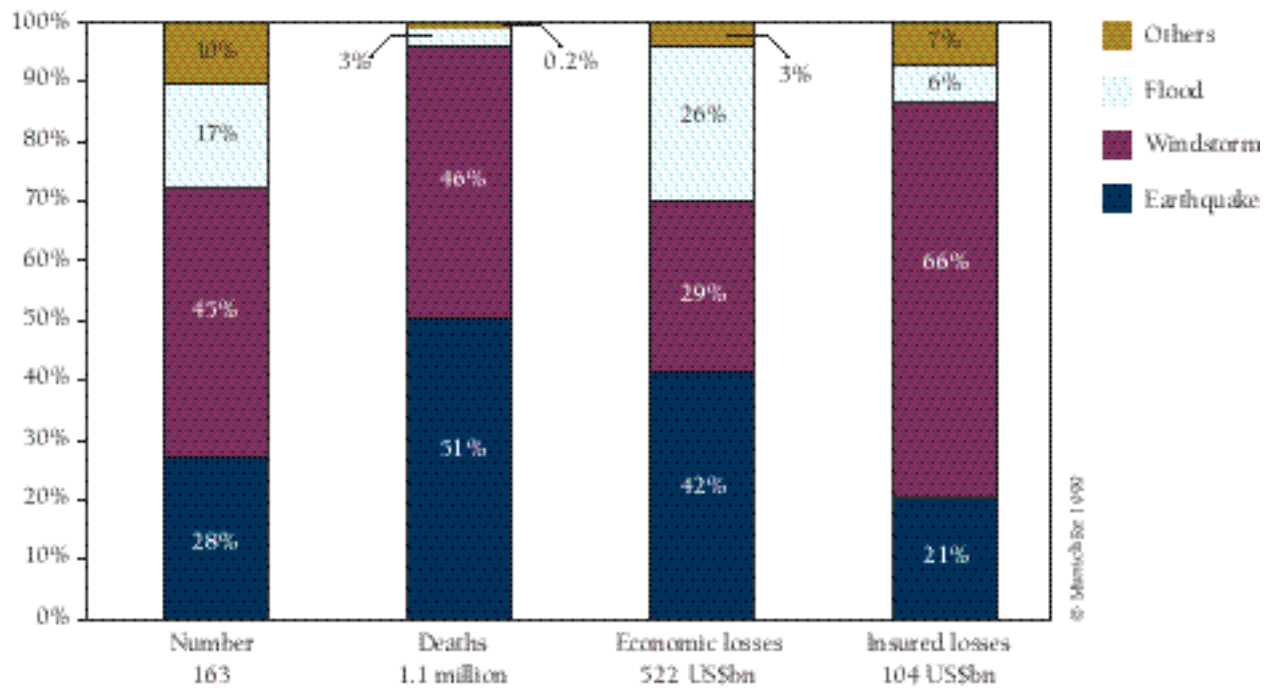


Figure 2: The great natural catastrophes observed during the years 1970 through 1998 are dominated by windstorm events. This pertains to both the number of events and number of deaths claimed, as well as to economic and — even more important — to insured losses

densely populated coastal regions, particularly in view of the anticipated rise in sea levels.

Against the gloomy backdrop of these feared changes, the decisive question is not whether and when there will be definitive proof of the anthropogenic climate change, but whether the climate data available to date and/or the model climate calculations can provide sufficient starting points for sensibly estimating the future changes and developing the right adaptation and avoidance strategies in good time. The risk of error will remain large in the foreseeable future. This makes it all the more important for the strategies themselves to be adaptable and measurable against the damage to be avoided. Successful from the outset are so-called ‘no regret’ strategies, such as the reduction of fuel consumption in motor vehicles or the reduction of energy consumption in general, because, even if they prove to be less relevant to the climate than expected, they certainly lead to desirable savings and are also suitable for demonstrating that the industrial nations are aware of their responsibility towards the Third World.

Natural catastrophes in Germany

Natural catastrophes in Germany are for the most part caused by extreme atmospheric events. Windstorms take a clear first place, both in numbers of loss events and deaths and also in economic and particularly in insured losses. This is followed by floods and other natural catastrophes (including winter losses, forest fires, landslides) and, finally, by only rare loss-producing earthquakes, which are only rare occurrences here. In the time period from 1970–98, windstorm events constituted a total 63% of all 465 registered catastrophes, 57% of the 752 catastrophe-related deaths, 57% of the economic loss total of DM 25 billion and as much as 86% of the insured natural catastrophe loss amount of DM 9 billion (Figure 2, *Munich Re* 1999b). The proportions of other catastrophe types are correspondingly lower.

Of course a time period of 29 years does not suffice to establish a truly representative picture of the catastrophe exposure in

Germany, but the time segment selected can definitely be regarded as typical for the natural catastrophes observed and, at the same time, it proves that even in a few decades, essential dimensions of influence can change greatly and thus make an obvious comparison over longer periods of time problematical. On the other hand, the exposure environment staked out in Germany is presumably more or less characteristic for neighbouring countries as well.

The picture however changes significantly when the loss potentials of extreme natural catastrophes are considered. Should such an event occur, consequences as dire as virtual failure of all structural and organisational prevention measures must be feared. Here events take on great significance that, on the one hand, have only a very low occurrence probability, like a severe earthquake or storm surge, but which can induce exceptionally great losses if a ‘big one’ strikes in a densely populated region. Estimates of this show that in Germany, in spite of its rather moderate exposure by worldwide comparison, catastrophic losses are also conceivable that are clearly comparable with a number of the well-known catastrophe scenarios from other countries. This is true in spite of the fact that scenarios like volcanic eruption and meteorite impacts, that have in the past left significant marks on Germany’s landscape, have not been taken into account here.

Insurance aspects

Insurance, as an important element of private, company and public protection against risk, has as its primary objective minimisation of the insured’s risk of financial ruin. This also extends to natural catastrophes that are covered by many of the insurance products available today.

In regions like central Europe, where the natural catastrophe risk is generally rather low, the pertinent insurance tends to provide protection against frequent small or minor losses rather than against the rare losses that constitute an existential threat. The insured frequently views this type of insurance protection as

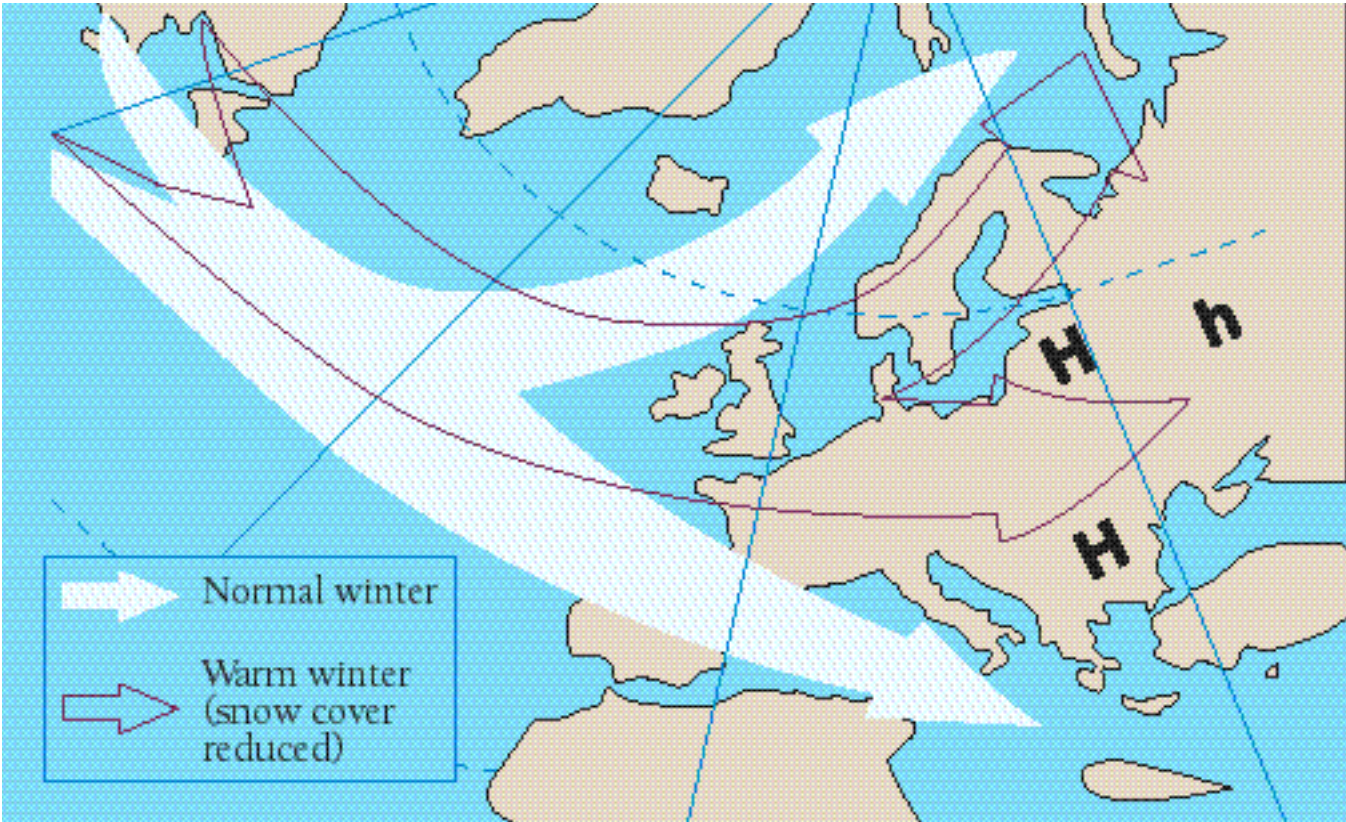


Figure 3: Cold winters with an extensive snow cover over central and eastern Europe are as a rule marked by a cold high-pressure system that acts as a barrier against the stormy low-pressure system approaching from the North Atlantic. However, since the beginning of the 1980s, during unusually mild winters, the cold high-pressure system has been only weak or has withdrawn far to the east, providing no resistance to the low-pressure systems frequently allowing them to penetrate far into central Europe

a form of ‘savings bank’ into which he not only regularly pays premiums, but from which he also more or less regularly expects payments. The concept of protection against risk, and thus the interest in real risk minimisation, is overshadowed by this, but can be revived by giving insurance protection a suitable structure, eg. by introducing substantial deductibles or by scaling deductibles according to exposure and loss susceptibility.

For example, for the coverage of flood losses, what is important is correct assessment and appraisal of the different exposures that are usually located within a very small area but that at the same time constitute a broad spectrum of exposures, and also drawing the appropriate consequences from this for structuring insurance protection. For this assessment, insurers avail themselves more today than ever of geoscientific investigation methods, particularly geographic information systems, and of loss minimisation methods.

The insurance industry has developed a number of instruments that permit limitation and control of the catastrophe risk if correctly and selectively applied (see Table 2). Thanks to increasingly sophisticated global risk management, the industry appears to be well prepared for any emergency and is also apparently in a position to handle catastrophe problems of the future. Insurance is also able to actively contribute to long-term climate protection by utilising its financial and political influence, its means of motivation and its own environmental protection potential to minimise the potential negative effects of the climatic changes that are materialising, serving its own interests in doing so.

From the standpoint of the re-insurer, and also from an overall economic view, the major losses to be expected from windstorms and other extreme natural catastrophes play a decisive role. In

central Europe as well, the potential loss amounts that could accumulate in an extreme event are of dimensions that require a well-balanced participation in the risk of insured, direct insurance and reinsurance markets and, in an emergency, also the State. There are various approaches in different European countries for assuring adequate financial security of the population and economy against a maximum expected claims burden.

The incidence and extent of loss of major natural disasters will, in the future, continue to increase dramatically throughout the world. The emerging warming of the earth’s atmosphere and the resultant rise in sea levels, as well as the intensification of wind-storm and precipitation processes, will substantially intensify this trend unless drastic preventive measures are taken soon.

In its own interests, the insurance industry must take on a major involvement in the preventive measures, in order to be able to guarantee coverage of natural hazards in the long term. By designing its insurance products appropriately, it can motivate policyholders—and also the authorities—to take action to prevent losses, while at the same time reducing its own loss potential and associated capacity problems.

Table 2: The proper response of the insurance industry to the deteriorating environmental conditions must include:

- Sound technical pricing
- Significant deductibles
- Appropriate liability limits
- Restricted covers
- Transparency/accumulation control
- Loss prevention/mitigation
- Awareness/education

The Social Impact of Disaster

Luis Rolando Duran, Center for Co-ordination for Disaster Prevention in Central America

THE YEARS 1997 and 1998 were characterised by a new situation for Central America. Natural disasters caused situations of extreme crisis and affected the whole region at practically the same time. El Niño, the forest fires and the hurricanes of 1998, the worst one being Hurricane Mitch, swept Central America, a region that is used to the tragedy caused by natural disasters but not on such a wide scale. As usual it was the poorest area that were most affected.

In the case of Hurricane Mitch, the tragedy captured the attention of the whole world. It made newspaper headlines, television and electronic news bulletins and led to international support. Under this tragic context the disaster in Central America was soon attributed to the fatalistic, the divine and magical. It was seen as the region which nature had destroyed. The painful scenes of death, injuries and the devastation of the land and buildings led to scenes of joint help, both anonymous and excessively identified heroism and extreme worry when faced with such tragedy.

The questions arising from such a dramatic situation were: Why are these disasters so clearly Central American and why are the poor still the most vulnerable?

Nature is not to blame for the vulnerability of the region

With the consolidation of the peace process when the last internal war, finished after the Guatemala peace agreements were signed, everything pointed to a process of 'Peace, Freedom, Democracy and Development for Central America' as this slogan for the Central American Integration System states. However, many believe that the many factors that led to the war were still present, therefore making the regions and in particular the national peace processes significantly weak.

It is of no surprise that these underlying factors are the same ones that also determine the magnitude of the so-called 'natural disasters'. These are high levels of poverty and isolation, careless usage of the area which is focused on obtaining the maximum added value without any major considerations for environmental maintenance and equilibrium.

Growing levels of democratic participation, which are still below what is expected, prefigure highly vulnerable areas. In fact, the differences that exist amongst countries concerned with these advances are almost in direct proportion to the effects of disasters themselves.

Was the disaster in the foothills of the Casitas Volcano in Nicaragua really a product of Hurricane Mitch? A remote and secluded town that barely has any access to public services and little construction or planned use of land finds itself exposed to this particular phenomenon. The obvious result of this is thousands of deaths. What would the result of this disaster have been if that town had been in a better state?

The evaluations are very simplistic, the analysis of cause and effect are carried out based exclusively on the 'absolute' value that appears on the list of damages as well as the timing and intensity of the disaster. It is very clear, however that the situation is

not that simple. Neither Hurricane Mitch nor nature are responsible for the lack of regional development that is present in Central America at the end of this century. Like the Sword of Damocles the blame for fuelling the extent of the disaster can be placed, in fact, on the lack of development. This hurricane was significantly marked by social and ecological aspects, which now must decide the direction of regional development.

With this in mind it is essential to look at how to deal with the after-effects of the disaster and to look into its causes. Then it can be possible not only to understand the actions taken as a consequence but also to identify more clearly both the options that are available and the challenges set.

Act of God or growing social deterioration?

In the aftermath of Hurricane Mitch it has been possible to identify a series of different views as well as finding solutions to the problem which originated from these points of view. It is necessary to evaluate some of these views because of how they influence future actions. It is important to point out that many of these points of view are linked throughout the different sectors, thus giving a complex range of opinions and solutions.

The fatalistic view

There is a high tendency to consider the Hurricane Mitch disaster as an extreme situation caused by either coincidence, divine intervention or by an unforgiving Mother Nature who is punishing the region of Central America and delaying the development process. This view goes across different levels of Central American society. It is most evident in parts of the population where religious convictions and a lack of education lead to supernatural reasons for explaining these disasters. This way of thinking has also been evident in the high circles of Central American governments as there is a tendency to label Hurricane Mitch as a punishing event which is a product of fate.

This view which has been studied time and time again and which is ever present, reduces the real possibilities of taking proactive action to improve the situation, especially when it concerns the whole community. Therefore this view presents an important challenge for the authorities who are responsible for risk, in terms of facilitating and improving education concerning vulnerability and natural disasters. This is needed to trigger a change in attitude concerning this problem.

The view of extreme natural disaster

There is another belief that the destruction caused by the hurricane is exclusively linked to the actual magnitude of the natural disaster in such aspects as intensity, duration of rainfall, level of growth, the instability of mountains, periods of re-occurrence etc. The explanations given for the disaster vary from how rare and unusual such phenomena are to 'The Rainfall of the Century' (as it was called in Nicaragua) or the physical destruction of the river basins after drought and forest fires. As a consequence the disaster becomes a basic problem of overflowing and of rain.

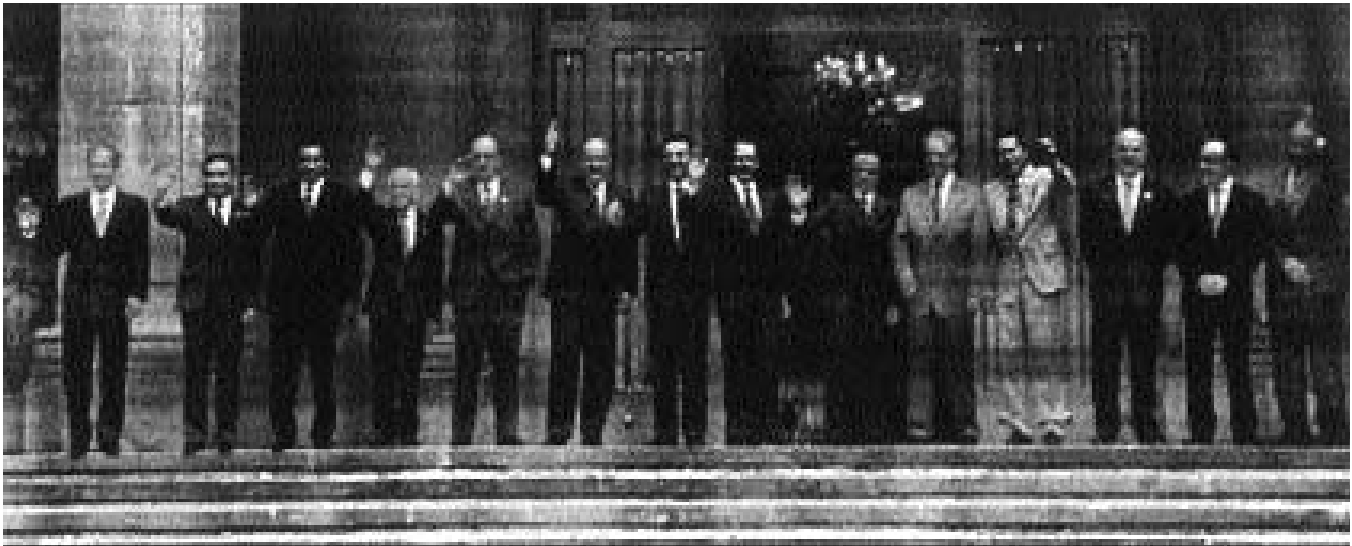


Photo: Associated Press

Rio Group leaders at the Los Pinos presidential residence in Mexico City in May 1999. From left, Guatemalan President Alvaro Arzu, Panamanian Foreign Minister Jorge Eduardo Ritter, Peruvian vice President Ricardo Marquez, Bolivian President Hugo Banzer, Uruguayan President Julio Maria Sanguinetti, Paraguayan President Luis Gonzalez Macchi, Ecuadoran President Jamil Mahuad, Mexican President Ernesto Zedillo, Argentine President Carlos Menem, Brazilian President Fernando Henrique Cardoso, Venezuelan President Hugo Chavez, Chilean Foreign Minister Jose Miguel Insulza, Colombian Foreign Minister Guillermo Fernandez, and Guyanese Foreign Minister Clemen Rohee. Rio Group leaders met Saturday to discuss issues ranging from regional financial crisis to natural disaster relief to relations with the European market.

This belief, which is even common in some scientific sectors, presents a series of problems such as the blur of social construction standards of risk. They magnify the purely natural or physical aspects as if it were possible to separate the two.

Examples of how these conditions are interrelated to form different types of disaster can be linked to the evaluations of the Hurricane Mitch situation. For example the extended duration of the rainfall in Costa Rica, Guatemala and El Salvador are not very different, however the effects of the rain on the area and the infrastructure are totally different.

On a political level, the general thinking is that the development process was going well until the hurricane came along. Therefore the social, economic and ecological disaster is considered to be a direct consequence of not only the hurricane and the time of year, but also of bad luck.

As an example, the Central American presidents met in Comalapa, El Salvador on 9 November 1998 to try to address the Mitch situation together. They declared that the important advances that they had achieved in the area were a sign that the model of development that they had been implementing was the right one and that it guaranteed a healthy and sustained increase in their economies.

The presidents added, however, that as a result of the impact of the Hurricane Mitch disaster it was essential to join forces within the region — not only to preserve the advances that had already taken place but also to accelerate their economic and social development.

This view, which sees Mitch as either an extreme event that invades, impacts and delays the development process or as a probable natural phenomenon, represents serious danger for the countries concerned. This again is a consequence of not learning from experience and placing the blame for a serious situation like this on external factors that do not lead to solutions. It is worth asking not only what the basis for the development model is and why the national and regional investment process has not been able to manage the risks, but also to what extent this same process implies increased social and environmental vulnerability.

The cyclical view

The third prevalent argument in some specialised sectors is the view that disasters are a cyclical and recurring phenomenon. The limitation with this is that they tend to analyse the problem after, and not during the event. In this case the possibilities of action become guesswork or a series of statistical exercises.

There is a tendency to talk about before, during and after Hurricane Mitch as if it were a linear event, with a clearly marked beginning, middle and end. In fact, it is predicted that Hurricane Mitch will be repeated. With this in mind, the possibilities of a new Mitch or a new disaster of these proportions are analysed.

In this way the main challenges are not only to understand, investigate and act on the real causes of disasters in a more positive way, but also to look at the permanent and changing level of risk. The risk should be thought of as a continuous situation and not as a cycle. While natural disasters are cyclical, the risk of them becoming disasters is variable and controllable.

Therefore the causes of the Mitch disaster are not the same as the causes of Hurricane Mitch. Disasters are caused by weaknesses and factors present before and during the disaster that are still present today with no end in sight. Risk can be variable, it can be dealt with and reduced to 'acceptable risk' by those who are affected by it. However, for this to occur it is essential to have a clear view of the factors that create, cause and extend the disaster.

The biggest challenge in this sense is to take into consideration those factors of vulnerability and to realise that Mitch is a difficult moment in the permanent state of risk. We must also realise that those communities that were most affected continue to be vulnerable and have become even more so. What is more urgent is that there are areas that were not affected by Hurricane Mitch but are in the same position of need, if not worse.

The lessons learnt and the challenges that lie ahead

According to the previous analysis of the views that exist in Central America with respect to the situation during the hurricane, it is clear that a series of challenges and opportunities for the Central American region have been set.



Photo: Palm Beach Post

As waves flood the resort of Palm Beach, Florida, a man is stranded up a pole...

If it is possible to consolidate the view that the risk factor is a continual one where its factors are established by a linked relationship between threats and vulnerability (with all the different factors that make up the latter), it would be possible to set out more appropriate control measures and risk management with the wider picture in mind.

The main lessons that have been learnt as well as the challenges that lie ahead and the future opportunities (these are by no means exhaustive) are as follows:

Development is not attainable without risk management: Firstly, the previously announced regional development that was becoming evident in the economic indicator did not survive this difficult test. Without getting into a debate about the development model and inter-regional and global relations, it is obvious that both a lack of attention or inadequate attention paid to the generating factors of vulnerability and risk become the main obstacle for the same process that ignores and even aggravates these factors.

It is necessary to include the variable of vulnerability as a main idea in all the stages of development taking on the challenge of setting out clear objectives and not falling into the trap of mere words and expressions.

Risk management measures in all sectors are included in the Regional Plan for the Reduction of Disaster co-ordinated by CEPREDENAC. Some sectors, such as The Ministry of Agriculture

and the Regional Committee of Hydraulic Resources, have already started to implement these measures. Special care should be taken when it comes to construction and the regional economic sector.

Private investment and ways of improving competitiveness require risk management

The process of public and private investment as well as advances in competitiveness and its strategies should take risk and vulnerability factors into account. This should be done in two ways, one being through the investment risk itself and its necessary reduction and the other through the environmental and social risk that the investment or the project in question generates.

Therefore, we must give the investment decision-makers access to quality information on threats of natural disasters, vulnerability and risk and in the future they should know about the options and solutions for their decision-making process.

At a time when Central America is hoping for growth in competitiveness as a way of taking on the global challenge, a breakdown of risk with more than just the 'financial threats' is essential.

Examples of this type include: projects promoted by the Organization of American States on the River Leon and La Masica and the early warning system on the Coyolate River which was pioneered in Guatemala. Other projects include those promoted by the Agricultural Areas Programme and supported by the EU. All of these projects proved to be successful at local level. In countries where centralised institutional standing practically collapsed, their local bodies continued to work and were able to achieve something. It is important to remember that local success has been more evident in the ability to act than in risk management. However, this represents an excellent opportunity to move towards more solid actions.

Risk management is a complex task for the State that cannot be the sole responsibility of one institution

With the recent exception of Guatemala, no other country has a legal framework for mitigation. Even today, this is still taken on by certain institutions that were set up to provide emergency assistance. It is obvious that this method is untenable as it tends to give the responsibility for both the actual disasters and mitigation to just one body which, in the majority of cases, has very limited resources.

The establishment of new risk management systems that have a clear distinction between the responsibility of dealing with disaster, mitigation and prevention of these disasters is a task that cannot be put off. It is therefore necessary to be clear about the effectiveness of not only the current national systems of prevention and mitigation but also the traditional emergency services. We must also clearly identify the levels of responsibility with reference to the State and the public.

CEPREDENAC have thought about modernising national diagnostics as well as implementing national plans for mitigation and treatment of natural disaster.

In conclusion, we could say that even though Hurricane Mitch brought negative results for the region, it has forced Central American countries to think about the present model of development and the necessary balance between the factors that weaken certain sectors of the population and the strategic and economic measures that are promoted. With this in mind and from a totally independent point of view, the obvious options are those of reducing the vulnerability and strengthening and ensuring development. They not only demand passing attention at times of tragedy but they also demand committed attention which must involve targets for change.

DISASTER.



RELIEF.

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The Physical Impact of Disaster

Dr John Zillman, Bureau of Meteorology, Australia

NO PERIOD OF HISTORY and no part of the globe have been spared the impact of natural disasters. In scale, they range from the mass extinction of 65 million years ago, which many scientists attribute to the global environmental impacts of a large meteor strike on the Yucatan Peninsula of Central America, to the highly localised destruction by extreme weather phenomena such as hailstorms and tornadoes.

By most measures, the most severe effects result from flooding but, in terms of scale of damage, numbers of people affected and numbers of deaths, tropical cyclones (hurricanes and typhoons), droughts and earthquakes are not far behind. Table 1 (from *De and Joshi*, 1998, and based on IDNDR data) shows the percentage distribution of effects by main disaster type over the thirty-year period 1963–92.

The nature of the effects vary widely according to the type of natural hazard (*Bryant*, 1991) and can be summarised as follows:

- Physical destruction of houses and other built structures by the force of the wind, ocean waves, floods, mud slides, avalanches, lava flows and earthquakes
- Sinking of ships by the combined forces of wind and wave, sometimes in combination with ocean currents and/or sea ice
- Inundation of coastal areas, roads, houses, river deltas etc, by storm surges and wind-driven waves, sometimes exacerbated by tidal effects and river flooding
- Inundation of farms, houses, roads, bridges and towns by local heavy rain (flash floods) and riverine floods
- Freezing of crops, stock, water pipes, transport systems etc by extreme cold
- Burning of buildings and forests by fires caused by natural (eg. lightning) or human (eg. motor vehicle) ignition in circumstances of extreme heat and wind, including ignition by electrical faults and gas leaks resulting from earthquake damage; and or by burning ash from volcanic eruptions
- Desertification by the combined effects of recurring drought, overgrazing and other unsustainable land management practices
- Loss of human life from the impacts of all of the above, singly or in combination.

Table 1: Significant disasters worldwide by type, according to damage, people affected and death toll, 1963–92 (*De and Joshi*, 1998)

Significant Damage	%	Number of deaths	%
Earthquakes	10	Earthquakes	13
Tropical cyclones	30	Tropical cyclones	19
Drought	22	Drought	3
Floods	32	Floods	26
Other disasters	6	Epidemics	17
		Landslides	7
People affected	%	Storms	6
Earthquakes	4	Other disasters	9
Tropical cyclones	20		
Drought	30		
Floods	32		
Famine-food shortage	4		
Other disasters	7		

Earthquakes

The most devastating of all natural disasters are earthquakes which affect many parts of the world. They usually occur without significant warning and when severe, can reduce whole cities to burning ruins and rubble in a matter of minutes. The greatest damage usually occurs in cities and towns within a few hundred kilometres of the epicentre, which is often located along fault lines at the boundaries of the earth’s tectonic plates. In addition to the collapse of built structures, earthquakes can also trigger avalanches and rockfalls. Undersea earthquakes can often trigger tsunamis (sometimes referred to as tidal waves) which move as low amplitude waves over long distances across the ocean at speeds up to 1,000 kilometres per hour but which, on reaching shallow water, can build rapidly in height and inundate coastal communities with little warning.

The great San Francisco earthquake of April 1906 left much of the city in ruins with fires burning for three days. More than 500 people perished from building collapses and the subsequent fires. 65,000 Peruvians perished from a huge undersea earthquake off the coast from Chimbote in 1970. A terrible earthquake in Armenia in 1988 virtually destroyed the town of Spitak with the death toll in the region of more than 100,000. The most recent major earthquake to hit a large centre of population destroyed several areas of the Japanese city of Kobe in January 1995 with building, highway and subway collapses and subsequent fires killing more than 5,000 people and injuring more than 40,000.

Volcanoes

One of the best known natural disasters of history was the destruction of Pompeii when Italy’s Mount Vesuvius, inland from the Bay of Naples, buried its inhabitants under a rain of burning ash in AD79. Volcanic eruptions have also been the source of many modern disasters with the Island of Krakatoa in the Sunda Straits of Indonesia blowing itself apart in August 1883 sending atmospheric shockwaves around the globe, injecting huge volumes of ash into the stratosphere and producing blood-red sunsets and climatic cooling for several years.

The eruption of Mount Krakatoa also triggered tsunamis which drowned tens of thousands of people in island and low-lying coastal areas. More recent great eruptions, such as that of Mount St Helens in Washington State (US) in 1980 and Mount Pinatubo in the Philippines in 1991, also had both major short-term local and long-term widespread impacts.

The unique combination of the eruption of Mount Pinatubo with the passage of a typhoon over the island of Luzon produced huge ash deposits and mud flows which inundated tens of thousands of houses forcing the evacuation of 200,000 people and leaving more than 1,000 dead. Mount Pinatubo also had major impacts around the world with crimson sunsets and global cooling effects lasting for several years.

In addition to their many other impacts on affected communities and the environment, volcanic eruptions pose a particular threat to aviation with several recorded instances of ingested

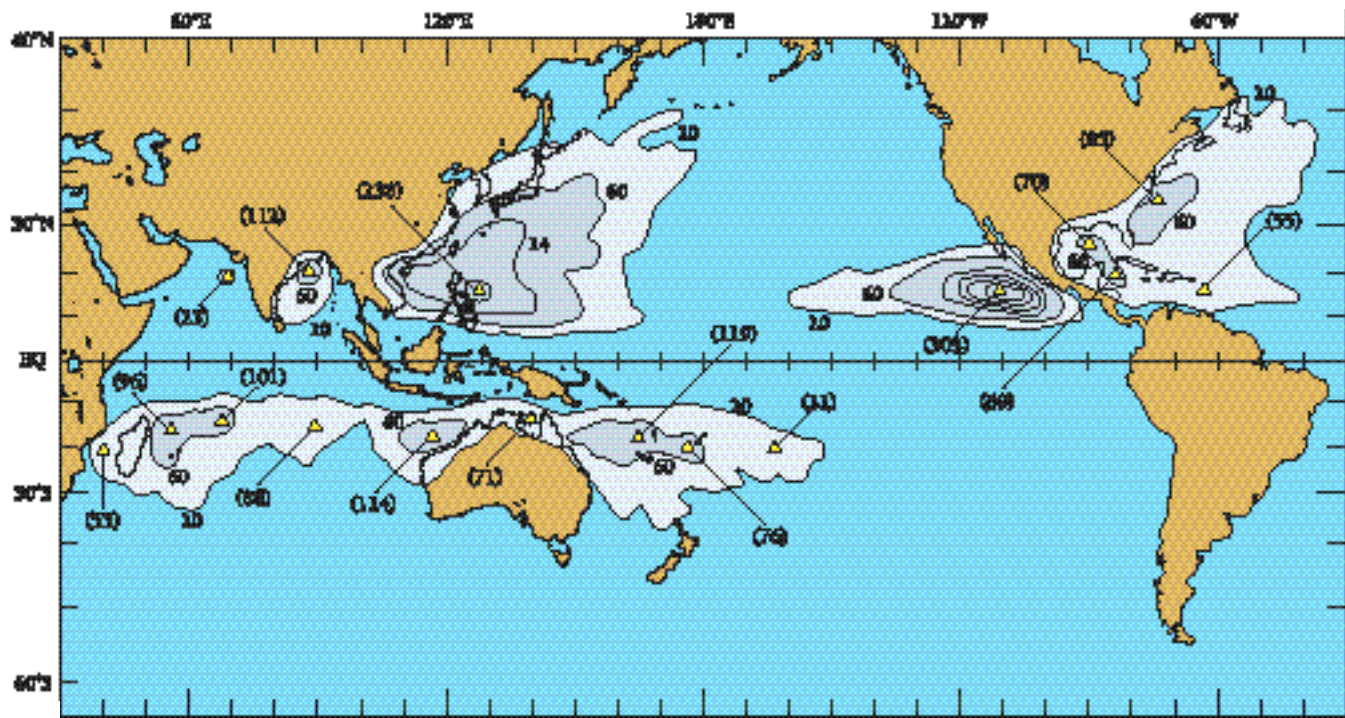


Figure 1: The major breeding grounds and impact areas of tropical cyclones (known as typhoons in the western north Pacific and hurricanes in the eastern Pacific and Atlantic). The isopleths show the frequency of cyclones per 100 years within 140 kilometre of any point (Zillman, 1999)

volcanic ash leading to the failure of the jet engines of overflying passenger aircraft.

Hurricanes

The hurricanes, typhoons and other tropical cyclones which affect coastal and island communities in five major tropical ocean basins (Figure 1) are among the most fearsome of all forms of natural disaster. They bring both immediate damage from destructive winds, torrential rain and storm surge inundation of low lying coastal areas and, often in their wake in developing countries (Zillman, 1999), disease and famine as a result of the destruction of the infrastructure needed to maintain supplies of drinkable water and food.

One of the fiercest hurricanes ever to hit the United States was Hurricane Andrew in August 1992 which moved in from the Bahamas, cut across southern Florida leaving a trail of wrecked houses and other facilities on land and enormous loss of small craft in coastal areas before sweeping into the Louisiana coast near New Orleans and causing some US\$ 20 billion dollars damage. In April 1991, a six metre storm surge associated with an intense tropical cyclone submerged a vast stretch of the Bangladesh coast and Bay of Bengal islands with the loss of some 140,000 lives. The physical impact of the catastrophic Hurricane Mitch which swept through Honduras, Nicaragua, El Salvador and Guatemala in Central America in October–November 1998, was devastating with roads and bridges washed away, banana and coffee crops destroyed and whole villages engulfed by torrents of water and mud from sustained torrential rains which even burst the cone of the Casitas Volcano in western Nicaragua. More than two thirds of the public infrastructure of Nicaragua and Honduras was destroyed with more than 10,000 people left dead and millions homeless. Total damage exceeded US\$ 30 billion with rebuilding of shattered towns and public infrastructure in many areas expected to take a generation.

Despite loss of less than 100 lives, Tropical Cyclone Tracy on Christmas Day 1974 virtually demolished the city of Darwin in northern Australia. Twenty-five years later, Tropical Cyclone Vance struck the Western Australian town of Exmouth with the strongest wind gust (144 kt) ever recorded on the Australian mainland but, thanks in large measure to excellent advance warning, not the loss of a single life.

Mid-latitude storms

Many of the great marine disasters of history have been the result of wind and waves from intense mid-latitude storms. Although usually having less destructive winds than tropical cyclones or hurricanes, they can still produce winds in excess of hurricane force which, combined with high seas, can sink even large ships, seriously erode coastlines and destroy coastal installations. One of the more notorious mid-latitude storms of recent times was the one which wreaked havoc across southeast England on 17 October 1987 with the loss of 19 lives. It was probably the most severe storm to hit the UK since the Great Storm of 1703.

Virtually all the destructive elements can be in evidence with mid-latitude storms, singly or in combination, especially rain, snow, hail and wind. They can be equally devastating on land or at sea.

Tornadoes and other severe storms

One of the great challenges to the meteorological warning community in most countries is to reduce the impacts on local communities of the thousands of thunderstorms that form every day around the world. In their severe form, they have the capacity to do enormous local damage in a very short period of time through torrential rainfalls and the resulting flash floods, through forest fires lit by lightning strikes, through hail damage to buildings, vehicles and crops (hail damage from the Sydney hailstorm of 14 April 1999 made it one of Australia's costliest-ever natural



Photo: B. Dixon

Figure 2: The United Nations building is left deserted as heavy snow and blizzard conditions bring New York City to a standstill during the 'Storm of the Century' in March 1993

disaster with total damage estimated of the order of US\$ 1 billion), and through the destructive force of very strong winds in gust fronts or tornadoes.

Severe storms cause damage on an annual basis in most parts of the world but certain areas, such as Tornado Alley in the US, are particularly vulnerable to their impacts. Tornadoes striking populated areas can leave narrow (few hundred metres wide) trails of up to tens of kilometres in length of almost complete destruction in their wake.

Floods

Flood disasters impact most countries from time to time, with those countries that rarely experience flooding sometimes being amongst the hardest hit when it does occur. The largest threat to life and the most significant structural damage often results from very fast rising flash floods caused by torrential local rainfall for which only short warning lead-times are possible. Slow rising riverine floods, on the other hand, may lead to inundation of vast flood plains far from the source of the rain and up to months later as flood crests progress slowly down a major river system. Crop and stock losses are often large as waters rise.

On 31 July 1976, sustained heavy rain over the Rocky Mountain National Park in Colorado, US, sent a wall of water rushing down the Big Thompson River, sweeping away cars and bridges, uprooting trees, collapsing houses and tents of holiday-makers with some 140 people drowned. Flooding over vast areas

of the Yangtze River basin in China in the northern summer of 1991 destroyed some 20% of China's summer harvest, caused many thousands of deaths by drowning, forced the evacuation of almost ten million people and, directly or indirectly, affected some 200 million people, almost one fifth of the population of China. Two years later in the northern summer of 1993, another great river system, the Mississippi in the US, experienced record flood heights along a stretch of more than 1500 kilometres with loss of some fifty lives and another 70,000 left homeless across nine mid-western States of the US.

Blizzards

The northern mid-latitudes, especially North America, Europe and parts of Asia, frequently experience winter blizzards with gale force winds and heavy snow bringing most forms of transportation to a halt, cutting power supplies, sometimes for days on end, and often leading to substantial loss of life through exposure to intense cold. Less frequently, icestorms such as those which hit parts of Canada in January 1988, can lead to almost complete breakdown of infrastructure and loss of stock and human lives.

Over the period 12–14 March 1993, the 'Storm of the Century' paralysed the entire eastern coast of North America from Florida to Nova Scotia with unprecedented snowfalls and high winds forcing the closure of every major airport in the eastern United States. More than 1.5 metres of snow covered the Appalachian Mountains and the 250mm of snow dropped on New York City, whipped into drifts by freezing winds, brought the city to a standstill. Even the United Nations building fell silent (Figure 2).

Drought

Whereas the impacts of most natural disasters of meteorological origin are immediate and violent, those from drought build up slowly and last over many years. Failure of the monsoon or of the normal wet season for two or three consecutive years in mid-latitude countries, often in association with the El Niño phenomenon, can leave normally productive lands desolate and semi-arid areas virtually uninhabitable. With vegetation gone and water supplies diminished, sheep and cattle perish and, even with artificial feeding, stock losses are often very large. The Dust Bowl era of the 1930s in the US Midwest was probably one of the worst sustained drought periods on record on any continent with dust and sandstorms carrying huge volumes of normally fertile soil away in the winds for years on end. Roads and fences were buried in choking dust and essentially all farming industry collapsed. The protracted drought in the African Sahel in the 1960s and 1970s and the great drought of 1982–83 in eastern Australia are among others that have had major serious impacts on regional and national capacity for survival of the rural sector.

Bushfires

In several parts of the world, bushfires and forest fires are an integral part of the endless cycle of flood and drought. Vegetation which has flourished during periods of good rain dries out in drought times and is ignited, by lightning or by human activities, in meteorological circumstances which favour the rapid spread of the fire. Major fires in California (US), Australia and South-east Asia over the past two decades have caused catastrophic impacts, especially the extreme smoke haze which covered much of South-east Asia as a result of forest fires during the 1997–98 El Niño event. The Black Friday (1939) and Ash Wednesday (1983) bush fires in south east Australia were aptly named given the loss of life and destruction of property that resulted from these two major conflagrations.

Photo opposite: Tony Stone Images

III

THE INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION (1990–2000)

1990–2000

The goals and aims of the Decade

Terry Jeggle, IDNDR Secretariat, Switzerland

IN THE mid-1980s, a group of forward-thinking scientists took up a challenge posed by Dr Frank Press, the then President of the American National Academy of Sciences: given the demonstrated capabilities of science, and rapid developments in technology, could it not be possible to reduce the loss of life and damage experienced by the growing number of natural disasters? Following recommendation of a subsequent Ad-hoc ‘Group of Experts’ appointed by the United Nations, and drawn predominantly from the technical and scientific communities, an international initiative for greater concerted effort in disaster reduction was proposed.

The Member States of the United Nations unanimously proclaimed the International Decade for Natural Disaster Reduction (IDNDR) by UN resolution 46/182 on 22 December 1989. The same resolution adopted an IDNDR International Framework of Action for 1990–99 with the objective to ‘reduce the loss of life, property damage, and social and economic disruption caused by natural disasters, through concerted international action, especially in developing countries’.

The Decade has been established on the basic understanding that sufficient scientific and technical knowledge already exists, which, with more extensive application, could save thousands of lives and millions of dollars in property losses from natural and similar disasters. As a promotional mechanism, IDNDR would provide a framework and serve as a catalyst for greater disaster reduction by directing increased attention to hazard awareness and risk management at the international, regional, national and local levels of responsibility. It would provide a stimulus and encourage the benefits of shared experience to expand the use of practical measures for more effective disaster preparedness and management practices.

The IDNDR has sought to inform the public and to influence the development of official policies by focusing global attention, and seeking to engage an everexpanding range of multi-disciplinary interests and collaboration among many different parties. Further research into understanding hazards and their impacts has been promoted within professional organisations, and new networks and means of exchanging data and practical experiences have been promoted through multi-disciplinary endeavour. Annual public information campaigns have also spurred a variety of local initiatives tailored to address the individual needs evident within local communities.

IDNDR goals and programme targets

The goals of the IDNDR were declared at the start of the Decade that gave precedence to the scientific and technical rationale of the Decade:

- To improve the capacity of each country to mitigate the effects of natural disasters, in the assessment of disaster damage poten-

tial, and in the establishment of early warning systems and disaster resistant capabilities

- To devise appropriate guidelines and strategies for applying existing scientific and technical knowledge
- To foster scientific and engineering endeavour aimed at addressing critical gaps in knowledge
- To disseminate existing and new technical information
- To develop measures for the assessment, prediction, prevention and mitigation of natural disasters through programmes of technical assistance and technology transfer, education and training, and to evaluate the effectiveness of programmes.

These goals were embodied in three programming targets established by IDNDR’s international advisory IDNDR Scientific and Technical Committee at its first meeting in 1991. They provided emphasis to the fundamental issues for disaster reduction activities to be sustained. Such targets could also serve as a basis for assessing the achievements of the Decade by the beginning of the 21st Century. All countries were encouraged to have in place, by the year 2000:

- Comprehensive assessment of risks from natural hazards, integrated into national development plans
- Mitigation plans of practical measures to be applied at national and local levels — that would address long-term disaster prevention, preparedness and community awareness on a continuing basis
- Ready access to warning systems by those people most at risk, at global, regional, national and local levels.

The application of science and technology was recognised as being essential for reducing the risk of natural disasters, but in the early years of the Decade, it became evident that this was not sufficient by itself. This broader requirement was developed from a more astute appreciation of the multiple effects of disasters on modern societies, demonstrated by several very costly natural disasters during the first half of the 1990s. These include the consequential costs and long-term effects of Hurricane Andrew and the Northridge earthquake in the United States, the Baguio earthquake, followed a year later by the Mount Pinatubo volcanic eruption in the Philippines, severe floods in China and elsewhere throughout Asia during the period. These are only a few examples of events which created a greater awareness about humankind’s own role in creating, or tolerating, an unacceptable vulnerability to natural hazards.

The growth of a global economy during the same period with more broadly distributed functions and facilities, as well as the rapid spread of global telecommunications and media coverage, further intensified the immediacy and perceived extent of natural disasters. The resulting social and economic implications of these



Photo: Palm Beach Post

Hurricane Andrew: The 1992 tropical cyclone Hurricane Andrew, Florida, builds up as motorists hurry home...

risks has lent a much greater importance to public policy decisions and local community responsibilities in preventing natural disasters.

The global relevance of natural disaster prevention was also becoming more widely recognised through other international development initiatives during the mid-1990s. The global commitment to sustainable development conveyed by Agenda 21 (*UN Text*, 1992a) emphasised that sustainable economic growth and development could not be achieved without measures to reduce losses from natural disasters. This further established close linkages between disaster losses and environmental degradation. In a similar context, the Rio Declaration (*UN Text*, 1992b) explicitly stressed the need for the international community to assist states afflicted by natural disasters and other emergencies that are likely to produce sudden harmful effects in the environment of those States. The outcomes of the First Global Conference on the Sustainable Development of Small Island Developing States (*UN Text*, 1994a) and the Programme of Action for the Least Developed Countries for the 1990s (*UN Text*, 1990) called for priority attention to be given to Small Island Developing States and least developed countries through activities which were promoted under IDNDR.

The feasibility of disaster reduction began to be accepted, as techniques and methods demonstrated their potential. Noting the consequences of growth on the immediate environments on which all societies depend, there has been an emergent need for established prevention strategies to become integrated into national plans for sustainable development.

There was equally a progressive recognition of the value of better and more timely access to effective early warnings, particularly at local levels, and amongst the more vulnerable segments of the population.

Public perceptions and media attention however, have often continued to be captivated by occasions of international emergency assistance and relief activities following individual disaster events. Subsequent policy analysis and technical assessment of the costs involved in these highly visible natural disasters have demonstrated that modern societies can no longer afford, either financially or socially, to rely only on expectations of contingent relief assistance. Preparedness measures for more efficient rescue and relief activities will remain necessary, but their expenditure will be justified less easily, unless efforts are first made to save lives and to protect assets before they become lost.

The world conference on natural disaster reduction

These growing economic considerations and other social commitments essential for sustainable development were expressed in an international context at the official United Nations World Conference for Natural Disaster Reduction, convened from 23–27 May 1994, in Yokohama, Japan. This meeting brought together representatives from 155 nations, demonstrating a broad commitment from public officials and the varied professional interests of other participants. The objectives of the Conference were set out to: a) review the accomplishments of the Decade; b) chart a programme of action for the future; c) exchange information on the implementation of Decade programmes and policies; and iv) increase awareness of the importance of disaster reduction policies. Accordingly, technical and plenary sessions of the Conference encouraged activities which reflected the widest range of disaster reduction endeavours, internationally and within individual countries, to protect the social resources and economic assets of all countries affected by natural hazards.

The mid-term evaluation of the Decade conducted at the World Conference noted that, at that time, 'awareness of the potential



Photo: United Nations

Delegates observe a minutes silence during the opening meeting of the 19th special session of the General Assembly

benefits of disaster reduction is still limited to specialised circles and has not yet been successfully communicated to all sectors of society, in particular policy makers and the general public' (*UN Text*, 1994b). Activities were cited, however, in the areas of training, technical applications, and research at several levels of involvement which have had positive effect in some regions of reducing disaster losses. New efforts in disaster reduction had not yet systematically become part of multilateral or bilateral development planning, and the hope was expressed that more opportunities could be mobilised, among people professionally involved and the public alike, to realise the potential existing within the information media, industry, scientific community, and the private sector. The range of articles appearing here, within this volume of *Natural Disaster Management*, is an apt demonstration of the growth in interest and amongst professional groups of commitments to disaster prevention in the intervening years.

It was further observed as part of the mid-term review of the Decade that 'although not a part of the mandate of the Decade, the concept of disaster reduction should be enlarged to cover natural and other disaster situations including environmental and technological disasters, and their relationship which can have a significant impact on social, economic, cultural and environmental systems, in particular in developing countries' (*UN Text*, 1994c). This led to the broader reference to 'natural and similar disasters which have an adverse effect on the environment' in official UN documentation during the remainder of the Decade. Crucially, this has given greater expression to the close relationship existing between natural phenomena and human behaviour in creating social and economic disasters. While natural hazards would continue to occur, the alteration of human behaviour and

societal practices could enable the risks posed by those hazards to be mitigated.

By joining forces at the Conference, in both sharing their experiences and expressing their common needs, the national delegations and practitioners drawn from many professional disciplines emphasised the social and economic motivations for disaster reduction. This re-enforced the earlier rationale for the Decade, complementing and extending its initial scientific foundation. The participants adopted basic principles and operational guidelines for natural disaster prevention, preparedness and mitigation, embodied in the *Yokohama Strategy and Plan of Action for A Safer World*, later endorsed by the Member States of the United Nations General Assembly (UNGA, 1994). This primary output of the conference served to document the mid-term review of accomplishments and noted further requirements to realise the objectives of the Decade.

Most importantly, it outlined specific recommendations for action. Activities were identified at the community and national levels of responsibility, in regional and sub-regional areas, and at the international and bilateral levels of political involvement. In leading to the next century, these same objectives and primary areas of interest remain valid and have become the basis for the IDNDR Action Plan for 1998–99 to develop greater opportunities for multi-disciplinary involvement through expanding inter-agency and organisational partnerships.

The international framework for action

The Decade's organisational structure includes several mechanisms to promote international cooperation. These include an advisory International Scientific and Technical Committee, and a

representative Contact Group of dedicated countries and United Nations Agencies concerned with the subject. The creation of national committees, or focal points for disaster reduction in almost 140 countries has proven to be one of the most important institutional components of the Decade in practical terms. The IDNDR International Framework for Action includes national government authorities, scientific and technical institutions, academic researchers, the media and other communicators, professional organisations, private commercial interests, insurance, financial and investment bodies, Non-Governmental Organisations, local community leaders, or other forms of civil society. An international Secretariat, located at the close of the Decade within the United Nations Office for the Co-ordination of Humanitarian Affairs, strives to serve these national interests and other institutional bodies within and beyond the UN.

Throughout the Decade, the IDNDR Secretariat has engaged many of these partner affiliations through such activities as an International Day for Natural Disaster Reduction each October, administration of an annual award, the United Nations Sasakawa Award for Disaster Prevention, the promotion of annual public information campaigns around a global theme, etc. These efforts seek to promote the adoption of a global culture of prevention by a sustained commitment to advocacy, the development of agreed policies, and assured co-ordination by many actors working together for a common purpose. The global appeal of disaster prevention therefore, has come to be recognised as:

- Universal in application, relevant to all countries, whether they are rich or poor
- International in concept, but realised through people's own local efforts, where they live and work
- Multi-sectoral, involving many different professional abilities and different types of organisations
- Sustained by a collective appreciation of protecting social resources and economic assets that people believe are important to them.

Partnership for the future: Making disaster prevention a public value

With the rapidly rising costs of disasters, the multiple dimensions necessary and the many organisational responsibilities for successful prevention, partnership is an essential feature of disaster reduction. Public understanding and professional capabilities need to be developed within national policies and applied in local communities. Different types of resources are required from various contributors, so that each may benefit more fully. Experiences must be shared and information disseminated to bridge gaps between:

- Official policies and public understanding
- Public authority responsibilities and commercial sector opportunities
- Scientific or technical knowledge and practical application
- Multi-disciplinary abilities and inter-sectoral relationships
- International promotion and local practicality.

As the millennium approaches, it becomes ever more important to reflect on accomplishments of disaster prevention, in order to determine the best platform in rapidly growing modern societies for a sustained commitment to hazard awareness and risk management practices for disaster prevention.

A strategy for the future must reflect these and similar commitments in other professions and be crafted to create institutionalised competence for disaster reduction beyond the year 2000. Efforts must maintain the momentum that has grown, particu-



Photo: Courtesy of Dr Gerhard Berz

After the event: Damage caused by Hurricane Andrew, Florida, 1992

larly during the latter half of the 1990s, by recognising the social, political and economic values of risk management for disaster reduction. In order to consolidate the accomplishments of the IDNDR, there are lasting principles which can guide collective efforts into a 'Safer world in the 21st Century'. They include the following:

1. Recognition among policy and decision-makers that disaster reduction is feasible, viable, and makes sense — in terms of policy, practice and investment
2. The identification of disaster reduction with sustainable and long-term national or organisational developmental plans and accomplishments
3. The recognition that effective disaster reduction involves the application of a full range of professional disciplines, which extend from the scientific to the social and from the academic to the practical
4. Advanced technical and scientific research is desirable, but more basic public understanding of hazards and a shared civic responsibility to prevent disasters from occurring, are fundamental considerations
5. Structured information exchange and the formation of effective organisational relationships that extend knowledge and transfer practical experience are essential for institutionalising a 'culture of prevention'. Advocacy remains crucial for success
6. Motivations must be understood to be about building capacities, by making better use of resources, and protecting assets — especially in the natural and physical environments upon which all societies, and many livelihoods, depend.

Ultimately, the success of disaster reduction will be measured by the public understanding of these concepts, and the acceptance of its feasibility, especially in local communities where people live and work.

It is simply a matter of values.

LESSONS FROM THE 1990s

Disaster loss mitigation and sustainable development

James Bruce, Chair, IDNDR Scientific and Technical Committee 1990–94, Canada

IT IS INCREASINGLY recognised that to ensure sustainable development, countries must increase their preparedness for natural hazards and take steps to prevent losses, human and economic, from such hazards. It is also now apparent that there are strong linkages between disaster losses and other sustainable development issues such as changes in land use, coastal zone management and climate variability and change. Near the close of the IDNDR, it may be valuable to consider the early days of the Decade and the emergence and strengthening of recognition of these linkages over the past ten years.

The beginnings of the IDNDR

The United Nations General Assembly in 1989 recognised both the enormous losses and suffering from natural disasters, and the rapid growth of damages, and decided to declare the 1990s as the International Decade for Natural Disaster Reduction. The impetus for the IDNDR came not just from the terrible loss statistics, but also from the recognition that much can be done to minimise property damage, loss of life and suffering from natural disasters. The tragedy is that many of the disaster prevention and preparedness techniques that have worked successfully in some countries are not applied in many of the most vulnerable countries of the world. It is not just industrially developed countries that have put in place effective procedures to reduce disaster losses, but some developing countries as well have undertaken effective disaster prevention activities. It was the challenge of the IDNDR to ensure the transfer and use of appropriate disaster mitigation techniques, in all countries. In addition, where further scientific developments would help in alleviating suffering and losses, the IDNDR needed to encourage mobilisation of the scientific and engineering communities to devise new, cheaper, more appropriate methods to achieve these goals. Indeed, it was the scientific community, led by Dr Frank Press, then President of the US National Academy of Sciences, which first pressed for a disaster reduction Decade.

Thus UNGA Resolution 44/236 was born from a recognition of three basic facts about natural disasters in the late 1980s:

- Losses in both economic and human terms were enormous and increasing rapidly
- Proven disaster mitigation measures, if more widely applied, could significantly reduce the losses and suffering
- The scientific and engineering communities are willing and able to develop increasingly effective, and more cost-effective warning, preparedness and prevention techniques.

By the time of the 1991 meetings of the 25 member 'Scientific and Technical Committee' (STC) in Bonn, Germany and in Guatemala

City, some of the concepts and ways forward were already being developed. There were, in effect, four pillars to the IDNDR strategy. All countries were urged to form broadly-based National Committees for IDNDR to promote and coordinate efforts in disaster mitigation. Some countries had already done so by 1991, since the General Assembly Resolution had requested this.

The STC recognised that for these efforts to be effective, there should be established some targets or goals to be achieved. Indeed, it was at the Bonn session of the STC, March 1991, that the targets of the Decade were first agreed and promoted.

The UN Agencies, non-governmental international organisations and the scientific community mobilised in support of reducing disaster losses. This was promoted by an active UN inter-agency secretariat committee led by the IDNDR Secretariat and by STC approval of a series of Demonstration Projects to illustrate the kinds of studies needed. A major effort was essential on information dissemination, including forums for exchange of information on mitigation techniques, and awareness raising. As this thrust developed, it took the forms of regular publication of *Stop Disasters*, co-sponsorship of many regional workshops and promotion of a mid-decade high level World Conference held in Yokohama, Japan, 1994.

Targets and programme framework

In its first Annual Report to the UN Secretary General and through him to the General Assembly in October 1991, the STC proposed for adoption three main decade targets and a programme framework for achieving them. These were subsequently adopted by the UNGA and countries urged to follow them. As part of their plans to achieve sustainable development, each country should have in place:

- Comprehensive national assessments of risks from natural hazards, with these risks taken into account in development plans
- Mitigation plans at national and/or local levels involving long term prevention and preparedness and community awareness
- Ready access to global, regional, national and local warning systems and broad dissemination of warnings.

To achieve these three targets, the STC identified a programme framework which consisted of seven main activities and supporting activities.

The latter cut across all programme elements and includes education and training, public information programmes, transfer of appropriate technologies both between and to developing countries, and application of existing knowledge and techniques. In addition, a number of important research needs were identi-



Photo: Associated Press

A small fishing boat and a van are overturned on the edge of what was once a wharf of a port on Okushiri Island, Japan, July 1993 — one day after a major earthquake shook the island and a tsunami flattened the seaside area

fied to devise better, and more accessible, techniques to provide socio-economic input to policy development.

Disaster losses soaring

In spite of national and international mitigation efforts, as the Decade continued, disaster losses mounted from about US\$ 1 billion per year in the 1960s to US\$ 40–50 billion in the first half of the 90s and more than US\$ 100 billion per year in the last years of the Decade. A large percentage of people affected and perhaps about three quarters of losses are due to storms, floods and droughts — hazards where the frequency and severity may well be affected by global environmental changes due to human activities. The reasons for this rising toll of losses raised certain questions. Are the natural hazards that became disasters now more frequent than in earlier decades? Or are the escalating losses due exclusively to growing human population, and increased exposure of infrastructure and activities in vulnerable areas?

Land use changes and disasters

The relationship is well understood between the removal of forests and other vegetation on the slopes of watersheds and floods and landslides. Flood peaks and landslides are substantially increased by loss of vegetation on the hillsides. In addition, the expansion of cities with accompanying increases in paved and roofed areas results in higher run-off rates and greater floods in urban and suburban areas. For example, in one study in southern Ontario, the percentage of rain and snowmelt which runs off increased from 10 to 43% with urbanisation of the watershed. Thus, human actions are undoubtedly increasing the percentage of rain or snowmelt that run off quickly causing floods.

In the case of droughts, studies in the Sahelian region and elsewhere have shown that while drought periods are caused by large scale changes in the general circulation of the atmosphere, local actions can prolong the dry periods and make their effects more devastating. Removal of vegetation for firewood, or by grazing

animals, changes the albedo or reflectivity of the land surface and the surface roughness, both leading to prolongation of drier weather and its adverse effects. Losses of vegetation also reduce the penetration of water into the soil accelerating run-off. From these examples, it is evident that human actions in affecting land uses and vegetation subsequently have significant effects on floods and droughts.

Climate

The most remarkable manifestation of the natural variability of the climate system is the ENSO phenomenon, El Niño, with abnormally warm water in the eastern equatorial Pacific Ocean, and La Niña with abnormally cold. Both phases significantly alter global circulation and weather patterns. Devastation through floods, fires and droughts linked to the very intense 1997–98 El Niño have been estimated to cost more than US\$ 33 billion worldwide, with particularly heavy losses on the west coast of South America and in Central America.

A subject of intense research is whether the apparent century long increase in intensity of El Niño events is part of a natural long term fluctuation or whether it may be due in part to increased forcing of climate by greenhouse gases. Recent theoretical work by Sun (1997) and modelling by Knutson and Manabe (1998), suggest that the increased radiative forcing and warming, due to growth of atmospheric greenhouse gas concentrations have affected El Niño intensity and that intensities will continue to increase in coming decades. However, other modelling groups have been unable to detect such a linkage.

Regardless of the outcome of this scientific debate, it is clear that countries must become much better prepared to cope with the droughts and floods that follow El Niño and La Niña events.

In reviewing climate statistics, there is strong evidence for regional increases in frequency of some severe climate events. For example, over continental USA the frequency of heavy one day rains in excess of 50 mm, has increased 20% over the past century. The number of very severe extra-tropical storms in the northern hemisphere during winter has also increased over this period. These observed trends and other changes, such as increased frequency of droughts in mid continents, and accelerated sea level rise, have been projected by climate models with increased greenhouse forcing.

While some scientists still consider that changes in the observed record may be part of natural variability, if the greenhouse gas explanation is correct, then climate extremes will continue to increase in future with accompanying disasters.

Changes in exposure

However, it is impossible to attribute all or even most of the past increases in disaster losses to this first factor, the change in environment due to human actions. Rather, the evidence of increased exposure of human settlements to risks posed by natural hazards is probably the dominant cause. The 20th Century has seen rapidly rising total populations, migration to cities, and especially to coastal regions of great vulnerability.

The example of Florida is a striking one. The number of people living in the counties along the sea-shore, on this low lying peninsula, has risen from 0.5 million to nine million in the past six decades. The value of property at risk has risen by a larger degree.

It is interesting to note, however, that while this enormous build-up of infrastructure and population has occurred along the vulnerable Florida coastline, the loss of life in hurricanes has steadily declined due to an excellent regional storm warning system, and effective evacuation plans.

Future outlook

Looking to the coming decades it seems evident that those concerned with disaster losses should form strategic alliances with linked international activities that continue beyond 1999. Among those of greatest importance are:

- Agenda 21, and especially disaster mitigation actions under the headings of *Water* and *Habitation* (1992)
- The Framework Convention on Climate Change (1994 ratified)
- The global Convention on Desertification (1997 ratified)
- The increased funding of climate change and variability responses and drought mitigation actions through the Global Environmental Facility (GEF)
- The Barbados Program of Action for Sustainable Development of Small Island Developing States (1994).

On the first of these, the UN's Commission for Sustainable Development reviews progress in putting in place the programmes of Agenda 21. Under several headings of this Agenda, disaster reduction activities are required to be strengthened.

The Framework Convention on Climate Change in Article 4 — 'Commitments' calls for 'meeting needs of developing countries arising from adverse effects of climate change'. This article especially identifies countries susceptible to storm surges such as 'small island countries', and 'countries with low-lying coastal areas', as well as 'countries liable to drought and desertification' and in a more general category 'countries with areas prone to natural disasters'. In all of these cases, disaster reduction programmes of the kind promoted by and coordinated through the IDNDR can be the most effective adaptation responses to climate change and variability, and to sea level rise.

In the third of these initiatives, projects on drought preparedness and management should be recognised and strengthened through this Convention on desertification. The IDNDR STC meeting in New Delhi, 1–5 February of 1993, focused particular attention on 'Management of Droughts' drawing heavily on effective Indian and Ethiopian techniques and experience. Widespread dissemination of these techniques is needed

To support many of these activities, a number of the industrialised countries pledged greater funding to the GEF which is operated by the World Bank, United Nations Development Program, and the United Nations Environment Program. Developing countries pressed successfully for addition of drought and desertification and for support of measures for adaptation to climate change as topics for funding through the GEF.

The first two chapters of the paper 'Sustainable Development action plan for Small Island Developing States' (Barbados, 1994) deal with:

- Climate change and sea level rise, and
- Natural and environmental disasters.

Clearly, the drafters of the plan have identified these as the linked issues most seriously threatening small island states.

The close linkages between global change, both environmental and demographic, and the soaring losses due to natural disasters are outlined. It appears that for the coming decades, these linkages need to be more formally recognised in a number of ways.

Such recognition would strengthen action related to global change by focusing attention on the most obvious and devastating manifestations of change-natural disasters. At the same time, such alliances would strengthen progress towards the goal of reducing losses of life, human misery and economic losses due to natural disasters.

IV

THE NATURE OF HAZARDS

KEYNOTE PAPER

THE NATURE OF HAZARDS

John Rodda, International Association of Hydrological Sciences, UK

NATURAL DISASTERS seem to occur all too frequently. In most years they result in thousands of lives being lost because of the impact of tropical cyclones, floods, earthquakes, volcanic eruptions, droughts and other hazards. Settlements are destroyed or badly damaged, soils in productive agricultural areas are swept away and natural habitats degraded. Those who survive can be hit by disease, suffering and loss that may take years to assuage.

No part of the world seems to escape these events. Earthquakes take place where geological conditions appear to be most stable tornadoes can touch the remotest areas, while flash floods feature in the driest of deserts. Wildfires and plagues of insects remove valuable crops and eradicate essential elements of eco-systems. Tsunamis top sea defences on sheltered coastlines. All in all, the globe seems to have an amazing ability to generate a variety of geophysical phenomena and a range of ecological events operating over time scales upwards from minutes, events that can alter systems which may have been established for eons.

For the last 200 years or so, science has been building an understanding of many of these phenomena and the mechanisms and processes which trigger their occurrence, govern their magnitude and determine their frequency. However, the overall progress of science has been very uneven, so that knowledge is incomplete in many areas. It is fortunate that in some of these areas where the science is less advanced, threats from natural hazards are being accommodated wholly or partly by the engineering design of the structure concerned, or by similar preventative measures. Then risk assessment, which combines information on the nature of the hazard with information on vulnerability of the targets is helping to clarify decision making for disaster management and the development of mitigation strategies. But currently accelerating population numbers and the menace of climate change are creating conditions where vulnerability is increasing. More and more of the world is coming under threat from natural hazards, as population pressure requires less favoured areas to be settled and conurbations to become bigger. Added to these problems, the extremes of weather, tropical cyclones for example, appear to

be increasing in severity and seem likely to affect wider areas in the future. A global view of natural disasters has often been difficult to obtain in the past because of lack of a reliable body of data. However, data for 5200 disasters in 179 countries for the years 1963 to 1992 were brought together for the World Conference on Natural Disaster held in Yokohama in 1994. These data showed a steep rise in deaths over the period, a rising number of people affected and an increasing amount of damage.

Much of the progress in some sciences has been stimulated by the need to forecast extreme events and to provide warnings of their occurrence. In the 19th Century, for example, the first weather forecasts were made to protect coastal shipping and meteorology made significant advances because of demands to develop this capability. Subsequently, most of the other geophysical sciences developed similar capabilities to those in meteorology, and there have been developments in other sciences, such as in agriculture which build on these forecasts. Adequate knowledge of these sciences allows certain characteristics of likely hazardous events to be estimated with some measure of success. These include characteristics such as location, duration, magnitude, frequency, trajectory and extent. At the present time, in addition to the various types of weather forecasts, such as those for hurricanes, heat waves and tornadoes, there are forecasts for floods, avalanches, mudslides, landslides, volcanic eruptions, tsunamis, and similar rapidly occurring events. While some progress continues to be made with determining the onset of earthquakes, the predictive capability in seismology does not compare with that in meteorology and with that in the other sciences of the fluid earth. The forecasting of drought is another area of difficulty.

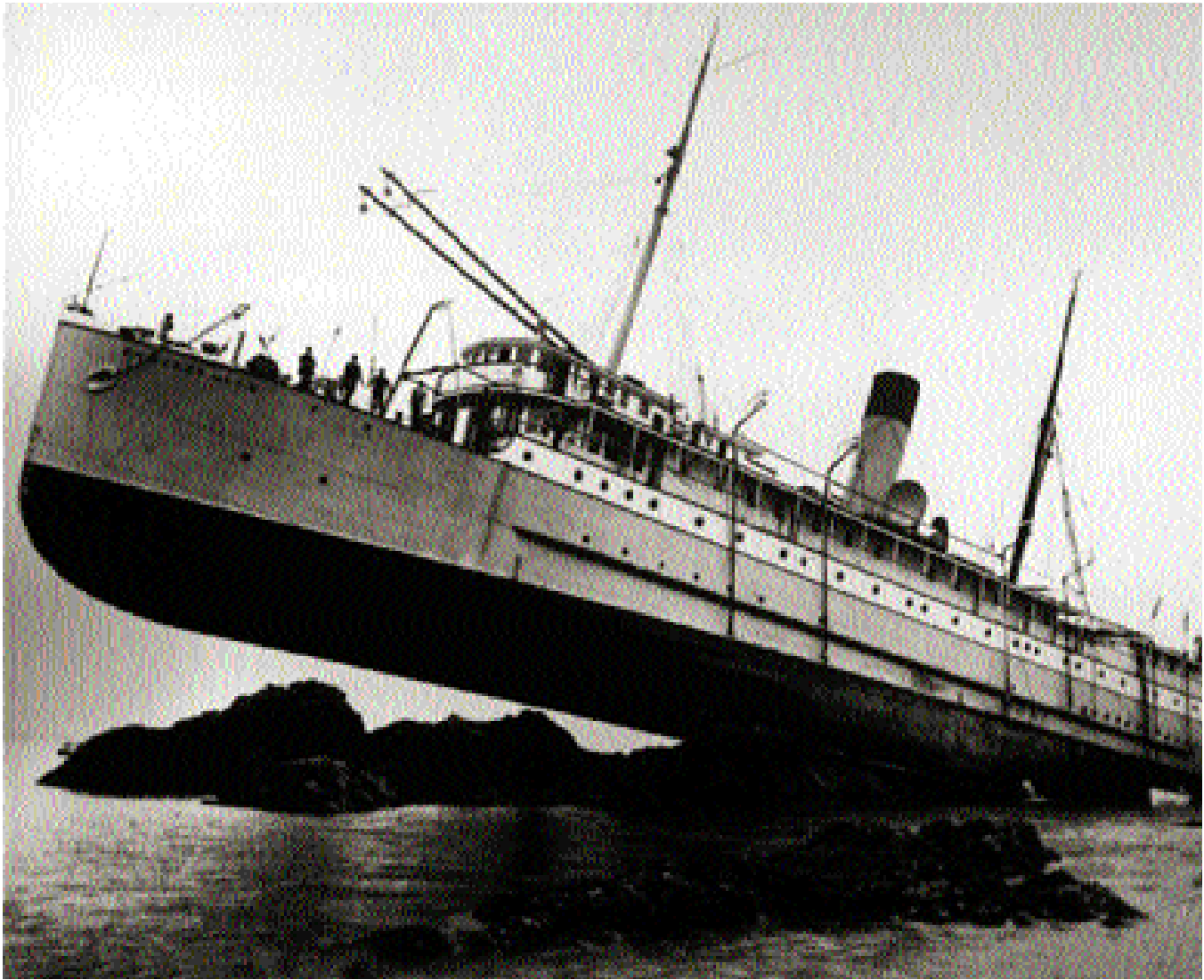


Photo: Superstock

Casualties of a natural disaster: Shipwrecked on Sentinel Island, Alaska, USA in 1910

Large computer-based numerical models of the atmosphere, the oceans, or one or more river basins are used, sometimes coupled together, to simulate what is likely to happen over 24 hours and several days ahead. These models are driven by data collected in real time from networks of *in situ* instruments on the land, other instruments in the atmosphere and in the seas and oceans, together with remotely sensed data from radars on the ground and from orbiting and geostationary satellites. Similar systems may be employed to estimate when a volcano is likely to erupt, or to determine when a plague of locusts may reach a certain area.

Different types of forecast have to be disseminated to the police, civil defence, military and the media for warnings to be issued to the general public and for preventative measures to be taken. The lead time for a forecast is a very important factor. Warnings for an event only minutes ahead may be of little general use, two to four hours allows householders and farmers to take certain precautions, several days are needed for the successful evacuation of a low lying densely populated coastal area.

Unfortunately developing countries suffer most from the effects of natural disasters. This is because they frequently lack reliable warning systems, their civil defence arrangements may need strengthening and their fragile economies make them less able to withstand the financial burden forced on them by a natural dis-

aster. Being hit by a hurricane or an earthquake can set back a nation's development by a decade or more, and such an event can be a serious impediment to the goal of sustainable development. The effect of Hurricane Mitch in Central America, 1998, is an example of the worst possible kind of disaster. However, as richer nations seem willing to continue to provide large sums for post-disaster relief and rehabilitation in affected countries, it would be much more cost effective to spend money on pre-disaster preparedness measures.

Technology transfer to the more vulnerable nations is an important part of improvements to this preparedness. There are also considerable economic benefits, to say nothing of the human benefits, in focusing on preparedness. Studies of forecasting and warning systems show cost/benefit ratios of 1:10 to 1:15 and the cost of disaster resistant buildings adds an extra two to 12 per cent, very little compared to the cost of rebuilding. With the number and costs of disasters continuing to rise, the countries which have invested in proficient integrated disaster management systems are likely to see better returns for their investments. There is considerable scope for further research into the economics of hazards and disasters.

Raising public awareness of disasters and improving education and training are also essential elements of progress in disaster management.

HYDROMETEOROLOGICAL HAZARDS

Tropical cyclone

Ricardo Alvarez, Florida International University, USA



Photo: Associated Press

Debris is widely scattered after a cyclone in Bangladesh

NINE-HUNDRED YEARS ago the poet Jelaluddin Rumi wrote about our vulnerability to (damaging) winds. An extinct aboriginal people of the Caribbean, the Taino, called the deity of terrible winds huracán. The derived Spanish word huracán translates into English as hurricane. The Chinese word taa-fung, meaning great wind, refers to storms occurring in the China sea and traces its roots to typhoon the Greek word for whirlwind, which in English defines a rotating windstorm or a destructive force. This bit of anecdotal history and etymology illustrates the importance given by humankind to the destructive force of wind and attempts to describe the characteristics of certain windstorms.

This article addresses specific windstorms known as tropical cyclones, their inherent potential for damage and society's efforts for damage reduction through mitigation, preparedness and education.

Cyclone from the Greek *kykouma* wheel, coil, from *kycloun* to go around, from *kyklos* circle. A clear etymological reference to closed circulation and the rotation of wind. Tropical cyclones are

large-scale weather systems developing over tropical or subtropical waters, where organised surface wind circulation is present. Depending on central sustained wind speed these may be classified as depressions, storms or hurricanes.

Behold the atmosphere

To understand the nature and characteristics of tropical cyclones it is important to look at the Sun, the engine that starts it all, a 4.5 billion-year old second-generation star made mostly of hydrogen and helium and minute fractions of oxygen, carbon, nitrogen and many other elements. Considered ordinary by many astronomers, the sun nevertheless, by a process of internal nuclear reaction and radiation through space, is by far the main source of energy and light for the Earth.

The magnitude of energy reaching the Earth from the Sun, known as solar constant or total irradiance, equates to 1,367 watts/square metre. The significance of this value is revealed when the area Earth's surface, 5,100,000,000,000 square metres ($5.1 \times 10^{14} \text{ m}^2$), is taken into account.

The primary receptor of such immense amount of solar energy is that gossamer thin and seemingly insubstantial envelope surrounding the Earth: the atmosphere.

With a total mass less than one millionth that of the Earth, this layer of gases held by gravity around our planet is where we live and breathe. The atmosphere is the venue for complex and inter-active chemical and physical processes that are essential for the support of life as we know it. The atmosphere is in constant motion, and it is where our climate and weather events take place.

One important function of the atmosphere is in distributing energy and in attempting to balance temperature, pressure and moisture around the planet. The atmosphere moves air to carry heat away from the tropics, a band of earth reaching to 23°27' north and south of the equator, toward the polar regions where it is cooler. It is beyond the scope of this text to describe in detail how this redistribution of heat takes place. However it is important to note that it involves a divergent component resulting in the movement of air away from the tropics, and a rotational wind component resulting from the vorticity generated by the Earth's rotation. This mechanism involves the large-scale motion known as tropical circulation and the interaction of the atmosphere with the oceans and land masses.

One area of concern is the interaction of atmospheric processes with human activity. Although uncertainty remains, there is an accumulation of scientific empirical data suggesting that human activity may be contributing to changes in atmospheric balance. This may affect climate and extreme weather events, if it is not doing so already. In consequence, humankind must be observant of its role in altering important natural processes and the need for corrective and timely actions.

Tropical cyclones are needed

Tropical cyclones are needed as an effective method, or safety-valve, for dissipating heat accumulated in the ocean and in the tropical regions of the atmosphere. This need is evidenced by the fact that most hurricanes take place during summer and autumn, when the tropics reach their highest temperatures. It is then that the coupled atmosphere-ocean heat transfer engine must be most effective in diverting heat toward the polar regions. In some countries there is a consequential need for tropical cyclones which result from the rains associated with these systems, that are critical for the irrigation of crops and the production of foodstuffs to feed many millions of people.

Cyclogenesis

Cyclogenesis refers to the formation of cyclones. To the combination of conditions needed for cyclone formation, the area where such conditions may be present, and to triggering events as well.

Although the main conditions and favourable areas for tropical cyclogenesis and triggering events have been identified, the genesis of tropical cyclones is still poorly understood. In general, tropical cyclogenesis requires:

- An area of warm sea surface water with a thermocline of 26°C or higher
- Coinciding low atmospheric pressure
- A disturbed atmosphere with large cloud mass, embedded rain bands and thunderstorms
- Absence of or minimal upper wind shear
- Steering winds, generally from the east
- A relative humidity of 80 per cent in the tropical atmosphere.

These conditions are generally present in tropical waters during summer and early fall, giving rise to an accelerated transfer of

heat from the sea surface to the tropical atmosphere creating the energy source for tropical cyclones.

Despite these ubiquitous conditions tropical cyclones do not form spontaneously, outside triggers are needed. In the Atlantic tropical cyclones are most often triggered by atmospheric waves moving westward over sub-Saharan Africa.

Other phenomena, often extra-regional, have significant influence on cyclogenesis. For example, tropical cyclone formation in the North Atlantic is related to periodic El Niño events in the Pacific and related to drought in the Sahel region of Africa. Empirical data clearly shows these connections, but they are not yet fully understood.

Even under ideal conditions tropical cyclones are relatively rare, with an average of 80 such systems forming all over the globe in six areas known as tropical cyclone basins that include:

A large portion of the North Atlantic (including the Caribbean and Gulf of Mexico), The Western North Pacific, The Eastern North Pacific, The Northern Indian Ocean, The Southern Indian Ocean, and The Southwest Pacific/Australia region.

Vulnerability

Vulnerability results from the interaction of human activity with hazards. With few exceptions, most coastal and island regions of the world are vulnerable to tropical cyclones.

Vulnerability to tropical cyclones can be absolute or relative. Absolute vulnerability is a function of location. For example: islands in the western Caribbean are vulnerable to hurricanes by virtue of being located in the path of such weather events.

Relative vulnerability involves exposure to consequential hazards resulting from the interaction of local factors, such as topographic relief, and components of tropical cyclones such as high winds or storm surge. Such consequential hazards include flash floods, mud-slides and beach erosion.

With regards to adverse impacts from tropical cyclone on a given location, vulnerability must be viewed, analysed and understood, from a range of perspectives including: a) physical, b) ecological, c) structural, d) social (human), e) economic, and f) political aspects.

Components

Assessing vulnerability to tropical cyclones, requires knowledge of conditions for, and area of, cyclogenesis, specific local factors, the physical characteristics on such events, and a knowledge and understanding of the family of components that constitute a tropical cyclone.

With regard to their physical characteristics tropical cyclones come in an ample range of sizes often affected by the specific basin where they originate. While there are no average hurricanes, the following are typical of most tropical cyclones:

- Basically circular in shape with a diameter ranging from 180 to 1000 kilometres
- A central 'eye' around which rotation takes place counter-clockwise in the Northern Hemisphere, and clockwise in the Southern Hemisphere. The diameter of the eye ranges from 15 to 50 kilometres. The 'eye' is usually cloud free or partially overcast and it is the point of lowest surface barometric pressure
- The eyewall surrounds the 'eye' and consists of tall cumulonimbus clouds that descend almost to the ocean surface
- One or more rain bands embedded in cumulonimbus cloud formations, spiralling cyclonically about the central eyewall
- Minimum sustained rotational wind speed of 32 metres per second for hurricanes, ranging up to 90 metres per second for the strongest hurricanes

- Low central surface barometric pressure that may drop to 870 millibars (normal sea level pressure is 1013 millibars) in the ‘eye of the storm’ region
- Forward system motion at velocities ranging from near zero to eight metres per second, or higher as a tropical cyclone moves farther from the equator.

Embedded within these typical physical characteristics are components that are important causes of potential damages:

- Intense winds with all their characteristics of higher gusts, turbulence, shear etc
- Changes in pressure resulting from the movement of air against, over, or around, obstacles, such as buildings
- Storm surge
- Precipitation, mainly in the form of rain but also as hail
- Severe lightning
- Tornadoes and water spouts.

The potential for damage

Tropical cyclones must be viewed as hazards or potential sources of damage. Damage results from the action of single or combined components of a tropical cyclone on built or natural structures.

However, a considerable amount of damage from hurricane impact is also due to human factors or decisions. For example, strong hurricane winds can generate flying debris that can break unprotected windows, allowing wind and rain inside buildings to cause injury and major property damage. The emphasis here is placed on the lack of window protection as this implies a human decision.

Tropical cyclones, hurricanes in particular, are very complex systems in which a large number of components and factors interact, often in rapidly and continuously changing ways to cause damage upon landfall.

Although no scientific method or engineering formula can precisely predict the amount of damage caused by a hurricane there are scales, mostly based on descriptive, generic and subjective elements, that provide qualitative estimates of damage from hurricanes. The best known — The Saffir/Simpson Hurricane Damage Potential Scale — is shown in Table 1.

Even a widely adopted scale, such as the Saffir/Simpson, needs to be complemented by comprehensive vulnerability assessment and hazard identification efforts, taking into account the specific factors involved in the region or community under analysis.

For example: storm surge is a function of several factors including near-shore bathymetry/slope, coastal topography, barometric

pressure, astronomical tides, maximum sustained wind speed, velocity of forward motion, characteristics of the basin under impact, and the angle of approach of the hurricane with respect to the shoreline. While the Saffir/Simpson scale provides a range of values for storm surge for each category of hurricane, an accurate estimation of surge at a specific location requires analysis of the factors listed above.

The same argument applies to the estimation of damage potential from a hurricane. The Saffir/Simpson scale provides a qualitative and subjective measure of damage potential for each category of storm, but the analysis of numerous specific factors is needed for more accurate damage projections.

Experience shows even a low category storm (Hurricane Mitch, 1998) may cause extreme damage when certain factors, such as slow forward motion, interaction with mountainous terrain and large amounts of rain combine with human factors, such as deforestation, to devastate entire regions in two countries.

There is an obvious need for complementary tools to help provide more accurate estimations of damage potential from hurricanes, especially with respect to human or social vulnerability. These may include new hurricane-impact simulation and visualisation models, and advanced data acquisition technologies to assist with hazard assessment and risk identification.

Damage reduction through mitigation

In its simplest definition hazard mitigation is damage reduction. A regulatory definition in the United States reads ‘Hazard mitigation means any cost effective measure which will reduce the potential for damage to a facility from a disaster event’.

Hazard mitigation measures must also be practical, structurally and technically effective, addressing specific causes of damage identified through analysis of vulnerability.

Mitigation through education

Effective hazard mitigation requires constant application by everyone, from policy-makers and professionals to the general public. It also requires the creation of a true culture of mitigation in vulnerable communities.

These requirements can only be met through an educational effort that will provide the knowledge and tools so that all concerned practice hazard mitigation on a regular basis. Education of everyone involved, from children to adults, professionals in many fields to elected officials, from bureaucrats to the citizen-at-large, becomes an essential component of mitigation.

Table 1: The Saffir/Simpson Hurricane Damage Potential Scale

Scale Number (category)	Central Pressure (inches)	Winds (mph)	Surge (feet)	Damage	Examples (in Florida)
1	≥ 28.94	74–95	4–5	Minimal	Hurricane Agnes '72
2	28.50–28.91	96–110	6–8	Moderate	Hurricane Cleo '64
3	27.91–28.47	111–130	9–12	Extensive	Hurricane Eloise '75
4	27.17–27.88	131–155	15–18	Extreme	Hurricane Andrew '92
5	<27.17	>155	>18	Catastrophic	Hurricane Florida Keys '35



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HYDROMETEOROLOGICAL HAZARDS

Flood

Professor Dennis Parker, Flood Hazard Research Centre, Middlesex University, UK



Photo: Tony Stone Images

Streets partially submerged by flood water in mid-West USA

FLOOD DISASTERS are among the world's most frequent and damaging forms of disaster. They are becoming more prevalent and harmful over time, despite some outstanding efforts and achievements to prevent them. The application of science and medicine has undoubtedly enhanced our ability to predict and survive floods, but population growth and social, economic and political processes have increased society's exposure and vulnerability to these hazards making them virtually endemic. Unfortunately, the potential for flood disasters is often underestimated. Severe floods usually occur infrequently making it difficult for communities to retain a collective memory of the risks which can guide future generations. Environmental changes brought about by human activity, including urbanisation and greenhouse gas emissions causing global warming, have insidious and deceptive effects on flood potential. A world without flood disasters is currently unachievable but through careful planning a range of measures can be successfully assembled to reduce these threats.

Flood hazards are the product of an interaction between environmental and social processes in which the principal motivation for the interaction is the desire to exploit natural resources. River

floodplains and flood prone coastal zones are powerful magnets for activities such as farming and urban development. Although flood disasters are caused by natural events, they are also importantly caused by the social, economic and political environment which structures and configures the lives of individuals and communities. Even the environmental processes which generate floods are increasingly interfered with by human activities which transform the natural environment into a semi-natural one.

River flooding is usually produced by prolonged heavy rain or melting snow. The 1993 Mississippi flood was a particularly severe example lasting several months and affecting a large part of the North American continent. Such floods may be deep or shallow, but even shallow floods can be dangerous. Intense storms can produce flash floods over relatively small areas. In these floods the flood peak is relatively high but short-lived and floodwaters may travel at high velocities. They are common in arid, mountain and metropolitan areas. Urbanisation worsens floods because natural permeable ground surfaces are replaced by impermeable ones which increase runoff rates generating higher, more frequent floods. Flash floods often kill and produce severe structural damage. Along coastlines storm surges coinciding with high tides

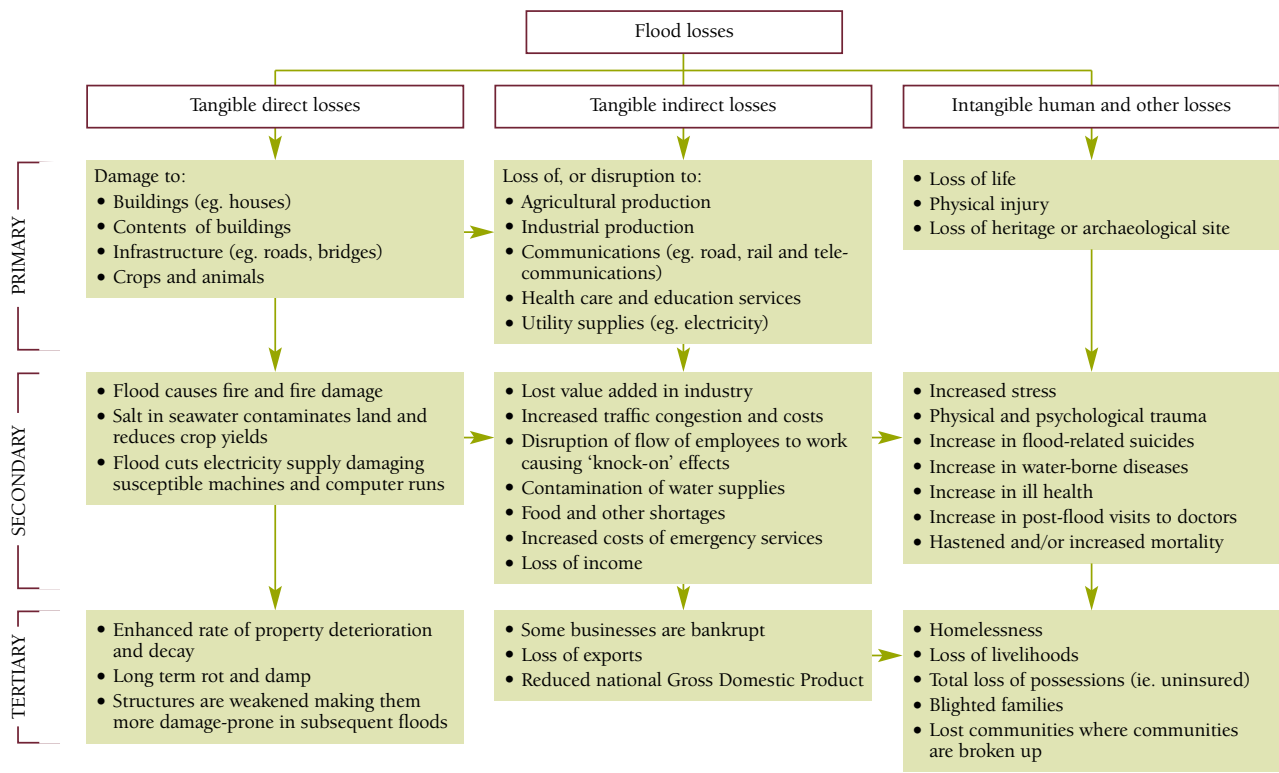


Figure 1: The adverse impacts of flood disasters

can produce destructive sea flooding. These floods are usually associated with a temperate or tropical cyclone, and may be several metres deep.

Some types of flood are relatively unusual and confined to particular environments. Jokulhlaups are caused by sudden releases of meltwater from ice-dammed lakes in glaciers. In northern latitudes floating ice jams reduce the capacity of river channels and when ice jams melt they shift suddenly releasing a flood wave. Dam-break flooding is a low-probability but potentially high consequence risk. Dams may cause flood disasters for a variety of reasons including design and construction error, earthquakes and landslides. Tsunamis are oceanic gravity waves generated by submarine geological processes such as earthquakes. They travel fast in the open ocean and can be many metres high at their peak, causing devastation and death along occupied coasts. They occur in several of the world's oceans but are particularly prevalent in the Pacific.

Occupation of flood zones and the tendency of humans to expose themselves to floods is an important driving force behind increased flood disasters (Parker, 1995). Growth of population in flood zones, the accumulation of wealth exposing more and more damageable property to floods and migration to cities are causes. Coastal flooding is steadily worsening because of sea level rise linked to global warming. Most new large coastal cities will be in the developing world where those exposed to flooding are amongst the most vulnerable in the world. Low-lying island states are also facing increased flooding owing to sea level rise. Vulnerability to flooding is an important 'social' driver behind flood disasters. High vulnerability stems from social, economic and political processes which cause people to have limited capacity to anticipate, cope with, resist and recover from a flood. The most vulnerable are low-income peoples, migrants, those living in flimsy houses, those without insurance or financial reserves, the elderly and the infirm. They may be the slum residents of blighted areas of Metro Manila living in or near drainage channels, or the

'char' people (charlands are low-lying islands and sand bars within rivers) of Bangladesh.

Flood disasters have wide ranging negative effects (Figure 1). Floods are estimated to have killed an annual average of 12,700 people between 1972 and 1996. They adversely affect more people than any other type of disaster. The annual average number of people estimated to be adversely affected by floods increased from 18.87 million to 130.43 million between 1972 and 1996. The annual average number of people made homeless over this period is approximately 3.5 million. The annual average estimated dollar damage caused by floods between 1987 and 1996 is US\$ 24.98 billion: most occurred in Asia and Europe (International Federation of Red Cross and Red Crescent Societies, 1997). Bangladesh has suffered some of the world's most damaging floods. In 1970 coastal flooding caused by a tropical cyclone killed an estimated 500,000 people, and the effects of the 1974 river floods led to several hundred thousands dying in a famine.

Options for addressing flood disasters are numerous. A distinction exists between traditional (ie. indigenous) and non-traditional (ie. advanced technological) methods. Indigenous methods have evolved over centuries through accumulating flood knowledge. For example, in many parts of the world (eg. Malaysia and Thailand) houses in flood prone areas have been constructed on stilts. The crude earth embankment is an old method of protecting land from flooding, and the home-made 'flood shield' (used to prevent floodwater from penetrating doorways) is an almost universal adaptation. These methods are small-scale, low-cost, simple and effective, but local knowledge of them decays as migration from stable, rural to more dynamic urban ways of life occurs. Non-traditional methods are those introduced through applications of science and technology: they include structural and non-structural measures.

Structural measures, the classic flood mitigation approach, are typified by the engineered flood wall or levee, and the flood control dam or the flood barrier. They are usually large scale,

capital intensive and are designed to reduce the flood risk by containing floodwaters. Flood control dams are limited by their environmental intrusiveness, their large financial cost and the tendency of some to rapidly collect sediment. Massive tidal flood barriers are used to exclude tidal surges and to protect large parts of Holland and eastern England. Barriers require heavy investment and usually rely upon reliable forecasts of tidal surges because they require closing before flooding. Structural measures often reduce flood disaster potential but they are not problem-free. Aggressive rivers, such as the Mississippi or the Brahmaputra, overtop and breach levees causing widespread losses. Another common structural approach is to deepen, widen or straighten river channels to increase their capacity to carry flood flows but unless constructed sensitively such measures can be environmentally and politically unacceptable. Evidence from the United States is that the construction of levees increases land values and encourages urban development in the protected area. Subsequently, when the levees are defeated, flood losses are higher than in the pre-levee period. On low-lying coastlines the best defences against erosion and flooding are beaches, sand dune and salt marshes. Flood problems arise when these erode—a process hastened by global warming and sea level rise. Low-lying coastal areas may be protected by ‘hard’ defences such as sea walls and offshore breakwaters. Experience with such structures, which are designed to alter sediment flow along the coastline and to interfere with the natural equilibrium of beaches, has been largely unsuccessful—they create other erosion and related flooding problems. Engineers and planners now believe in ‘soft’ defences which do little to alter natural coastal processes. Renourishing beaches artificially, constructing groynes to capture sand and shingle, and protecting dune and salt marsh buffers are proving to be more successful.

The principal form of non-structural flood hazard reduction is regulation of floodplain development, although related measures including flood warning and evacuation are also important. Flood proofing involves adapting buildings to make them more resilient. Buildings may be elevated onto mounds or fitted with water-tight doors. The objective of regulation is to prevent undeveloped flood zones becoming unwisely developed. In extreme cases, where flood risks are severe, properties or entire communities may be relocated. The use of non-structural measures has grown as the limitations of structural measures have become recognised. The concept of floodplain management has reached its highest articulation in the United States, although suitable elements of this strategy are now widely used elsewhere. Floodplain management involves the zoning of floodplains so that land use is attuned to different levels of flood risk, the regulation of floodplain development with flood insurance incentives, and the integration of a wide range of measures including building codes and flood proofing. In the United States federal flood insurance is only made available to those in communities adopting floodplain regulations, presenting these communities with a regulatory incentive. Non-structural measures are not always effective. Floodplain development can only be effectively managed when floodplains are mapped, but the quality of flood maps may be poor. Communities experiencing economic decline are likely to welcome development almost anywhere, including in floodplains. Failure of the private sector to comply with flood reduction regulations is often a major limitation. Refusal of permission to build in floodplains may be successfully challenged in courts of law. Flood warning systems underperform for several reasons, including breakdown or slowness in the warning dissemination process, insufficient targeting of warnings and failure of warning recipi-

ents to respond appropriately. Flood proofing may only be effective where shallow flooding is expected. Some problems may be overcome by increased public awareness of floods and appropriate responses to them.

The form of floodplain management developed in the United States is unsuitable for less developed societies, especially those with rapidly growing cities containing large numbers of poor migrants, where flood insurance markets are undeveloped and where constitutional rights to property present a barrier to planning controls. In poor nations regulatory strategies may be infeasible because of a large informal sector in which individual decisions are taken out of necessity but without regard to the constraints imposed by public regulations. Many of the world’s megacities in developing countries now contain extensive floodplain squatter settlements. Here structural flood measures may be infeasible because of a severe shortage of finance and high levels of foreign debt. Engineering projects may simply displace rather than protect the poor.

Reduction of flood disaster potential may come indirectly through policies designed to address other problems. For example, economic and social policies designed to reduce the fragility of local coastal economies by protecting natural resources may lead to increased resilience and enhanced ability to cope with sea flooding. Public policies designed to reduce social exclusion and to provide increased educational opportunity can reduce the vulnerability of communities to floods. In some cases ‘institution building’—such as the creation of a flood agency—may be required. Unless countermeasures are taken, the implementation of policies addressing problems apparently unconnected to floods can intensify flood disaster potential.

The goals of sustainable development provide a valuable framework for flood disaster reduction (*World Commission on Environment and Development*, 1987). Sustainable communities are those that are able to weigh up natural risks and balance them successfully against other goals, and they are communities that can survive and prosper in the face of exposure to floods. Sustainable communities are ones which identify and pursue strategies designed to reduce their member’s vulnerability by addressing social, economic and political inequities and by giving all within their community access to resources to reduce flood exposure and vulnerability (*Beatley*, 1998).

Sheep trapped by rising flood water caused by Cyclone Elaine, Western Australia, March 1999



Photo: Dr John Zillman, *The West Australian*

HYDROMETEOROLOGICAL HAZARDS

Drought

Professor Thomas Downing and Karen Bakker, University of Oxford, UK



Photo: Associated Press

September 1998: A farmer lets the dry loose soil shift through his fingers as the drought continues in southwestern Oklahoma, USA. Many farmers should have already planted their wheat crop but the soil was too dry

DROUGHT, AND the ensuing consequences of starvation and famine, is one of the major natural hazards to affect people around the world. According to the International Federation of Red Cross and Red Crescent Societies (IFRCRS, 1993) —based on data received from the Centre for Research on the Epidemiology of Disasters (CRED), during the period 1969 to 1993 —drought led to over 73,000 deaths, affected 58 million people and resulted in economic losses of nearly US\$ 4 billion.

Drought, as an emblem of distinct meteorological phenomena, has many facets. What is the nature of the drought hazard? What is vulnerability? Who are vulnerable? What constitutes risk? How are the facets of drought changing? What should be done to mitigate drought losses? These are the central questions of this introduction to drought.

This paper is structured following the common definitions of natural hazard:

Hazard	Potential threat to humans and their welfare &
Vulnerability	Exposure and susceptibility to losses
<i>equals</i>	
Risk	Probability of hazard occurrence &
Disaster	Realisation of a risk

However, each of these compartments is problematic to some extent, particularly in the context of long-term global change. Further details of some of the arguments presented here can be found in Downing and Bakker (1999), while Downing (1995) and Downing, Olsthoorn and Tol (1999) present case studies of climatic hazards related to climate change.

Changing hazard?

Drought hazard may be defined as the sum of the geophysical elements that cause a shortage of moisture—including rainfall, temperature, humidity, radiation, soils, vegetation and land cover. There is no shortage of definitions of drought and corresponding indices of drought hazard (Hayes, 1999). Figure 1 (page 42) suggests five layers of definition, using stylised data, to illustrate some of the more common approaches and difficulties. Defining drought hazard is primarily the remit of meteorological indicators, such as the rainfall anomaly, standardised precipitation index, and accumulated atmospheric water deficits (precipitation minus evapo-transpiration).

For example, the probability of summer precipitation less than 50% of normal increases from 1% at present to 12% in the 2050s. This simple measure should be extended to include additional

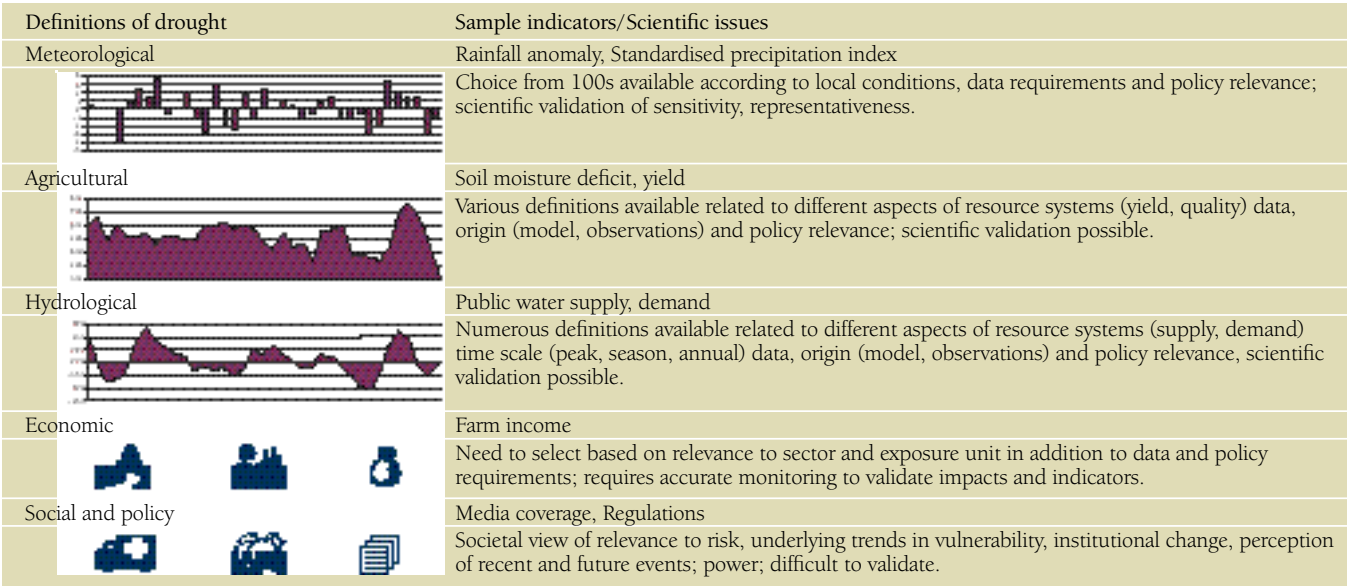


Figure 1: Illustrations of drought definitions. The left panel portrays idealised indices — for meteorology, agriculture and hydrology these are standardised time series; similar time series could be portrayed for economic effects and for significant social and policy events

climatic elements (particularly temperature), the distribution of drought episodes (within a season and over years), duration and persistence (probably more important, the frequency), magnitude (many impacts are non-linear), and spatial distribution (eg. potential for regional disruption of water supplies).

Changing vulnerability?

What determines the relationship between a hazard and its effects? Who are vulnerable? Why? These questions require a broad analysis of drought vulnerability (see for example, Sen 1981, Watts 1983, Blaikie et al. 1994, Downing, Watts and Bohle 1996, World Food Programme 1999).

Particular vulnerabilities are the conjuncture of social, economic and political structures. Bohle et al (1994) suggest a tri-partite causal structure of vulnerability (Figure 2) based on the human ecology of production, expanded entitlements in market exchanges, and the political economy of accumulation and class processes. Vulnerability *per se* is best viewed as ‘an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of harmful perturbations’ (Bohle et al 1994, pp. 37–38). This conception of vulnerability shifts the focus of vulnerability away from a single hazard to the characteristics of the social system.

Regardless of the nuance of vulnerability frameworks, key concepts are:

- Everyone is vulnerable, although their vulnerability differs in its causal structure, its evolution, and the severity of the likely consequences. Not all people or regions are vulnerable to the same extent. Models of vulnerability suggest that specific groups of people are vulnerable, due to a variety of often overlapping factors such as demography (eg. women, children, elderly, disabled), socioeconomic class and livelihood (eg. marginal farmers, under-employed), or resource management (eg. junior water rights, common property users).
- Vulnerability is a relative measure — critical levels of vulnerability must be defined by the analyst, the vulnerable themselves, external aid workers, or policy makers.
- Vulnerability relates to the consequences of a perturbation, rather than its agent. Thus, people are vulnerable to loss of life,

livelihood, assets and income, rather than to specific agents of disaster, such as floods, windstorms or technological hazards. This focuses vulnerability on the social systems rather than the nature of the hazard itself.

- The locus of vulnerability is the individual related to social structures of household, community, society and world-system. Places can only be ascribed a vulnerability ranking in the context of the people who occupy them.
- Vulnerability is spatially variable. Vulnerable groups are dispersed over space. Patterns of vulnerability depend on geographical linkages (such as competition between markets) and are often contingent on past conditions (such as the harvest in the previous season). Drought vulnerability is qualitatively different for different nations (and individuals). In the poorest households and economies, drought can still threaten lives. However, in most of the developing world, drought vulnerability constitutes a threat to livelihoods, the ability to maintain productive systems and healthy economies.
- Vulnerability is dynamic, not static. It changes over time, incorporating social responses as well as new rounds of hazardous events. Although considerable improvements have occurred over the past several decades, some regression as well has been noted in Eastern Europe and the former Soviet Union. Drought is a relatively short-term event (spanning several years); vulnerability changes at a variety of time scales, from within a season to decade-long trends in development.

In stark contrast to modest shifts in drought hazard (the probability of specific climatic episodes), vulnerability can vary between extreme crises and complete safety (in either direction) in a few months or even days. Trends in such a dynamic state are inevitably specific to individuals, communities and places. Some of the major determinants include: population growth, settlement patterns and migration, economic development, health and health infrastructure, mitigation and preparedness, and early warning, emergency assistance and recovery.

Changing risk?

The conjuncture of hazard and vulnerability can be portrayed as risk. A risk assessment in the context of famine early warning

Level	Conditions	Typical coping strategies and/or behaviours	Intervention to Consider
Slightly vulnerable	Maintaining or accumulating assets	Assets/resources/wealth: either accumulating additional assets/resources/wealth or only minimal net change (normal 'belt-tightening' or seasonal variations) in assets, resources or wealth over a season/year ie. coping to minimise risk. Production Strategy: any changes in production strategy are largely volitional for perceived gain, and not stress related.	Development Programmes
	Maintaining preferred production strategy		
Moderately vulnerable	Drawing-down assets	Assets/resources/wealth: coping measures include drawing down or liquidating less important assets, husbanding resources, minimising rate of expenditure of wealth, unseasonable 'belt-tightening' (eg. drawing down food stores reducing amount of food consumed, sale of goats/sheep. Production Strategy: only minor stress-related change in overall production/income strategy (eg. minor changes in cropping/planting practices, modest gathering of wild food, inter-household transfers and loans etc.)	Mitigation and/or Development: Asset Support (release food price-stabilisation stocks, sell animal fodder at 'social prices', community grain bank, etc.)
	Maintaining preferred production strategy		
Highly vulnerable	Depleting assets	Assets/resources/wealth: liquidating the more important investment, but not yet 'production', assets (eg. sale of cattle, sale of bicycle, sale of possessions such as jewelry) Production Strategy: coping measures being used have a significantly costly or disruptive character to the usual/preferred household and individual life-styles, to the environment, etc. (eg. time-consuming wage labour, selling firewood, farming marginal land, labour migration of young adults, borrowing from merchants at high interest rates).	Mitigation and/or Relief: Income and Asset Support (Food-for-work, Cash-for-Work, etc.)
	Disruption preferred production strategy		
Extremely vulnerable or at-risk	Liquidating means of production Abandoning preferred production strategy	Assets/resources/wealth: liquidating 'production' resources (eg. sale of planting seed, hoes, oxen, land, prime breeding animals, whole herds). Production Strategy: Seeking non-traditional sources of income, employment, or production that preclude continuing with preferred/usual ones (eg. migration of whole families)	Relief and/or Mitigation: Nutrition, Income and Asset Support (food relief, seed packs, etc)
Famine	Destitute	Coping strategies exhausted: no significant assets, resources, or wealth, no income/production.	Emergency Relief (food, shelter, medicine)

Table 1: Vulnerability matrix for the US Famine Early Warning System

systems is shown in Table 1. The progression of famine risk, from normal to at-risk, suggests different facets of underlying vulnerability and drought (as one trigger of famine), corresponding to different kinds of interventions.

In a static environment, where vulnerability does not change and hazardous events are random, the overlay of hazard and vulnerability can be appropriate. In most cases however, where past experience influences vulnerability, and present drought events are likely to modify future behaviour, the compartmentalised approach becomes problematic. This is especially apparent with drought, which is both natural and social. Analytical emphasis on either side of this dichotomy obscures the hybrid nature of drought hazard. A focus on meteorological and hydrological measures often neglects the ‘socially constructed knowledge, ideology and institutions other than the market as mediators between humans and nature and among humans themselves’ (Emel, Roberts and Sauri, 1992).

The social construction of drought risk, for example, is critical to definitions of hazard and the political, economic and social construction of vulnerable groups. Drought becomes an emblem or sign of antagonistic social forces (Eagleton, 1991) or a ‘a site where the established institutions of society are put to the test’ (Hajer, 1995). Changes in the social construction of risk are likely to be tangential to the prospective changes in the idealised compartments of hazard, vulnerability and risk. For this reason, an analysis of drought requires a further analysis of critical, non-meteorological factors.

Drought policy: From definitions to action?

The perception and experience of drought ‘are mediated at all levels by non-meteorological factors’ (Solway, 1994). An understanding of the discursive production of drought, as emblem beyond the norms and vagaries of weather and climate, is critical to preparedness and mitigation. In examining unquestioned assumptions and definitions, discourse analysis can stimulate creative rethinking and require the identification of new problems before new solutions are designed.

Shifts in drought discourse are occurring in many regions. For example, in Europe increasing population density in some regions, increasing per capita demand for water, and an exceptionally dry period up to 1998 have forced a re-examination of

water resources, water use and water management. Managed drought in Africa has to a large extent replaced the drought equals food crisis sequence prevalent until the 1970s. Treating drought as a norm rather than an exception requires a focus on scarcity rather than abundance, and on conservation rather than growth.

Framing drought as hazard, vulnerability and risk provides a palette for colouring the icon or emblem of drought as a conjuncture of geophysical and socio-institutional facets (Bakker, 1999). A colourful picture provides insight—does it stimulate action? What do we need to learn to reduce the adverse effects of drought? At the least, we suggest developing drought policy in three arenas, reflecting recurrent themes in the IDNDR:

Monitoring: The foundation of effective action is widely regarded as an adequate basis of historical information and monitoring of current conditions. The technical aspects of monitoring weather, land cover and hydrology are well covered in numerous scientific articles, workshops, projects and even manuals of operational rules. What is missing is systematic monitoring and synthesis of the multiple facets of drought, as noted in Figure 1. Drought monitoring systems should be structured to represent the diversity of drought impacts and not be satisfied with monitoring only meteorological or land surface indicators.

Seasonal forecasting: Great strides in seasonal forecasting of climate (and drought in particular) are underway in many parts of the world (eg. Washington and Downing, 1999). The challenge is to deliver reliable forecasts to the most vulnerable; to use forecasts to adapt resource management over the long-term.

A science-policy regime: Because drought is multi-faceted, development of effective policy requires collaboration between the full range of relevant scientific disciplines, and a knowledgeable political clientele. A hydro-illogical cycle is often proposed that suggests that action will only follow a drought when public and private attention is heightened. This is certainly borne out at the visible tip of policy change and enactment. However, underlying the visible spectrum of action is an existing epistemic community that assembles scientific data, carries out specific studies and draws lessons for drought mitigation. This scientific effort itself needs to be mobilised, facilitated and focused.

Footnote: Based on the HADCM2 Medium-high (IS92a) GGa results for southern grid boxes in the UK. Source: (Hulme and Jenkins, 1998).

HYDROMETEOROLOGICAL HAZARDS

Tornado

Timothy Reinhold, Clemson University, USA



Photo: Tony Stone Images

A tornado striking buildings in Texas, USA in June 1995—it scattered debris up to 96 kilometres (60 miles) from the town

TORNADOES CAN produce the most violent windstorms known to man. While many people tend to think of tornadoes as a phenomenon that primarily occurs in the United States, they have been known to occur throughout the world. A single tornado event in Bangladesh on 13 May 1996 resulted in the deaths of 525 people and 35,691 injuries (Hayashi, 1997). Eighty-two people lost their lives on 6 July 1928 when a tornado struck Warsaw, Poland (Munich Re, 1993). Tornado events have been known to occur singly and in clusters. An outbreak of 148 tornadoes occurred throughout much of the eastern United States on April 3–4, 1974. This event set what is probably the record for a clustering of tornadoes.

Until the advent of the Doppler radar, or unless a tornado funnel was spotted, it was usually necessary to view damage from the air in order to conclusively determine whether the incident was a tornado or some other extreme wind event such as a downburst or micro-burst. Debris left by tornadoes tends to be scattered in a variety of directions as a result of the rotating flow, while microbursts and downbursts tend to blow debris in a single direction. The world owes much of what it knows about tornadoes to the pioneering work of Dr Theodore Fujita, a longtime researcher of the phenomenon at the University of Chicago. Many of the unusual traits of tornadoes, such as the existence of multi-

ple suction vortices within a rotating air mass, were first suggested and then verified by Dr Fujita. The scale used by the US Weather Service to classify tornadoes by intensity is the Fujita Scale.

Attempts to describe tornadoes, their loads and effects in engineering terms have proceeded with limited success. First, there is very little hard data on wind speeds in tornadoes. Second, the limited number of photogrammetric analyses of wind speeds (the use of sequential motion picture or video frames to track the movement of debris in a tornado) and more recent Doppler radar measurements of speeds correspond to elevations well above ground level. Little is known about the actual magnitudes and variations of wind speeds near the ground. Consequently, tornado wind speeds are usually estimated by indirect means using damage observations. Photographs of damage in a particular storm are compared with a set of photographs selected by Dr Fujita which show various levels of damage ranging from loss of roof covering to foundations and concrete slabs which have been swept clean. The reference photographs correspond to Fujita scale values ranging from F0 to F6. A range of wind speeds is suggested for each Fujita scale. A Fujita scale value of F5, the highest classification that has ever been assigned to a tornado in the United States, corresponds to wind speeds ranging from 117 to 142 m/s (261 to 318 miles per hour).

Most analytical models of tornado winds have employed some variation of a Rankine vortex to represent the radial variation in wind speeds. However, research has shown that tornadoes tend to progress through various stages during their life cycle and can contain complex structures such as multiple suction vortices. This suggests that existing analytical models are, at best, only crude approximations.

Even in the United States, the probability that a particular building will be struck by a tornado is so low that there are no specific provisions which deal with the tornado threat in any of the general building codes. However, tornado hazards have been considered in the design of nuclear power plants, where the consequences of damage from a tornado could be unacceptably high. Consequently, many of the engineering related studies of tornadoes in the United States have been driven by concerns about tornado effects on nuclear power plants. Much of this research was conducted during the 1960s, 1970s and early 1980s under the sponsorship of the US Nuclear Regulatory Commission. As new construction within the nuclear industry has slowed, significantly less funding has been available in recent years for tornado research.

It should be emphasised that tornado intensity usually varies dramatically along the path as it makes contact with the ground. The width of the damage zone can vary along the path and different areas within the damage zone are likely to experience significantly different wind speeds and wind directions. For example, if a tornado is classified as an F5 tornado, estimates of the path area which actually encounter F5 winds range from less than 1% to about 3.5%. Similarly, if a tornado is classified as an F4 tornado, estimates of the path area which actually encounter F4 winds range from about 1% to about 7%. Analysis of statistics on tornadoes in the US suggests that 90% of the area affected by tornadoes is struck by winds with speeds below 50m/s (112 miles per hour) and about 98% of the area affected by tornadoes is struck by winds with speeds below 70m/s (157 miles per hour).

Hazards

The primary hazards associated with tornadoes include a drop in atmospheric pressure inside the vortex, direct wind pressures from contact with tornado winds, flying debris and the impact of trees, towers, light and utility poles which may be blown over.

Most houses and buildings contain enough leaks around windows and doors or through attic and soffit vents to allow equalisation of pressure differences associated with the drop in atmospheric pressure inside the vortex. A number of years ago, it was thought that houses exploded when a tornado passed over them because of the sudden pressure drop in the vortex. However, field observations of heavily damaged buildings demonstrated that usually one wall was blown inward while the roof lifted off and the other three walls blew outward. This is consistent with damage observations from intense straight-line winds. Therefore, recent research has discounted the importance of the pressure drop for all but the best-sealed buildings or nuclear containment vessels.

Direct wind pressure remains one of the more important hazards. Winds in tornadoes, even weak ones, approach or exceed most of the design wind speeds specified in building codes, except for design speeds in regions subjected to hurricanes, typhoons or cyclones. Experience has shown that most conventional construction contains little margin of safety for wind events with speeds that meet or exceed nominal code values. There are so many critical connections, so many opportunities for the creation of a weak link during the construction process, and so much

uncertainty in wind loads, that the margin of safety expected by the designer has been significantly reduced or removed entirely.

Significant damage can also be traced to the impact of wind-borne debris or to the impact of falling objects. Furthermore, when windows or doors on the windward face are burst open from wind pressure or the impact of flying debris, the pressure that would have occurred on that surface is transmitted into the building. This can lead to significant increases in loads on other surfaces. The increased loads can be twice as high as the loads that would have occurred if the window or door remained intact. Since most buildings are designed as enclosed structures, without accounting for large internal pressures, these increases can produce loads that exceed the nominal failure capacities for roof and wall panels, for fasteners used to attach these panels, and/or for connections between the roof and the walls. Once the building begins to come apart, loads and resistance can change dramatically leading to progressive structural failures. If the tornado is travelling slowly, the building can literally disintegrate and the debris can be blown from the foundations. Tornadoes also contain large updrafts, which can lift debris to high elevations. It is not uncommon for debris to be transported thousands of metres before returning to the earth.

A recent study by Thambuswamy (1996) illustrated, by reference to the failure of an Alabama church, how if the windows had remained intact, a significantly higher wind speed would have been required to destroy the building than that which actually occurred.

Protection

There are two approaches for providing tornado protection, which offer some merit. First, property owners can build shelters into their buildings or provide a common shelter area for a group of properties such as a mobile home park. The shelter would be designed to offer protection from wind pressure, debris impact, and falling objects. Texas Tech University researchers have been involved in the development of tornado shelters for many years. Working with the US Federal Emergency Management Agency, they have recently published a document (FEMA 1998), which provides guidance on building a safe room inside a house. Second, since the vast majority of areas affected by tornado winds are subjected to wind speeds below those of an intense hurricane, cyclone or typhoon, construction of buildings using techniques employed in these high-wind regions should provide significant protection for both people and property. This second approach has so far received less attention but is an area of current research.

Different protection schemes may be appropriate for different locations. The key issues are warning people in time for them to take cover and ensuring that there is a relatively safe place to go with sufficient time to get there. Current warning technology usually provides a fairly broad warning area. Consequently, people frequently do not perceive the threat as real until they have some other reinforcement of the validity of the threat, such as seeing the funnel cloud or hearing the winds. By the time they see or hear the tornado, there may not be sufficient time to get to the best shelter site. The broad coverage of Doppler radar in the United States is making a significant difference in both warning times and warning precision for tornado strikes. In some instances, warning times for a specific tornado have approached or exceeded 15 minutes. Integration of Graphical Information System (GIS) technology with Doppler radar images is providing greater precision in establishing warning areas. This is expected to improve public response once people understand that the warnings have in fact become more precise and hence, more credible.

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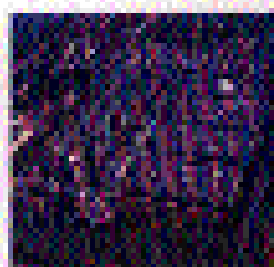
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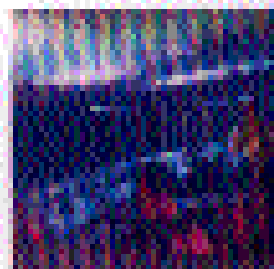
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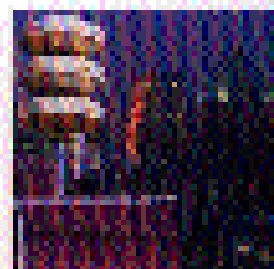
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HYDROMETEOROLOGICAL HAZARDS

Extreme Temperature

Christopher Adams, Colorado State University, USA



Snow covered streets during a winter freeze: A temperature gauge registers minus 11 degrees celsius

EXTREMES OF HEAT and cold have a broad and far-reaching set of impacts on the United States. These include significant loss of life; illness; and economic costs in transportation, agriculture, production, energy and infrastructure. The 1976–77 winter freeze and drought is estimated to have cost US\$ 36.6 billion in 1980 dollars (US\$ 72.2 billion in 1998 dollars). In 1980 the nation saw a devastating heat wave and drought that claimed at least 1700 lives and had estimated economic costs US\$ 15–19 billion in 1980 dollars (US\$ 29.6–37.5 billion in 1998 dollars).

While these are atypical examples, in recent years there have been, on average, about 1200 deaths per year due to extreme hot and cold weather.

While there are numerous case studies of particular events, little systematic knowledge exists on the impacts across various sectors of the nation. The most rigorously documented impacts are the health impacts, based to a large part on epidemiological studies conducted by the US Centres for Disease Control and Prevention (CDC) and others in the public health arena.

Extreme heat

On average over the last 30 years, excessive heat accounts for more reported annual deaths in the US than hurricanes, floods, tornadoes, and lightning combined.

Much of the literature on extreme heat impacts combines both heat and drought into one climatological event. This is especially true of the work in assessing the economic impact. It is often unclear if the impacts are from a short duration heat wave or a longer-term drought. In many cases the two hazards are inextricably linked. In the area of health impacts, the focus has been on the temperature as a causal agent of health effects.

Health impacts: The July 1995 heat wave in the United States killed 522 people in Chicago alone. Research by CDC found that on average 384 people were killed by excessive heat each year during the period 1979–92. Attributing excessive heat as a cause or contributing factor in mortality has varied considerably across jurisdictions. This has led to speculation that the actual, as opposed to reported, death toll is much higher. For example, one study suggests that the actual death toll of the 1980 heat wave

may be 5,000, not the official number of 1700. Other studies indicate that diagnosis of heat-related deaths have been regularly underestimated by 22 to 100%. In 1996, the US National Oceanic and Atmospheric Administration (NOAA) co-sponsored heat wave workshop focused on the health impacts of heat waves better forecast techniques, and community preparedness. The health effects were viewed as preventable to a large extent with improved forecasts, warnings, community preparedness, and appropriate community based response. Heat waves are categorised by officials from CDC as known preventable epidemics.

Those at greatest risk of death in heat waves are the urban dwelling elderly without access to an air-conditioned environment for at least part of the day. Thus prevention and mitigation combine issues of care for the aging and of public health.

One area not well understood is the morbidity, or injury and illness, associated with heat waves and excessive heat. Research has focused on mortality, in part because mortality data was available. This is a critical area for research in understanding and preventing the deleterious effects of excessive heat. Scientists at the 1996 heat wave workshop identified this as a high priority research need.

Transportation impacts: There are several impacts on transportation documented in case studies. Aircraft lose lift at high temperatures. Phoenix airport has been closed due to periods of extreme heat that made aircraft operations unsafe. Highways and roads are damaged by excessive heat. Asphalt roads soften. Concrete roads have been known to 'explode' lifting three to four foot pieces of concrete. During the 1980 heat wave hundreds of miles of highways buckled. Stress is placed on automobile cooling systems, diesel trucks, and railroad locomotives. This leads to an increase in mechanical failures. Train rails develop sun kinks and distort. Refrigerated goods experience a significantly greater rate of spoilage due to extreme heat.

Agriculture: Various sectors of the agriculture community are affected by extreme heat. Livestock, such as rabbits and poultry are severely affected by heat waves. Millions of birds have been lost during heat waves. Milk production and cattle reproduction also decreases during heat waves. Pigs are also adversely affected by extreme heat. High temperatures at the wrong time inhibits crop yields. Extreme high temperatures can significantly reduce all wheat, rice, maize, potato, and soybean crop yields at key development stages.

Energy: The electrical transmission system is affected when power lines sag in high temperatures. In the summer of 1996, a major US West Coast power outage involving four states was blamed in part on extreme high temperatures causing sagging transmission lines to short out. The combination of extreme heat and the added demand for electricity to run air conditioning causes transmission line temperatures to rise.

The demand for electric power during heat waves is well documented. In 1980, consumers paid US\$ 1.3 billion more for electric power during the summer than the previous year. The demand for electricity, 5.5% above normal, exceeded the supply, causing electric companies to have rolling black out periods.

Water resources: The demand for water increases during periods of hot weather. In extreme heat waves, water is used to cool bridges and other metal structures susceptible to heat failure. This causes a reduced water supply and pressure in many areas. This can significantly contribute to fire suppression problems for both urban and rural fire departments.

The rise in water temperature during heat waves contributes to the degradation of water quality and negatively affects fish populations. It can also lead to the death of many other organ-

isms in the water ecosystem. High temperatures are also linked to rampant algae growth, causing the death of many fish in rivers and lakes.

Extreme cold

The average number of deaths in the USA attributed to cold is 770 per year—substantially higher than the number attributed to heat.

Health consequences: The health consequences of extreme cold are greater in terms of mortality in humans. It appears that the causal mechanism for cold related mortality is not so much a single cold snap, as it is a longer-term chronic exposure. Thus the deadly nature of heat waves *per se* appears to be greater than that of short periods of extreme cold. Research indicates that those at risk are primarily either engaged in outdoor activity, or are the elderly who are chronically exposed to colder indoor temperatures. This mechanism of injury causes a different set of problems for community mitigation than the heat problem.

Transportation: There are a variety of transportation effects due to cold weather. Diesel engines are stressed as fuel often gels in extreme cold weather affecting trucking and rail traffic. Rivers and lakes freeze stopping barge and ship traffic. Subsequent ice jams threaten bridges and can close major highways. Cold temperatures take their toll on vehicle batteries. Sheer cold temperatures stress metal bridge structures. Transportation losses for the winter of 1976–77 came to US\$ 6.5 billion in 1980 dollars

Agriculture: Cold temperature effects on agriculture are frequently discussed in terms of frost and freeze impacts early or late in growing seasons. Absolute temperature and duration of extreme cold can have devastating effects on trees and winter crops as well. Prolonged cold snaps can affect livestock not protected from the frigid temperatures. In the winter of 1983–84, a single cold snap in December destroyed over US\$ 1 billion of the citrus crop in Florida. Louisiana lost 80% of its citrus crop. Tennessee estimated US\$ 15 million in agriculture losses. Texas experienced hundreds of millions of dollars in crop damage.

Energy: Energy consumption rises significantly during extreme cold weather. In the winter of 1976–77 additional energy consumption cost US\$ 3.8 billion (1980 dollars). This includes increased costs of electricity, fuel oil, and coal.

Water Resources and Infrastructure: Extreme cold temperatures can cause significant ground freezing problems, especially if there is little snow cover. Buried water pipes can burst causing massive ice problems and loss of water pressure in metropolitan areas. This poses a variety of health and public safety problems. One case of a broken water main in Denver, Colorado forced the entire evacuation of the medically fragile patients of the Veteran's Hospital in sub zero temperatures. Other cases of broken water mains have shut down subway systems and financial centres.

Schools often close during extreme cold snaps for the safety of children who wait for school busses.

Summary

The total impact of temperature extremes are not fully documented and known. Much of the documentation of temperature effects is combined with other meteorological events and uses climatological scales of space and time. The nature of seasonal impacts is more cumulative and complex than the impacts of cold snaps and heat waves.

Yet the impacts are measurable. Weather forecasting must take into account the hazards and the impact of temperature extremes in order to provide useful, understandable, and timely information for nations and cities to reduce natural disasters.

HYDROMETEOROLOGICAL HAZARDS

Lightning

Richard Kithil, National Lightning Safety Institute, USA



The Manhattan skyline, New York, illuminated by lightning at night

LIGHTNING IS A capricious, random and unpredictable event. Its' physical characteristics include: average peak current of 30 kA with time to peak from zero of several micro-seconds; temperatures to 30,000 K; voltages approaching 100,000,000 V; and creation of an acoustical shock wave (thunder). Globally, some 2,000 on-going thunderstorms cause about 100 lightning strikes to earth each second. Annually in the USA lightning causes more than 26,000 residential fires with damage to property in excess of US\$ 5 billion (NLSI estimates). It is the second-most frequent cause of weather-related casualties in the USA, behind floods.

The phenomenology of lightning, as presently understood, follows an approximate behaviour. Evaporation of earth surface water, caused by the sun, forms clouds of gaseous moisture. Low temperatures in the upper atmosphere freeze moisture into ice particles. Under the influence of high winds, the collision of these micro-solids produces positive and negative charges on them. Voltages grow as the thundercloud grows. Static discharges (lightning) occur from within a cloud, from cloud-to-cloud, and from cloud to ground. The downward leaders from a thundercloud pulse towards earth. Those driven by sufficient voltages seek out targets on the earth (fences, trees, blades of grass, power poles,

etc) which emit varying degrees of electrical activity during this event. Upward streamers may be launched from some of these objects. A few tens of metres off the ground, a 'collection zone' is established according to the intensified local electrical field. Some leader(s) may connect with some streamer(s). This completes the circuit. The 'switch' is closed and the current flows. We then observe lightning striking the earth.

Absolute lightning prevention is impossible. A diminution of its consequences, together with incremental safety improvements, can be obtained by the use of a holistic or systematic hazard mitigation approach, described below in generic terms.

Lightning rods

From the 1700s lightning rods have conducted stray voltages away from buildings to earth. Lightning rods, now known as air terminals, are believed to send streamers upward at varying distances and times according to shape, height and other factors. Different designs of lightning protection systems (LPS) may be employed according to different protection requirements. For example, the USA utility industry prefers overhead shielding wires for electrical substations. In some cases, no use whatsoever of air terminals is appropriate ie. munitions bunkers, picnic shelters,

etc. The LPS does not provide for safety to modern electronics or to people within structures.

Air terminal configurations may alter streamer behaviour. In equivalent e-fields, a blunt pointed rod is seen to behave differently than a sharp pointed rod. Faraday Cage and overhead shield designs produce yet other effects. Air terminal shapes and performance is a controversial and unresolved issue. Commercial claims of the 'elimination' of lightning deserve a sceptical reception.

Downconductors, bonding and shielding

Downconductors should be installed in a safe manner through a known route, outside of the structure. They should not be painted — this will increase impedance. Gradual bends (minimum 20cm radius) should be adopted to avoid flashover problems. Building steel may be used in place of downconductors where practical as a beneficial part of the earth electrode subsystem.

Bonding assures that all metal masses are at the same electrical potential. All metallic conductors entering structures (air conditioning power, gas and water pipes, signal lines, HVAC ducting, conduits, railroad tracks, overhead bridge cranes, etc) should be integrated electrically to the earth electrode subsystem. Connector bonding should be thermal, not mechanical. Mechanical bonds are subject to corrosion and physical damage. Frequent inspection and ohmic resistance measuring of compression and mechanical connectors is recommended.

Shielding is an additional line of defence against induced effects. It prevents the higher frequency electromagnetic noise from interfering with the desired signal. It is accomplished by isolation of the signal wires from the source of noise.

Grounding

The grounding system must address low earth impedance as well as low resistance. A spectral study of lightning's typical impulse reveals both a high and a low frequency content. The high frequency is associated with an extremely fast rising 'front' on the order of ten microseconds to peak current. The lower frequency component resides in the long, high energy 'tail' or follow-on current in the impulse. The grounding system appears to the lightning impulse as a transmission line where wave propagation theory applies.

A single point grounding system is achieved when all equipment within the structure(s) are connected to a master bus bar which in turn is bonded to the external grounding system. Earth loops and differential rise times must be avoided. The grounding system should be designed to reduce AC impedance and DC resistance. The shape and dimension of the earth termination system is more important a specific value of the earth electrode. The use of counterpoise or 'crow's foot' radial techniques can lower impedance as they allow lightning energy to diverge as each buried conductor shares voltage gradients. Ground rings around structures are useful. They should be connected to the facility ground. Exothermic (welded) connectors are recommended in all circumstances, as they require no inspection or maintenance.

Cathodic reactance should be considered during the site analysis phase. Man-made earth additives and backfills are useful in difficult soils circumstances: they should be considered on a case-by-case basis where lowering grounding impedances are difficult and/or expensive by traditional means.

Transients and surges: Ordinary fuses and circuit breakers are not capable of dealing with lightning-induced transients. Lightning protection equipment may shunt current, block energy from travelling down the wire, filter certain frequencies, clamp voltage

levels, or perform a combination of these tasks. Voltage clamping devices capable of handling extremely high amperages of the surge, as well as reducing the extremely fast rising edge of the transient are recommended. Adopting a fortress defence against surges is prudent: protect the main panel (AC power) entry, all relevant secondary distribution panels, all valuable plug-in devices such as process control instrumentation, computers, printers, fire alarms, data recording & SCADA equipment, etc. Further, protect incoming and outgoing data and signal lines. Protect electric devices which serve the primary asset such as well heads, remote security alarms, closed circuit television cameras and high mast lighting. Vents which penetrate from one structure to another should not be ignored as possible troublesome electrical pathways.

Surge suppressors should be installed with minimum lead lengths to their respective panels. Under fast rise time conditions, cable inductance becomes important and high transient voltages can be developed across long leads.

In all instances, use high quality, high speed, self-diagnosing protective components. Transient limiting devices may use a combination of arc gap diverters-metal oxide varistor-silicon avalanche diode technologies. Hybrid devices, using a combination of these technologies, are preferred. Clamping voltage requirements are important. Reputable vendor products are tested to rigid ANSI/IEEE/ISO9000/IEC test standards and low-priced, 'bargain' products which proliferate the market (caveat emptor).

Codes and standards: Some commercial codes and installation standards are incomplete, or out-dated. Reputable technical documents include the European IEC, German DIN-VDE, American IEEE, MIL-STD, FAA, NASA, which are supported by background engineering and the peer-review process.

Detection: Sophisticated lightning location equipment is operating in many countries. Such systems provide advance warning. Smaller lightning detectors, available at differing costs and technologies, sometimes are useful. An interesting application is employing them to disconnect from AC line power and to engage standby power, before the arrival of lightning.

Lightning sensors, when deployed on the LPS, indicate strikes to structures. Integrity of the LPS should be verified following such information.

Education: Preparedness includes: get indoors or in a car; avoid water and all metal objects; get off the high ground; avoid solitary trees; stay off the telephone. If caught outdoors during nearby lightning, adopt the Lightning Safety Position, staying away from other people, taking off all metal objects, crouching with feet together, head bowed, and placing hands on ears to reduce acoustic shock.

Measuring lightning's distance is easy. Use the 'Flash/Bang' (F/B) technique. For every count of five from the time of seeing the lightning stroke to hearing the associated thunder, lightning is one mile away. A F/B of 10=2 miles; a F/B of 20=4 miles, etc. The distance from Strike A to Strike B to Strike C can be as much as 5–8 miles. Suspend activities when you first see lightning or hear thunder, if possible. 'If you can see it, flee it. If you can hear it, clear it.' Do not resume outdoor activities until 30 minutes from the last observable thunder or lightning. Organisations should adopt a Lightning Safety Plan and integrate it into their overall safety plan.

Testing: Modern diagnostic testing is available to mimic the performance of lightning conducting devices as well as to indicate the general route of lightning through structures. Knowing the behaviour of an event prior to occurrence is every manager's earnest hope.



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GEOLOGICAL HAZARDS

Earthquake

Robin Adams, International Seismological Centre and Robin Spence, Cambridge University, UK



Photo: Tony Stone Images

Mexico City: Constructing high-rise buildings over the old lake-bed is no longer permitted because the ground has been repeatedly found to amplify the earthquake shaking experienced by these buildings

THE UNDERLYING cause of earthquakes is the accumulation of stress in the Earth, due to long-term movements of its outer layers, driven by thermal energy in its interior. When this stress becomes large enough, it is relieved by a sudden release of energy from a volume of rock, causing an earthquake. The earthquake is usually associated with rupture, and if this rupture reaches the surface, it may be recognised as a geological fault. The rupture spreads from a point of initiation known as the focus or hypocentre, and may extend for up to a hundred kilometres or more for the largest earthquakes. Elastic waves spread out from the source, first reaching the surface at the epicentre, which is the point directly above the focus. These waves may be recorded on instruments or felt as earthquake shaking.

Intensity and magnitude scales

The effects of earthquake shaking are described by intensity scales, which usually range to a maximum of XII to describe the worst damage. Earthquake magnitude relates to the total energy released at the source, and is determined from seismograph records.

Magnitude is a logarithmic scale, with each change of one unit implying a change of ten times in the amplitude of ground shaking, and about thirty times in the energy released. An earthquake as small as magnitude two can be felt if close by, and the largest known earthquakes have magnitudes approaching nine. There are several types of magnitude, but most are referred to as Richter magnitudes. Recently a further measure of earthquake size, seismic moment, has been introduced, which is related to the size of the source and the amount of rupture. Thus, an earthquake will in general have only one magnitude, which is a property of the source, but may cause various levels of intensity at different sites. The effects of an earthquake at a particular place will depend on the magnitude of the earthquake, the distance from its focus, and the properties of the ground between the source and the site, and beneath the site itself.

Global earthquake distribution

The distribution of earthquakes around the world is largely explained by plate tectonics. The outer layers of the Earth are

divided into several large plates, which move in response to underlying forces. Stress accumulates along the boundaries between these plates, giving rise to interplate earthquakes. One of the main plate boundaries encircles the Pacific, and about 80% of the total earthquake energy is concentrated in this zone. In most places, such as Japan, the Philippines, the Southwest Pacific and South America, the movement includes a vertical component, and earthquakes occur down to considerable depths, sometimes as much as 600 km. In California, however, the movement between the plates is essentially horizontal, and earthquakes occur only at shallow depths down to a few tens of kilometres. A line of plate boundaries also extends from near Indonesia through Asia to the Mediterranean region, and another system is delineated by the mid-oceanic ridges. Plate boundaries are well marked by earthquakes, but in addition there are many intraplate earthquakes far away from plate boundaries, and often in the interior of what appear to be largely stable continents. On the average there is an earthquake of magnitude eight somewhere in the world about once a year, one of magnitude seven about once a month, and several of magnitude six a week.

Earthquake hazards

Countries near plate boundaries experience frequent earthquakes. In these places there is often an awareness of possible earthquake occurrence, and most older structures have already been subjected to earthquake shaking, and the very weakest will not have survived. These areas often have deep earthquakes, the effects of which may be spread over a wide area without being particularly strong at any one place. The occasional events in what appear to be stable continental regions are often quite large, for as these rocks are not broken so often, they can store more energy. Such earthquakes can cause high damage, for structures may not have been subjected to previous shaking, and the population may not have thought it necessary to have taken even basic anti-seismic precautions. Examples of such intraplate earthquakes are those near New Madrid in central United States in the early nineteenth century, and more recently near Latur in Peninsular India in 1993, which although of only 6.2 magnitude resulted in more than 10,000 deaths. On a smaller scale, the earthquake near Liege in Belgium in 1983 caused few casualties, but did an estimated US\$ 50 million worth of damage, despite having a magnitude of only 4.6 on the richter scale.

In some of the more developed countries, styles and standards of construction have been developed that keep earthquake damage low. In Japan and New Zealand, for example houses are often constructed of wood, and will withstand strong shaking without collapsing. In other countries, such as many of those in the Middle East, the only common building materials available are masonry or stone, which afford little earthquake protection, and the population is forced to rebuild using the same materials. In these countries, earthquakes of even moderate magnitude can cause great damage when they occur at shallow depth close to centres of population. The Colombian earthquake early in 1999, for example, caused at least one thousand deaths, despite having a moderate magnitude of only 6.1.

Surface breaks on faults during an earthquake will destroy any structure across them, but most earthquake damage is caused by shaking. This is greatly affected by soil conditions. In sedimentary basins, for example, resonances can result that affect structures of a particular size, as happened in the Mexican earthquake of 1985. Poor soils can also increase the intensity level by up to two steps, as shown by the failure during the Californian earthquake of 1989 of the part of a freeway in Oakland that

crossed muddy soil. In addition, earthquake shaking can itself damage the ground, causing cracking, slumping and landslides, that is often erroneously taken to be faulting. In sandy soils, the shaking may cause liquefaction resulting in the sinking of foundations, as occurred in the wharf area at Kobe in Japan in 1995. A further effect of offshore earthquakes can be the generation of tsunami waves in the sea, which cause great devastation in coastal areas, as in the Alaskan earthquake of 1964, or in Papua New Guinea in 1998, where the death toll was more than 2,000. Fortunately, tsunami waves travel relatively slowly in the deep ocean, and their arrival at distant places can often be forecast with some success, and the population warned.

Prediction of earthquakes

The prediction of specific earthquakes in terms of place, size and time has long been sought, but has met with little success. One notable exception is the Haicheng earthquake in China in 1975, the only major earthquake to have been predicted with enough accuracy to have enabled successful civil precautions to have been taken. Seismologists now prefer to concentrate on determining seismic hazard, which is an estimate of the likelihood of shaking exceeding a given level at a given place within a given period. This is determined by considering past earthquakes, both those located instrumentally in recent times, and those revealed by evidence from history and geology. Investigation is also aided by considering the geological and tectonic environment of a site. With such information engineers and planners can take steps to reduce the effects of those earthquakes that do happen.

Earthquake consequences

The damage to structures caused by ground shaking is very often only the start of a chain of effects which together create a natural disaster. Frequently the collapse of buildings results in death and injury to their occupants. Where buildings are made of heavy materials and have not been specifically designed for earthquakes, death tolls can be very high. The most lethal earthquake this century was that in 1976 which hit the mining city of Tangshan in China, where the buildings were mainly of brick masonry, killing at least 250,000 people. Even in Japan, where more precautions were evident in modern building practices, the 1995 Kobe earthquake resulted in over 5,000 deaths, mainly through the collapse of old timber frame buildings with heavy tiled roofs. By contrast, death tolls in areas with lighter-weight materials can be much smaller. In the 1989 Loma Prieta earthquake and the 1994 Northridge earthquakes, both in California and of comparable magnitudes to the two devastating earthquakes mentioned above, less than 100 people were killed, at least in part because timber frame buildings with lightweight roofs are the normal way of building houses.

In a post-earthquake emergency it is essential to get the injured to hospital as quickly as possible, and this involves alert emergency services with a search and rescue capability, and functioning emergency hospital services. All too often, though, these emergency services are themselves badly affected by the earthquake, diminishing the community's capacity to respond just when it is most needed. In the 1997 Umbria-Marche earthquake, the hospital at Foligno, the large town nearest to the epicentre was put out of action. And in the 1999 Quindio, Colombia earthquake, several of the fire stations in the city of Armenia collapsed rendering the local emergency services ineffective.

A further devastating consequence of the ground shaking in large urban areas can be the rupture of gas mains or the overturning of heaters, causing fires. A large number of fires burning

uncontrollably can quickly turn into a conflagration, devastating whole districts and killing many people. The 1906 San Francisco earthquake and the 1923 Great Kanto earthquake which hit Tokyo are two famous examples of earthquake-caused fires, the latter causing thousands of deaths. More recently, serious fires occurred after both the 1995 Kobe and 1989 Loma Prieta earthquakes, increasing the damage caused by ground shaking.

Even those people who survive uninjured are likely to be made homeless by a serious earthquake, either for a few days while safety checks are carried out, or for much longer periods during the often protracted process of repair or rebuilding. Tents and caravans, usually provided by military or civil protection organisations, are gradually replaced by more substantial prefabricated homes, but many people are often displaced from their permanent homes for years. Such large-scale and long-term homelessness can be just as devastating to a community as the deaths and injuries caused.

It is not just homes which are destroyed, but also business premises and people's livelihoods. Small businesses, shops and workshops are often worst hit, and agriculture is often seriously affected when greenhouses or animal shelters are destroyed. Such loss of income is often not covered by insurance, so rebuilding is difficult. The effects of an earthquake on the economy of a region can be very serious, as homelessness leads to outmigration and businesses locate elsewhere. The 1997 Umbria-Marche earthquake in Italy occurred in an area which derived much of its income from tourism, a large proportion of which was lost as tourists stayed away, believing the damage to be worse than it was. In the 1995 Kobe earthquake, the closure of the port, one of the busiest in Japan, caused huge loss to the economy of a region far beyond the area damaged.

Protection strategies

Since earthquakes cannot at present be predicted, it is rarely possible to give warnings which are sufficiently specific or in sufficient time for organised evacuation. After a damaging shock has occurred it is usual to warn the population of the likelihood of aftershocks, which can be as great or greater than the first shock. In the 1997 Umbria-Marche earthquake, the most destructive shock occurred nine hours after the first and the warnings issued after the first event may have helped reduce the casualties in the second one. However, in most cases, warning cannot be relied on; thus the construction of safe buildings and preparedness planning are the most important elements of a protection strategy for areas at risk from earthquakes.

Preparedness planning involves the community at all levels. In a known earthquake area, it is essential to have well-equipped and well trained emergency services, a capability to carry out search and rescue operations, to fight fires and to support or clear dangerous structures, and hospital and mobile treatment centres which will not be damaged by the earthquake. A national civil protection organisation equipped to establish temporary settlements and to manage the chaotic conditions in the aftermath of an earthquake is also essential. Earthquake protection also involves training and preparedness planning on the part of every organisation, businesses, schools, colleges, community groups, and individuals and their families. California, Japan, Greece and Turkey are among earthquake-prone areas which have highly developed earthquake awareness and public training programmes already in place.

It is equally important to ensure that the buildings in a known earthquake area are as safe as it is economically feasible for them to be. Absolute resistance to the greatest earthquake possible is

in most cases, even if technically possible, too expensive to contemplate, except for buildings of high strategic importance like hospitals or dangerous structures like nuclear power plants. So construction codes and standards have been developed which attempt to achieve a balance between cost and safety, providing a high degree of safety against collapse, but allowing for some repairable damage in the event of a large earthquake. Developments in engineering seismology and earthquake engineering knowledge are continuously improving the quality of these codes, and increasingly engineers are able to design new buildings with a reliable degree of safety. Evidence of recent earthquakes, such as those of Kobe (1995) and Quindio, Colombia (1999) have demonstrated that buildings designed to these newer codes do perform as expected.

As most cities grow by only a few per cent each year, there remains a huge problem of buildings built to older codes, or before codes were introduced at all. This problem is particularly severe in areas like Europe where the existing buildings form a much-treasured part of the historical and cultural heritage of a region. Techniques have been developed to strengthen older unsafe buildings, whether of masonry or of modern materials, to improve their earthquake resistance. However, the cost of such upgrading is often prohibitive, and it is difficult to enforce a requirement of upgrading on building owners who cannot afford it. Thus, even in the wealthier earthquake areas of the world, like Southern California and New Zealand, progress in strengthening weaker buildings has been slow.

In most earthquake-prone cities, it is now possible to identify parts of the city in which the earthquake risk is higher than elsewhere, either because of the proximity of a known fault; the nature of the soil; susceptibility to landslides; concentrations of high-risk buildings; the use of certain building materials or the risk of a tsunami. Planning regulations can be used to restrict new building in certain areas, to reduce concentrations of populations in high-risk areas, or to prohibit building in hazardous materials or unsuitable forms.

In Mexico City, building high-rise blocks is no longer permitted on the part of the city situated over the old lake-bed, because the ground has repeatedly been found to amplify the earthquake-shaking experienced by these buildings.

Developing and transitional countries constitute a special problem for earthquake risk, because many of the earthquake protection measures described above are too expensive to be feasible and sometimes because, even when construction standards and planning regulations exist, they cannot be enforced. For poor people anywhere, spending money to protect themselves from a hazard which might not occur in the next 50 years is likely to have a lower priority than meeting the basic needs of food and shelter. Also, as parts of the world are undoubtedly becoming safer, there are many cities springing up in the earthquake areas whose uncontrolled growth is creating a serious condition of vulnerability to future shocks. Nevertheless, there are many examples to show that when an earthquake has occurred in a region, an opportunity exists to bring about a general improvement in construction standards by modifying traditional building techniques. Over the five years following the destructive 1993 earthquake in Maharashtra State in India, when approximately 7,000 people died, thousands of traditionally constructed houses have been strengthened through government- and NGO-sponsored programmes.

For all our present-day scientific and technical skill, the world's earthquake problem is still a long way from being solved and so will require continuous attention.

GEOLOGICAL HAZARDS

Volcano

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Photo: Tony Stone Images

ONE OF THE most important aspects of volcanic eruptions that must be recognised is that a range of different hazards can occur, one after the other or even at the same time. Before an eruption begins moderate-sized earthquakes may cause some damage near the vent. The ground may be deformed as magma moves towards the surface. Earthquakes or ground deformation can produce landslides. When the eruption starts, blocks of rock can be ejected explosively from the vent while fast moving, hot flows of ash, rock and gas move laterally from the vent and columns of ash rise in the atmosphere and drift downwind. A lava flow may also move from the vent. Clouds of toxic gases and aerosols can form. In large eruptions sectors of the volcanic cone may collapse to form rock avalanches. If these reach the sea tsunami can result. In the aftermath of an eruption rainfall can mobilise the ash that mantles the hillslopes, producing mudflows down drainage channels and across low-lying land.

Only exceptional eruptions produce all of these hazards, but each volcanic hazard has a range of physical properties with differ-

ent sectors around the volcano affected by different hazards at differing distances from the volcano and at different times. In addition, these volcanic hazards have different frequencies of occurrence and consequences of varying severity for humans, property, infrastructure and economic activity. The mix of volcanic hazards and the extent of vulnerabilities produce a particularly wide sweep of risks and the need for a number of risk management strategies.

Volcanic hazards and vulnerability

Attention is focused here on the properties of volcanic hazards that are most important in terms of vulnerability.

Lava flows tend to move at velocities of only a few kilometres per hour or less. Some flows are tens of kilometres long. As lava flows follow topographic depressions their paths are reasonably easy to predict and map. Lava flows crush or bury houses and other objects in their paths, but the rate of movement is sufficiently slow that people can usually escape. Active lava flows have



Photo: Associated Press

A man rides his horse in the Mexican town of Santiago Xalitzintla, as the volcano Popocatepetl spews steam in the background. Located 80 kilometres (50 miles) south east of Mexico City, the volcano blasted steam and ash into the air several times a day during December 1998, living up to its name 'Smoking Mountain' in the Aztec language

temperatures from 600–1000°C, well above the ignition points of many materials. Long-continued eruptions of lava can produce noxious hazes with deleterious effects on humans, other animals and vegetation.

Fresh bombs are ejected explosively from volcanic vents, endangering objects within a few kilometre of the source. As bombs may have densities as high as 3t/m³, impact energies are very high, certainly sufficient to penetrate all roofs except those made of reinforced concrete. Fresh bombs may have temperatures above the ignition points of many materials.

Finer material is carried higher in the atmosphere by the rising eruption column. In a large eruption, ash (usually called tephra) can reach elevations of more than 20 kilometres, and drift downwind for a thousand kilometres. Ash fall is thickest near the vent, thinning exponentially downwind. Lightning strikes occur from the cloud to the ground while shock waves produced by explosions break windows at distances up to tens of kilometres. Ashfall often produces impenetrable darkness that may last for up to a day. Where the ashfall is 20–30 cm thick the collapse of some house roofs is likely, particularly if the ash is wet, because most houses are vulnerable to thicknesses of less than a metre. Volcanic ash is also abrasive, conductive and magnetic, posing severe problems for the operation of any machinery (including aircraft) or unprotected electronic equipment.

Problems may last for weeks or longer if dry ash blows in the wind. Many humans experience respiratory problems even with ashfalls of a few centimetres, though most serious injuries and fatalities result from the collapse of roofs under the load of ash. Ash fall may not be the most severe volcanic hazard, but it certainly produces the most widespread risks.

Quite commonly during an eruption, sections of the rising ash column break away to rush down the side of the volcano as fast moving clouds of solids and gas. These pyroclastic flows (and related phenomena called pyroclastic surges) have emplacement temperatures ranging from less than 100°C to more than 900°C. Flow velocities may be as high as 160m/s. Small flows travel 5 to 10km down topographic depressions. Larger flows can travel up to 50–100km from the vent and climb over large topographic obstructions. Pyroclastic flows are the most destructive of volcanic hazards. Few humans survive except at the very margin of a flow. Even substantial structures are destroyed by impact forces.

Volcanic mudflows or lahars are one of the most common volcanic hazards. Freshly fallen volcanic ash destroys much of the vegetation cover, allowing even small amounts of rain to mobilise the ash deposits on hillslopes. Small flows of ash from slopes combine to form raging torrents with bulk fluid densities as high as 2–2.4t/m³ and sediment contents of 75–90% by weight. Lahars produce rapid aggradation, incision and/or lateral migration of streams. They may travel tens of kilometres from the volcano with the hazard continuing for months or years after the eruption has ceased. Lahars are particularly destructive of bridges and other lifelines such as water and gas pipes that are carried across rivers on bridges. Lahars can inundate large areas of houses and agricultural land. Other volcanic hazards are less common but can be extremely damaging. Sub-glacial eruptions produce massive amounts of meltwater which can burst from the glacier, producing discharges of as much as 100,000m³/s, and inundation and destruction across wide areas. Rock or debris avalanches resulting from a collapse of a sector of the volcano can bury areas of more than 100km², and create areas of new topography. In

coastal situations avalanches are likely to generate immensely destructive tsunamis. Glacier bursts, rock avalanches and tsunamis can all be extremely damaging even at distances of several tens of kilometres from a volcano.

Earthquakes accompanying or preceding volcanic eruptions are usually of only small to moderate magnitude, so that damage and fatalities are limited to relatively small areas with soft soils and vulnerable buildings. Damage to buildings produced by ground deformation is comparatively slow, commonly extending no more than a 20 kilometre radius from the volcano. Even reinforced concrete buildings can be destroyed if deformation is severe enough. Gases and aerosols from volcanoes may be a significant hazard. CO₂, fatal to humans and other animals, collects in areas of low ground or poor drainage. Other products such as SO₂, H₂S, HF, and HCl are corrosive or reactive, damaging lungs and eyes as well as metals and other materials. Fine-grained ash often has acidic aerosols attached. Rain falling through an eruption cloud may have a pH of only 4.0–4.5, leading to problems with water supplies.

Risk reduction

Volcanic hazards occur at different times in differing sectors around the volcano, with different frequencies and potential consequences. Risk reduction is obviously complex with few universal solutions.

Warning systems that accurately interpret the likely timing and course of an eruption are important. In most cases these rely on careful monitoring of eruptions and a thorough understanding of the past eruption histories and the eruption potential of individual volcanoes. In the ideal situation, detailed studies will have charted the course and severity of past hazards on high-quality hazard maps, so that the areas around the volcano most prone to specific hazards have been excluded from high-density land uses and/or have been readied for evacuation.

A successful warning implies not only that the advice proved to be technically correct but also that those at risk responded in an appropriate fashion—for example, by evacuation, or by the taping of building openings to minimise the entry of volcanic ash. Good science and warning systems were largely responsible for limiting the fatalities produced by the 1991 Pinatubo eruption, the largest eruption of the 20th Century.

However, warnings in the face of an eruption can do little to reduce the risk to buildings. Surprisingly, given the large number of towns and cities within reach of volcanic eruptions, few efforts have been made to develop building codes which increase the resilience of buildings to ashfall, the most widespread of all volcanic hazards. Such a code would specify steep low-friction roofs designed to shed ash loads, strengthened roof structures designed to carry ash loads, the absence of overhanging awnings and gutters, adequate sealing of openings, positive pressure air-conditioning, a raised floor to prevent the entry of minor mudflows, and a hardened interior refuge that might allow survival in the event of small pyroclastic flows.

Nonetheless, it must be recognised that few buildings or structures can be made resilient to lava flows, lahars and pyroclastic flows. While it is not possible to channel pyroclastic flows, both lava flows and lahars can be diverted or ponded. A successful formula for the diversion of lava flows was developed on Mount Etna in the early 1990s, using earthmoving equipment, reinforced concrete tetrapods and large quantities of explosives. Small lahars have been routinely controlled in Japan for decades using Sabo, masses of concrete and steel structures to remove the larger boulders and debris and settling basins to pond the remaining debris.

However, in the aftermath of large eruptions, lahars are likely to prove uncontrollable as Sabo works, diversion channels and settling basins are overwhelmed by the volume of sediment.

The range of potential hazards and the scope of vulnerabilities of humans, buildings, other infrastructure and economic systems indicate that volcanic risks around the world run from low to extremely high. Although it can be argued that the risks tolerated in less-developed nations are higher than those in the more affluent countries, the long dormancy of many volcanoes and the potential for rare very large eruptions from some volcanoes may challenge this generalisation.

International efforts

At one level international efforts have been poor. For example, remarkably little effort has been made, compared with engineering seismology, to investigate the effects of volcanic hazards on buildings, other structures, and lifelines. At another level, however, there have been substantial international efforts that have saved thousands of lives.

In the aftermath of the 1985 eruption of the Nevado del Ruiz volcano in Columbia, where approximately 23,000 people were killed by lahars, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) produced videos entitled *Understanding Volcanic Hazards and Reducing Volcanic Risk*. The wide availability of these videos has been important in educating communities at risk and the media about styles of eruption, the range of volcanic hazards and the potential consequences. A second IAVCEI initiative of vital significance has been the World Organisation of Volcano Observatories (WOVO) which encourages the exchange of information and technology between volcano observatories and provides highly-trained rapid-response technical support to assist at volcanoes which are moving quickly towards an eruption. Aircraft encounters with volcanic ash over Indonesia and Alaska and in several other parts of the world led to the establishment of the International Airways Volcano Watch under the auspices of the International Civil Aviation Organisation and the World Meteorological Organisation. Nine Volcanic Ash Advisory Centres have been set up to detect monitor, and forecast the movement of volcanic ash clouds around the globe and to provide standardised, timely, and accurate information.

In 1998 the Cities on Volcanoes conference was held in Naples to highlight the proximity of volcanoes to major urban areas and to 'bring together volcanologists, sociologists, economists, and city planners to evaluate volcanic crises preparedness and management in megacities and densely populated areas'. A second conference is planned for Auckland in 2000.

Recognising that available resources could be too thinly spread during the IDNDR, IAVCEI determined that research efforts and public-awareness activities aimed at enhancing an understanding of the volcanoes and the hazards posed by them would be focused on a small number of carefully selected high-risk volcanoes. Sixteen active volcanoes were chosen for detailed study: Avachinsky-Koryaksky (Russia), Colima (Mexico), Etna (Italy), Galeras (Colombia), Mauna Loa (USA), Merapi (Indonesia), Niragongo (Congo), Rainier (USA), Sakurajima (Japan), Santa Maria/Santiaguito (Guatemala), Santorini (Greece), Taal (Philippines), Teide (Spain), Ulawun (Papua New Guinea), Unzen (Japan), and Vesuvius (Italy).

International conferences and workshops have been held on most of these volcanoes during the Decade, focusing the attention of volcanologists on crucial risk reduction issues and strengthening the links between scientists and other groups with a vital concern for volcanic hazards risk reduction.

GEOLOGICAL HAZARDS

Tsunami

Eddie Bernard, National Oceanic and Atmospheric Administration, USA



Figure 1: Damage to a Japanese village as a result of the 1993 'Sea of Japan' tsunami

TSUNAMIS ARE a series of ocean waves generated by abrupt, large disturbances of the ocean surface such as earthquakes, volcanic eruptions, landslides, slumps, and meteor impacts. These waves can engulf a coastal community within minutes of their birth and cause loss of life, catastrophic destruction to structures and infrastructure, and severe erosion of the shoreline by hours of repeated attack of waves many minutes apart (Figure 1). Human suffering during tsunami flooding can be enormous: people are swept along with other debris in the tsunami-induced currents at speeds up to 60 kilometres per hour, resulting in drowning due to multiple injuries like broken bones, lacerations, abrasions, punctures, and crushed body cavities. Following the hours of tsunami attack, survivors may suffer from exposure to the environment: untreated shock may lead to gangrene, exacerbating the injuries and leading to more deaths. Since 1850, tsunamis in the Pacific have caused the death of over 120,000 coastal residents. Tsunamis are a major hazard to coastal residents in earthquake-prone regions (Table 1).

Tsunamis produce physical indicators of their presence and intensity. Knowledge of these indicators can be used to mitigate the harm to a coastal community. Most tsunamis are caused by

large earthquakes. For nearby coastal residents, strong ground shaking is the best indicator of tsunami potential. However, some damaging tsunamis are not associated with strong ground shaking. These tsunamis may be caused by 'slow' earthquakes, submarine slumping, or earthquake sources too far away to be strongly felt. Many, but not all, of these tsunamis are preceded by an abrupt lowering or draw down of the ocean surface, exposing the coastal sea floor. As the wave approaches the exposed coast, it produces a loud roar — similar to a jet plane or speeding train. The waves recede with nearly as much power as they come in, sucking trees, structures, and victims into the ocean. A period of seductive calm may occur in between successive waves, enticing the uneducated to return to the coast, ignoring the danger of the next wave.

Although 99% of tsunami deaths will occur near the generating source, tsunamis can inflict damage across entire ocean basins. Tsunamis originating in Chile have killed residents of Hawaii and Japan hours later. Tsunamis that damage distant shorelines come without the earthquake indicator but the waves will cause sudden changes in sea level and create a loud roar as they approach the shoreline.

Event			Casualties
1883	Krakatau	36,500	
1868	Chile	25,674	
1896	Japan	21,959	
1976	Philippines	8,000	
1899	Indonesia	3,620	
1933	Japan	3,064	
1854	Japan	3,000	
1998	Papua New Guinea	2,182	
1923	Japan	2,144	
1861	Indonesia	1,700	
1992	Indonesia	1,500	
1946	Japan	1,330	

Table 1: The worst 12 Pacific tsunami disasters since 1850

Over the past 100 years, about five tsunamis occur each year, one of which causes death and destruction (*Lockridge and Smith, 1983*). During the 1990s, 82 tsunamis have been reported with eleven causing 4,601 deaths and more than US\$ 1 billion in damage. Interestingly, two of the twelve most destructive Pacific tsunamis since 1850 occurred during this decade (Table 1). Tsunami deaths will probably continue to increase because of the worldwide migration of populations to vulnerable coastal areas.

Mitigation: The tsunami resistant community

The best tsunami mitigation strategy is to keep people and critical facilities out of the area of flooding. Three effective steps to create a tsunami-resistant community are to:

- 1. Produce tsunami hazard maps to identify areas susceptible to tsunami flooding
- 2. Implement and maintain an awareness/educational programme on tsunami dangers
- 3. Develop early warning systems to alert coastal residents that danger is imminent.

For example, before the 1993 Sea of Japan tsunami, residents of the fishing village of Aonae had taken these steps. About 1,400 people were at risk of dying from the one-hour tsunami attack on 12 July 1993, that flooded the village within 15 minutes of the earthquake. Upon feeling the earthquake shaking, most villagers immediately evacuated to higher ground. This action saved the lives of 85% of the at-risk population (*Bernard, 1998*). In contrast, most of the 2,730 residents of Warapu Village, Papua New Guinea, were not aware of the link between earthquakes and tsunamis. Some villagers went to the coastline after the earthquake shaking to investigate the loud noise from the sea. As a result of this inappropriate behaviour, fewer than half of the at-risk population survived the tsunami that arrived about 20 minutes after the earthquake stopped shaking the village (*Dengler and Preuss, 1999; Kawata et al, 1999*). These two examples illustrate that knowledge of tsunami dangers saves lives.

Step 1: Produce tsunami inundation maps. The first step in mitigation is to identify areas that are susceptible to flooding

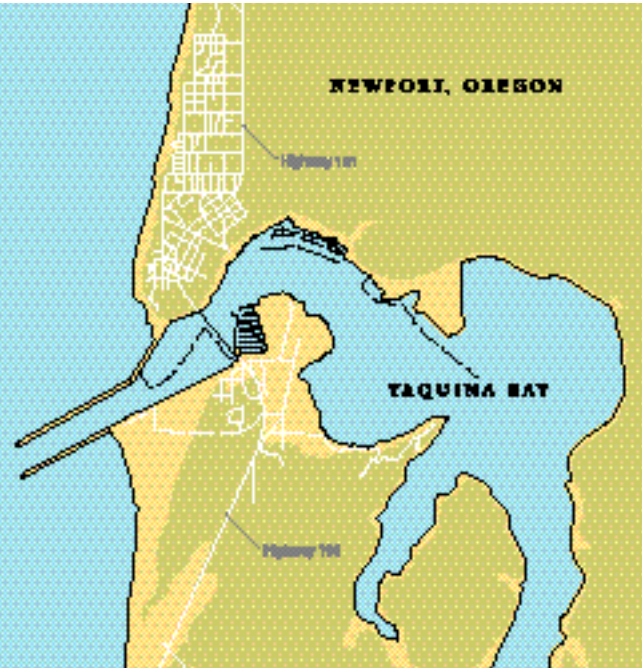


Figure 2: Tsunami inundation map for Newport, Oregon, USA

before the tsunami occurs. The ideal way to identify those areas is to use historical information as a guide but, in most areas, the historical record is short and data on tsunamis are rare. During this decade, six disastrous tsunamis were carefully surveyed by teams of international scientists to collect data on tsunami flooding processes. Using these data, scientists have developed numerical models to simulate the behaviour of tsunamis to estimate the areas that could be flooded. In 1989, the IUGG Tsunami Commission and the United Nations Intergovernmental Oceanographic Commission (IOC) formed a partnership to develop an internationally accepted methodology to produce tsunami inundation maps as a contribution to the International Decade of Natural Disaster Reduction (IDNDR) (*Bernard, 1993*). Professor Nobuo Shuto (Tohoku University) of the Tsunami Commission, with support from Japan and the IOC, established the Tsunami Inundation Modelling Exchange Program to transfer tsunami inundation mapping technology to other countries through a comprehensive training program. As of 1999, Professor Shuto, with the help of F. Imamura and M. Ortiz (*Ortiz, 1996*), were responsible for the production of 73 tsunami inundation maps in nine countries. The tsunami inundation map of Newport, Oregon (Figure 2), is a product of this technology. Technical manuals have been written to aid in the technology transfer so that 14 institutions in 11 countries now have the ability to produce maps (Table 2: *Shuto and Imamura, 1997*). Recent advances in internet technology may pave the way for even easier access to this technology. In summary, the technology and training now exists to produce tsunami hazard maps for any tsunami-threatened community.

Step 2: Implement and maintain a tsunami awareness programme. Once the areas of tsunami flooding hazard have been identified, a community-wide effort of tsunami hazard awareness is essential to educate the residents as to appropriate actions to take in the event of a tsunami. Awareness education must include the creation of tsunami evacuation procedures to remove residents from the tsunami hazard zones, the implementation of an education programme for schools to prepare students at all age levels, the co-ordination of periodic practice



Figure 2: Tsunami hazard road sign

drills to maintain the preparedness level, the development of a search and rescue plan, and the involvement of community organisations to educate all sectors of the population at risk. The IOC has developed products to assist countries in implementing tsunami awareness programs. Written educational materials in numerous languages, educational curriculums, videos, and reports from communities with comprehensive awareness programmes are available through the International Tsunami Information Centre. The US has recently developed road signs (Figure 2) for identifying tsunami hazard zones and evacuation routes. Road signs and other mitigation products are available through the US National Tsunami Hazard Mitigation Program. In summary, tsunami awareness activities are probably the most cost-effective way to create a tsunami-resistant community. However, communities must be committed to a continuous, long-term education programme as tsunamis are infrequent events and succeeding generations may forget tsunami safety lessons.

Step 3: Develop early warning systems to alert at-risk populations. Since earthquake waves travel 25 times faster than tsunamis and the speed of a tsunami is proportional to the depth of water, tsunami warning systems have used these principles in providing crude alerts about the time of arrival of tsunamis since 1933 (Dudley and Lee, 1998). Following the destructive 1960 Chilean tsunami, the IOC established the International Tsunami Information Centre to organise formal communications of tsunami warnings to all Pacific nations. To implement the warning system, a co-ordinating group was formed to ensure all nations received adequate, reliable warnings. This group accepted the offer of the United States to operate a tsunami warning system for the Pacific that would establish and maintain a network of seismometers and sea level sensors in Pacific nations feeding into the Pacific Tsunami Warning Centre in Hawaii. The Centre monitors seismic sensors continuously, and when large earthquakes are detected, the Centre can issue warnings within 60 minutes of tsunami arrival times to threatened countries through an extensive communication system. The Centre monitors sea level sensors to determine if a tsunami existed and its magnitude, and if warranted, warn other countries or cancel the warning based on

Countries with Tsunami Hazard Maps

Chile	Mexico
Colombia	Peru
Costa Rica	Puerto Rico
Ecuador	Turkey
Korea	USA
Japan	

Table 2: Coastal communities with tsunami inundation maps

updated data. A 60-minute response time is too slow for areas close to tsunami source areas, so regional and local warning systems were established in Chile, Japan, Russia, French Polynesia, and the United States (Bernard et al, 1988). Regional and local systems cover earthquakes in a smaller geographical region and can evaluate the earthquake faster and issue warnings more quickly. A limitation of these systems is a high false alarm rate because not all coastal earthquakes generate tsunamis and some warned tsunamis are so small that they are perceived as false alarms. Efforts are underway to reduce false alarms by using more advanced analysis of earthquake waves and deep-ocean sensors to detect the size of tsunamis in the open ocean (Bernard, 1998). Japan started issuing regional tsunami height forecasts in April 1999 (Takehata, 1998).

In summary, tsunami warning systems are effective in detecting tsunamis, but their lack of accuracy leads to false alarms. One promising system was installed in Chile using single station seismometers and satellite communication (Bernard et al, 1988). Affordable and reliable local warning systems are the challenge of the new millennium.

The future

The tsunami community, in concert with the IUGG Tsunami Commission and the IOC, have developed, tested, and implemented a method to produce tsunami inundation maps over the past decade. This effort, along with six tsunami field surveys, has led to the creation of 73 maps in nine countries, representing a major accomplishment. However, 4,601 people died a violent death from tsunamis in this decade. By contrasting the death rate of informed and uninformed swpopulations, ignorance of tsunami dangers may have added over 1,000 fatalities to the death toll. There is a need to resolve to improve efforts to educate coastal populations on the hazards of tsunamis. The tools are available, the expertise exists to properly use those tools, and communities at-risk are willing to take action. At a minimum, an effort should be made to provide every vulnerable community in the world with tsunami inundation maps and awareness information. This action alone may reduce the future tsunami death toll by 25–40%. There is now an opportunity to develop a low-cost, reliable, local tsunami warning technology to prevent more deaths. Action taken now can minimise the future impact of tsunamis. A good start has been made but, with additional resolve, we must not stop until deaths by ignorance of tsunami dangers are eradicated. Mitigation is the vaccination against the tsunami hazard.

GEOLOGICAL HAZARDS

Landslide

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LANDSLIDES MAY BE considered as an environmental or geomorphic product of dynamic processes related to landscape evolution. They represent a continuous search for balance between the strength of the geological materials on which slopes are naturally excavated and the gravitational forces or loads driving the mass instability. These natural geomorphic processes associated with landscape evolution are also affected by human activity, creating hazardous environments as a result of human development. The risk of disaster is a consequence of the interference between natural processes and human activities. Therefore, the determination of risk will be influenced by the vulnerability of the elements at risk.

Identification and assessment

The power of a landslide process depends on the degree of development of the landslide morphology and the activity of the slope movement, combined with the magnitude of the landslide. Any inventory of precedent landslides should include data about the activity and degree of development of each particular movement. This data may be used for a further zoning of landslide hazard, risk or danger in a region.

To enable assessment of the spatial forecasting of landslides, a map of landslide prone zones, susceptibility levels or hazards can be deduced from a preliminary analysis of the regional distribution of those factors related to the inventory of scars and deposits (Brabb et al, 1972). A detailed analysis of the landslide activity along the different stages of development, from an incipient open crack at the upper side of the slope to mass displacement, is also important in order to properly assess the correct landslide risk. Movements of variable speeds may be observed during prolonged activity, or renewed activity after an inactive interval.

To assess triggering factors of shallow landslides, earth or debris flows which have highly catastrophic consequences, a combina-

tion of geotechnical data and hydrological modelling provide the basis for predictive maps (Terlien, 1996). The methodologies of landslide mapping are very varied, in both deterministic and statistical approaches (Van Westen et al, 1999). Remote sensing methods interfacing Geographical Information Systems provide very interesting tools for the whole arena of landslide research, particularly as high resolution satellite images become more widely available.

An integrated methodology of landslide hazards and risks by means of a GIS can have the following steps:

- Inventory of rupture zones and landslide deposits
- Terrain modelling—variables computed and introduced into GIS application
- Landslide susceptibility map—obtained by methods appropriated for each type of movement as an expression of hazards
- Exposure map—obtained by extension of the susceptibility zones which could be affected by the mass propagation
- Landslide danger map—obtained by conditioned modelling of the exposure map with data related to the observed landslides activity and degree of development
- Specific or total risk maps may be obtained from a reliable map of elements at risk in the region, although further research into this is required.

A key point for any landslide predictive mapping project is the participation of those professionals engaged in the application of the established zoning in, for example, land-use planning and insurance premium determination. Their absence can lead to difficulties in terms of language and zoning compatibility with regard to objectives and legal scope. For mitigation planning purposes, DeGraff et al (1991) propose a methodology suitable for GIS applications to identify landslide-susceptible areas and implement mitigation projects (Figure 1).

Figure 1: A methodology suitable for GIS applications

Planning stage	Hazard identification	Landslide inventory
Preliminary mission	Identify hazard issue	As available
Development diagnosis	Degree of hazard from all types of landslides	Simple
Action plan and project formulation	Degree of hazard from all types of landslides supplemented by hazard from some specific types	Intermediate
Project implementation	Site-specific hazard based on geotechnical models	Detailed



Photo: Tony Stone Images

Houses collapsing into mud as a result of a landslide

Risk reduction

Kockelman (1986) originally proposes four approaches to the development of hillside slopes that can reduce economic and social losses due to slope failures:

1. Restriction of development in landslide-prone areas
2. Codes for excavation, grading, landscaping, and construction
3. Physical measures (drainage, slope-geometry modification and structures) to prevent or control landslides
4. Development of warning systems.

In the United States, these four methods of hazard mitigation, used with modern geotechnology, are considered to have reduced losses by up to 97 per cent in some regions. Of course, these programmes require input and co-operation from many parties, from geologists to government officials.

In planning landslide hazard-reduction programs, attention should be paid to possible interrelationships between landslides and other hazards. Building-code requirements in one geographic area may deal individually with landslides, floods, earthquakes, and tornadoes, but the ideal requirement is one that takes into account all of these hazards (Schuster & Kockelman, 1996).

The imbricated network of organisms, public and private interests dealing with the problems is described within USGS Circular 880 (1982), where it establishes how 'the criteria, decisions, and methods used in applying the landslide research findings to planning and decision making may be of value to other jurisdictions in which similar hazards exists, and for which adequate landslide

information is available. The adaption and adoption by other jurisdictions depends upon the presence of similar public awareness, enabling legislation, hazard issues, priorities, community interest, innovative decision makers, and staff capabilities'.

Insurance programmes can reduce the impact of landslide losses on individual property owners by spreading these losses over a larger base and discouraging development in landslide-prone areas, thereby encouraging lower-risk land uses.

Government efforts are also crucial. In California, USA, the San Mateo County zoning ordinances began to apply preventive measures in 1973 by regulating a maximum average density of one dwelling unit per five acres, and a slope-stability ordinance further restricts development to one unit per 40 acres where the land is underlain by landslide deposits more than 500 feet long. The basis for these ordinances was a landslide susceptibility map and a slope angle map of the county.

The Territory of Hong Kong also relies on a rainfall-monitoring system for identifying periods of high landslide potential. An excellent example of integration of landslide activity inventory and analysis with susceptibility evaluation and hazard zoning and mitigation measures was performed by the Civil Engineering Department of Hong Kong. Check dams, slit dams, flow impediments, deposition areas, channel works and containment structures are typical works resulting from this mitigation project in Hong Kong where the demand for land is a continuous trend. There, more than 25,000 visible landslides have been collected in natural terrain on a 1:5,000 base map.

Emergency response and crisis management	Dealing with the problems only after they arise: planning for these emergency procedures may be needed where development has already taken place without reference to the stability of slopes. • This response involves avoidable costs and may be unacceptable where public safety is at risk.
Planning for losses	Spreading the losses by insurance, statutory compensation or fiscal measures: the risk of losses may need to be accepted where development has already occurred on unstable slopes. • This response involves avoidable costs and may be unacceptable where public safety is at risk.
Modify the hazard	By prevention or correction: slope stabilisation measures, rock fall protection structures, good practice in property maintenance and restrictions on certain engineering activities may help to prevent or reduce the losses arising from landsliding. • This response may be justified where there is a significant risk to public safety or building and structures; implementation may be constrained by economic or land ownership considerations.
Control the effect	By avoidance: the identification of landslides and the use of hazard in planning control may enable the effects to be avoided altogether by not developing in landslide areas; and By engineering controls: planning and building controls may enable losses to be avoided or reduced through design and construction measures.

Figure 2: Unforeseen landslide events

In France, the ZERMOS (zones exposed to slope movements) programme started in 1972 in a preliminary stage and, from 1975 to 1980, developed several 1:25000 landslide hazard maps for consideration in the legal regulation of land-use planning. These hazard maps have attained a departmental use in the Alps Maritimes, an area particularly affected by landslide hazards.

In the United Kingdom, there has been considerable research into landslides and the British Department of Environment recently proposed a planning policy guidance for the development of unstable land affected by landslides (*HMSO, PPG 14, 1996*). This guidance is more detailed than previous common practice in the UK and may therefore raise resource implications for some local planning authorities. The recommended incremental method of landslide assessment it includes will enable these costs to be spread over a period of time. There is also a possibility of some compensatory savings over the long term in respect of the costs of local authority developments, including unforeseen landslide events (Figure 2).

A risk map as a base document for land-use planning has recently been adopted in Switzerland (*Lateltn, 1997*) for the integration and recognition of natural hazard is a legal task to be accomplished in the land-use planning projects. Although the natural risk maps are not documents with legal meaning, once these maps are included in the administrative process of land-use planning their consequences are at a regulatory legal level. Different counties must develop their own natural hazard maps, particularly as natural hazard maps are often a condition for financial support of mitigation projects. The change of land-use or activities will only be permitted and observed after a process of consideration of possible influence and vulnerability.

Conclusions

A new era of GIS and remote sensing techniques clearly maintains the need for high quality geological field data as the basis for any landslide research. If the use of these maps and new GIS applications are proposed to civil engineers, land-use planners and insurance officers, there is a definite need for new official regulations and good basic field geology in many countries. In addition, a new approach is needed to encourage the participation of the end user of such maps to improve their usefulness and social acceptance. It is also important to develop method-

ologies for the assessment of landslide hazards that are compatible with other natural hazards studies. The new era of powerful GIS and high resolution remote sensing tools also provides the potential for an era of improvement in the preparation of landslide and other natural hazard maps. This is more likely to occur if the end user is convinced of the value of such studies.

A good proposal made on the basis of these and other collective experiences, could be a successful and unified national programme of landslide hazard reduction following the key elements discussed by Swanston and Schuster (1989):

- Identification of a central organisation for management of a national landslide loss-reduction programme
- Establishment of limits of responsibility of federal, state and provincial, municipal, and private entities in dealing with landslide hazards
- A national effort to identify and map hazardous areas, define process characteristics, and deter, mine degree of risk
- Development of guidelines for application of reduction techniques to identified hazards
- Development of minimum standards of application and professional practice (standards should be created by professional societies in collaboration with federal and national governments)
- Regulation of minimum standards of application and professional practice (in conjunction with professional societies) through periodic review and upgrading of practice guidelines; building codes, and land use practices
- Strong support of federal and national government and university research dealing with process mechanics, reduction techniques, and warning systems
- Provision of a central clearing house for collection and distribution of publications and guidelines to professionals, agencies, and local governments
- Relief and compensation programmes through federal and national and private insurance funds.

Despite all these proposals and experiences, it remains far too frequent that it takes an actual disaster to occur to provoke action. As such, perhaps the greatest challenge, and one which is being strongly promoted through the IDNDR, is to ensure that efforts are focused on disaster preparedness and prevention.

GEOLOGICAL HAZARDS

Glacial

Dr John Reynolds & Dr Shaun Richardson, Reynolds Geo-Sciences Limited, UK

WHEN A GLACIER or glacier-related feature adversely affects human activities, directly or indirectly, it is considered to be a hazard. During the 20th Century over 32,000 people have been killed by glacially-related phenomena. Many hundreds of millions of dollars worth of damage have been caused and vital infrastructure either damaged or destroyed.

Of the glacial hazards listed in Table 1, probably the most significant in terms of potential disaster mitigation is that posed by Glacier Lake Outburst Floods (GLOFs, Ives, 1986).

In the Himalayas and the Andes, there is a growth in the exploitation of hydro-power and increasing pressure on rural development. Yet it is in these high mountainous areas that glacial hazards are most prevalent. These mountains contain many thousands of glaciers ranging in size from less than one square kilometre to tens of square kilometres. As climate changes and the glaciers recede, lakes commonly form behind moraine dams created by the previous advance of the glaciers. These dams are prone to sudden and catastrophic failure as a consequence of one or more breach mechanisms, such as melting ice cores or seismic shaking. Upon failure of a dam, many millions of tonnes of water and debris can be released to flow downstream, sometimes at speeds of up to 80 kilometres per hour. The resulting GLOF deluge rips up vegetation and rock debris, and defoliates trees whose trunks then become massive battering rams. The combination of water, timber debris and mud is lethal both in terms of the immediate damage caused and the environmental havoc that remains after the floodwave has passed.

One aspect that is most frequently ignored is the fact that GLOF waves can travel over distances in excess of 200 kilometres. For example, the Lunana flood that occurred in Bhutan in 1996 killing 27 people still had a floodwave height of two metres at a distance of 200 kilometres from the source, as measured by river hydrographs. The initial volume of water discharged when the glacial lake breached through its moraine dam is thought to be around 45 million cubic metres. Peak discharges of the order of 2,500 cubic metres per second have been estimated for this event. Low-lying farmland, rural housing, footpaths, livestock, etc, as well as unsuspecting people close to the river are extremely vulnerable to floodwaves even as small as two metres high. However, closer to the source, floodwaves can reach 20–50 metres above the normal river level, especially on the outside of meanders, as the flood ricochets off the often steep valley flanks.

Assessment of the hazards and associated preparedness

Historically, the first time people become aware of the dangers of GLOFs is when they strike, causing significant damage. For example, in Nepal, the catastrophic drainage of Dig Tsho in Central Nepal, totally destroyed a hydro-electricity plant two weeks before its inauguration in 1985. The Lunana flood previ-

ously mentioned was the first officially recorded disaster of its kind in Bhutan. In Peru, in 1941, six thousand people were killed by a flood of only four million cubic metres of water when it struck a shanty area of the town of Huaraz. Each of these events caused the respective government to respond to the issue of glacial hazards. In Peru, even after more than 50 years after the Huaraz disaster, there is no inventory of glacial lakes within the country. Similarly in the Himalayas, no national inventories exist to indicate the potential scale of the problem. Yet it is clear from an analysis of reported events in the central Himalayas that the number of events and their frequency of occurrence are increasing, see Figure 1 (*Reynolds Geo-Sciences Ltd, 1998*).

From experience over the last 15 years, it is clear that the most efficient first stage in assessing the potential scale of possible glacial hazards in a geographical region is through remote sensing using satellite imagery. For example, in a three week period in 1998, a review of glacial hazards in Bhutan was undertaken and over 400 different glaciers were examined using satellite imagery with a ground resolution of the order of 20 metres. From this it was possible to identify traces of past GLOF events, glacial lakes currently considered to be at risk, and areas that could develop significant glacial lakes in the future. In Central Nepal, as part of the Tsho Rolpa GLOF Risk Reduction Project, monochrome vertical aerial photography has been used as well as colour oblique photographs obtained from a helicopter. Key areas can be investigated very quickly and high quality images obtained for subsequent analysis.

In order to complement remote sensing analysis, it is essential that detailed ground investigations are also undertaken. Detailed topographic surveying of profiles and benchmarks is required as baseline data. Detailed geomorphological mapping should be coupled with this to determine the glacial geology of the natural dam, and a glaciological review made of the local glaciers to assess the avalanche risk, modes of ice calving and potential sizes of ice block detachment. Where an active glacier terminates in or near a lake, ice calving from the ice tongue can produce displacement waves that can easily propagate along the lake to reach the terminal moraine and still be two metres high. Where the freeboard (height of dam above water level) is only around 1 metre, such a displacement wave is large enough to overtop the dam and cause regressive erosion of its outer flank. In some cases, this is sufficient to trigger the collapse of the dam.

As most glaciers in the Andes and Himalayas were previously much larger than at present, significant bodies of stagnant glacier ice remain buried within the moraine dams of some lakes. A buried ice core like this can eventually result in degradation and subsidence of the dam and lead to its eventual collapse. Where these significant buried ice masses are thought to occur, they can be investigated by using geophysical methods such as Ground

Time Scale	Hazard	Description
Minutes	Avalanche	Slide or fall of large mass of snow, ice, and/or rock
Hours	Glacier Outburst	Catastrophic discharge of water under pressure from a glacier (especially in the case of ice-dammed lakes)
	Glacier Lake Outburst Flood (GLOF)	Catastrophic discharge of water arising from a breached dam of a glacial lake
	Jökulhlaup	Sub-glacial outburst associated with volcanic activity
	Aluviòn	Catastrophic flood of liquid mud, irrespective of its cause, generally transporting large boulders (Spanish; plural: aluviones)
Days-weeks	Flood	Areal coverage mostly by water
Months-years	Glacier surge	Rapid increase in rate of glacier flow
Years-decades	Glacier fluctuations	Variations in ice front positions due to climatic changes, etc.

Table 1: Types of snow and glacier hazard (after Reynolds, 1992)

Penetrating Radar and electrical methods (DHM, 1996; Reynolds, 1997; Yamada, 1998).

Disaster prevention and hazard mitigation

Having identified a risk of glacial hazards in relation to vulnerable communities and infrastructure, it is then necessary to try to prevent a disaster if at all possible. This can be achieved through two routes: installing an Early Warning System (EWS) and through hazard mitigation.

For an Early Warning System, some form of parameter criteria need to be established for the style of hazard for which warning is to be provided. For a GLOF, for example, a rapid rise in water level in a succession of sensors located along the likely discharge route would trigger the sounding of a siren warning of an impending GLOF wave.

One such system has been installed in the Rolwaling, Central Nepal, to warn of a flood event from Tsho Rolpa. Local villagers downstream of the glacial lake have been involved in the design and location of the system and are active participants in maintaining it. Regular alarm drills are carried out so that all local residents know what to do in a real emergency.

While the presence of an EWS gives some sense of security, it does little to actually prevent the massive destruction that may result from a GLOF. The only way of achieving this is to remove the main source of a GLOF, ie. the water within an affected lake. This can be achieved by various methods, depending upon the scale of the problem and the time and budget available to undertake the work. In some cases, the water level can be reduced using siphon pipes. These have been used to great effect in the Cordillera Blanca (Reynolds *et al*, 1998) and have also been installed at Tsho Rolpa (Reynolds, 1998). Simple engineering cuts through natural dams have been achieved in Peru. Although, if care is not taken, this in itself can lead to a major catastrophe (eg. Lliboutry *et al*, 1977).

Excavation through the crest of a moraine, insertion of a culvert system and reconstruction to restore freeboard has also been undertaken in Peru (Reynolds *et al*, 1998). For much larger lakes and where solid rock is accessible, tunnelling through bedrock to provide drainage tunnels has also been successfully undertaken (Reynolds, 1992; Reynolds, *et al*, 1998).

An important aspect of making high-altitude glacial lakes safe is that the methods of remediation can be harnessed to facilitate

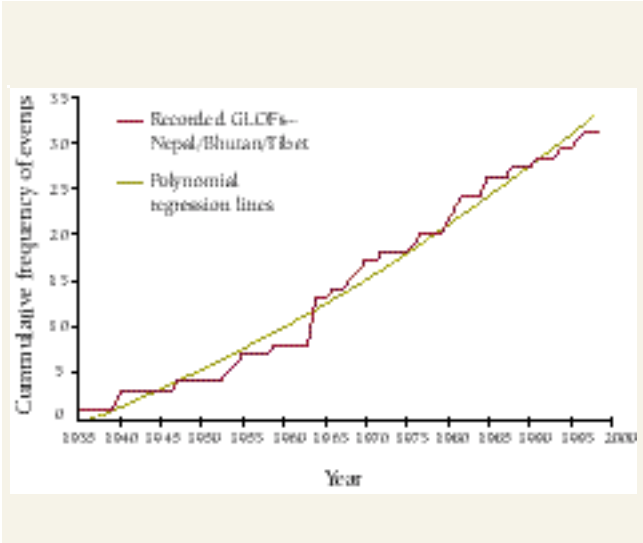


Figure 1: Cumulative frequency of recorded glacial lake outburst floods in Central Asia (for 31 events)

safe management of the water resource for hydro-electric power at a local scale (micro-hydro power) and for export (major hydro-electric power generation facilities). Dry season river flows can also be enhanced to maintain adequate water levels to protect valuable fish stocks and to maintain water supplies for local usage. Disaster risk reduction methods can thus be integrated into regional or national rural development strategies.

While the problem of formation and potential catastrophic drainage of glacial lakes is clearly developing, the technology is available to identify the scale of the problem. Assessment of glacial hazard risk can be undertaken using remote sensing techniques followed up by detailed ground investigations. Given the time, resources and political will, it is possible to identify, assess and drain potentially problematic lakes to remove the water that can form a Glacial Lake Outburst Flood. By so doing this removes the cause of the risk.

The methods of risk reduction can also be used to assist in the management of glacially-derived water resources both for local use and for regional exploitation especially for the generation of hydro-electric power.

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ENVIRONMENTAL AND TECHNOLOGICAL HAZARDS

Wildfire

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Wildfires—a fire which rages out of control, are common in all vegetation zones and are mostly caused by negligence

WILDFIRES ANNUALLY effect several hundred million hectares of forest and other vegetation of the world. In some ecosystems fire plays an ecologically significant role in biogeochemical cycles and disturbance dynamics. In other ecosystems fires lead to the destruction of forests or to long-term site degradation. In most areas of the world, wildfires burning under extreme weather conditions have a detrimental impact on economies, human health and safety, with consequences which are comparable to the severity of other natural hazards/disasters.

Fires in forests and other vegetation produce gaseous and particle emissions that have impacts on the composition and functioning of the global atmosphere. These emissions interact with those from fossil-fuel burning and other technological sources which are the major cause for anthropogenic climate forcing. Smoke emissions from wildland fires also cause visibility problems which may result in accidents and economic losses. Smoke generated by wildland fires also affect human health and, in some cases, to loss of human lives. Fire risk modelling in expected climate change scenarios indicate that within a relatively short period, the next three to four decades, the destructiveness of human-caused and natural wildfires will increase. Fire management strategies which include preparedness and early warning

cannot be generalised due to the multi-directional and -dimensional effects of fire in the different vegetation zones and ecosystems and the manifold cultural, social, and economic factors involved. However, unlike the majority of the geological and hydro-meteorological hazards included in the IDNDR Early Warning Programme, wildfires represent a natural hazard which can be predicted, controlled and, in many cases, prevented.

Global fire occurrence

Reliable statistical data on occurrence of wildfires and land-use fires, areas burned and losses are available for only a limited number of nations and regions. Within the northern hemisphere, the most complete dataset on forest fires is periodically collected and published for all the member states of the Economic Commission for Europe (ECE). Most recently this was for the period 1996–97 (ECE/FAO, 1998). It includes all Western and Eastern European countries, countries of the former Soviet Union, the USA and Canada. Since the dataset is restricted to forest fires, it does not include land-use fires which are also a major source of fire-caused smoke pollution.

Other countries from outside the ECE/EU region report fire statistics in the pages of International Forest Fire News and other published and non-published reports. This statistical data is

currently updated at the Global Fire Monitoring Centre (GFMC) as part of the first phase of the Global Vegetation Fire Inventory.

A global dataset of fire activities has been developed on the basis of active fires detected by the NOAA AVHRR sensor (Dwyer *et al*, 1998). This dataset provides the temporal and spatial distribution of vegetation fires throughout the year. However, it does not yet provide a quantitative database in terms of area burned, vegetative matter combusted, and gas and particle emissions generated. Spaceborne sensors have been used in a large number of case studies to determine land areas affected and emissions produced by fires. Thus, potential tools for a quantitative inventory of fire effects using spaceborne sensors are available.

The following information is partially taken from the International Decade for Natural Disaster Reduction (IDNDR) Early Warning Programme Working Group Report ‘Fire and Related Environmental Hazards’ (Goldammer, 1997), the FAO study on ‘Public Policies Affecting Forest Fires, Europe and Temperate-Boreal Asia’ (Goldammer, 1998), and the Global Fire Monitoring Centre database (Goldammer, 1999; GFMC website).

Main types of vegetation fires

Wildfires (uncontrolled fires) are common in all vegetation zones. They are mostly caused by negligence and are often associated with escaped land-use fires. Both wildfires and land-use fires can directly or indirectly cause immediate damages or have long-term environmental or humanitarian consequences. Despite the fact that many ecosystems are well adapted to fire and land-use fires often follow traditional and established practices, there is an increasing tendency of fire events which can cause conflicts with the needs of the rapidly growing populations of developing countries and conflicts at the interface with vulnerable structures of industrialised societies.

Wildfires in forests: In the temperate and northern boreal forests, wildfires are occurring regularly during the dry northern summers. In North America and Eurasia between five and 20 million hectares are burned annually. In the less populated high latitudes the ignition sources are dominated by lightning, while in more frequently populated regions humans become the predominant fire cause.

In the Mediterranean region an average of about 0.6 million hectares of forest and other land is burned annually.

The equatorial rain forests are usually too moist to allow the propagation of wildfires. However, extreme droughts in association with forest exploitation periodically create conditions of flammability, fuel availability and fire spread in the equatorial rain forests. Such events regularly occur in the forests of tropical South Asia in association with cyclic climate variability caused by the El Niño-Southern Oscillation (ENSO) phenomenon. Some examples of large-scale (catastrophic) fire events are given below.

The largest areas affected by uncontrolled wildfires in tropical forests are in the seasonal forest biomes (deciduous and semi-deciduous forests, sometimes also referred to as ‘monsoon’ forests). Here, the fires are burning in short return intervals of one to three years. The tropical submontane coniferous forests (pine forests) are also subjected to regular fires.

Burning of tropical grass, brush and tree savannas: Tropical savannas cover an area of about 2,300–2,600 million hectares worldwide. Savannas typically consist of a more or less continuous layer of grass with interspersed trees and shrubs. There are numerous transition types between savannas and open forests. The surface fuels in these ecosystems which are dominated by grasses and leaves which are shed during the dry season, are burned periodically at intervals which may range from one to four years. This fire frequency has been increasing in some regions as a result of increasing population and more intensive use of rangeland. The area of savannas potentially subjected to fire each year is up to several hundred million hectares. As a result, savanna burning releases about three times as much gas and particle emissions into the atmosphere as deforestation burning. It is estimated that more than 3,000 million tons of vegetative matter are burned in tropical savannas annually.

The conversion of forest and brushland to plantations, agricultural and pastoral systems: Two types of forest clearing for agricultural use are common, predominantly in the tropics: shifting agriculture, where the land is allowed to return to forest vegetation after a relatively short period of use, and permanent removal of forest to be converted to grazing or crop lands. In both instances, the clearing and burning follows initially the same pattern: trees are felled at the end of the wet season. After extraction of marketable and otherwise usable trees, the vegetation is left for some time to dry out in order to obtain better burning efficiency. In shifting agriculture, which is practiced by several

Table 1: Market values such as loss of timber or tourism activity have been calculated below

• The large wildfires in Borneo during the ENSO drought of 1982–83 burned more than five million hectares of forest and agricultural lands. Loss of timber values of ca. US\$ 8.3 billion, and a total of timber and non-timber values and rehabilitation costs of US\$ 9.075 billion. • First assessment of damages caused by the fire episode of 1997–98 in Indonesia on ca. 8–9 million ha: US\$ 10 billion (short-term health damages, losses of industrial production, tourism, air, ground and maritime transportation, fishing decline, cloud seeding and fire-fighting costs, losses of agricultural products, timber, and direct and indirect forest benefits and	capturable biodiversity); 40 million people in SE Asia affected by smoke in various degrees (by increased morbidity and mortality; long-term health effects); less than 250 human deaths toll by aircraft and maritime accidents. • The fires burning in Mexico during the 1998 episode forced the local government to shut down industrial production in order to decrease additional industrial pollution during the fire-generated smog. Daily production losses were ca US\$ 8 million.	• Australia’s Ash Wednesday Fires of 1983: human death toll: 75 burned homes: 2539 burned dom/livestock: 300,000 • Extended forest and savanna fire in Côte d’Ivoire 1982-83: human death toll: >100 burned land area: 12 million ha burned coff/plantations: 40,000 burned cocoa plantations: 60,000 • Forest fires in the Northeast of the People’s Republic of China during the 1987 drought: human death toll: 221 burned forest: 1.3 million ha homeless population: 50,000 total human death toll 1950–90 (all China): 4,137	• Same fire episode in the Soviet Union during the 1987 drought: burned forest: 14.5 million ha • Mongolia steppe and forest fires 1996–97: burned area 1996: 10.7 million human death toll: 25 burned domestic animals: 7000 burned stables/houses: 576/210 damage assessment: US\$2 billion burned area 1997: 12.4 million ha • Yellowstone National Park (USA) 1988: suppression costs: \$US 160m loss in tourist revenues between 1988 and 1990: \$US 60 million

hundred million people worldwide, the cleared areas are used for agriculture for a few years until yields decline, and then are abandoned and new areas cleared. The generally observed shortening of shifting agriculture cycles is increasingly associated with site degradation and make this traditional land-use technique one of the leading causes of global tropical deforestation.

The conversion of primary or secondary forest into permanent agriculture and grazing land, including tree plantations, is driven by expanding human populations that require additional food and living space, but also by large-scale resettlement programmes and land speculation. The net amount of plant biomass which is combusted in the process of vegetation clearing is somewhat in the range of one to two billion metric tons per year.

The burning of agricultural residues, the control of bush and weeds, nutrient cycling on grazing and croplands: A substantial amount of agricultural residues, eg. straw and stalks, is disposed by burning. The magnitude of this practice is extremely difficult to quantify because of its distributed nature. No statistics are available, mostly because material of direct economic value is not involved. It has been estimated that between 800 and 1,200 million tons of agricultural residuals are burned annually, making this practice a major source of atmospheric pollution, mainly in the tropics.

By tradition, fire is also a common practice to control bush and weed encroachment and grazing and crop lands.

Recent major fire episodes and losses

Comprehensive reports with final data on losses caused by forest and other vegetation fires (wildland fires), including impacts on human health, are only occasionally available. The main reason for the lack of reliable data is that the majority of both the benefits and losses from wildland fires involve intangible non-use values or non-market outputs which do not have a common base for comparison, ie. biodiversity, ecosystem functioning, erosion, etc. Market values such as loss of timber or tourism activity have been calculated in some cases, see Table 1.

Smoke pollution generated by wildland fires occasionally creates situations during which public health and local economies are affected. Fatalities in the general public caused by excessive carbon monoxide concentrations have been reported from various fire events, eg. the above-mentioned forest fires in China in 1987. Firefighters who are regularly subjected to smoke are generally at higher health risk.

The use of fire in forest conversion and other forms of land clearing and wildfires spreading from these activities are very common in tropical countries. In the 1980s and 1990s most serious pollution problems were noted in the Amazon Basin and in the South East Asian region. The most recent large smog episodes in the South East Asian region were in 1991, 1994 and 1997 when land-use fires and uncontrolled wildfires in Indonesia and neighbouring countries created a regional smog layer which lasted for several weeks. In 1994 the smoke plumes of fires burning in Sumatra, Indonesia reduced the average daily minimum horizontal visibility over Singapore to less than two kilometres; by the end of September 1994 the visibility in Singapore dropped to as low as 500 metres. In the same time the visibility in Malaysia dropped to one kilometre in some parts of the country. A study on asthma attacks among children revealed that a high concentration of fire-generated carbon monoxide, nitrogen dioxide and inhalable suspended particulate matter was responsible for the health problems. The smog situation in September 1997 caused the worst smoke pollution in the region, reflected by a value of 839 of the Pollutant Standard Index (PSI)

in the city of Kuching (Sarawak Province, Malaysia); the government considered evacuating the 300,000 inhabitants of the city. It has been estimated that 40 million people suffered smoke pollution in Southeast Asia during the 1997–98 episode.

Smoke from fires can also cause disruption of local and international air traffic, and wildfires burning in radioactively contaminated vegetation lead to uncontrollable redistribution of radionuclides.

Hazard assessment as the basis of risk analysis

Early warning systems for fire and smoke management for local, regional, and global application require early warning information at various levels. Information on current weather and vegetation dryness conditions provides the starting point of any predictive assessment. From this information the risk of wildfire starts and prediction of the possibility of current fire behaviour and fire impacts can be derived. Short- to long-range fire weather forecasts allow the assessment of fire risk and severity within the forecasting period. Advanced spaceborne remote sensing technologies allow fire weather forecasts and vegetation dryness assessment covering large areas (local to global), at economic levels and with accuracy which otherwise cannot be met by ground-based collection and dissemination of information. Remote sensing also provides capabilities for detecting new wildfire starts, monitoring ongoing active wildfires, and, in conjunction with fire-weather forecasts, providing an early warning tool for escalating, extreme wildfire events.

Fire prevention and control: The role of communities

On a global scale, the majority (approximately less than 80%) of all wildfires start in the context of land use. Negligence, ignorance, and lack of ability (lack of technologies and training) to control escaping fires are the main responsible causative agents. Thus, fires represent a natural hazard which cannot only be predicted and controlled but also prevented. Fire prevention, however, must address different sectors of the society. Public policies which determine land use, protection of resources, or welfare of rural populations, create the main underlying conditions of wildfire occurrence. Individuals and groups which use fire in forests, agriculture and pastoralism are the main cause for disastrous wildfires. At the same time they are potentially threatened by wildfire.

Public education programmes for fire prevention address target groups which vary from country to country. Negligent urban people (tourists) are often main fire starters in the industrial countries, must be targeted by specific public awareness campaigns using mass media or specific advertisements, eg. in recreation areas, national parks etc. Education programmes for school children involve different media to transport messages of environmental protection including forest fire prevention.

Most important in wildfire prevention is the involvement of rural communities. Experience in community-based fire management shows that incentive programmes create conditions of a positive atmosphere of collaboration and trust between land users and authorities.

Conclusions

Unlike the majority of the geological and hydro-meteorological hazards included in the IDNDR Programme, wildfires represent a natural hazard which can be predicted, controlled and, in many cases, prevented. Since the majority of wildfires are caused by humans, the success and efficiency of fire-oriented disaster programmes primarily depends on pro-active fire prevention.

Environmental and Social

Maritta von Bieberstein Koch-Weser, The World Conservation Union, Switzerland

ALTHOUGH THEY occur regularly, floods and hurricanes are treated as unpredictable, one-time disasters and emergencies. When disaster strikes, funds are marshaled internationally for emergency assistance, mostly to repair the terrible damage that has affected local infrastructure.

In many places on earth we have seen repetitions of the cycle of physical reconstruction and nature's wrath in regular intervals. This suggests that we need to work on the fundamentals of greater resistance to natural disasters. Beginnings have been made in this respect. There are investments into greater resistance in the context of engineering, with better building standards, and with the construction of shelters. However, what is done so far is insufficient as the reconstruction and disaster preparedness concept is not extended to environmental and social interventions.

There is a need to develop a coherent disaster preparedness strategy on a country-by-country basis especially in river basins. Coherence will come when governments treat disasters as normal events, which deserve consideration in mainstream, long term planning. Coherence will come when basic structural improvements are put in place, which will make physical infrastructure, natural systems and water management, and human communities more resilient.

Let me argue for two aspects, which so far receive the least attention: environmental and social disaster preparedness and reconstruction.

Environmental reconstruction

Why has Hurricane Mitch been so devastating in Central America in 1998? Because many of the natural systems, which used to buffer against devastation, have been the drastically altered over the years. In upper watersheds, where forests used to protect the soil and to retain water, there are now communities with their housing, livestock and agriculture. In these unprotected watersheds the topsoil and entire communities were swept away by torrential waters. Gone are the previous absorptive capacity of forests and natural wetlands, which can absorb excess waters in a sponge-like fashion. And where even 30 years ago substantial coastal mangrove forests would have prevented much of the valuable soil from being swept up into the ocean, today there are only plundered remnants of mangrove forests, as these have been thinned out by people in search of fire wood, or as these have become shrimp farms or beach side tourism developments.

There are viable alternatives to these patterns of destruction. Nowhere was the positive role that intact natural systems can play in withstanding disasters more evident than in the very few Honduran watersheds where reforestation and soil conservation had indeed taken place as part of development assistance programs. 1998 provided the lesson that where nature is better managed, there is far less physical damage. In some of these better protected areas, there were no deaths at all among the affected population.

What will be different when the Hurricane Mitchs of the future recur, or when El Niño strikes once again? So far, not much,

because emergency assistance programmes are not focusing on medium and long-term disaster preparedness.

Unless true attention is given to investments in environmental reconstruction of upper watersheds, wetlands and mangroves, damage will be repeated and come each and every time with billion dollar price tags associated with infrastructure damage. Moreover, with time, there will be a detrimental cumulative effect, as finite environmental resources are swept away forever—precious soil and ecological resources.

Social reconstruction

Social reconstruction is a theme closely related to environmental preparedness and reconstruction. Unless Governments assist in strategic restructuring, local people have no choice following a disaster, they will reconstruct their lives in the very same unsafe places where they lived before, because these are the only places to which they have access. And they will repeat the very same inappropriate production patterns—the only ones they know.

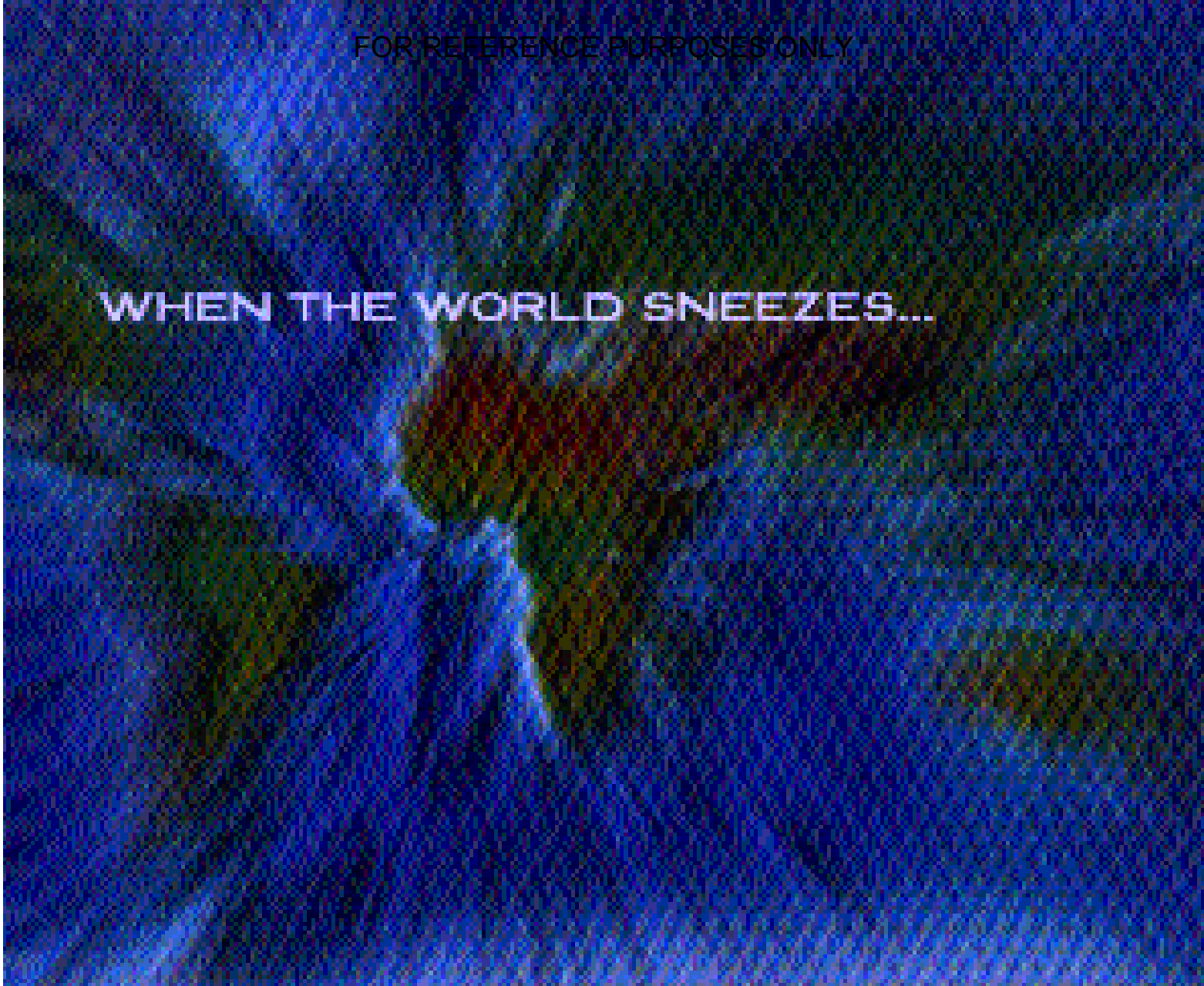
There is, therefore, a need for governments to carry out and financially support environmental zoning for disaster prevention, allowing only certain occupation and production patterns, eg. afforestation instead of agriculture or livestock grazing in mountain environments. In turn, these mandatory changes in land use or the stronger protection of wetlands and mangroves affect people—often poor people—directly, and they may require a strong combination of resettlement, land redistribution and education measures.

Social reconstruction is also fundamental to the saving of human lives. Most of the thousands of people who perished in the floods of 1998 were living in unsafe low-lying areas. Before they could flee, their houses were swept away. Typically, the poorest people live in the most marginal locations, in a dangerous flood plain, which nobody else claims, or on a steep hillside in inadequate housing which cannot resist a storm. Instead of concentrating funds in infrastructure alone, far more attention should be given to the need to find land and alternative habitats for the poor. This is where disaster prevention and preparedness encounter the most intractable difficulties, but where some of the greatest social, economic and environmental gains can be achieved in the long run.

Recommendation

Post-disaster reconstruction programmes should always include consideration and funding of environmental and social reconstruction and disaster mitigation programs. In the long term, these investments will have the highest rates of return for the national economy, and they will prevent large numbers of disaster-related deaths in the future.

While environmental and social reconstruction programmes have their pay-off in the prevention of damage to infrastructure, agriculture and human lives, they also have strong associated benefits of poverty alleviation, social justice, and preservation of ecological resources.

A person is shown from the chest up, wearing a white lab coat and a white mask. They are holding a white tissue to their nose and sneezing. A large, stylized blue sneeze cloud emanates from their nose, filling the upper half of the frame. The background is a solid light blue. The text "FOR REFERENCE PURPOSES ONLY" is at the top, and "WHEN THE WORLD SNEEZES..." is in the center.

FOR REFERENCE PURPOSES ONLY

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...YOU NEED STRONG, RELIABLE PAPER AT HAND

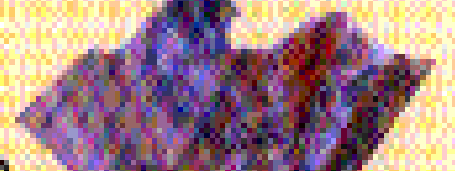
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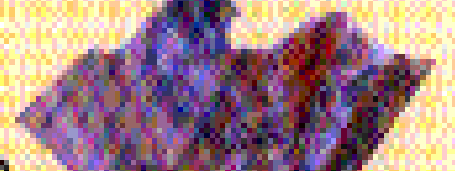
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ENVIRONMENTAL AND TECHNOLOGICAL HAZARDS

Technological

Peter Krejsa, Austrian Research Centres, Austria

THE PUBLIC perceives technological hazards through media accounts of accidental toxic or radioactive releases from chemical or nuclear facilities. Evacuations, destruction of crops and the treatment of milk at high cost, as waste, are known results. There can be worse, lifelong health consequences, such as genetic defects of future generations and land rendered inhabitable in perpetuity.

Protracted agonies are highly dreaded. Thus, there are important emotional differences with the loss of life of 40 people from a bus accident, an accident in a technical facility, a fire in the Mont Blanc tunnel or avalanches in the Alps with days of uncertainty as to loss of life — comparable with the uncertainty problem with Schrödinger's cat.

The media does not consider car accidents and air disasters as being related to technological hazards while truck accidents involving toxic chemicals are generally so classified. The public fears, but tacitly accepts, ocean oil spills such as the Exxon Valdez and pipeline-ruptures in the tundra because of dependency on oil and gas. The public fears and does not accept the risk of aircraft crashes over chemical or nuclear plants.

The media has not focused much on satellite entrance in the atmosphere with evaporation of isotope batteries or impact on the earth's surface while this is a fact not a risk.

There exists a long list of manmade hazards where scientific risk assessment differs dramatically from a media-based perception of risk. To this group of events we must add those triggered by natural catastrophes.

Technological hazards, perception and actions for mitigation and relief are problems and consequences of civilisation, culture and demography.

Risk perception is not a function of statistics and scientific rationality. Society's approach to disaster reduction may not follow the paths of scientific logic. There are of course different forms of logic. So from the standpoint of medieval society, the excessive construction of cathedrals was the logical assurance against evil and hell.

Description of risks

All catastrophic events are characterised by a spontaneous shift from risk to reality and the transformation of potentiality to fact. The quantitative description of such events is possible by the tools of probability theory which offer results for disaster prevention. A catastrophic event, consisting in a very quick transition from normal operation to an accidental condition, is subject to a mathematical model, called the theory of catastrophes.

Mathematical tools in combination with our knowledge of the properties of materials and substances involved allow the first essential step for disaster reduction: analysing causes, designing barriers and reactions to lower probability, incorporating redun-

dancy in critical facility equipment, changing processes and substances involved, scaling of facility dimensions.

The methods of risk analysis and assessment also allow prioritising systems of preventive measures for disaster mitigation and the planning of appropriate relief measures.

By reducing the probabilities of system failures through equipment, the costs of these preventive measures can pass thresholds where other processes or types of facilities are competitive and therefore applicable.

Thus one can proceed with more advanced technological strategies as from end of pipe technologies to sustainability.

Counter measures related to all kinds of facility/equipment failure on the basis of risk assessment are the cheapest and most effective means to reduce damage and especially costs in life and material. All the famous accidents as Chernobyl, Seveso, Bhopal could have been easily avoided by applying existing risk analysis and assessment tools.

Borderlines of technological hazards

Should we qualify as technological hazards only the release of large quantities of toxic materials as a consequence of accidental events? Under normal operational conditions chemicals are also released into the environment but this is normally in such small quantities that we assume a natural absorption capacity. The resulting low dose effects are difficult to predict. An accumulation can also result in a sudden effect — a catastrophic behaviour of the system. We know about the accumulating effects of substances such as carbon dioxide, methane and all the other greenhouse gases and of substances depleting the ozone layer and it seems that still other substance groups such as endocrine disrupters will show further limits of the natural capacity.

These endocrine disrupters seem to be responsible for the male to female fish ratio which in many rivers has reached about 70:30 per cent. This new ratio could affect fishery. Endocrine disrupters seem to be accumulated in sewage sludge, but not much is known about the fate of these substances when delivered on fields for agricultural purposes — with inhalation risk due to dust particles. At the moment, no regulatory actions are foreseen, because cause and effect have not been sufficiently proven.

We must also count among the technological hazards events like the so called 'Mad Cow Disease' resulting from the industrialisation of agriculture. Further, we must include ground water pollution by nitrate which is almost universal in the industrialised countries from extensive, industrialised use of the soils.

We must also consider all diffuse pollution, such as water from roads, rainwater acidity due to fossil fuel burning which dissolves tube materials, as well as all the products used in daily life which are not only a source of pollution at the end of their lifetime, but also as they are used. These include, for example, the dyes for

clothes which are released into the environment during each washing procedure. Rivers with up to 25% of recycled water are among other contributors to diffuse pollution.

At the moment, it does not seem that all pathways of genetic transfer are known. Genetic engineering probably adds to the enormous risks inherent in natural genetic changes. Incorporation of certain genes can, by design, prevent the natural germination of wheat thus rendering agriculture dependent on certain commercial ventures.

We should consider that regulatory actions take place about 20 years after the first research results which demonstrates the principal problem: substances produced in small quantities which are harmful to the natural equilibrium escape awareness for long periods of time. The effects of substances produced in high quantity are usually known and screened. Such substances are however so involved in the global economy that countermeasures or substitution demand a tremendous combined effort from science, industry and politics.

We have known the effect of greenhouse gases for many years from model predictions. If we consider it as a real problem obviously no adequate actions have taken place to date. Knowing that approximately only 20% of the world's population use 80% of the total energy, we must admit that under the existing political conditions no satisfactory solution is available. In consequence we have to consider mitigation measures for the future — such as dams for the low-lands.

Enormous regional environmental changes are due to the use of water for cotton production as in the former USSR. For the mega cities, deep underground water resources are exhausted. Fisheries of lakes are dead due to industrial effluents and there are enormous soil contaminations.

The dramatic image of birds coated with oil is easy to convey via television. However there are important sources of slow contamination which are not so readily visible such as the exchange of algae, bacteria and fish between different continents which is effected by maritime navigation. Often no natural competitors exist for such intruders in the new environment with a resulting explosion in population and serious damage to the natural equilibria established over thousands of years. Toxins are produced by these new algae and damage mussel populations, fisheries and regions of tourism. We also find the spread of tropical maladies via modern transport systems, such as malaria cases at the airport of Charles de Gaulle-Paris, contagion of passengers by virus and bacteria via air-condition systems.

Pro-active actions

Technological hazards due to natural hazards can be mitigated by estimating the probabilities of the natural hazards and potential damage. The construction of facilities is based on regional seismological data. Planning must also include the safety of facilities and equipment intended for relief forces in case of natural disasters. So here action is based on history with appropriate technical countermeasures.

Mitigation planning must also include installations and facilities which could affect health and safety in the case of a natural catastrophe. For example, the effects of flooding on dumping sites must be considered.

Another problem is connected to the time of alert before an catastrophic event. Flooding after rainfalls occasionally provides sufficient advance time for counter-measures, such as flooding in the flatlands of the Oder region in Germany but no time at all in cases of flooding in mountainous regions as happened in Vaison, France. In these cases, early warning systems will allow

appropriate mitigation. Regional risk analysis should be obligatory for an overall view of interaction between technological and natural hazards.

In the case of facilities with a high toxic potential, such as nuclear power plants, chemical production facilities and pipelines, early warning systems help reduce risks by shutting down facilities. Such systems should be sufficiently sophisticated to ensure reliability of predictions. Similar early warning systems will also play a more important role in traffic such as for high velocity trains. The effect of technological hazards on the environment, especially dose-effect accumulation, can lead to natural catastrophes due to back-looping, leading to non-linearity and the so called chaotic behaviour 'Butterfly Effect'. The technological hazard consists in the initiation of natural catastrophes, as by the greenhouse effect.

Developments and conclusions

A certain awareness of global problems has been achieved during the past decade. There is a growing understanding by politicians of global environmental interactions and common interests. It would be naive to believe that acceptable solutions can be found instantly. The scientific community itself seems not able to agree on worldwide priorities. The most effective media campaigns do not always represent the most important issues. Excellent knowledge in one special environmental problem does not necessarily demand a high priority on a global scale. A regional ranking of actions according to particular technological hazards is more appropriate than a sort of catechism of general priorities for universal application. What we do not know is if our general countermeasures are quick enough to avoid severe consequences of all the issues where only some have been pointed out.

In the future, technological hazard reduction has to be based on the development of sustainable resources management, new technologies and clean production processes, such as reducing the ecological footprint or factor ten technologies. We do not know if this will be sufficient and sufficiently rapid. For disaster prevention, the imperatives are to reduce the probability of events and the potential of damage.

How can we achieve these goals on a global scale?

The following is suggested:

- Organisational structures for appropriate communication systems
- Reinforcing international connections to provide and disseminate information
- Continuous data exchange, data mining, data merging
- Extensive use of modelling and simulation
- Development of meta-models to merge existing databases and models
- Development of appropriate tools for decision support and for benchmarking
- Development of new methods of effect measurement
- Enforced development of the prediction of molecule behaviour
- Concepts for urban ecology and the city of tomorrow, zero release processes
- Coupling of environmental issues with economy
- International conventions to achieve international standards.

FUTURE HAZARDS

Climate variation

Ian Burton, University of Toronto, Canada

THE RESTLESS atmosphere is in a constant state of flux. Any change, large or small, has some effect on human activities. Often these effects are beneficial. Sometimes they are adverse. From the perspective of human use the atmosphere is both a resource and a hazard. Described in terms of the prevailing climate in any one place, the atmosphere presents a diverse set of opportunities and threats. The extent to which the weather changes over time in any one place can be called its variability. Statistical summaries of diurnal, seasonal, inter-annual and longer term variability are described as climate. In this sense climate is only a statistical abstraction or creation. Climate statistics are nevertheless extremely important as an input to decision making and policy formation.

For many practical purposes climate is treated as stationary. It is not only the means which remain the same, but also the distribution or frequency of extremes. Weather observations of the most recent three decades are compiled into means and distributions (including extremes) and these statistical summaries are referred to as the 'climate normals'. Virtually the entire built environment of infrastructure is designed in the light of these 'normals'. This includes the heating, ventilation, and air conditioning standards for houses and commercial buildings. Similarly the design standards for bridges, roads, drainage systems, water supply systems, irrigation projects, transmission towers and lines, and the like are all based upon descriptions of normal climate and its variability.

In addition many human activities are based upon expectations of how the climate will behave. In agriculture the choice of crop, timing of planting and harvest, and cultivation practices reflect experience and judgments about weather, climate and variability. Investments and operations in the tourism and recreation business are extremely sensitive to climate variability. Industrial and commercial operations have generally been considered to be less at risk, but increasing competitiveness and innovations such as just-in-time delivery have made even these economic activities vulnerable to disruption from climatic events. When all else fails, many people often resort to insurance to provide protection against loss. In recent years the insurance industry has become increasingly exposed to large claims arising from climate variability around the world.

Figure 1 represents a theoretical formulation of the relationship between a fluctuating climate variable such as rainfall or temperature or some combination of the two in terms of stream flow, soil moisture availability and the like, and the concept of a damage threshold. It assumes that there is a 'safe' or 'normal' range of the variable within which damage is non-existent or minimal. Damage begins when some threshold is crossed. This can be at the upper range (too much rainfall produces floods) or at the lower range (too little rainfall results in drought). The

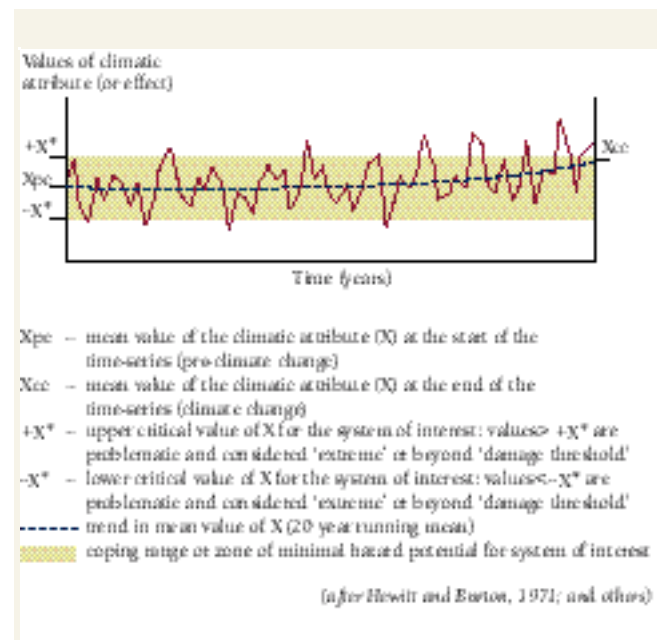
varying climate is thus both a resource (when it stays within 'normal' bounds, and a hazard when a significant damage threshold is crossed. This does not signify disaster however. The damage associated with a small and brief excursion across the threshold line is usually quite small. It usually requires greater magnitude or duration to create a disaster situation.

How are the thresholds determined? They are largely a function of the level of adjustment or adaptation prevailing in any one place. Thus it has been found that storm and flood discharge regimes from the state of Michigan cause considerably less damage when transposed to a comparable region of southern Ontario (Brown, Moin and Nicolson, 1997). The explanation for the difference lies not in the magnitude of the floods themselves (there is none), nor in the overall density of population and level of economic development, but in the different patterns of flood plain land use in the two jurisdictions. It appears that a much more effective policy of keeping development out of flood plains has been in operation in Ontario for the past 30 years or more.

More broadly the position of the thresholds depends upon the vulnerability of the society to climate variability. Examination of many specific cases in a diversity of countries has found that there is no simple linear relationship between development and vulnerability (Burton, Kates, and White, 1993).

While it may be supposed that richer and more technologically developed societies would be able to widen the band of safety

Figure 1: Climate time-series (hypothetical) showing sources of stimuli





Copyright 1998. Photo Storm. Licensed. June 1999

From one extreme to another, too much water...

between the hazard thresholds this has rarely happened. Greater wealth and security in some domains seems to be often associated with a propensity to increase risk taking in others. Thus in richer developed industrial societies such as the United States, damages from extreme events have continued to rise in spite of the growth in the potential technological and organisational capacity to reduce losses.

Disaster management and hazard theory

Natural disasters are almost always associated with extreme events. A focus on disasters (and in this the Decade is no exception) tends to create a preoccupation with the unusual event and a corresponding neglect of the ordinary. In the field of disaster management this has had two important consequences. First, at an intellectual level, interest has focused on the causes of disasters rather than on the nature of hazards. It is rather akin to a study of history that focuses on wars, battles, and military technology rather than the underlying causes of conflict. Second, the practical implication of this intellectual orientation is that much more emphasis has been given to fighting (managing) the disaster events themselves, than to understanding and modifying the social process that create vulnerability.

The different intellectual orientation is reflected in the literature of disaster studies (especially disaster sociology) on the one hand and on the other hazard studies as carried out for example by engineers, geographers and others.



Photos: Hulton Getty

...and too little: An empty reservoir in the UK after a severe heat wave

There is now evidence of a change in orientation within the natural disaster management community. It is increasingly recognised that disaster management which focuses heavily on the extreme events and emergency situations can serve at best as palliative treatment unless it is also accompanied by efforts to address the more fundamental causes.

Three perceptions of variability

In the aftermath of a disaster it is inevitable that both victims and helpers alike will ask 'why did this happen?' and 'why did this happen here?' Perhaps the most common answer is that it is an 'Act of God'. In other words, disasters are visited upon people by extreme events in nature over which they have no control. Either nature or God is to blame. A variant of this perspective is that a disaster is a form of punishment inflicted upon people for unacceptable behaviour.

With the growth in scientific understanding of the natural variability of the elements, and the growth in technological capacity to forecast and to some extent to control extreme events it might be expected that the 'Act of God' explanation would lose some of its credibility.

Its remarkable persistence may be attributed to the politically uncomfortable nature of the alternative. If God or nature cannot be blamed, then people must be responsible themselves. This perspective has found favour among a number of social critics (Hewitt, 1997) who argue that the economic forces of unsus-

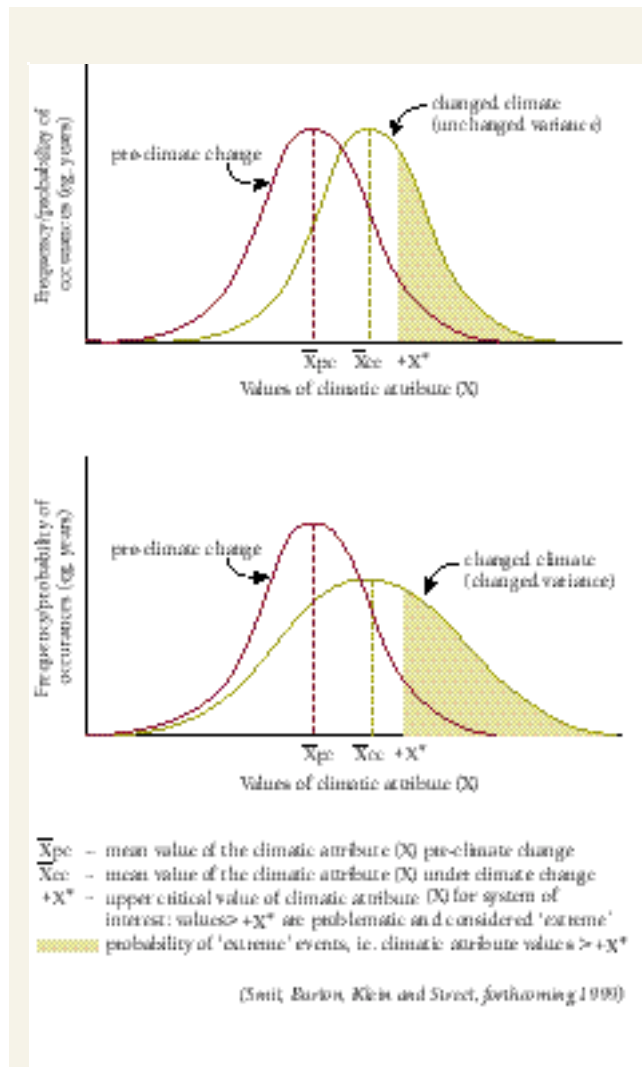


Figure 2: Climate change, variability and extreme events

tainable development have often forced the poor and disadvantaged into hazardous and disaster-prone locations.

A third view, sometimes referred to as the 'dominant paradigm' is that hazards are encountered in the search for the useful. In the normal process of development, and making use of the earth's resources to support life and livelihood, hazards are encountered. This view is consistent with the theory of climate and climate variability as both a resource and a hazard. (Burton, Kates, and White, 1993). There is in fact no 'safe' area between thresholds of damage where no costs are borne. Any activity to exploit the resources of the environment necessarily involves costs and risks as well as benefits and opportunities.

It nevertheless remains true that the impacts of hazards encountered in the search for the useful can be reduced both by expanding scientific understanding and policies designed to reduce social inequities. Improved scientific knowledge of the potential variability of climate and other natural phenomenon, especially in their most extreme and unsuspected manifestations can be used to guide and improve human choice and decision making. Similarly an awareness of the increased exposure to hazard of poorer and otherwise disadvantaged people by socially inequitable processes, can be used to counteract or amend such processes with beneficial results in reducing disaster potential. Thus all three perceptions of variability and its consequences have some validity and utility. What is needed is an enhanced capac-

ity to determine what the specific mix of explanatory variables is in the case of potential future disasters and hazard losses. The methodology for such an approach is poorly developed, but if such an approach could be more strongly developed based upon a 'meta theory' of disaster causation this would be a valuable outcome of the decade.

Variability is desirable and necessary

Much of the foregoing discussion has been based on the assumption that variability is an unfortunate feature of climate and other natural elements which calls for an improved scientific understanding and better management. There is a sense however in which variability is itself a resource. Both human and natural ecosystems have evolved in the context of a changing environment in which variability is an essential element. Both natural and human systems are adapted to a degree of normal variation, and a reduction in variation, or a decline into a constant or invariant environment would be potentially catastrophic. Environments with low variability are less attractive because they offer a narrower range of opportunities. Risks are encountered in the search for opportunities.

Future changes in variability

The present rising toll of disaster losses and disaster events makes it clear that human society as a whole is not now well adapted to climate variability. In seeking and making use of the opportunities that climate provides, human societies have made less than optimal choices. That we can and should do better has been an assumption of the Decade and is an ideal that will continue in follow-up activities. It is an irony that at precisely the time when the global community is waking up to the idea that disasters can be reduced by mitigative actions, a new threat should arise. Climate change has been characterised as a 'natural' hazard in its own right, and much research is being carried out on the likely impacts of future climates under increased atmospheric concentrations of greenhouse gases. The major threat of climate change, at least in the short and medium term is not the change in global means of temperature and other atmospheric variables, but the change in variability of climate and in particular the shift in the magnitude and frequency of extreme events.

Figure 2 shows in an hypothetical way the shift that occurs in the variability and the extremes of distributions as the mean shifts (Smit, Burton, Klein and Street, forthcoming 1999). It is now widely accepted in the atmospheric science community that the climatic means are shifting. It is less clear in what way the variance and the distribution of extremes will change. It is certain however that they cannot stay the same, and since human activities are most adapted to the 'middle range' of variability it is clear that variability is already a growing threat and will become more so in the future. This only adds greater urgency to the need to apply the lessons of the decade and to do so in the awareness that without much stronger efforts to reduce vulnerability now, losses and disaster frequency will continue to grow. This is explained by the well known factors of unsustainable development and because variability is itself changing due to anthropogenic climate change.

The natural disaster and natural hazards communities, and the climate change communities have pursued their respective agendas largely in isolation from each other (Burton 1997). As the Decade draws to a close and as the climate debate heats up, now is a good time to bring these two concerns closer together and to develop within the climate change community a greater appreciation of the lessons and understandings of the Decade.

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FUTURE HAZARDS

El Niño

Michael Glantz, National Center for Atmospheric Research, USA

THE EL NIÑO EVENT that occurred in 1997–98 is now considered to have been the most intense in the twentieth century, surpassing the previous ‘El Niño of the Century’, the 1982–83 event. El Niño is the result of air-sea interactions in the tropical Pacific Ocean along the equator. Under normal conditions, there is a warm water pool in the western Pacific and cold water upwelling off the western coast of South America. When El Niño appears every three to seven years or so, the westward-blowing winds along the equator weaken, allowing warm water in the western Pacific to move toward the central and eastern Pacific. This El Niño condition generally lasts from 12–18 months at a time and can vary in intensity from weak to very strong to extraordinary.

The ‘extraordinary’ El Niño events disrupt regional climates around the globe and have become associated with droughts in Indonesia, Philippines, Bolivia, Southern Africa, Northeast Brazil and Central America. And are also associated with heavy rains in parts of Kenya, Peru, southern Brazil and other locations. Estimates of damage associated with El Niño are in the tens of billions of dollars (US) and deaths in the order of a few thousand people.

The rapid decay of the 1997–98 El Niño event in May 1998 drew attention to El Niño’s counterpart, La Niña. Under La Niña conditions, the warm water pool returns to the western Pacific and upwelling of cold nutrient-rich deep water returns to the west coast of South America.

La Niña is viewed in many countries as an extreme case of normal, with rains returning to countries plagued with drought during El Niño, and drought returning to regions prone to heavy rains during El Niño.

El Niño is a natural process that has been associated with various kinds of hazards. Although paleological evidence has shown that El Niño events have occurred for thousands of years, scientists have recognised its worldwide consequences for regional climate and regional extreme weather-related events only since the mid-1970s. Thus, it has only recently been discovered to have such natural hazards-related impacts on societies around the globe. No country, regardless of its level of economic development, has been immune from its impacts. Those impacts have been referred to by scientists as ‘teleconnections’, or linkages at some distance between those El Niño-related hazards and changes in sea surface temperatures in the tropical Pacific along the equator.

The hazards it spawns include, but are not limited to, droughts, floods, frosts, fires and landslides. Perhaps if we link what spawns natural hazards (ie. El Niño) more closely to its potentially spawned hazards, we can shift our short-term responses towards pro-action (ie. prevention and mitigation) and away from reaction (ie. adaption and cleanup). Doing so would tend to push the early warning of specific El Niño-related hazards further

‘upstream’, thereby providing more lead time for societal coping mechanisms to come into play.

There is a long standing community of researchers with a focus on natural hazards, for the most part rapid-onset events such as river flooding, blizzards, avalanches, tsunamis, earthquakes and hurricanes. Although it meets many of the criteria used to describe them, El Niño has not as yet made this list of such hazards. Ian Burton and colleagues (1993, pp. 35–6) have listed characteristics that define a hazardous event: magnitude, frequency, duration, areal extent, speed of onset, spatial dispersion, and temporal spacing, each of which they define as follows:

Magnitude: Only those occurrences that exceed some common level of magnitude are extreme.

Frequency: How often an event of a given magnitude may be expected to occur in the long-run average.

Duration: The length of time over which a hazardous event persists, the onset to peak period.

Areal extent: The space covered by the hazardous event.

Speed of onset: The length of time between the first appearance of an event and its peak.

Spatial dispersion: The pattern of distribution over the space in which its impacts can occur.

Temporal spacing: The sequencing of events, ranging along a continuum from random to periodic.

These characteristics apply well to El Niño. The magnitude of an El Niño event is defined by degree of departure from a long-term average of anomalously warm sea surface temperatures in the central and eastern Pacific. Frequency relates to its return period, which scientists have suggested is of the order of two to ten years (more specifically, one could argue that a major El Niño occurs every eight to 11 years, and a minor one every two or three years). The duration of El Niño events is 12 to 18 months, with a few notable exceptions of multi-year El Niño events. The areal extent could be interpreted to mean the spatial extent around the globe of the impacts of El Niño and its teleconnections. This would vary directly with the severity of the event, with major El Niño events being linked to major worldwide impacts and minor ones linked to localised or regional impacts.

The speed of onset of El Niño of the order of months. Occasionally, however, events have appeared to begin, only to collapse after a few months. Spatial dispersion refers to the area in the central and eastern Pacific that is encompassed by the anomalously warm sea surface temperatures. Temporal spacing, with respect to El Niño, refers to the return period which, on average, has been four and a half years.

Because the characteristics of an El Niño clearly meet the criteria used to define a natural hazard, El Niño merits inclusion in the list of natural hazards. An explicit designation could help to

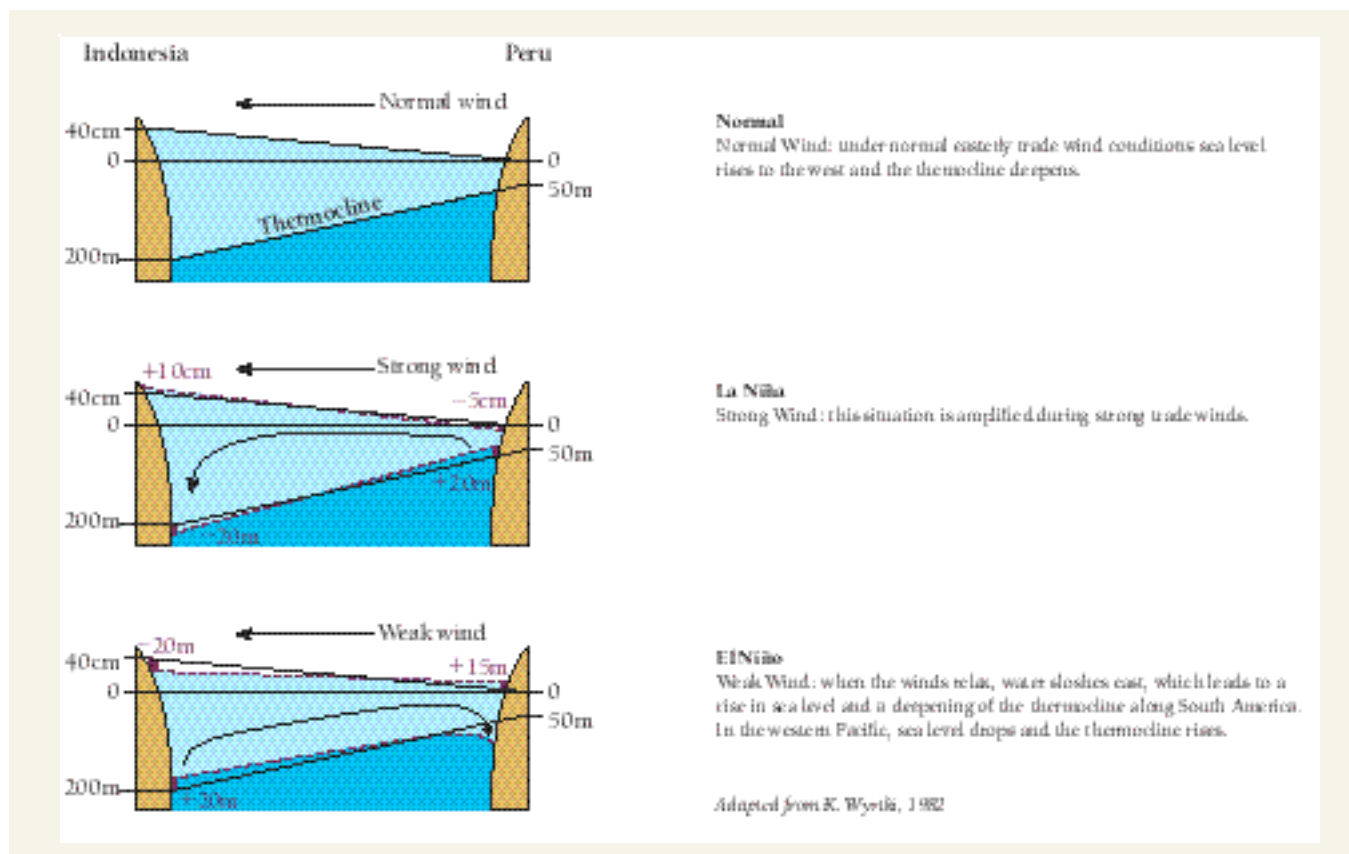


Figure 1: The response of the thermal structure of the equatorial Pacific to changing winds

improve the level of research on its societal aspects, as has been the case with other designated hazards.

Although El Niño's characteristics seem to fit well within the analytical definition of a natural hazard, it seems that hazards researchers prefer to argue why El Niño should not be viewed as a natural hazard. Perhaps it is time for them to broaden their perspectives of the phenomenon and its impacts on environment and society, so that El Niño can be viewed as a legitimate hazard (in this broader sense).

Those involved in hazards research have opposed considering El Niño to be a hazard because, they argue, like winter, it just is. For example, things may happen in wintertime, such as blizzards or ice storms, and while these are viewed as hazards, the winter that spawns them, they argue is not. This same reasoning is also applied to El Niño.

When one thinks about it, societies have coped with seasonal changes for as long as societies have existed. So, many things that will occur (eg. cold temperatures, snow, ice, sleet), we have already learned to expect and prepare for, even though any particular winter can be either long or short, warm or cold, early or late, mild or severe. Therefore, winter potentially spawns lots of hazards (some real and recurrent, others potential and occasional, some even rare and unexpected). Therefore, in a general (and potential) sense, a good argument can be made for considering winter as a hazard.

Societies and individuals tend to put into action their coping mechanism strategies and tactics instinctively when winter approaches. They adjust, on a seasonal basis, their perceptions of how they expect their normal activities to be altered. The more lead time they have to respond to winter (ie. to prepare in some way), the better prepared they might be before the weather extremes that the wintertime climate may bring. While we don't

explicitly consider the seasons as hazards in and of themselves, it would help to do so, because knowing a season is coming serves as an early warning to society and individuals to prepare for a different set of seasonal, climate-related problems with which they might have to cope.

By analogy, using the notion of winter-as-hazard-spawner as an example, one could make similar arguments for El Niño. Knowing that an El Niño is coming provides an early warning about possible changes in regional climate conditions and, therefore, in human activities and ecological processes that are likely to result from their adverse effects. And, if a goal of managing the impact of natural hazards is to reduce adverse aspects of those effects, then by viewing El Niño as a hazard (in the sense that it spawns hazards), we can get an earlier start in determining how we might best cope with those hazards known to be linked to El Niño and (La Niña) events.

Furthermore, El Niño is a phenomenon that extends across several seasons and can generate different changes within the different seasons. Thus, one can and perhaps will in future years speak of an 'El Niño winter' — a winter which enhances 'normal' wintertime hazards in certain ways in some parts of the globe, while reducing the likelihood of such occurrences in other parts.

In conclusion, whether we regard El Niño (or La Niña) as a hazard or a hazard-spawner, we must not lose sight of the fact that the definition of the event is not as important as our own actions to reduce the negative effects of the phenomenon and its related events. We know that El Niño can lead to devastation, so by concentrating our efforts on forecasting and early warning, society has the opportunity to develop the instincts to prepare for an El Niño event, however unpredictable, in the way we already prepare, sometimes without realising it, for the unpredictability of a harsh winter.

FUTURE HAZARDS

The growing complexities of natural hazards in the 21st Century

Claire Rubin, Claire B. Rubin & Associates, USA



Photo: Rex Features

Devastation and flooding as a result of a hurricane sweeping across Florida

IN LATE OCTOBER of 1998 Hurricane Mitch criss-crossed over Central America, its high winds and great torrential rains affecting five countries. In at least three of these countries, the effects were devastating. The catastrophic impacts of this disaster on people, structures, the terrain, and national economies completely overwhelmed in-country capabilities. Hurricane Mitch has become a 'defining event' for the international disaster community. In the aftermath of this disaster, which is now considered the most devastating hurricane in this century for the Western Hemisphere, disaster experts are re-examining many aspects of emergency management, both in the affected countries and in those wanting to help them respond and recover effectively. This recent event is a grim reminder that despite the technological advances of the 20th Century, catastrophic events still occur. Aside from providing yet another example of the enormity of the damage from a natural disaster, Hurricane Mitch also revealed the complexity of issues (environmental, economic, political, and cultural/sociological) that may become essential components of emergency management in the 21st Century.

As we approach the new century, we will face different kinds of threats and hazards and consequently new kinds of risks and disasters. The disasters of the future may not be bigger or worse, but they are likely to be more complex and require more sophistication in all phases of emergency management (preparedness, response, recovery and mitigation). Some researchers and futur-

ists contend that many future disasters will result as much from increased urbanisation, social complexity, and technological dependence as from the forces of nature.

This paper, which is a personal overview rather than a systematic summary of research and scientific progress, will examine some of the natural disaster agents whose characteristics and impacts have been changing in recent years.

Factors under consideration in discussing disasters of the 21st Century include:

- Effects of urbanisation and megacities on natural disaster management
- Linking of natural disasters with technological and environmental disasters
- Increased technological dependence on telecommunications and other infrastructure systems
- Changing scale of disasters
- Greater impact of natural disasters and new kinds of secondary impacts
- Increased vulnerability in certain geographic regions
- New developments in the capability to predict and control disasters
- Significance of societal and cultural characteristics of the affected country
- Growing interdependencies and international vulnerability from distant disasters.

Urbanisation

It is estimated that 'by the year 2020, 57% of the greatly increased total population in developing countries will be city dwellers' (ICE, Megacities). Recent research on megacities, defined by the United Nations as cities with a population of eight million or more, has revealed that many megacities in the developing countries are situated in hazardous zones prone to natural disasters. It is estimated that early in the 21st Century the explosion of urban populations will result in about 30 megacities, a few of which will have more than 20 million people and many others will have more than 12 million.

We know that disasters occur when major natural hazard events impact people, structures, and economic activities. In many countries, not just in the developing world, the most vulnerable sectors of the population are the poor, who typically live in areas most prone to natural disasters. With greater numbers of people living in potentially hazardous areas, and with more poor and socially/economically diverse people at risk, many future disaster events are likely to have an impact on a greater number of people and property. This greater ratio of impact (ratio of damaged structures to total structures) also has major implications for emergency management personnel and other professionals concerned with reconstruction and recovery.

Natural and technological disasters

Increasingly natural disasters are linked both to technological hazards/disasters and to major humanitarian needs. This growing inter-connection between natural and technological hazards/disasters should be taken into account by the emergency management community in the future. The most obvious connection is when the primary event is a natural hazard, such as an earthquake, and secondary hazards/disasters like pipeline breaks, utility failures, and urban fires result from this event. In the future there may be more and different kinds of secondary impacts. For example, major urban earthquakes have sometimes caused fires that did more damage than the earthquake itself. In the 1990s, disasters have involved both natural and technological hazard agents, such as major earthquakes that cause hazardous material releases — as occurred in Kobe, Japan and in Northridge, California.

Other frequent secondary effects of major natural disasters are power and telephone outages. Until recently the dependency on these services was not as heavy as it is currently, especially in most developed countries. Because reliance on computers both for basic economic activities and for emergency management functions, especially emergency response, is now substantial, computer services and telecommunications should be considered essential, even critical services.

Technological dependence

Some countries rely on telecommunications so heavily that these services are fundamentally essential to their domestic or regional economies. Therefore, it is possible that major and lengthy failures of telecommunications services might be considered the primary disaster and the natural disaster that caused it a secondary disaster. Among the many unknowns about this new dependency on technology is how to protect the needed systems from damaging events. As an example, more than 200 communications satellites now orbit the earth, including several dozen that serve the United States, yet few people realise that most of the country's vastly expanding volume of paging messages are relayed around the country by a single satellite. In May 1998, the worst communications failure in 37 years of satellite service occurred in the US Major problems with one telecommunica-

tions satellite (Galaxy IV) drastically affected 120 companies in the paging industry, along with radio, television, and other news broadcast media. 'When it failed, close to 90% of the 45 million US paging customers found themselves without service' (*Washington Post*, 21 May 1998).

New dimension of disasters

Some key aspects of natural hazards and disasters must be considered to anticipate future emergency planning and management needs. These include:

- Scale: Magnitude of the event and resulting deaths and damages
- Vulnerability: Exposure of and risks to the built environment
- Predictability: Short-term and long-term
- Controllability: Can processes be modified, effects reduced?
- Societal/cultural factors: The social system and its constituent groups
- Ecological factors: Environmental damage propensity
- Location: effects on more than one country
- Inter-relationships and inter-dependencies: New organisational arrangements affecting emergency management.

Scale: Greater, more deadly effects in the 21st Century

Some fairly recent natural disaster events have been unusually large. The El Niño weather/climate phenomenon in 1998 is reported to be the largest occurrence of this repetitive event in this century. This latest event had greater consequences and costs than any earlier one, even though the advance notice allowed for some mitigative actions. Similarly Hurricane Mitch, also in 1998, has been termed the most powerful and destructive hurricane to hit Central America this century. The effect of this hurricane was catastrophic: an estimated 11,000 fatalities and about two million people whose homes were damaged to some degree. The estimated total cost was about US\$ 8.5 billion.

Another extraordinary disaster was the earthquake in Kobe, Japan (1985), 'the first large earthquake to strike a modern, first-world industrial city (*Bauman report*, p. 1). The damage to the City of Kobe and its environs was profound, resulting in a major breakdown of critical urban functions. More than 6,000 people were killed, and the total damage is estimated at about US\$ 200 billion. Earthquake or fire destroyed or damaged over 129,000 buildings in the city, including about 120,000 housing units. (*Bauman report*, pp. 1–3). It is currently the most costly earthquake on record.

Certain vulnerable population groups will likely be more heavily affected by known hazards/disasters in the future. For example, many retirement communities in the 'Sun Belt' states of the US (Florida, Texas, Arizona, and Nevada) have been built in areas known for their hurricane hazards, tornado paths, or coastal storm risks. When Hurricane Andrew (1992) made landfall in Dade County, Florida, it had disastrous effects on a large area, including numerous retirement communities. A huge number of elderly people living on fixed incomes were rendered homeless, and a sizable number of transient agricultural workers lost their homes and their work. To date, Hurricane Andrew is the most expensive hurricane to hit the US, with an estimated total cost of about US\$ 26.5 billion.

While too much water resulting from hurricanes or excessive rain can cause problems, so can too little. The lack of water supplies for fast-growing residential areas in the states of California, Arizona, and Nevada poses an increasing risk. As new residential and commercial developments are created in great numbers in these semi-arid or arid areas of the USA there are growing physical and environmental problems. These in turn can

cause major political difficulties involved in diverting major rivers away from their traditional paths to supply the urban users.

Vulnerability

In geographic areas that have recently experienced major natural disasters, some of the pre-event practices, such as clear-cutting of trees, slash and burn methods to clear land for agriculture, and building in floodplains, have contributed to the vulnerability of the built environment to disasters. All of these practices appear to have contributed to the extreme devastation in the Central American countries recently devastated by Hurricane Mitch.

In the United States a sizeable group of disaster specialists from a wide array of specialties and disciplines has just completed a review of natural disaster research and scientific progress in the past two decades. In his report on the study *The Second Assessment of Natural Hazards Research*, the primary author, Dennis Mileti stated: 'Losses from hazards — and the fact that the nation cannot seem to reduce them — result from shortsighted and narrow conceptions of the human relationship to the natural environment. To redress those shortcomings, the nation must shift to a policy of 'sustainable hazard mitigation' (Mileti, pp. 2–3).

Then there is the issue of high costs as a result of the growing exposure to, and losses from, natural hazards. In the US the enormous costs of damages in terms of life, property and financial expenditure have become unacceptable, leading to many analyses of alternatives. The US Congress, the Federal Emergency Management Agency (FEMA), and many other organisations have been conducting studies and issuing reports on ways to reduce their impact and costs.

Predictability and controllability

Fortunately, some strides are being made in prediction capability, especially for meteorological events. In the USA scientists with the National Oceanographic and Atmospheric Administration (NOAA) were pleased, with good reason, about the accuracy of their recent predictive efforts regarding the 1998 El Niño event. Recent improvements in data collection and interpretation, enabled by more sophisticated computer and radar equipment, now assist with accurate, longer-range weather forecasts.

Similarly, scientists have been improving their tools and techniques for predicting hurricanes and also for providing the public with probability analyses that can be readily understood by laymen. For example, annual forecasts of Atlantic hurricanes prepared by scientists at Colorado State University have been helpful to emergency managers. In other fields such as earthquakes, however, scientists have not yet succeeded in significantly improving their predictive capabilities.

Although many serious scientific efforts have been made at controlling disaster agents (for example, efforts to stimulate rain in drought-stricken areas), generally this has not been a productive area of endeavour. More important are efforts to minimise the impacts and mitigate the effects of known hazards on structures and people. These include seismic safety measures (including the identification and mapping of seismically active areas and improved seismic-resistant construction techniques) and tornado watch and warning systems.

Societal/cultural factors

Questions about which populations are vulnerable or at high risk from exposure are linked to the nature and characteristics of the social systems of the communities or countries affected. As stated earlier, major natural disasters often have a disproportionately high impact on the poorest people, whose dwellings and work-

places are in the most hazardous areas. Both prior to and after a major damaging natural disaster, the diversity of ethnic and national backgrounds, together with low social and economic status, present special problems — ranging from determining warning methods, planning evacuations, responding to people with special needs, and implementing recovery measures.

Internationally we have seen an increase in what disaster officials call 'complex disasters', events that have complex, humanitarian aspects such as large, unplanned migrations due to war. A similar phenomenon now occurs in connection with natural disasters. For example, one consequence of the devastation from Hurricane Mitch in Honduras is a substantial out-migration from Honduras, due to economic rather than political exigencies.

Location

Increasingly disaster-prone areas may not only exist in one country, but may be multi-national or even global. Hurricane Mitch affected five countries in Central America. The ratio of impact was very high: in Honduras it is estimated that about 70% of the infrastructure, 90% of the power system, and 80% of the agricultural sector were destroyed (*US Army Corps of Engineers*, unpublished estimates, March 1999). Because its neighbouring countries also suffered great damage, assistance with relief and response had to come from outside of the region.

Distant (international) sources of disasters

In the future we may see more situations where localities, states, or nations will face disastrous conditions created by sources quite distant, possibly even from another country and hence circumstances beyond the control of their own emergency managers.

As an example, in early summer of 1998 many wildfires burned out of control in Mexico and Central America, causing serious smoke visibility and health problems for US citizens in Texas and other southwestern states. Clearly the societal risks and vulnerabilities in our modern industrial world are growing rapidly. As the effects of disaster events grow larger or cross national boundaries, international organisational arrangements will be needed to prepare for and respond to threatened or actual disasters.

New dependencies and inter-dependencies

Not only have telecommunications systems become an intrinsic part of the economy of some countries, they also are an essential component of the tools used to respond to major disasters.

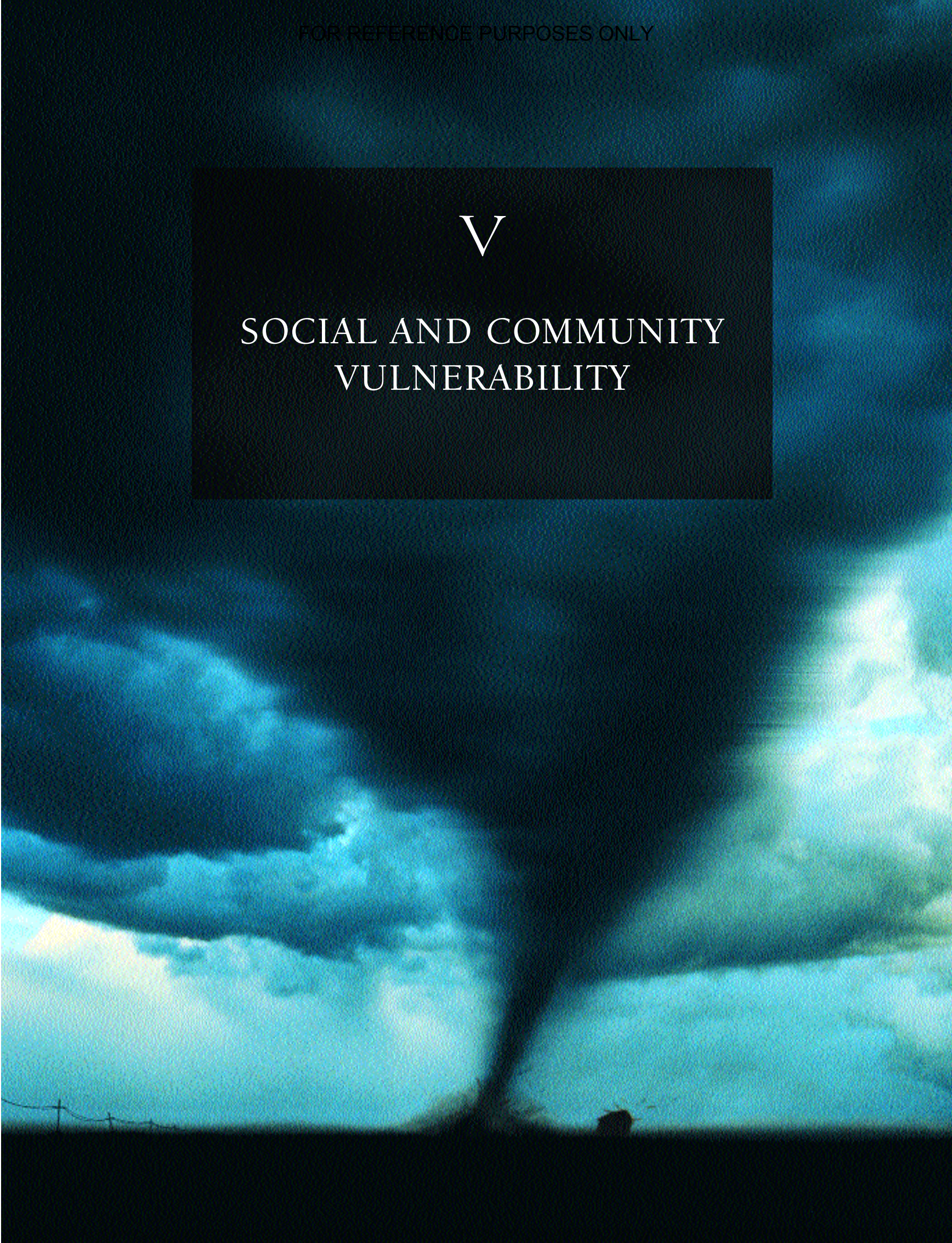
Increasingly, disaster warning and response mechanisms are highly automated and are heavily dependent on telecommunications. In the US, FEMA depends on complex telecommunications systems for the following essential functions: a) exchanging data with affected localities and states; b) maintaining Geographic Information Systems (GIS) used in response and recovery operations; c) maintaining the telephone-based registration process for victims to obtain disaster assistance; and d) preparing checks for financial assistance to victims.

In conclusion, the phenomenal proliferation of new technologies — such as the internet, email, fax machines, and cellular phones — are facilitating information and data transfers at a rate hard to grasp. Yet ironically, these new tools may cause disasters if and when they fail, whether by accident or by intent. The tools used today are quickly becoming targets and even weapons; we have the future fears of cyber-terrorism and cyber-warfare. As we enter the 21st Century, we will see new compounds of the elements of disaster.

Will we be ready with the necessary tools, organisations, and skilled personnel to deal with them?

V

SOCIAL AND COMMUNITY VULNERABILITY



KEYNOTE PAPER

REDUCING GLOBAL DISASTERS

Andrew Maskrey, LA RED, Peru

WHEN HURRICANE MITCH stalled over Honduras, the volume of rainfall was extreme by any standards. Mitch was an extraordinary natural event and politicians, the media and relief agencies alike were quick to focus on its devastating impact on one of Latin America's poorest countries. The 'official' version of the Mitch story was a familiar one of a devastating natural event wiping out decades of development gains in a country struggling to 'emerge' into the global economy.

But in the case of Mitch and similar catastrophes, this spin to the story needs challenging and deconstructing, in order to reveal both the real causes of the disasters that occurred as well as untold accounts of local communities that managed to successfully reduce their vulnerability before the hurricane hit.

Data collated by national disaster management agencies on the patterns of loss associated with Mitch shows a different picture to that of total destruction projected by the media. Maps displaying patterns of loss of life or damaged housing at the municipal level in both Honduras and Nicaragua, showed that while many localities suffered catastrophic loss, others suffered little or no damage. The Mitch disaster could be more accurately described as a large number of highly localised and geographically dispersed disasters, coinciding at the same time. While the cumulative impact of so many simultaneous disasters generated a national and regional catastrophe, focusing on this catastrophe blurs the unique configuration of causes and effects of each small, highly localised disaster.

While Mitch was an extreme hurricane, most of the loss and damage in Honduras was caused by collateral floods, flashfloods and landslides triggered by the enormous volumes of rainfall. Lives and livelihoods were affected by a range of socio-natural or environmental hazards, closely associated with decades of unsustainable patterns of land use, territorial occupation and natural resource mismanagement. A wide range of such hazards affected highly vulnerable communities. The location of settlements in

areas prone to floods and landslides, the lack of economic capacity to absorb and recover from losses and the fragility or absence of public services and institutions, particularly at the local level, are all factors of vulnerability which configured disaster occurrence and loss in the country.

While occasional large events such as Hurricane Mitch attract the attention of the media and international agencies, the ongoing processes which shaped the consequent disasters are common to many other regions. The large number of small scale disasters occurring daily in developing countries, and which are not captured in international disaster statistics, reveals how vulnerabilities and hazards accumulate over time. For example, the annual losses from small scale disasters in Colombia generally exceed that of the major Armero catastrophe of 1985. This growing incidence of small disasters, particularly associated with environmental hazards, provides a compelling image of vulnerable communities trying to cope with a gradual accumulation of risks over time: a radically different vision to that of occasional and inevitable large catastrophes eliminating decades of development gains. Vulnerability and hazard accumulation is firmly embedded in the development paths of many countries. Rather than being a victim of natural forces, development is often progressively poisoned from within.

Vulnerable communities living in, coping with and often accentuating risk on a daily and permanent basis is ultimately what the disaster problem is all about. A community's capacity to



Photo: Associated Press

A man digs a channel to direct muddy water away from his home Peru. This flooding, caused by changing El Niño weather patterns, is a serious, and unfortunately common problem

absorb the impact of a hazard event and recover from it is determined by its geographical location, the resistance of its physical structures and infrastructures, its economic capacity expressed in terms of asset levels, reserves and access to loans; its levels of social cohesion and organisation; its cultural vision of disasters and many other factors. Communities are not homogeneous. In the same way that one community is more or less vulnerable than another, there are also social groups, which due to their social or economic status, their gender or age, their ethnicity or their political or religious affiliation are more vulnerable than others. The way communities are forced to interact with their natural environment, through lack of access to land, credits, markets or through factors such as forced migration and civil conflict, not only increase their vulnerabilities but often magnify hazards as well. The more complex risk becomes, in function of the interplay of different hazards and vulnerabilities, the speed of change in these variables and their density in space, the more difficult it becomes for both communities and individual households to adapt to cope with risk. Disasters are unmanaged risks and thus unresolved development problems. When the growing occurrence of small disasters indicates the accumulation of risk at the local level, then sooner or later a threshold is reached when major catastrophes such as Mitch occur.

Social and community vulnerability in the IDNDR

Discourse and practice: Arguments in favour of empowering vulnerable communities to manage and reduce risks have become

incorporated into international discourse, such as the 1994 IDNDR *Yokohama Strategy and Plan of Action*. Dominant practice, however, at both the national and international levels, continues to focus on managing disasters rather than risks. While the IDNDR discourse has become favourable to reducing social and community vulnerabilities, in practice risks have continued to accumulate and disaster occurrence and loss has soared.

National disaster management agencies in many countries are mainly focused on responding to emergencies, and in the best of cases disaster preparedness and immediate recovery, reflecting the emergency management vision of disasters as unpredictable extreme events, unrelated to development processes. The fact that many such agencies are excessively centralised, means that their capacity at the local level, particularly in highly vulnerable communities may be weak or non-existent. At the same time, barriers may exist to community or civil society participation, particularly when national agencies are run by the military.

At the international level, many bilateral and multilateral organisations still maintain a strong functional separation between 'development' and 'humanitarian assistance' divisions, with an agenda increasingly driven by the growing number and size of complex emergencies and civil conflicts, rather than by disasters. Humanitarian assistance agencies in particular, devote a meagre percentage of their total resources to disaster reduction, usually narrowly defined as disaster preparedness, so as not to encroach into development. At the same time, while some development agencies may describe their programmes as reducing

social vulnerability, the specificities of disaster reduction and its mutual relationship to sustainable human development are most often ignored.

Disaster statistics, compiled by both international agencies and the reinsurance industry, include data only on large scale events, reinforcing a vision of disasters as abnormal events interrupting development processes. Impact studies focus principally on strategic economic sectors and the formal sector of the economy. The creeping impact of small scale disasters on the lives and livelihoods of vulnerable communities, whose economy is largely in the informal or subsistence sectors is rarely documented given that often the most vulnerable communities are those with the least assets to lose.

Local level disaster risk management on the agenda

During the 1990s, in the context of the discourse and framework provided by the IDNDR, encouraged by research findings from the 1980s and supported by some of the more enlightened bilateral and multilateral agencies, a growing number of individuals and institutions have begun to construct the practice of local level disaster risk management.

Returning to Honduras, amidst the destruction and loss associated with Mitch, there were real success stories of disaster reduction efforts which had helped vulnerable communities to reduce their risks. In the Municipality of La Masica, on the Caribbean coast of Honduras, a programme of capacity-building activities, supported by a number of different agencies, and including the development of a community based flood early warning system, enabled the community to mitigate the impact of Mitch-induced flooding successfully. In contrast to neighbouring areas, not a single life was lost in La Masica. In the neighbouring Valle de Sula, a process of strengthening local capacities for disaster reduction was reflected in a relatively low death toll in one of the most densely populated areas of the country. Similar stories emerge from around the world, demonstrating that when disaster reduction is focused on reducing local vulnerabilities and increasing the capacities of vulnerable communities, risks can be managed and losses reduced. Examples, such as the community based reconstruction programme after the Alto Mayo earthquake in Peru in 1991, and the cyclone preparedness programme implemented in coastal areas of Bangladesh, demonstrate approaches and models for working at the local level, which, when scaled up, can reduce risks to a large extent.

Other initiatives have begun to create a supportive environment to facilitate the wide adoption of local level risk management approaches. The emergence of regional disaster research networks, with a social vulnerability perspective, such as Duryog Nivaran in south Asia, PeriPeri in southern Africa and La Red in Latin America, has broken the isolation faced by the small number of researchers and practitioners in developing countries who focus on community vulnerability issues and has helped put local level risk management on the policy agenda. The publication of these networks' research findings, enables practitioners to base their programmes on visions of their own reality, rather than on imported generic models from elsewhere. The growing number of training programmes available in developing countries, with a local level risk management perspective, are indicators of the growing demand for approaches and programme models, and the number of people and institutions becoming involved with them.

Challenges ahead

While important progress is being made in putting vulnerable communities centre stage in disaster reduction, or at least in the

developing world, new challenges are also appearing which may define the agenda for the coming years.

Enormous economic and insurance losses have been suffered as a result of recent catastrophes. This, coupled with the collateral effect on financial markets plus the fact that much of the damaged or lost infrastructure had been financed with development loans, has led to growing pressure on both the multilateral development banks and the private sector. The pressure has ensured that risk considerations are factored into development and investment decisions in advance of major disaster. While the growing involvement of banks and the private sector, and the conditioning of development loans to risk management policies, must surely be positive developments, they do raise issues which need to be flagged.

A focus on factoring disaster reduction into development and investment projects, may lead to a scenario of progressively reducing risk in strategic economic sectors and for those with access to loan finance and insurance, while, at the same time, risk levels in highly vulnerable communities with subsistence livelihoods and living in marginal settlements continue to increase. There would seem to be a tendency to privatise risk: disaster reduction becoming mainstreamed for those people with the capacity to pay, while emergency response and humanitarian aid continues to be the only solution offered for the highly vulnerable segments of society.

Progress made on factoring risks into development and investment projects is unlikely to be sustainable unless commensurate efforts are made to strengthen the institutional risk management capacities of governments and civil society.

If the reform of national disaster management agencies and systems is to be sustainable, it must go hand in hand with factoring risk reduction into economic and infrastructure development. Agencies must broaden their agendas from emergency management to risk reduction and decentralise operations to ensure that civil society participation is encouraged rather than blocked.

While reconstruction planning and financing is paying attention to issues of social and ecological vulnerability, as the post Mitch reconstruction process demonstrates, national and international reconstruction efforts may still bypass the needs of vulnerable communities. In the year or so between disaster occurrence and national reconstruction plans are approved and financed, many vulnerable communities revert to coping with risk, often in the same or worse conditions than before the disaster actually struck.

There is an enormous challenge to develop community-based mechanisms for reconstruction planning and financing, which can enable local plans to be developed and financed incrementally, before the full extent of national planning is finalised.

Underlying these emerging challenges, the key issue remains of how to mobilise political commitment at the national and international level to the management and reduction of risks in highly vulnerable communities. As the IDNDR concludes, the empowerment of vulnerable communities with appropriate information and early warning systems, training and capacity-building and an appropriate legal and administrative framework to facilitate their participation in risk reduction remains an elusive goal. Without political commitment to this goal, development achievements will continue to crumble with every new major catastrophe. Only by harnessing the huge and largely untapped potential of vulnerable communities to manage and reduce risks at the local level and by providing appropriate support to their efforts, will it be possible to look forward to a more sustainable future in the next century and beyond.

THE PERCEPTION OF RISK

Ways to measure community vulnerability

Dr Ian Davis, Cranfield University and Dr Nick Hall, South Bank University, UK

POLICY-MAKERS who define disaster risk reduction and relief strategies, and maintain or allocate budgets, are almost invariably remote and far removed from the realities facing people who are most vulnerable to disasters. Obligated to paint on a national canvas, they are rarely able to step back from the 'big picture' although the impact of their decisions is often most strongly felt at the very local, individual level. The aid and development community is therefore exploring new approaches to understand better the needs, perceptions and resources of the community (Mitchell, 1997). One of the most promising—perhaps the only answer—is to support the development of better local and national disaster management capacities. The rationale for this approach, which is rooted in the principle of subsidiarity, is convincing. This principle implies that decisions and implementation tasks should be allocated to the most appropriate level, starting at the local level with individuals and households (Hall, 1997).

The growth of vulnerability

The reasons for this approach derive from a growing awareness that poverty levels, particularly in many southern countries are increasing (Blaikie *et al*, 1994). Although poverty and vulnerability to hazard are not synonymous, it is not surprising that hazardous events are claiming more lives and destroying more livelihoods than was the case twenty years ago (Twigg and Bhatt, 1998). To some extent this is because the poverty that drives people to precarious and unsustainable means of survival creates a range of hazards that become disasters, or at least aggravates what may have otherwise been minor natural calamities. An obvious example of this is settlement and farming on riverbanks prone to flooding. Increasing numbers of poor farmers have no option but to live and work on land they know to be unstable, but this practice may and often does result in flood where previously a river may not have breached its banks. A similar cycle of poverty leading to hazard is evident in urban slums which are frequently located on steep hillsides, where land-slips become an increasingly common hazard.

Reducing vulnerability at the community level

This increased focus on reducing vulnerability at the community level (which, thanks to Andrew Maskrey's efforts, belatedly entered the IDNDR agenda after the 1994 Yokohama conference). It has provoked reflection on two examples of analysis into disaster risk reduction in Asia.

The first research project occurred almost twenty years ago when a multidisciplinary team of engineers, planners, architects, a geologist and an anthropologist conducted what was probably the first integrated study of disaster vulnerability relative to housing and settlements. This was the International Karakoram

Project, in which one section focussed on the vulnerability of housing to a multitude of hazards in the remote, steep and treacherous valleys of Northern Pakistan (Davis, 1984). The focus of questions to community leaders centred on whether they adapted their dwellings and lifestyles to prevailing threats or whether they attempted to mitigate the impact of flood, landslide, avalanche, earthquake, drought hazards. We received a surprising answer.

Local adaptations to hazards

The research team learned of the local community's reliance on a range of traditional risk reduction measures, such as tying ropes across fast flowing rivers with bells attached to warn as the ropes broke when flash floods cascaded down the valleys, providing agile fishermen downstream all of twenty seconds to jump for safety. Riverside pastures were not farmed in earlier days due to the risks from flooding to both farmers and their crops or livestock, but as the population had grown in the area they had no other choice than to farm such vulnerable riverside lands.

There were other local warning systems to alert communities to landslides and rock-falls. In times of heavy rains villages would plant a sentry under the shelter of a tree all night. On hearing a landslide high above the settlement he would raise the alarm. One village leader described how his family vacated their house to run for safety only to see their entire village wiped out by a landslide a few seconds later.

Local perceptions of risks

Despite such ingenious adaptations to hazard risks, local communities seemed to attach minimal importance to the severe hazard threats they faced. The research group was continually asked why we were concerned about such 'secondary matters'. One village leader asked bluntly why we didn't help his community tackle 'real problems'. We gradually came to realise that the perception of risk of these vulnerable communities centred on what they regarded as far more immediate threats than infrequent natural hazards/disasters.

Their priorities related to everyday concerns affecting their health, family life and the all pervasive issue of livelihood security. One example was the lack of girls' schools in the region, with the consequence that in due course it was hard to find their daughters husbands whose parents demanded literate brides. A further concern in many settlements along the Indus river was the lack of bridges to enable villagers to take their goods to market in the nearest town. By the time they got their fruit and vegetables to market by the extended routes, their produce was less fresh than that of their competitors and there were fewer buyers. Their priority list also included repeated reference to health problems such as insufficient dispensaries and the totally inadequate supply of drugs.



Photo: PRIP Bangladesh

Figure 5: Painting of a family hearing a cyclone warning on the radio in Bangladesh. Teaching aid developed for use in a community preparedness training programme. The pictures are used by the facilitator to draw out the experience of cyclone warnings from the local community

Lessons from the Karakoram

Some significant conclusions emerged from the project. The first was an awareness that the communities had a very shrewd grasp of the risks they faced. Where they appeared to take risks, such as choosing to live on a dangerous slope prone to landslides, there were generally some very good underlying reasons for the decision. They chose to cultivate all available flat land rather than waste such a precious resource by siting buildings on it. In effect they accepted the risk from an infrequent hazard event in order to reduce the risk to their everyday economic needs.

The second lesson was the need to place safety from natural hazards within a wider context of 'felt needs' that affected everyday questions of economic survival or health protection. Put another way, disaster mitigation belongs within a broader development framework. We left Pakistan pondering a salutary lesson that the project was teaching us. This was the realisation that if we had been a group of consultants working in the spirit of IDNDR to reduce hazard risks, that without our detailed village consultations we could easily have gone off at a tangent. And we would have missed the key issue of local perceptions derived from an integrated environmental, economic and social risk analysis. We could easily have advocated a range of physical mitigation measures to increase safety in these hazardous valleys that totally disregarded the everyday livelihood protection issues, and furthermore any safety measures we might have advocated could have damaged the fragile local economy. Therefore increasing risks to the livelihoods (and the lives) of these communities.

Vulnerability mapping in South- and South East-Asia

The second example is drawn from research in India and the Philippines from 1994 onwards. Therefore a far more developed methodology was adopted than in the Pakistan case study.

The aim was to understand and systematically describe how to measure the ever changing patterns of vulnerability within cyclone-prone communities in Andhra Pradesh and in island communities in Central Philippines.

A rich assembly of local knowledge overlaid with secondary data (from government, NGOs and scientific agencies) allowed the selection of a number of key indices. Inevitably, comprehensive indicators of vulnerability and recoverability are unique to each place and often to each individual or household, and may well be irrelevant elsewhere. Examples of these indicators could include a number of critical questions that demand specific answers: where to evacuate, who owns the land, what are the political dynamics and how effective is land drainage or watershed management in the locality? These markers are none the less valid for their uniqueness. For the research teams in both places; most of whom were villagers, the most detailed picture of vulnerability and capacity was contained in three-dimensional maps of the villages and, in the Philippines, in the ingenious joinery displayed by local artisans who built a miniature, cyclone resistant house.

Subsequently, drafting a village level disaster management plan meant designing a system which recognised the responsibilities and opportunities (for compensation and emergency relief, for example) of local government agencies. The government's decentralisation programme is changing the role of central and local government, so this evolving capacity had to be factored in to local plans for the community.

Superceding external risk with manufactured risk

The annual BBC Reith Lectures form one of the pinnacles of UK scholarship, and in 1999 Anthony Giddens presented a brilliant exposition on the theme of 'Risk' in the second lecture of his

series. He suggested that there are two forms of risk to consider: 'external' and 'manufactured'. 'In all traditional cultures, one could say, and in industrial society right up to the threshold of the present day, human beings worried about risks coming from external nature—from bad harvests, floods, plagues or famines. At a certain point, however—very recently in historical terms—we started worrying less about what nature can do to us, and more about what we have done to nature. This marks the transition from the predominance of external risk to that of manufactured risk' (Giddens, 1999).

Although the societies we have described in Pakistan, India and the Philippines could all be described as 'traditional cultures' our research clearly indicated that they were all moving in the direction that Giddens identified. They were far more concerned about the threats to their livelihoods from the lack of education, infrastructure and the impact of deforestation than the external threats of flood and cyclone.

Participatory methods to map local vulnerability and plan community based risk reduction measures

Several Indian NGO's are concentrating some of their resources on bridging the information gap between disaster planners and disaster victims. They use a variety of research tools to explore and explain localised vulnerabilities; one of the most effective methods is also one of the simplest—storytelling. Individuals or families are encouraged to describe how they cope with or have suffered the effects of disasters; these stories are taped, transcribed and then refined and agreed in discussions with the NGO 'editors'. These live stories are then incorporated as case study material in training and planning sessions with planners and policy makers. When they are combined with independent post-event audits of disaster relief work, these victims' stories have proven to be very influential advocacy tools.

Framework for disaster management built from local knowledge and risk perceptions

Storytelling is just one of many 'action planning' or profiling techniques. The following chart sets out an idealised framework for disaster management that starts from the community level.

Although the framework suggests a linear approach, the text in each box implies that effective planning and intervention has to be based on iteration; the process is thus dynamic and circular. Feedback based on experience is the key to traditional hazard management strategies as it must continue to be for the future. What is critical is that experience of those most vulnerable is expressed, documented and widely recognised (Hall, 1997).

Priorities for community based risk reduction

In 1996 Astrid von Kotze and Ailsa Holloway, wrote one of the key books of the IDNDR that summarised their experiences gained from running disaster management training programmes for the International Federation of Red Cross and Red Crescent Societies in Africa (Von Kotze, and Holloway, 1996). This material has now become an essential tool for community based training to reduce risks. At the outset they set out the underlying assumptions of the training guidelines. They also form a concise summary of our own concerns for effective risk reduction at community levels: 'Reducing Risk is based on four assumptions. First, it assumes that risk reduction efforts are more effective and sustainable if they are linked with or integrated into existing community-based services. Second, it assumes that the relationships between agencies involved in disaster mitigation and communities at-risk should be those of active partnership. Third, it assumes that emer-



Photo: Courtesy Nick Hall

Figure 3: Community risk mapping in Panay Island, the Philippines. Precise details of the village street plan provoke considerable debate amongst people who know their home but rarely get the chance to map it and analyse it

gency operations are opportunities for promoting prevention, mitigation, preparedness and recovery—as well as relief.

Lastly, because in Southern Africa the greatest impact of recurrent threats falls on women, it assumes that disaster-related initiatives must consider gender, as well as actively involve women in their design and implementation in the community'. (Von Kotze, and Holloway, 1996).

Conclusion

We have attempted to show that if the resource base offered by a systematic understanding of the capacities and knowledge existing within communities is to be utilised, a substantial shift in approach is demanded of disaster management policy makers and implementers. Thus risk assessment can become debased to the mere collection and cursory analysis of vast quantities of physical data, often of dubious accuracy and practical relevance. To paraphrase Coleridge, all too often this results in 'Data data everywhere, but not a thought to think'.

Therefore, instead of concentrating on the physical aspects of risk leading to the imposition of external solutions to community problems, decisions need to be informed by the priorities, requirements and perceptions of those at risk, such as the vulnerable communities described earlier in the dangerous valleys of the Karakoram or cyclone-prone islands of the Philippines.

This calls for flexible and adaptable management systems, supported by new techniques for data collection and processing which give priority to facilitating a dynamic process of participation and dialogue.

Pacific Island vulnerabilities towards the end of the twentieth century

John Campbell, University of Waikato, New Zealand

PACIFIC ISLAND Countries (PICs) occupy a paradoxical place in the perceptions of people concerned with natural disasters. On the one hand, they only rarely make international headlines when they are affected by disasters. Even the 'worst' disasters in PICs seem relatively minor in international perspective. For example, the greatest number of lives lost in a Pacific Island disaster in the last 40 years is the 2,182 deaths resulting from the Aitape tsunami in Papua New Guinea in 1998 and no other event in this period has resulted in more than 300 fatalities. The most widespread loss of homes was in 1986 when 12,000 dwellings were destroyed by tropical cyclone Namu in the Solomon Islands and the highest estimated costs of any one disaster event is US\$ 300 million. However, when examined against the small populations of most PICs the losses are proportionately very high, a point made by James Lewis some 20 years ago when he referred to PICs as vulnerable states. This is one of the reasons why PICs, on the other hand, are often labelled by international agencies and researchers as highly vulnerable.

This essay examines the issue of island vulnerability with reference to PICs. The essay outlines the range of disaster experience in the region and evaluates the effects of disasters in the past decade. It also explores the ways in which the image of island vulnerability has grown in recent years and seeks to explain why this has occurred and the implications of this trend.

The Pacific Islands region

The Pacific Island region (Figure 1) includes 14 politically independent countries and a further eight territories of metropolitan countries. While definitions vary, there are between 7500 and 1100 islands and islets in the region, of which approximately 500 are populated. The region is marked by great environmental diversity and considerable socio-economic variation. As Figure 2 shows, Pacific islands may be grouped into four broad categories according to their environmental characteristics. Continental islands, found along the western Pacific above the subduction zones between the continental and oceanic plates, are large islands with considerable environmental diversity and high levels of tectonic activity. The other islands are all considerably smaller and are found at different stages in the evolution of oceanic islands which are formed over hot spots in the earth's mantle. Volcanic high islands, the largest of these, are often characterised by very steep topography and may be found in a variety of stages of erosion. Atolls do not exceed more than a few metres above sea-level, and have very small land areas. Raised limestone islands are essentially stranded atolls. As a general rule, the continental island countries have the larger populations while the atoll populations are often very small.

However, as Figure 2 shows, some of the highest population densities in the region are found in the very small atolls and the least densely populated nations are those formed of continental

islands. Most oceanic islands including volcanic high islands have little or no surface water resources.

These characteristics of PICs contribute to their disaster 'profiles'. The continental islands are found, by virtue of their genesis, along one of the most tectonically unstable areas in the globe, and are also located in the Western Pacific where warmer ocean surface temperatures (apart from during El Niño episodes) expose them to relatively frequent tropical cyclones. The atolls, by virtue of their very low lying nature and absence of surface water, are prone to drought and inundation during storm surge and other high wave events. With the exception of Nauru and Kiribati which are close to or straddle the equator, all PICs are to a greater or lesser extent prone to tropical cyclones.

Pacific Island vulnerability: A growing truism

The smallness and isolation of island countries, together with their oceanic locations may be seen as the basis for a long held view that they are particularly vulnerable. More recently small island developing states (SIDS) have been identified by a number of international organisations (eg. Commonwealth Secretariat, UN Commission on Sustainable Development, UN Conference on Trade and Development), and treaties (eg. UN Framework Convention on Climate Change), as particularly vulnerable. The Barbados Declaration which resulted from the Global Conference on the Sustainable Development of Small Island States stated:

'Small Island Developing States are particularly vulnerable to natural as well as environmental disasters and have limited capacity to respond to and recover from such disasters.'

This sentiment is also found in the 'Yokohama Message', an outcome of the World Conference on Natural Disaster Reduction: The adopted Yokohama Strategy and related plan of Action for the rest of the Decade and beyond...will give priority attention to the developing countries, in particular the least developed, land-locked states, and the small island developing states.

Added to these developments at the inter-governmental level, there has been growing interest in developing indices of island vulnerabilities such as environmental and economic vulnerability indices. These indices tend to be based on macro-level approaches and aim to identify differences in the vulnerability of nations. They reflect little on the levels of vulnerability, or its converse, resilience, at the community level.

The outcome of this growing discourse is that SIDS have become identified internationally as being highly vulnerable. But, does disaster experience in PICs justify the discourse of vulnerability that has recently emerged?

In this essay I seek to critically examine the assumption of vulnerability from two perspectives. First, I evaluate disaster statistics from the region over the 1990s. Second, I review coping mechanisms currently employed by PIC communities in the face of natural disasters.

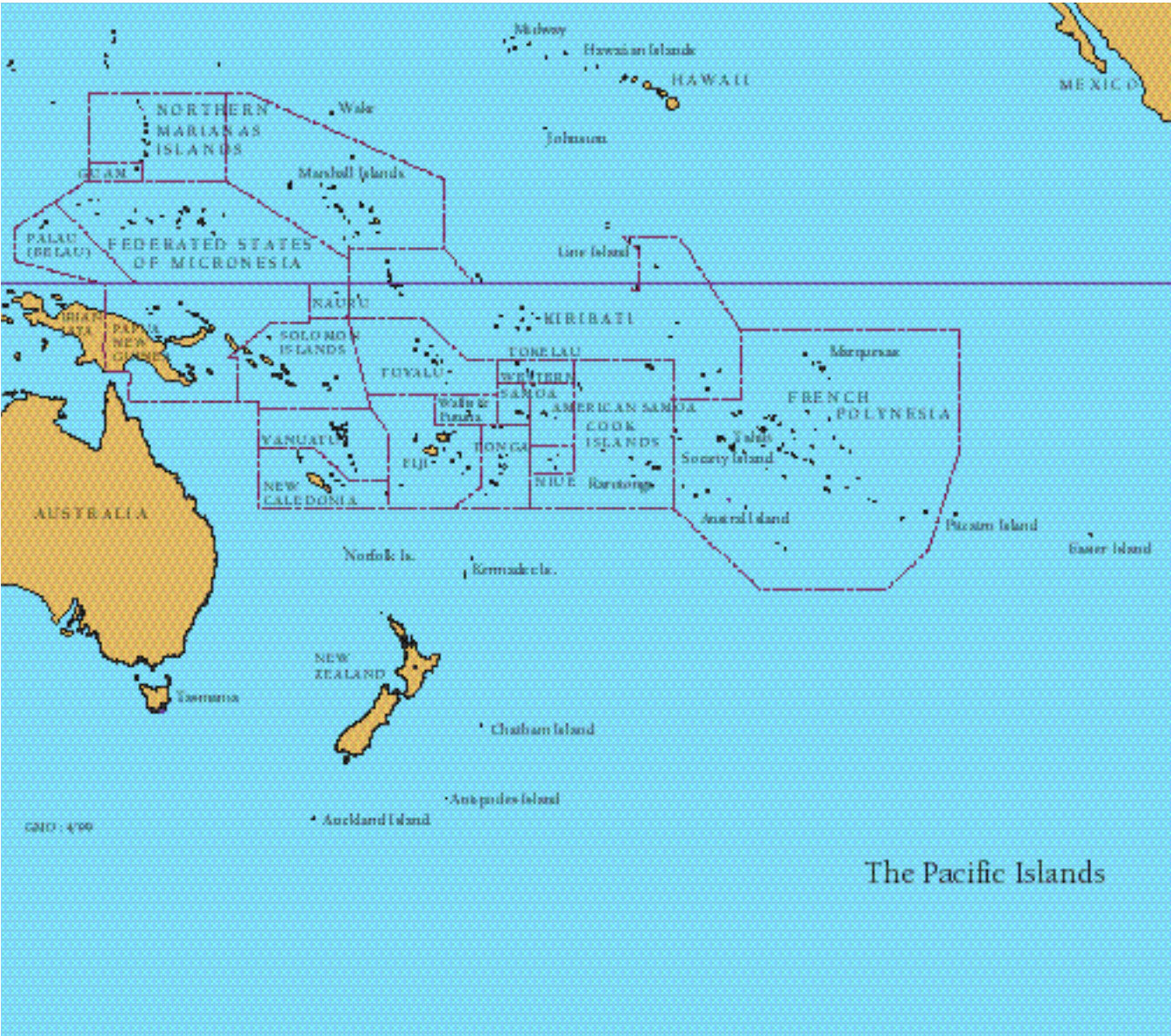


Figure 1: Map showing the countries and territories of the Pacific Islands region

Disasters in PICs during the decade

Table 1 indicates the effects of notable disaster events in the PIC region. As is evident from the table, PICs are prone to a wide gamut of natural extremes. The table does exhibit some interesting trends, although patterns in natural disasters are very difficult to establish over such a short time period and with such incomplete data. The first of these trends is the dominance of Papua New Guinea in the disaster statistics. The location, geology and topography of Papua New Guinea may be seen as significant factors in this trend as is the country’s very large population compared to the other PICs. It is important to note here, though, that Papua New Guinea is hardly a small island state, although it is a PIC. If we set Papua New Guinea aside, it becomes evident that the effects of disasters on small island countries in the Pacific region have been relatively moderate, and the most devastating events have occurred at the outset of the decade. The second trend is that the predominant types of extreme experienced in the region, outside of Papua New Guinea, are drought and tropical cyclones, the spatial and temporal patterns of incidence of which, are connected to the occurrence of El Niño events. During

these events droughts are often experienced throughout the region and tropical cyclone frequency increases. A third trend is the high monetary losses attributed to disasters in Guam. This reflects Guam’s status as a territory of the United States with a relatively well developed infrastructure and tourism industry.

Table 2 compares disaster effects in the 1990s with major events in previous decades. While the magnitudes of some of the events in the 1990s score highly on the indices used in the table they are not exclusively the ‘biggest’ events. This is despite a considerable growth in the value of infrastructure in PICs in the post-colonial period, growing economies and a marked increase in populations. From this perspective, the notion that contemporary disasters cause greater losses is difficult to sustain. It also raises questions about the validity of assumptions that PICs are highly vulnerable.

Contemporary coping in PICs

From the reports of early explorers, missionaries, traders, and colonial officers who began to interact with the people of the region some 150 or more years ago it would appear that Pacific Islands were comprised of thriving communities. While hardship

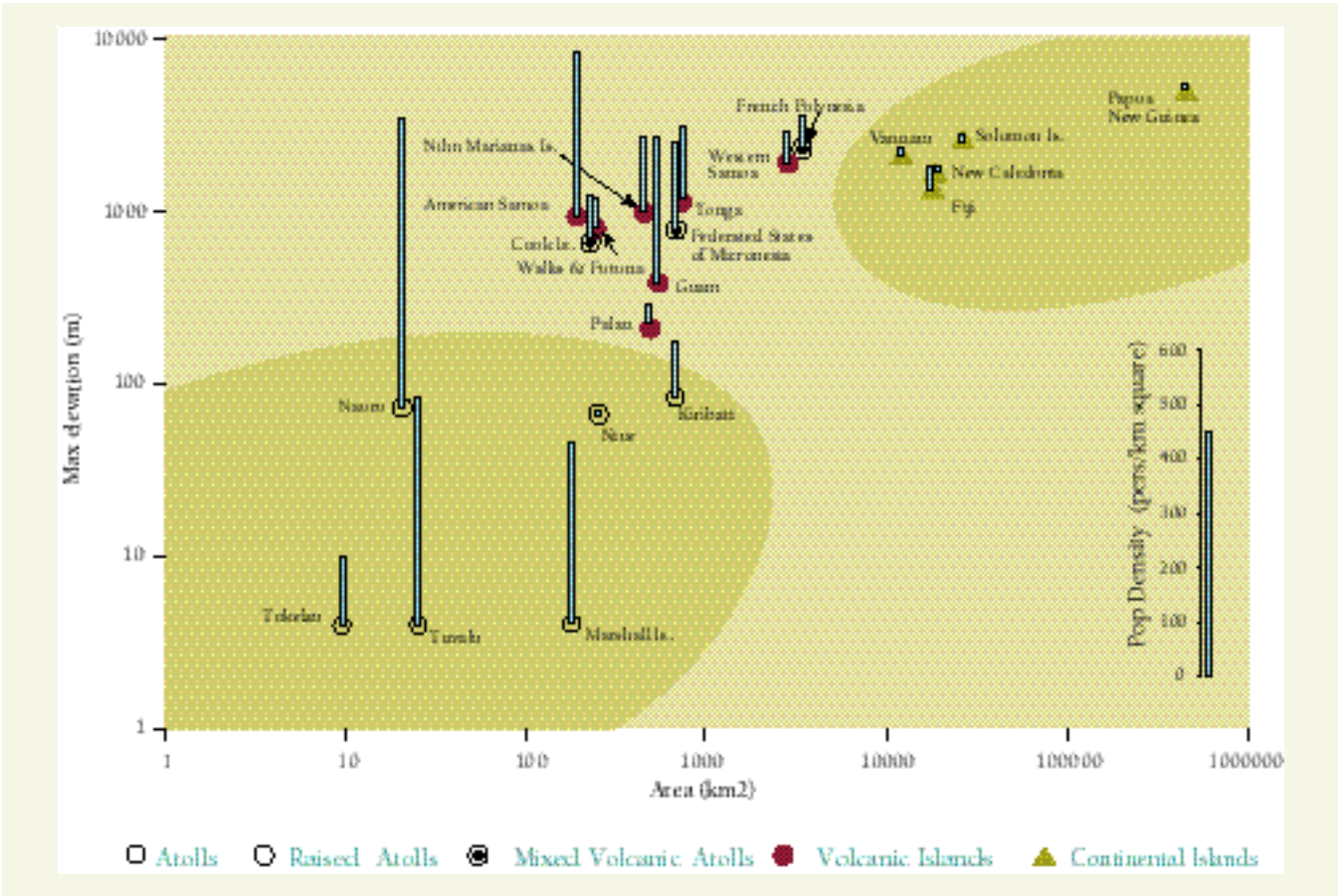


Figure 2: The countries of the Pacific Island region showing area (x-axis), highest elevation (y-axis) and population density (yellow bars). As the figure shows atolls, raised limestone islands, volcanic high islands and continental islands are clearly distinguishable in terms of physical environment indices. However, whereas the larger continental islands have low population densities the small atolls have very high densities

Year	Country	Type of event	Population affected	Number of deaths	Houses	Losses ¹ (US\$) destroyed
1990	Samoa	Cyclone Ofa				140,000,000
1991	PNG	Mudslide		200		
1991	Samoa	Cyclone Val	170,000			300,000,000
1992	Guam	Typhoon Omar			2,000	300,000,000
1993	PNG	Earthquake		48		
1993	Fiji	Cyclone Kina				110,000,000
1993	Fiji	Earthquake				110,000,000
1993	Solomon Islands	Cyclone Nina	88,500	11,992		
1993	Vanuatu	Cyclone Prema	9,000	1,200		
1993	Fiji	Cyclone Kina	150,000	21	2,000	140,000,000
1994	PNG	Volcanic Eruption	100,000	4		220,000,000
1997	Cook Islands	Cyclone Martin	1,649	19		7,500,000
1997	Tonga	Cyclone Hina			648	14,500,000
1997	Regional	Drought				
	Fiji					78,000,000
	Papua New Guinea	Frost & drought	1,200,000	'many'		50,000,000
	Marshall Islands					6,000,000
	FSM					9,000,000
All other PICs reported droughts although estimates of losses are unavailable						
Subtotal Regional Drought Losses: 143,000,000						
1998	PNG	Tsunami	11,854	2,182		
1998	Tonga	Cyclone Cora				56,000,000
1998	French Polynesia	Cyclone Alan		10		
1999	Fiji	Cyclone Dani	20,000	12		3,500,000
Note: These figures are not adjusted for inflation. This table only includes the events with significant effects						

Table 1: Significant natural disasters in PICs during the IDNDR

FOR REFERENCE PURPOSES ONLY

SOCIAL & COMMUNITY VULNERABILITY

Year	Event	Country	Measure of Effects-Mortality	Year	Event	Country	Housing Losses
1998	Tsunami	Papua New Guinea	2182	1986	Cyclone Namu	Solomon Islands	12,000
1991	Mudslide	Papua New Guinea	200	1993	Cyclone Nina	Solomon Islands	11,992
1986	Cyclone Namu	Solomon Islands	111	1972	Cyclone Bebe	Fiji	11,770
1973	Cyclone Lottie	Fiji	80	1983	Cyclones Eric/Nigel	Fiji	10,000
1979	Cyclone Meli	Fiji	53	1983	Cyclone Oscar	Fiji	4,733
1993	Earthquake	Papua New Guinea	48	1982	Cyclone Isaac	Tonga	2,000
1988	Cyclone Uma	Vanuatu	48				

Year	Event	Country	Monetary Estimates(US\$) ¹
1976	Typhoon Pamela	Guam	300,000,000
1991	Cyclone Val	Samoa	300,000,000
1992	Typhoon Omar	Guam	300,000,000
1994	Volcanic Eruption	Papua New Guinea	220,000,000
1987	Cyclone Uma	Vanuatu	150,000,000
1990	Cyclone Ofa	Samoa	140,000,000
1993	Cyclone Kina	Fiji	110,000,000

Footnote: These amounts are not adjusted for inflation¹.

Table 2: Major events of the last three decades compared

may have resulted from natural disasters there is evidence that high levels of community resilience existed, underpinned by a range of coping mechanisms such as inter-island exchange, agricultural diversity, intra-community co-operation, the use of famine foods and food preservation, and traditional building construction methods.

It has been a common observation of the small group of researchers working on natural hazards in PICs that many of these traditional measures have fallen into disuse. Generally it has been postulated that colonisation and the introduction of a new religion broke down traditional political (and associated trade and exchange) structures. The introduction of cash and the availability of rice (as a consumer good) reduced the need for food preservation and the use of famine foods, and commercial agriculture saw the replacement of resilient diverse agro-ecosystems with monocropping. Traditional housing gave way as new, but not necessarily effective, materials were introduced. Equally important, the provision of relief replaced the need for self-sufficient responses to disaster losses. In the post-colonial era, inputs of relief increased dramatically. The image that emerged in the 1970s and 1980s was one of increasing dependency in the face of disaster.

This image of vulnerability seems to be belied by the statistics of disaster effects. While there can be no doubt that disasters do cause considerable havoc and loss of life and property, and place pressures on food security, PIC communities show considerable resilience when disasters occur and governmental response efficiency is steadily improving in many countries. There are still strong levels of intra-community co-operation in disaster response. While some traditional coping strategies have fallen away new ones have emerged. The widespread migration of Pacific Island people to metropolitan countries in recent decades has been matched by a marked increase in the role of remittances following disasters. Migrants whether living in Australia, New Zealand, USA or further afield are still members of their village communities and are an important component of post-disaster response. In similar fashion, there is growing mutual assistance

among PICs not only in sharing resources when disasters occur, but also in building disaster management capabilities by sharing experiences and knowledge. Many countries have encouraged the building of cyclone resistant structures, especially in post-disaster housing rehabilitation schemes. Perhaps most important, PIC communities are not passive in the occurrence of disasters. In event after event, as is the case in most parts of the world, communities show tremendous levels of resilience.

People living in PICs are exposed to a wide range of extreme events. The effects can be devastating as was illustrated by the recent tsunami in Aitape, Papua New Guinea. There is still considerable room for improvement in natural disaster reduction capabilities. However, in the face of a growing perception to the contrary Pacific Island Countries are not exceptionally vulnerable.

Conclusion: Vulnerability, a problematical notion?

The concept of vulnerability has gained considerable purchase in a number of development oriented sub-disciplines including those associated with natural disaster reduction. The notion, however, is imbued with a number of unsatisfactory connotations. Vulnerability suggests weakness, inability, lack of positive attributes and passivity. These attributes are not characteristic of the people or communities of most PICs. Indeed one suspects that many so-called vulnerable peoples around the world have superb levels of resilience in the face of massive hardship.

While the notion of PIC vulnerability has become accepted as a truism it is often based on tautological assumptions about the relationship between smallness, isolation and developing country status, and vulnerability.

Moreover, indices of national vulnerability give little insight into the vulnerability or otherwise of local communities such as villages, outer islands and urban settlements. Closer examination shows the persistence of high levels of resilience and pro-active response. These strengths should be encouraged and supported. Instead there is a growing discourse of vulnerability, a discourse which if continued and entrenched may well prove to be a self-fulfilling prophesy.

Mapping Vulnerability-Participatory Tool Kits

Mihir Bhatt, Disaster Mitigation Institute, India

ONE OF THE most important gains of the International Decade for Natural Disaster Reduction (IDNDR) is the movement of policy investments from the concepts of hazards and disasters to the concepts of risk and vulnerability. This movement is important because first, it has brought the people — as victims, survivors, or vulnerable communities — into the centre and secondly, it has started integrating science and technology efforts with political-economy and social-science considerations. Investments must generate yield. The gains of this decade, obviously, must be consolidated over the coming years. From the experiences of Disaster Mitigation Institute (DMI) at the grassroots as well as the larger South Asian regional level, it is clear that there is a demand for such a consolidation of gains (Bhatt, 1999a).

Demand

There are several examples where this demand has been recognised. Duryog Nivaran, a South Asian initiative in disaster mitigation, is actively involved in useful and innovative work on the concepts of vulnerability reduction (Twigg, 1998). La Red, a Latin American initiative in community based disaster mitigation, promotes community based mitigation. Harvard Institute for International Development has developed a reducing vulnerability/building capacity framework. OXFAM-UK, and its partners in South Asia have developed community manuals for vulnerability reduction. Other important international and local NGOs have also done pioneering work. The demand for implementing these concepts is increasing, as is the demand for the application of these concepts, not only among those who have developed them, or those who funded the development (Athar, 1999), but also from those for whom they have been developed: the vulnerable communities.

DMI's own experiences over the past five years in promoting vulnerability reduction at the grassroots level through its four programmes — Food Security, Water Security, Habitat Security and Work Security — shows that development, application and refinement of vulnerability reduction tools are urgently needed (DMI, 1997). These tools are what will operationalise the concepts of vulnerability reduction at the grassroots. The worth of any concept is measured in its application. DMI's work in the disaster-prone region of South Asia, through its partners in Duryog Nivaran, has shown that this demand for tools is also region-wide. The demand may be articulated or latent, but it is there. Thus, it appears that in the future ahead, increased investments of time, resources and efforts will be needed to develop these vulnerability reduction tools that will help consolidate the gains of IDNDR.

Experience

Some excellent tools have been developed over the past decade. A short list of examples includes OXFAM in Bangladesh, which has developed vulnerability reduction through the experiences of its extensive relief operations (Bhatt, 1999a). Church Auxiliary

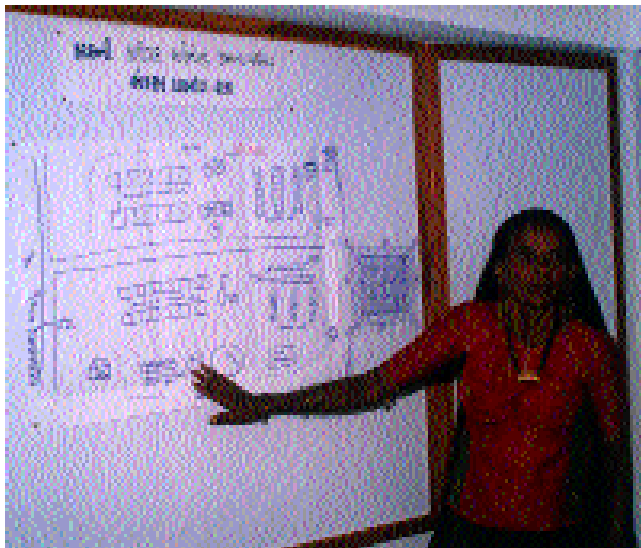
Services Association (CASA) in India has an innovative set of tool kits that link resettlement efforts with rehabilitation. Intermediate Technology Development Group (ITDG) in Sri Lanka has been developing tools to address the vulnerability of agriculture populations in arid areas. Among these examples is the set of tools developed by DMI in urban risk reduction, which includes Strategic Action Planning Tools; Participatory Evaluation Writing Tools; Activity Clock; Seasonality Mapping Tools; Tools for Making Chronology of Disasters; Relief Responsive Index and Performance Audit Tools (DMI, 1998). These tools are used with coastal communities, desert artisans, urban slum dwellers, flood plain communities, saltpan workers and tribal contract labour. The tools are also used in different stages of disaster mitigation relief, rehabilitation and preparedness. DMI has worked with local NGOs such as Banaskantha DWCRA Mahila Sewa Association or Gujarat Jan Jagran Sangh; government agencies such as National Centre for Disaster Management at Indian Institute of Public Administration; regional training institutes such as Asian Disaster Preparedness Centre; and other bodies. Based on this experience of DMI, it is possible to first draw lessons and later enlist future areas in which to invest efforts.

Lessons

First, universal, agency-wide, or comprehensive vulnerability reduction tools become more useful when they are localised. That is, when the tools are adapted or re-invented to address the specific regional, city-wide, or neighbourhood related demands for vulnerability reduction, they become more effective. Local tools do not mean that they are closed off from global or agency-wide influences. Local tools are ones that address the household, and its relation to the state and corporate economy. The more localised the tools are, the more effective they will be in reducing vulnerability reduction.

Second, the debate over naming has been useful. Victims, survivors, vulnerable groups, affected people, displaced communities, or project beneficiaries are groups that have been conceived as the users of these vulnerability reduction tools. However, tools and their uses have been more effective where the users are conceived as citizens. Citizen concept acknowledges a community with political rights and responsibilities. This acknowledgement includes a democratic claim to joining decision-making and being accountable for it. In developing countries, large numbers of people do not have voter cards, ration cards, labour identity cards, property titles or wage slips from the formal sector employer. Therefore, they do not exist as citizens in the eyes of the authorities, who need such documentation before providing relief or including them in rehabilitation projects or allowing them to participate in preparedness planning. When vulnerability reduction tools initiate such citizenship documentation, they are more effective (Bastian, 1996).

Third, the tools that recognise and promote the voice of these victims as citizens are more effective because they become inclusive tools, democratic tools that are transparent to many, if not all,



Woman of the desert area of Kutch in India presenting her Action Plan for preparedness and village development at Disaster Mitigation Institute (supported by UNICEF)

and tools that hold the users accountable to the outcome. Here, the voice does not mean the voice that is heard in a short-notice, top-down, public consultation organised by a visiting mission of a multilateral organisation. Rather it is an effective voice, a voice that is backed with certain power and authority arising out of authenticity. Tools that enhance this voice of the victim or the vulnerable citizen are able to more effectively reduce vulnerability (Bhatt, 1999b).

Fourth, the vulnerability reduction tools are more effective when they recognise and encourage co-existence and co-operation of diverse victims or vulnerable citizens. In fact, the tools that value such a variety of differences among individuals and groups are more likely to be taken up for use by the affected local, multi-cultural reality. The homogenising influence of commercial media and the entertainment culture leads us to believe in an increasing global uniformity. That may be true, but equally true are the real and emerging differences in need and interest arising out of social, ethnic, gender, religious, age, labour-market, income, participation and representation-related differences. When these differences are denied, they leap to the fore and turn natural disasters into complex emergencies.

Fifth, and in many ways especially crucial, is the fact that tools that increase the access and range of ownership of income or assets are more effective. The tools that lead to work, shelter, food, finance, education, or good health by reducing vulnerability are more in demand by the victim or vulnerable citizens over those tools that only relate to vulnerability analysis, however thoroughly. Concrete, measurable and livelihood related gains are a must (Bhatt, 1999 b).

Areas for investments

Lastly, let us look at future areas where a larger degree of investment in time and resources is needed to develop vulnerability reduction tools. Tools that build organised, collective strength of the victims across regions, disasters and responses will be extremely useful in making these citizens visible and heard. Similarly, tools that will improve the quality and standard of relief performance across agencies are in demand from both the relief recipients as well as the relief giving agencies. Economic and accounting tools that help a range of stakeholders to review public



Photo: Red Cross

Red Cross aid workers in India, after an earthquake in September 1993

expenditure on relief are in the process of being developed and will have tremendous use in coming years (Mistry, 1999).

Risk auditing is an idea gaining ground. Tools that help risk audit of increasing local and global investments in urban infrastructure will be of crucial help to a range of agencies and authorities, especially the local authorities (OCDS, 1997; Bhatt *et al*, 1998). Though several notable tools have been developed for making gender concerns central to vulnerability reduction efforts, notably by Oxfam, Tear Fund and CARE, the scope for future development is tremendous (Bari, 1997). Global trade and finance has created a demand for local risk reduction funds owned and managed by the victims or vulnerable citizens. Currently, tools that can build such risk reduction or social security funds are rarely conceived, but certainly need to be developed. A similar global force that has created strong local demand is the rapid and revolutionary spread of information technology. Unless vulnerable citizens have the tools to benefit from these early warning, communication, data analysis, or management information systems, they will continue to be vulnerable (MEERP, 1998). Equally important is the need for investments in the tools that address the vulnerability arising out of lack of integration between natural resource conservation and disaster mitigation. One is leading to another, causing great loss of life and resources. Environmental and emergency concerns remain separated, and at the individual victim or vulnerable citizen level, without tools to integrate the two, this separation costs time and resources, hindering the vulnerability reduction processes.

Conclusion

The above mentioned demand for investments in vulnerability reduction tools will consolidate the gains of IDNDR. In fact, it will include so far unreached populations of victims or vulnerable citizens in the mainstream of vulnerability reduction efforts.

CASE STUDY

The power of education

Linda Berry and David King, James Cook University, Australia

HOWEVER CAREFULLY WE plan for the mitigation, response and recovery from natural disasters, people are isolated and reliant upon their own knowledge and preparation during the passage or maximum impact of a natural hazard. A combination of clear and accurate warning messages with high levels of community awareness and accurate risk perception will give the best level of preparation for people to act self-reliantly during the impact of a natural hazard, thereby reducing the extent to which it becomes a disaster. While it may not be easy to put in place warnings and education for rare hazards, it is achievable for events that occur frequently and have a period of build up, such as floods and tropical cyclones in Northern Australia.

Research carried out by the Centre for Disaster Studies into community awareness and response, suggests that people are a long way from self-reliance when faced with a natural hazard. Targeted educational programs need to increase preparation, awareness and response to warnings, as well as improving the mechanisms by which warnings are transmitted and received. Education and awareness must also be a continuous process as the population continuously changes and grows.

Throughout Northern coastal Australia, as well as in the countries of the Pacific, rapid urban growth is attracting large numbers of people into coastal areas where vulnerability to cyclone and flood is high. Much of this new population is highly mobile. In far north Queensland's coastal townships the average households length of residence in current dwellings is four years and in the region generally just eight years, although indigenous communities tend to be longer-term regional residents. Throughout the Pacific region there is a constant movement of people between rural and urban coastal villages.

In moving to new cities and new areas individuals lose their local knowledge of familiar hazards and must learn new strategies to deal with new phenomena. They are likely to have limited personal experience of new hazards. Throughout the hazard literature there is consensus that direct personal experience is a powerful influence on how people perceive the risk of hazards and what precautionary measures they will take to ensure their safety and well-being. Family and close friends that communicate their personal hazard experience will influence the risk perception and consequent behaviours of those with less experience. In the move to new areas, however, people often

lose their family and community networks. This is particularly true of the non-indigenous communities both in Australia and throughout the Pacific region

These factors increase community vulnerability. Research carried out by the Centre for Disaster Studies immediately after floods and cyclones shows that reliance upon neighbours, and preparation and awareness to a level where people are sufficiently self-reliant to deal with the hazard, may be crucially important in reducing vulnerability.

Post disaster studies in Northern Australia have concentrated on issues of warnings, preparation and impact from cyclones and floods. The wet season in northern Australia can be guaranteed to bring severe weather conditions every year. Between 1997 and early 1999 the Centre has carried out ten studies relating to six separate weather events (cyclones or cyclone-related floods) in eleven towns and cities across North Queensland. The events were Tropical Cyclones Gillian, Justin, May, Syd and Rona, with only Rona being classified as 'severe', flood damage, however, in some places was catastrophic.

From all of these studies we can summarise six main groups of impacts. These are the unequal distribution of the impact; a lack of expectation of the impact; late or minimal preparation; loss of services during the event; community or neighbourhood response; and confusion concerning warnings and the media.

The unequal distribution of the hazard impact causes a proportion of the population to experience major loss, while most of the rest of the community was less inconvenienced. Very often it is the most socio-economically (and sometimes politically) disadvantaged that settle in the areas at most hazard risk. In the flood affected regions of Queensland, areas or houses that were devastated were in especially vulnerable areas, where preparations of the residents should have been much greater. Some places, such as the Black River settlement at Townsville, should never have been at such a vulnerable site. Disasters in these vulnerable places have raised urban and community planning issues, but by being relatively small parts of affected communities they may benefit from special mitigation works as well as targeted education campaigns.

Despite the obvious vulnerability of some communities, people in flood affected areas continue to report their astonishment at the disaster; a lack of expectation that flood waters would ever rise that high. In the outback Queensland town of Cloncurry, residents watched as the



Often very brave individuals end up moving goods and even elderly neighbours, in fast-flowing floodwaters in the pitch dark due to late action and intervention



A child's drawing of a cyclone, Australia

water in the Cloncurry River and its branches rose and spilled over the banks without taking any precautionary measures until water actually flowed into their homes because they were confident that flood waters would not come up as high as they eventually did. In all of the floods we have examined, record levels have been broken, however, in northern Australia records are relatively recent and remembered community experience is not an adequate preparation. In many communities residents believe that for some reason their area is protected from hazard impact. In Cairns there is a strong and growing perception that the Great Barrier Reef and surrounding mountain ranges protect the area from tropical cyclone impact. Residents of Wujal Wujal, a remote coastal indigenous community north of Cairns, express the belief that the hills around their settlement will protect them and that traditional practices will keep thunder and lightning storms at bay. People in the Gulf of Carpentaria townships of Normanton and Karumba often state that they are immune from tropical cyclone impact (destructive winds and storm surge) but not from consequent flooding. It is also relatively common for communities, that have been devastated by floods, to consider them to be a rare event (such as 'one in 100 years') and common for them to feel safe for the future because they have had their 'big floods'. The central Queensland

town of Charleville experienced two such events within nine years and the affected residents expressed both amazement and anger. In the face of both floods and cyclones, people reported doing minimal preparation before the event, often because they lacked experience and an appreciation of the potential risks of the event. They also generally left it to the last minute, especially removal of belongings from rapidly rising floodwaters. Not only were the belongings put at greater risk by late intervention, they were also often very brave individuals who ended up moving goods and even elderly neighbours, in fast flowing floodwaters in the pitch dark. Late preparations for cyclones, especially once destructive winds have commenced, is particularly dangerous. Tropical cyclone and flood awareness literature that is made freely available to the public emphasises the need for households to be well prepared for the cyclone season and to ensure that they have adequate emergency provisions on hand. Many households however, particularly those in the most vulnerable areas, lack the financial resources to do this. Cyclone Rona (*Cape Tribulation*, 11 March 1999) hit land on the evening of social security payments day, catching many households at the end of their fortnightly provisions.

In recent times communities that are regularly affected by isolating floodwaters have grown reliant on emergency

supplies being air lifted to them. Shop keepers and households in the often flood-bound townships of Normanton and Karumba no longer over-stock their shelves and fridges prior to the wet season in case there is no flooding and stock is not used or sold before the recommended 'use by' dates. This dependence on external assistance presents problems for emergency services as helicopter food drops are often delayed by difficult weather conditions.

In both floods and cyclones people reported that they had helped neighbours, or been assisted by their neighbours, often these people were previously unknown to them. In many disasters, especially the floods, the emergency services were as isolated as the rest of the community. During the event and for extended periods afterwards, houses were without power and water. In remote areas communities faced the additional problems of ineffective sewage systems. Communications were usually severely limited with telephone services interrupted and back up radio and satellite telephone communication being only barely satisfactory. Generator power is limited and inadequate to service entire communities.

As the definition of a disaster is a complete overwhelming of utilities and emergency services, people are on their own once a natural hazard impacts a community. It is obviously crucial that everybody knows what to do and how to avoid danger in these predictable disasters. It is also important for communities to be not only cohesive during a disaster but aware of its own strengths and limitations. In the Cairns region the urban community is seriously fragmented with more than 50% of households admitting to having either minimal or no contact with their immediate neighbours. During a recent early morning evacuation of a Cairns suburb, ahead of expected flooding, several households did not receive instructions to leave the area. One was an elderly lady with severe arthritis who slept through the door knock. Apparently none of these residents were missed by their neighbours and were confused to wake up in the morning to find the neighbourhood deserted.

Despite advances in technology and communications, remote communities often received limited or no warning of an impending natural disaster. By relying on the media to relay warning messages, communities are constrained by the availability of power, radio and television transmissions in remote areas, and by the reliability of the media in urban areas. People criticised television channels that were perceived to have either exaggerated or alternatively to have ignored specific hazards. It is significant that people continue to rely upon their own observations or those of friends. In the more remote communities of Queensland there is a dependence on the Bureau of Meteorology's weather fax service for timely warnings. This is normally received as a faxed satellite image, which is often not easy to interpret. It is usually received by a facility with generator power and displayed on a public notice board or inside a shop window. People must therefore leave the safety of their homes or shelters to get the latest warning messages. It is clear from studies of communities shortly after a natural

disaster has occurred, that there is much that can be done to improve warnings and levels of awareness and preparation. Detailed household surveys of hazard awareness and preparedness indicate significant misconceptions and gaps in people's hazard knowledge and understanding and post disaster studies highlight problems in hazard warning response. The need for focussed, targeted community hazard education and initiatives to strengthen community social structures has been clearly indicated.

To be effective, hazard education must address the specific demonstrated needs of the group it is targeting. The efficacy of people's preparatory behaviours and the appropriateness of response to hazard warnings are largely dependent on hazard awareness and the perception of the hazard risk. The development of such awareness and perception is based largely on previous experience together with hazard education. It is not possible to give people direct experience but it is possible to offer focussed education as a continuous process that meets their changing community needs. In 1996, Cairns students were surveyed in an effort to determine the level of cyclone awareness and understanding within this younger section of the community. This group demonstrated some knowledge of cyclone processes, however, like the community's households, it held a very biased perception of the risk and an even stronger belief that the area is in some way naturally protected from cyclones. They also had very limited knowledge of preparatory behaviours.

An interactive, tropical cyclone awareness-raising CD ROM game *Stormwatchers* has now been developed as an educational aid for primary school students. This game, through a series of realistic scenarios, demonstrates appropriate warning behaviours and involves the player in preparatory activities. Schoolteachers have found it relatively simple to work through and informative and are including it into curriculum studies. It is hoped that children will pass knowledge gained from this activity on to their families and incorporate it into their own future cyclone preparation routine.

People throughout hazard prone regions need the tools to develop strategies to enable them to be as self reliant as possible when faced with danger and isolation. Information and education are arguably the most powerful tools that can be offered. Communities that are cohesive will benefit from community education programs, communities that are more fragmented require a different approach. A multimedia approach with participant involvement in the education process is likely to have the broadest reach and the greatest potential for success. An understanding of community structure and processes and experience is essential to provide the necessary framework within which hazard awareness materials can be developed and demonstrated community needs be met. Individuals, families and communities that are well informed and well prepared for hazard impact will respond appropriately to the situation they are faced with and therefore minimise the total disaster potential.

VI

RISK ASSESSMENT

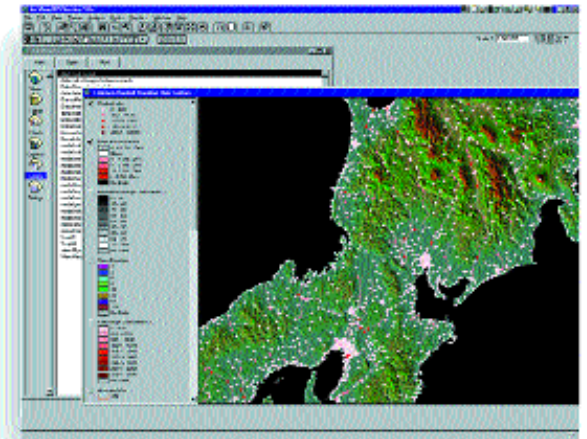


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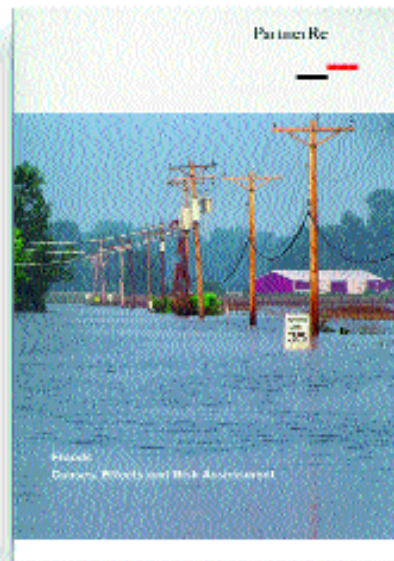
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KEYNOTE PAPER

THE EVOLUTION OF RISK ASSESSMENT

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RISK ASSESSMENT of natural disasters has for years been defined as the process or science of pin-pointing where and when a natural disaster is likely to occur. In recent years, this definition has been expanded to include an assessment of the event's aftermath; specifically its long- and short-term effects.

The immediate impact of a geological event — such as a mudflow, earthquake, massive earth movement, tsunami or volcano — is now being analysed in conjunction with more far-sighted concerns, such as an increased potential for infestation by insects, animals and plants. Hydrological and meteorological events such as climate extremes, hailstorms, floods, hurricanes, severe storms, tropical storms and droughts are analysed in much the same way; but such added factors as originating location and potential for infestation are also taken into account.

Another important shift in the way we conduct risk assessment has resulted from the development of new technology and the growth of the internet, advances that enable researchers to significantly enhance their approach to disaster management. No longer relegated to simply forecasting the probability of an event, managers now have the resources to digitally simulate natural disasters and analyse their impact on a given area. Used effectively, these simulations will allow for flexible planning and the ability to better accommodate the effects of a natural disaster.

The effort that once went into compiling and analysing reams of hard copy historical data can now be channelled into performing mathematical modelling and flow analysis on electronic versions of the historical databases. These calculations, in turn, enable researchers to design computer simulations that consider the potential for loss of life, damage to transportation and communications infrastructures, political fallout, and many other social, cultural and economic concerns.

Advances in software development have yielded an impressive range of analytical power tools capable of performing such critical functions as risk analysis, decision trees, optimisation, and financial analysis, to name only a few. Cyberspace continues to

broaden the spectrum of available information and individual researchers who were once restricted by the cost and accessibility of technology are now able to perform sophisticated risk calculations on their laptop computers. In the future, as risks become better defined, we must continue to base our research on historical events, while at the same time refine and enhance our techniques through the use of new technology.

In leveraging today's most influential technological advancement, the government has become an important source of information on natural disasters. According to the White House website, the government's Committee on Environmental and Natural Resources (CENR) has made significant progress in the following areas: expanding our national capabilities for hazard identification and risk assessment, advancing our understanding of what causes these hazards, and laying the foundation for more timely and reliable forecasting. The CENR is a subcommittee of the National Science and Technology Council, a cabinet level council established in 1993 as the 'principal means for the President of the USA to co-ordinate science, space, and technology policies across the federal government.'

When all countries share their natural disaster risk information, the result will be a truly global understanding of risk assessment. Technology has made the world a very small place. If we look at the Earth as one continuous geographical area with a number of subsets, and if we share critical information from each subset over the internet, we can succeed in linking the resources of our international risk assessment community. This data can be updated continuously, resulting in more concise and accurate forecasting. This must be the goal of every nation if we wish to sustain our communities in the wake of natural disaster.

The Risk Triangle

David Crichton, CGU Insurance, UK

THE DRAMATIC increase in average annual economic cost of natural disasters can, to a great extent, be explained by population growth, movement into more hazardous areas and also increased wealth, at least in the developed world.

There is strong evidence, however, that we may now also be seeing more frequent and severe weather conditions. Certainly there are indications that the climate is changing (Figures 1, 2).

Whatever the causes, insurers are 'in the front line' when it comes to the effects. In the past, historic claims experience was a good measure for predicting future risk. This only really works if the risk is changing at a predictable rate. If the climate is changing this adds more uncertainty to any predictions, and climate change presents the biggest potential challenge faced by insurers in the next century, perhaps even the next millennium. Insurers will need to be able not only to anticipate future risk levels, but also to explore new ways to reduce them.

One way to explain how insurers, or indeed anyone involved in disaster reduction, can do this is to use the concept of the 'Risk Triangle' (Figure 3). 'Risk' is the probability of a loss, and this depends on three elements, hazard, vulnerability and exposure. For example with property insurance, we have to consider the frequency and severity of the hazard, such as a flood or storm; the vulnerability of the insured property to that hazard, that is the extent to which it will suffer damage or loss, and the exposure of the property to the hazard, for example its value and location.

If we think of the size of the risk as being the size of the area of the triangle, then by simple geometry, we know that this in turn depends on the size of each of the three 'sides' of the risk triangle. If any one component or 'side' of the triangle is zero, then there is no risk. So for example, if we can reduce exposure by reducing the number of properties we insure, we reduce the area of the triangle, so reducing our risk. Of course in doing this, we also reduce our income and society (or other insurers) still have to bear the rest of the risk.

Disaster management practitioners will find much of this very familiar except perhaps for the way insurers use the term 'exposure'. When an insurer accepts a 'book' or portfolio of risks, it knows that its maximum exposure to losses is the value of that book of risks. When a disaster happens, the insurer writes a cheque and walks away, its duty done.

For a country, the 'exposure' would mean the population, the infrastructure and the built environment. After a disaster, its problems have just begun. Recovery will depend on the strength of its economy and its institutions and their resilience and preparedness for the disaster.

Having said that, the insurance risk triangle is of value in helping those involved with disaster management understand how risk can be measured and also managed. One solution for a country where there is a high level of natural hazard, for example, is to look at ways to discourage the development of housing and industry in areas where the hazard is particularly high, such as floodplains. In this way, the country's assets will be less exposed to flood.

Another solution is to reduce vulnerability, by having appropriately resilient building standards and designs, and sound disaster preparedness measures. Even if the built environment remains vulnerable, the vulnerability of the country's economy can be reduced by having contingency plans to help with rapid recovery using local institutions, government resources such as the army, and stockpiles of emergency food and shelters.

Even the hazard can be reduced in some cases, for example by the construction of flood defenses. At the very least, the authorities should make sure that they do not increase the hazard, for example by re-routing rivers or constructing inadequate culverts.

The concepts used in the risk triangle could apply to any type of risk in any country, but for the purposes of illustration an outline follows recent UK property insurance work.

Managing risk

There has been a major change in the approach by some insurers in response to increasing risk. They have been adopting a strategy which has been described as an 'Integrated Property Damage System' (Dlugolecki, 1998). As risk increases, insurers find that they need to move from a 'passive system' of simply paying for the damage. First, they progress to a 'reactive' system and then evolve into a 'planning' system.

In a reactive system, insurers will provide risk management advice to their customers, and will apply policy conditions or exclusions to the risks they accept, in order to encourage customers to take precautions. They will also start to reduce exposures. As the risk continues to increase, insurers move into the 'planning' system mode, to prepare for the future, by sponsoring research, and liaising with Government to implement measures to reduce the risk for society as a whole. Insurers will start to act collectively to feed back information to the other components of the economic system, and if the risk becomes severe enough, or if Government and the public are not responding positively, they will collectively start to withdraw from the market.

In the UK and the USA, some insurers have now very much moved to a 'planning mode', and are working closely with Government on disaster preparedness. Government have generally welcomed closer involvement by the insurance industry, after all, insurers have a great deal of expertise in dealing with risks. They also have a considerable incentive to get it right.

Hazard

Scientists are predicting that climate change will produce increases in the frequency and severity of floods in the UK. There is an increasing consensus that the South East will have more summer droughts, which could lead to building subsidence, while the North and West will be much wetter, with more extreme rainfall events. The UK has a maritime climate and research has indicated that warmer winter months in the UK are associated with more frequent and severe storms.

The last twelve years have seen the three most damaging UK storms this century, and two of these, in 1990, cost insurers some

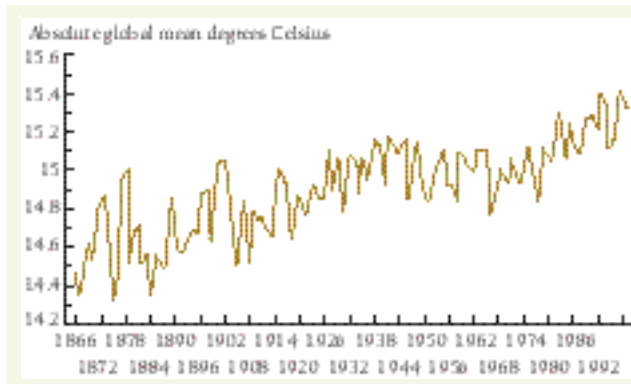


Figure 1: Compiled by Worldwatch Institute from James Hansen and Reto Ruedy, Goddard Institute for Space Studies, 14 January 1997

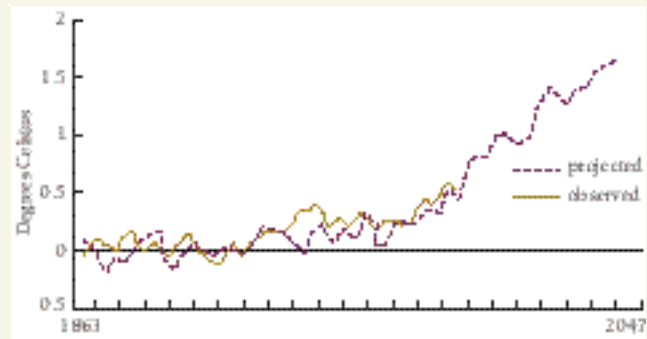


Figure 2: Compiled by the Worldwatch Institute¹

£2,500 million. The UK has the highest winds and the highest tides in Europe, and it seems clear that it is likely to suffer more than other European countries from the effects of sea level rise and increased storminess.

Increasing rainfall will add river flooding to the problem: already, since the 1970s, average rainfall in the West of the UK has risen from 1,700 mm a year to 2,400 mm a year, and predictions from the UK Climate Impacts Programme could mean that flood protection designed for a 'once in a 100 years' flood will not be adequate for the same floods once every 60 or even 30 years.

In the UK, insurers still remember the devastation of the coastal floods of 1953. Many of its flood defenses were built just after that storm, and are in need of repair. Governments are concerned too, and there is now a close relationship between the insurance industry and the Environment Agency which is the relevant Government agency in England and Wales on these issues. The UK insurance industry trade association, the Association of British Insurers has funded research into the condition of sea defenses and has been working with Government and engineers on future strategies to reduce the flood hazard.

Vulnerability

Insurers are well placed to know how much damage a flood or storm can cause and how much it costs. By providing claims data to researchers looking at the vulnerability of buildings to wind-storm and flood, valuable progress has been made in identifying the types of properties which are most vulnerable.

By measuring the likely costs of flood and storm events with more certainty, UK insurers will be better able to assess the extent to which they need to spread the risk onto the global insurance market by buying reinsurance. In this way, the UK economy as a whole benefits. The research will also help with future reviews of building regulations.

Exposure

Unless they can obtain adequate premium levels for the risk, insurers will want to reduce their exposures in high hazard areas. This is a particular issue for UK flood risks. Many houses have been built in floodplains in the last forty years, when flooding was less common than it is now, and according to the EA, planners in England and Wales are still allowing developments in areas at a high risk of flooding. In Scotland, insurers were closely involved with drawing up new planning guidelines issued in 1996. Under these guidelines, planners are advised to consult insurers to see if insurance cover will be available before giving consent for new developments in flood hazard areas. This gives

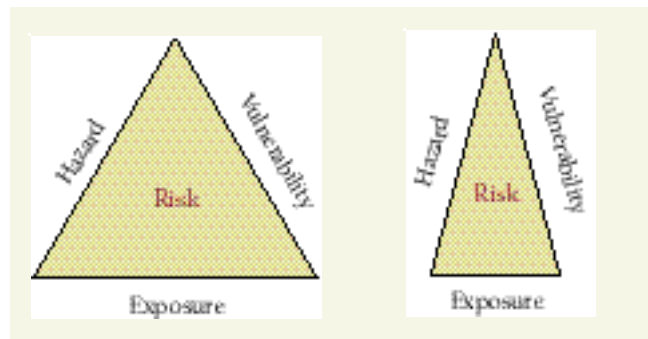


Figure 3: The Risk Triangle

insurers the opportunity to indicate that the risk is unacceptable before the buildings go up, rather than afterwards. The system is working well, developers realise that without insurance, they will not be able to sell the buildings they want to erect, so they are happy to co-operate.

Insurers would eventually like to see a similar system applied in England and Wales.

Exposure accumulation

The UK is the only country in the world where flood cover is automatically provided under all home insurance policies. Insurers are becoming increasingly concerned that this means that those in safe areas are subsidising those living in hazardous areas. In 1997 they advised UK Government that if they continued to allow new developments on flood plains, insurance cover might not necessarily be available (Crichton and Mounsey, 1997).

Managing accumulations of exposure is an important element of an insurer's strategy. Geographic information systems are used extensively for identifying and measuring exposure accumulations, and hazard data from various sources, including satellites, are being used.

Great advances have been made in the insurance industry in the last few years in developing disaster preparedness and management techniques using the risk triangle concepts.

The probability and severity of natural hazards is now being modelled in very sophisticated ways, and large databases have been established of exposure and vulnerability information. This expertise may become beneficial in helping governments and disaster relief agencies in the future. Insurers are now more receptive than ever before to dialogue with such agencies, recognising that such dialogue can not only be mutually beneficial but will be essential if climate change predictions become reality.

The uncertain nature of catastrophe modelling

John Major, Guy Carpenter & Company, Incorporated, USA

CATASTROPHE SIMULATION (CAT) models represent the cutting edge of risk management science. The best models—available now from an ever-increasing number of vendors—required hundreds of person-years and teams of PhDs to develop. As sophisticated as those models are, consumers of modelling services are themselves becoming more sophisticated. When they compare (apparently inconsistent) results from multiple models, issues of model accuracy and data limitations naturally arise. It is the purpose of this article to address and begin to quantify uncertainty in catastrophe simulation models.

What is uncertainty?

Let us be clear in our terminology. By randomness, we refer to the fact that a future outcome cannot be predicted with perfect accuracy. By uncertainty, we refer to the fact that a current state of affairs is not known perfectly. People who deal in risk use mathematical techniques to quantify and model processes that create randomness. However, their models do not perfectly capture the reality of those processes, and so the models are subject to uncertainty.

Consider the example of rolling dice. With two perfectly symmetrical and balanced six-sided dice, we can enumerate all possible rolls and tabulate their probabilities. There are six ways to get a seven out of thirty-six possible rolls. Will the next roll be a seven? We do not know. We only know there is a 16.67% probability that it will be a seven. This is an example of modelling randomness. In a similar vein, we cannot predict whether next year will bring us a US\$ 100 million hurricane. However, we may understand this is a relatively rare event, occurring once every 500 years. This understanding allows us to operate our business with some (but not perfect) assurance of solvency.

What if the dice are not symmetrical and balanced? If we do not have perfect knowledge of the process that is generating our future outcomes, we have uncertainty. Our probability calculations may be wrong. Similarly, we cannot know for sure that the annual rate of hurricanes making landfall in the USA is 2.2 storms per year. This is our best estimate, based on observing the past, but it may not reflect current realities very well.

The sources of uncertainty in CAT models

CAT models have three major components: The hazard component is used to generate the pattern of physical disturbance (wind speeds, ground motion, etc) associated with a geophysical event (hurricane, earthquake, etc). The engineering component applies the physical intensity field to site-specific building information and calculates damages. The insurance component then applies deductibles, limits, and other insurance particulars to calculate the financial impact of the simulated event.

In a probabilistic analysis, the hazard module generates a representative sample of the totality of possible events. The output is the exceedance probability (EP) curve, representing the probability that the maximum loss to the portfolio of buildings in the

course of a year will exceed various dollar amounts. The EP curve quantifies the randomness of catastrophe losses, allowing us to make sensible business decisions in the face of an unpredictable future. However, each component of the CAT model is, alas, subject to uncertainty.

Because hurricane records span only the past 100 years, knowledge of the true long-run climate parameters is necessarily limited. Earthquake hazard models incorporate the expected behaviour of known or suspected faults, but the specifics again are not known with a high degree of precision. Meteorological and geophysical models for other hazards like tornadoes, hail, volcanoes etc are equally tentative.

Engineering models typically blend historical data analysis with experimental or theoretical engineering studies. Again, the knowledge is not complete. Data is limited and experiments cannot capture the full complexity, say, of real houses, trees, flagstones, etc, near the beach.

Even the insurance component is affected somewhat. When it comes to the interpretation or representation of complex reinsurance treaties, there may be some uncertainty as to whether the model accurately reflects what would happen after a significant catastrophe.

There are at least four distinct species of uncertainty operating here: First, inaccuracy arising from a limited data sample is known as sampling error. Our estimates of hurricane frequency may be affected by the 'luck of the draw' from the past 100 years.

Second, uncertainty as to whether the correct type of mathematical formula has been chosen is known as model specification error. One modelling firm may use the 'negative binomial' formula while another uses the 'Poisson' formula. Both may do a good job of explaining historical observations, yet disagree markedly about the likelihood of extreme numbers of occurrences.

Third, uncertainty as to whether all relevant factors have been considered is known as non-sampling error. Very little in CAT modelling results from controlled experiments. Climatology may be affected by some factor that has recently changed but is not in the model. The El Niño-Southern Oscillation cycle is perhaps the best example.

Finally, implementing such complex calculations requires numerical methods such as approximation or Monte Carlo simulation. This leads to approximation error and process risk, respectively. Because accuracy can be improved by applying more computer resources, this source of uncertainty is not insurmountable. Nonetheless, with some CAT models, analysis of a large portfolio can take a powerful machine several days.

Quantifying uncertainty

It is clear that probability theory is the appropriate vehicle for quantifying randomness. In the dice example, while we don't know the outcome of the next roll, we can feel comfortable stating the probability of each possible outcome (eg. 1/6 for a seven,

1/36 for a twelve). But uncertainty is different from randomness. How can it be quantified?

One approach is to treat uncertainty as a special sort of randomness, and then to apply the usual tools for modelling randomness. The result of such analysis is couched in terms of a confidence interval. This is a statement of our willingness to bet on the unknown specifics of the random process.

Going back to the dice example, say we cannot examine or weigh the dice. We may only observe that over the course of 100 rolls, a seven came up 12 times. Our estimate of the probability would then be 12/100 or 12%. Applying the tools of statistics, we would say that a 90% confidence interval for the probability of rolling sevens is from 7.1% to 18.7%. In other words, I would be willing to take a bet with 9:1 odds that the long run average rate of sevens is between those two numbers.

Sampling error

Hurricane CAT models provide estimates of the probability that hurricane damage to a portfolio of properties will exceed given thresholds. These estimates are founded on (among other things) the hundred year historical record of hurricanes. Analogous to counting sevens in a series of dice games, our estimates of hurricane occurrences may be affected by the 'luck of the draw' of the past hundred years, and might not accurately represent the true long-run behaviour of hurricanes.

Research at Guy Carpenter INSTRAT has addressed this question. For example, a model may state that the 1% annual exceedance probability level (ie. 100-year loss) for a portfolio is US\$ 1 billion. We may then find that a 90% confidence interval for the 100-year loss is from US\$ 500 million to US\$ 2.5 billion. Alternatively, we may express confidence around the probability: a 90% confidence interval for the probability of exceeding a US\$ 1 billion loss is 0.6% to 1.6% (60 to 160 years). For the geographically well-dispersed US portfolios we studied, and loss levels typical of high catastrophe reinsurance layers, these are realistic figures. Dollar amounts can only be specified to within a factor of 2 to 2.5 (up or down) and probabilities to within a factor of 1.6 — precision beyond that is impossible due to data limitations.

These results should be 'robust' in the sense that they apply roughly equally to various vendors' models. Regardless of statistical or computational technique, having only 100 years of hurricane history creates an irreducible amount of uncertainty around model results. Furthermore, there is no reason to expect precision in earthquake, tornado, volcano, hail, freeze models etc, or models for other parts of the globe, to be materially better.

Model specification error

Developers of CAT models must, out of practical necessity, make assumptions about the mathematical forms used to describe real-world random processes. With that as background, it is understandable that the 199 Florida Commission on Hurricane Loss Projection Methodology, upon initial certification review of four candidate models, obtained 100-year loss estimates that varied from low to high by a ratio of almost 2:1.

El Niño and potential non-sampling error

As of today, all commercial CAT models assume a 'stationary' climate, of which the past 100 years is representative. However, there is at least one non-stationary climate factor that scientists, modellers, and the general public alike seem to feel may be important: El Niño.

The El Niño Southern Oscillation (ENSO) is the name given to the coherent ocean-atmosphere coupling that can exist in the



Photo: Guy Carpenter & Company, Incorporated

equatorial Pacific. El Niño refers to a period of higher than usual Sea Surface Temperature (SST) over the east equatorial Pacific. The opposite, cooling, phase is known as La Niña (or El Viejo). It is generally believed that the presence of El Niño warming will decrease the number of hurricanes formed in the Atlantic.

Research at Guy Carpenter INSTRAT showed that while the ENSO cycle has a definite correlation with the rate of hurricane formation in the Atlantic, there is little apparent correlation between ENSO and the occurrence of hurricanes making land-fall on the US coast. The effect of ENSO on insurance losses is also uncertain. However, if ENSO does affect insurance losses, then the size of the effect is on the order of a 2:1 ratio between the dollar losses (at a given probability threshold) in different parts of the cycle. This means that modellers are faced with a potential factor of two in changing their models to account for El Niño, but they can't be sure whether this factor is real or an artifact of sampling error.

Reinsurance buyers and sellers, of course, will make their own judgments as to the effects of El Niño. The well-informed model user knows how to modify the model outputs accordingly.

The real world

How should insurance executives, risk managers, reinsurance buyers, reinsurance underwriters and executives, CAT bond investors, etc. react to these various uncertainties?

Parties who wish to hedge some of their risk may conclude that their 'net risk' or 'risk including uncertainty' is a bit higher than the models would nominally indicate. Some adjustment needs to be made. This does not mean that insurance executives should be disheartened. Many of the crises that challenged the industry in the past few decades — environmental liability, asbestos, malpractice, product liability, health care inflation, etc — were not foreseen as risks with any quantified probability attached. Fortunately, when placed in perspective, the uncertainty in CAT models does not fare too badly against other insurance risks.

Insights into flood risk assessment and management

Edward Evans, Halcrow Water and Peter von Lany, Halcrow Management Sciences, UK

OVER THE last ten years there have been severe floods in many parts of the world. Despite continuing investment in flood defence schemes, floods still threaten life, damage property, disrupt communications and affect economic activity. Economic losses attributed to natural disasters in 1998 totalled some US\$ 93 billion of which roughly one half were caused by floods (*The Economist*, 3 April 1999). In some areas risks created by floods have increased in scope and in severity.

The effective assessment and management of flood risk¹ remains a significant challenge to professionals in this field. By risk assessment we mean determining the likelihood of flooding and evaluating its consequences. We try to manage risks by controlling them, or by adjusting our activities to reduce their exposure to risks, or, if possible, by avoiding risks altogether.

Whilst well-developed computational techniques exist for determining flood frequencies and for mapping and estimating flood damages, there are significant uncertainties inherent in the assessment of flood risk. Some of these uncertainties, such as those associated with climate change, are likely to remain with us for some time to come. These uncertainties have a strong influence on decision making in flood risk management.

Flood risks result from a complex interaction of physical, environmental, socio-economic, and political circumstances and as such, invite a wide range of potential mitigation measures. Flood risk mitigation measures are usually classified as 'structural', or 'non-structural'. Structural measures are civil engineering works that control flood risk, non-structural measures are all those that fall outside this category. Flood risk mitigation measures aim to modify one or more of the following sources of risk, as illustrated in Figure 1:

- The frequency of the flood producing processes and/or the resulting flood hazards
- The exposure and vulnerability to flooding of human and environmental systems
- Economic and financial losses that result from flooding.

All these measures need to be underpinned by public awareness of flood risks, and public participation in decisions on how best to manage these risks.

There has been a general rise in flood risk over the last decade. This can be attributed to a number of factors. The most significant of these is an apparent rise in the incidence of extreme flood producing weather events, possibly due principally to climate change. Despite these events, economic development on flood plains has continued to grow in many countries, even where the risk of flooding is well understood and planning instruments exist to restrict flood plain development. The so-called 'dilemma of flood plain occupancy' first identified in the USA in the late 1950s is now attracting widespread attention from many governments and flood defence authorities.

In areas that are densely populated and economically active, a new type of risk is created by flood defence: that of potentially catastrophic inundation following sudden and unexpected failure of these defences. Existing risks can be exacerbated by allowing responses to flood hazards to be driven by short-term expediency rather than by developing a flood risk management strategy that is integrated with long term water and land resource planning.

Three projects that have taken place during the International Decade for Natural Disaster Reduction help us to present insights into fluvial flood risk assessment and management:

- Research into the performance of emergency responses to floods in England and Wales — the research identified weaknesses in the flood defence emergency response systems that existed at the time, and recommended improvements to these systems
- A study of the causes and consequences of flooding on 3,000 kilometres of flood plain along the rivers Paraná, Paraguay, and Uruguay in Argentina — the study developed a framework for integrated flood risk management
- The development of a national strategy for flood control in Hungary — this study is examining the levels of flood risk along the major international and national rivers within Hungary.

Flood defence emergency responses in England and Wales

Flood defence emergency response systems are well established in many parts of the world. They are a predominantly human system in which people acting to reduce risks sometimes create new risks. Their aim is to ensure public safety and to reduce flood damage through flood warnings; assistance in flood fighting activities such as emergency strengthening of flood defences and sand-bagging; evacuation of those likely to be affected by flooding; and assistance in making good flood damage after the event. The flood emergency response system in England and Wales is supervised and carried out in part by the Environment Agency (Figure 2), a national authority with statutory duties and responsibilities in relation to flood defence.

Our research, carried out for the Environment Agency in the early 1990s, showed that emergency responses, particularly the provision of accurate and well targeted flood warnings can be very cost effective. But, to ensure effectiveness, flood warnings need to be received several hours prior to the onset of flooding. In addition, reliable flood hazard information needs to be made available to the public and to those involved in emergency responses. One example of such information is a set of maps being produced by the Environment Agency to show areas at risk from flooding in England and Wales.

Good decision making is required to preserve confidence in the supervising authority and others. It reduces the occurrence of the so-called 'cry wolf' problem which was found to occur when recipients do not act on flood warnings because they believe them to be over-pessimistic.

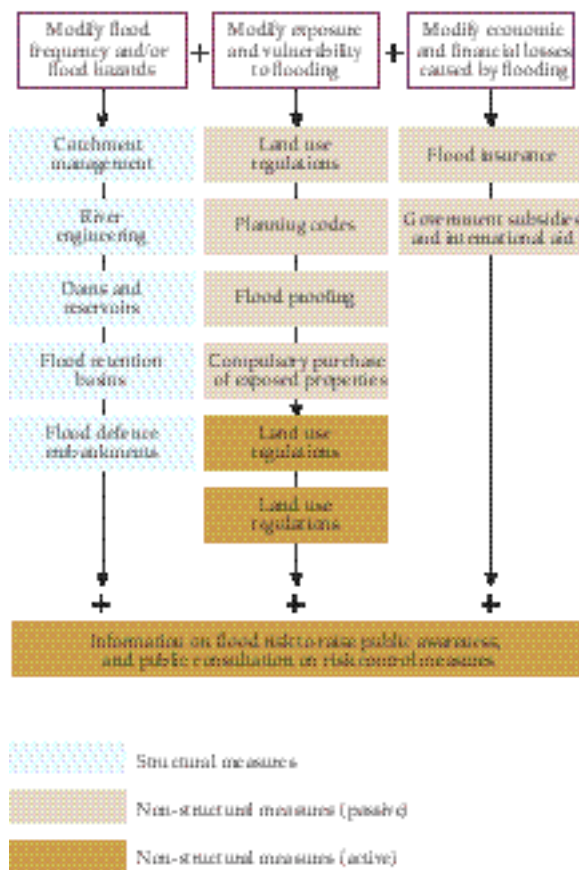


Figure 1: Overview of potential flood risk mitigation measures

Good communications are also essential. This includes well worded flood warnings, clear advice on flood hazards and emergency actions and close liaison with the other participants in the emergency response system. These can include the police, local government, and the armed forces.

The performance of flood emergency responses in Britain continues to attract attention. A review of emergency responses during the Easter 1998 floods in Britain, in which several lives were lost, found room for improvement in the arrangements for flood warnings and their dissemination. There were also indications that in some cases the performance of the authorities involved in the emergency responses did not meet the expectations of the public.

Flood risk management in Argentina

On eighteen occasions between 1812 and 1998, large floods have been recorded on the Rio Paraná, the Rio Paraguay, and the Rio Uruguay. These three rivers lie in the second largest watershed in South America. The largest of these floods was also the longest, lasting for almost eight months from December 1982 to July 1983. It caused losses estimated at over US\$ 2 billion. One half of the large floods since 1812 occurred between 1966 and 1998. The recent increase in flood frequency is most probably caused by climate change and has also been associated with the incidence of El Niño.

Another severe flood in 1992 encouraged the government of Argentina in 1994 to commission a study of flood risk along the rivers Paraná, Paraguay, and Uruguay, within Argentina itself.

The study identified a clear need for a sustainable flood risk management strategy. It produced a framework for integrated flood risk assessment and management which was applied in

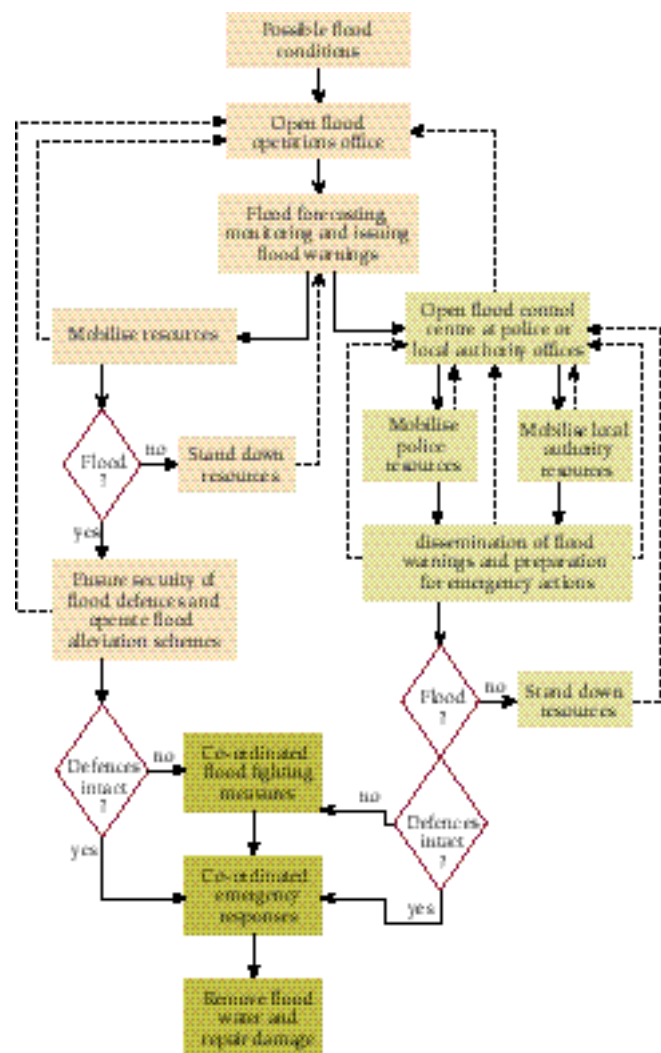


Figure 2: Structure of a typical flood emergency response system in England and Wales

general along the 3,000 kilometres of flood plain along the three rivers studied. It was subsequently applied in greater detail during flood risk management studies for key towns along the Paraná and the Paraguay rivers.

The assessment of risk involved the application of innovative statistical analysis of flood frequency, and hydrodynamic modelling of the river system to simulate the extent of flooding. Output from these models was used in a geographic information system to map flood limits and to calculate flood damages.

The study found an urgent need to resolve the dilemma of flood plain occupancy in order to make the best sustainable use of flood plain land. Reliance principally on structural flood defence measures was found not to be sustainable because of the resulting 'escalator effect'.²

A further impediment to sustainable flood risk management was the tendency, as a matter of custom and practice, to respond to flood risks with short-term measures. The need for an integrated long-term strategy was widely accepted.

The study identified the combined use of structural and non-structural risk mitigation measures as central to achieving more effective flood risk management. Determining the most efficient use of flood plain land and then regulating its development would help resolve the dilemma of flood plain occupancy and reduce the escalator effect. The implementation of an integrated risk



Photo: Tony Stone Images

Flooded farmland in the UK

management strategy had to take into account constraints imposed on it by certain features of the Argentine constitution. Planning instruments needed strengthening. Changes in the institutional framework were recommended, as was the promotion of public awareness of flood risk, public participation in flood risk management, and the assessment of the environmental effects of flood control options.

A national strategy for flood control development in Hungary

Hungary has just over 4,200 kilometres of flood levees, defending an area of about 21,250 kilometres square. This is equivalent to 23% of the area of the country, giving Hungary the largest total area protected from flooding in any country in Europe. About one-third of the economic activity of the country takes place within these flood protected areas.

Hungary started to develop its flood defenses in the middle of the 19th Century. By the middle of the 20th Century, the nation's flood defence systems had evolved to almost the extent existing in 1999. The flood levees form 151 flood basins. Secondary levees prevent flood water from flowing between basins. A programme of embankment raising and strengthening is still underway following severe floods that led to levee failures and some inundation along the Danube in 1954 and along the River Tisza in 1970.

The flood levees, combined with emergency responses — in particular flood fighting — provide a good level of security from significant inundation. Flooding in Hungary has not resulted in any loss of life from flooding since 1879. Nevertheless, concern about the safety of the flood levees has been growing over recent years. Some levees are affected by poor subsoil conditions and others have severe cracking following a recent sequence of dry years. Maintenance and rehabilitation costs have risen. These concerns led to the commissioning, by the Hungarian government, of a study into the development of a strategic plan for prioritised investment in flood defence.

There are a number of risk issues in developing such a plan. The first of these is to re-examine the basis on which the levee crest levels are set. These are currently determined by legally prescribed peak river water levels, plus a provision for free board, that generally does not take into account potential flood damage and losses. The intention is that all events up to the specified water level will be contained.

An alternative approach is to specify the maximum frequency of inundation that can be tolerated, taking into account the probability of flood defence failure and its impacts. Thus, flood risks

can be compared with other risks that affect the public and managed accordingly. Decision criteria would need to go beyond traditional benefit-cost analysis. Decisions would need to take into account factors such as uncertainties inherent in determining the probability of flood defence failure and the effectiveness of flood-fighting; as well as the flood threat to public safety and to sites of historic, cultural, and environmental importance.

A more economically efficient solution could be considered. That is, to move from uniform standards of defence to individual standards for groups of basins, each justified in terms of a balance between flood defence costs and the level of flood risk avoided in these basins. Such a solution would have to be acceptable to policy makers and to the public. It would need careful justification.

The high level of investment required to maintain the flood levees has stimulated thinking into how this burden could be shared between the state and the beneficiaries of flood defence. Much depends on the beneficiaries' willingness to pay. The role of the insurance sector in cost sharing is being investigated. The study is also assessing public perceptions and awareness of flood risk. Active public participation in the debate on how best to manage floods is envisaged.

Key issues for the new millennium

The above case studies have highlighted some of the key challenges to strategic flood risk management in the new millennium. Resolving the dilemma of flood plain occupancy is perhaps the most fundamental challenge. Concerns about public safety and environmental protection need to be brought into the argument alongside issues of economic efficiency and the costs and benefits of flood defence.

The escalator effect brought about by an over-reliance on structural measures can be reduced through integrating structural and non-structural measures. But, implementation is not always straightforward. Structural measures are relatively easy to manage, whereas many non-structural measures require the close co-operation between different institutions to be fully effective.

During the last decade, following the Rio de Janeiro 'Earth Summit' in 1992 and Agenda 21, there has been a growing acceptance of the need to plan the use of land and water resources in a sustainable manner. This goes beyond good environmental management to the integrated management of rivers and the use of flood plains a. It requires good risk assessment and management.

For their part, flood risk assessors and managers need to work to ensure confident decision making based on reliable information, sound analysis making good use of available technology and a clear understanding of the key issues, uncertainties, and their effects. Good analysis is needed to enable clear justification of the rationale behind decisions on flood risk management, and to evaluate the trade-offs often implicit in such decisions. Good risk management should not underestimate the value of informing public awareness on flood risks and encouraging public participation in risk management decisions and actions. Ultimately it is members of the public who are the main stakeholders in society's response to flood hazards.

Footnotes

1. In this article, the level of flood risk is measured as the probability that flooding will occur multiplied by its human, economic and environmental impacts. The impacts of flooding depend on the exposure and vulnerability of social and economic activities in the flood plain and its environment to flood hazards created.
2. Investment in flood defenses to protect existing developments, leading to new developments within the defended areas, leading in turn to further investment in flood defenses.

Understanding Urban Risks

Anil Sinha, Ministry of Agriculture, India

URBAN AREAS are growing at a very fast rate all over the world, particularly so in developing countries. In most of the cities, there is influx of populations from the surrounding areas, mainly in search of employment and better living conditions. It is estimated that by the end of this century, 50% of the population will live in urban areas which are only three per cent of the total land mass. In the present decade, a population growth of at least 80% occurs in towns and cities. The situation is more alarming in the developing nations, where 80% of the total population of the world will reside within the next 25 years. Out of the 20 largest cities, 17 will be in the developing world by the end of this decade. City authorities in India as well as in other developing countries are unable to provide basic infrastructure and services. In most of the larger cities, 30–60% people are living in squatter settlements. Even though nearly ten hectares of fertile land is encroached by urbanisation every day, still there are areas in some of the cities, like Delhi and Calcutta, where population density is more than 150,000 people per square kilometre (walled city of Delhi—166,300 people per square kilometre).

The demand for land in cities has led to the use of marginal land, prone to natural hazards such as floodplains, unstable slopes and reclaimed land, unsuitable for any habitation.

1994 Surat Plague, India

Surat, India's diamond city, so called because of its flourishing diamond industry, can be cited as a classic example of disaster due to environmental neglect and degradation. On the 22nd of September 1994, hospitals in the city started reporting deaths due to plague. Within 48 hours over 600,000 people had fled the city. With these people the suspected plague germs also spread to other parts of the country and the world, giving rise to international panic. The Plague of Surat could have been predicted and avoided through timely action of cleaning up garbage dumps and unsanitary conditions. However, people continued to live quietly until they were given some cause for concern by the dying rats. It finally took human toll to get the residents and the government into action for cleaning up the city.

Disasters in urban areas are often distinguished from common or constant environmental hazards. Interestingly, if 1,000 people are killed by a flood, earthquake or industrial explosion in a large city, such a disaster is reported around the world. Yet the annual death in the same city of 1,000 people from traffic accidents, or 10,000 children from easily preventable diseases are not considered disasters. The difference between disasters and other environmental hazards becomes even less clear as the latter becomes particularly serious. For instance, when gradually worsening air pollution reaches certain levels it may be characterised as a disaster.

Urban stresses

The world is experiencing population explosion with the time span for every additional billion of population being only ten to



Photo: Rex Features

People fleeing from the city of Surat spread plague to other parts of the country in India, 1994

twelve years. The world population size is estimated to be eight billion by 2025, of which 56.5% will be urban. Of the increase, a large proportion would be in developing countries including India, whose population size is estimated to be about 1228.8 million, with an urban component of 658 million.

India is experiencing massive and rapid urbanisation. A second urban India is being added in a period of just two decades. It is estimated that by 2025, the urban component, which is presently approximately 25% will be more than 50%.

The trends indicate the continued urbanisation and metropolitanisation in the decades to come. The National Commission on Urbanisation has estimated that, by 2,001, the urban share will be 35% accounting for a population size of 35 million and that there would be 40 metropolitan cities. Some of the urban agglomerations today accommodate more than ten million people. Their number and size will also grow. Such concentration trends in the Indian demographic scenario would surely subject its cities to greater risk of damage to life and property in the event of disaster.

Nature of risks

Most prominent amongst the disasters striking urban settlements frequently are those of floods and fire, with lower incidences of earthquakes, landslides and cyclones. Of these, floods are more devastating due to their widespread and periodic effect. Fires have more localised effects but are very frequent in urban areas leading to heavy losses of life and property.

Studies indicate that the loss of life and property due to floods has been increasing over the past decades. The prime reason for this is unplanned urban growth on the banks of the rivers and in other low-lying areas in the vicinity. The floods of Punjab in 1993 and those of Haryana and Delhi in 1995 bear testimony to this. These kinds of disasters can only be averted with the help of disaster-conscious urban planning and development in flood sensitive areas.

Fires have emerged as a critical issue in urban planning due to the rising frequency of fire incidents, leading to huge losses. Fires

are very common in slum and squatter settlements in large cities and in high rise buildings. Fire fighting capabilities are very essential, but these are mostly curative measures. More importantly, preventive measures are required to address this critical issue effectively and efficiently. Hence, to control and manage fire disasters, it is essential to have, and implement, proper land use zoning, land subdivision, and building regulations.

Development versus environment

Developmental activities compound the damaging effects of natural calamities that we have always been facing. The floods in Rohtak (Haryana) in 1995 are an appropriate proof of this. Even months after the flood waters had receded, large parts of this town were still submerged. This was not damage due to floods, but due to the waterlogging which resulted because of poor land use planning. Ad hoc land use decisions are a common practice in India due to the immense demand pressures on a scarce land supply.

Safety factor for human existence

The quality of life of an individual is determined largely by socio-economic and physical environment. From a different perspective, enhancing quality of life is minimising frequency and intensity of disturbances to average human existence. The core issue therefore is to reduce the vulnerability of the community. It is also obvious that the nature of the vulnerability of the community is largely dependent on the social structures, the physical structures and the economic assets.

The core issue, therefore, becomes promoting measures that ensure safety of individuals against such vulnerability which often manifests as hazards in form of accidents, illnesses and other factors that could contribute to mortality.

Knowledge and research project

Urban risk reduction, India: The project aims at developing a method for integrating risk reduction into urban planning with community participation. Its main objective is to develop and test a methodology combining risk identification with action planning to integrate sustainable risk reduction measures into existing urban planning practices for improving urban settlements vulnerable to environmental degradation and natural hazard.

The project seeks to test this application in India, within four vulnerable urban communities in the towns of Delhi and Ahmedabad. Findings from the performance of the methodology will be incorporated into a dissemination package for reducing

risk in particularly vulnerable urban areas. The package will be not only be aimed at government departments but NGOs and international agencies also.

Though the concept of community participation in urban planning processes has been around for a long time, it has remained an ineffective tool, mainly due to outdated and half-hearted participatory mechanisms. The present project looks at the viability of Participatory Rapid Appraisal (PRA) and Action Planning tools in the Indian urban context.

Agenda for action

In the contemporary context, a broader approach is required which not just looks into technology, adaptability and cost aspects, but also on how these aspects could be imparted effectively to the community. The users in general need to appreciate the high priority which needs to be given to safer living.

The urban planning, development and management processes have traditionally been dealt with in a sectoral manner. The safe city concept, particularly due to its participatory approach, would try to bring about strategic integration of various urban sub-sectors and present a integrated development framework. This is a need that has also been stressed by the National Commission on Urbanisation's Working Group on Physical Planning in India, in stating that 'it also provides for checking costs compared to the benefits of alternative packages of projects aiming at pragmatic goals, and permits a much tighter and more efficient implementation control and evaluation of large scale innovations'.

Risk reduction efforts need to be based as much in urban governance and management as in urban planning. Good urban governance includes the state, but transcends it by taking in the private sector and civil society. All three are critical for sustaining human development. The state creates a conducive political and legal environment. The private sector generates jobs and income, and civil society facilitates political and social interaction-mobilising groups to participate in economic, social and political activities. Because each has weaknesses and strengths, a major objective of our support for good governance is to promote constructive interaction among all three (*UN Policy Document on Governance for Sustainable Human Development*, 1997).

Within the framework of safe urban planning and management, the traditional wisdom of urban planning that was evolved during the historic vedic period in India needs to be revived and imbibed in the current practices. The concept of the 'Vastu Purusha Mandala' that dealt with the habitat space as a living organism was very conscious of the fragile relationship between development and environment, and this consciousness led to design and development parameters that were far safer than those followed today.

Conclusion

Urban populations are growing rapidly the world over, but their growth in the developing nations is most alarming since it is taking place in the absence of well planned and structured settlements. The civic services and the general quality of the settlements is of a low standard, as a result of which the urban communities are being subjected to an ever increasing risk of natural as well as technological disasters. In such a situation, the only viable way to a safer living is through preparedness to face disasters, since hazards cannot be controlled. This requires concerted efforts on part of the government agencies, voluntary organisations, and most importantly the community itself. Risk awareness has to be created and preparedness plans formulated, so that the urban populace may live a safer life.

Risk due to environmental stresses: Delhi, India

Every ninth student in Delhi's school suffers from Asthma. Delhi is the world's fourth most polluted city. Each year poor environmental conditions in the city's informal areas lead to epidemics. In 1995, 423 lives were lost due to dengue fever. In 1996 there were 8,992 cases of gastroenteritis, of which almost 8% were fatal. Poor precautions and ill-maintained electricity lines lead to innumerable fire incidents every summer. Fifty seven people lost their lives in a major fire at a cinema in south Delhi in June 1997 due to electrical fault. Over one million citizens of Delhi face the risk of floods, should the level of river Yamuna rise by a few meters. Delhi is in seismic zone IV with expected earthquake of 6 to 6.5 on the Richter scale threatening much of the old dilapidated and poorly constructed informal structures where 60% of the city's population resides. Delhi has one of the highest road accident fatality ratios in the world. In many ways Delhi reflects the sad state of urban centres within India that are exposed to risks which are misconstrued and almost never taken into consideration for urban governance.

REFLECTIONS FROM AUSTRALIA

A risk management approach to disaster management

John Salter, City of Adelaide, Australia

NARROW MODELS have advised the management of emergencies and disasters. This is currently being improved by the adoption of a more holistic view of risk and the development of tools to assess community vulnerability.

In response to pressures for change, the emergency management community in Australia is re-inventing itself to deliver services which will better meet the needs of communities. Some of the key shifts in service provision are summarised in Table 1 below. These shifts involve migrating business beyond ‘responding to events’ to embrace the broader set of issues associated with ‘risk and its management’. This involves vulnerability, not just hazard; partnerships, not merely single agency ‘silos of excellence’; and community participation in decision making, not just the consideration of the community as a target audience for selling a position arrived at in isolation. These shifts are fundamental in nature, involving paradigm shifts which impact the structures of organisations and the cultures of their members.

National emergency risk management guidelines

For any service provision, national guidelines provide the basis of a consistent approach. Further, citizens have a right to, and a reasonable expectation of consistency in the quality of service provisions which relate to public safety.

Two of life’s basic rules (that change is inevitable and resisted) have provided an interesting context for the development of national Emergency Risk Management guidelines over the last three years. Conservative reaction to the development of national Emergency Risk Management guidelines has ranged from the ‘dismissal’ position (same wine, different bottle), to the ‘entrenched’ position (when it is not necessary to change, it is necessary not to change).

It is important to recognise that the risk management approach is not ‘business as usual’, nor does it merely provide ‘a tool’ (for analysis/assessment). The approach provides a fundamental basis for the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring risk.

Advantages of adopting a risk management framework (as identified and agreed by Australia’s National Emergency Management Committee, 1996) include:

- It is a formalised, systematic analysis and decision-making process
- It is a common process across all organisations, facilitating both promotion and integration.

An outcome of that 1996 meeting was the agreement to develop national Emergency Risk Management guidelines, and to incor-

porate the risk management approach into other emergency management products.

The guidelines are derived from a standard (AS/NZS 4360 Australia/New Zealand Risk Management Standard:1995), therefore outline expectations related to both processes and outcomes. Emergency management has lacked a sufficient framework in the past and was often marred by narrow, hazard-based approaches characterised by working in isolation (from the community at risk). ‘Process’ features in the guidelines emphasise the involvement of all stakeholders in decision making and the ‘outcomes’ focus is on risks to communities, not just hazard agents.

Key aspects of the guidelines

The specific meanings attributed to words are not what are most important in the guidelines. Nevertheless, some terms within the emergency management community are ones which have a specific particular use, special meaning or emphasis. Indeed these context sensitive terms, and the concepts and principles they reflect, differentiate the emergency risk management guidelines from the general risk management standard. Some of these key terms are:

- Community — a group with a commonality of association and generally defined by location, shared experience or function
- Environment — conditions or influences comprising social, physical, biological and built elements, which surround or interact with a community
- Hazard — a situation or condition with potential for loss or harm to the community or environment
- Risk — a concept used to describe the likelihood of harmful consequences, arising from the interaction of hazards, communities and the environment
- Treatment options — measures which modify the characteristics of hazards, communities and environments.

Table 1: Shifts in emergency management

From	To
Hazards	Vulnerability
Re-active	Pro-active
Single agencies	Partnerships
Science driven	Multi-disciplinary approach
Response management	Risk management
Planning for communities	Planning with communities
Communicating to communities	Communicating with communities

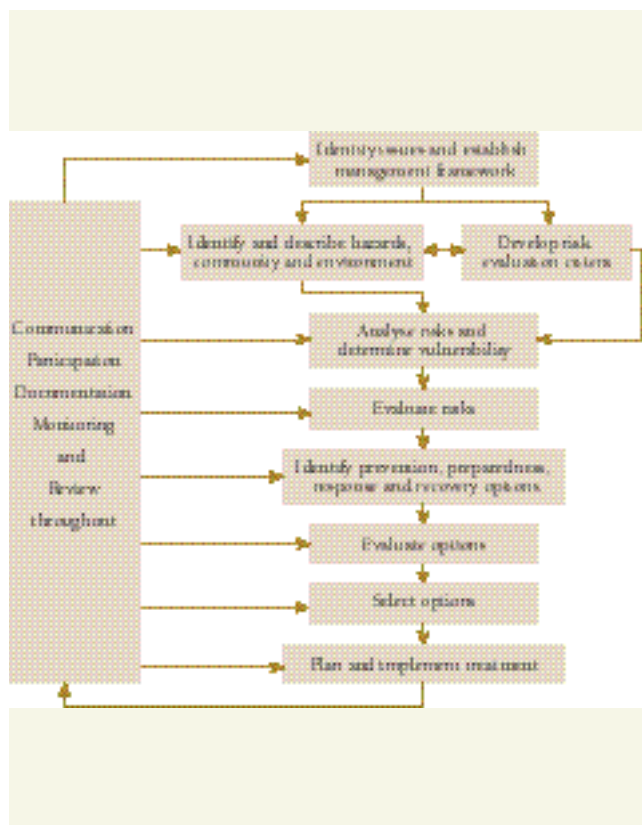


Figure 1: Main elements of the emergency risk management framework

As outlined in the diagram in Figure 1, the Emergency Risk Management Guidelines provide a contextually enhanced framework which parallels a general risk management approach.

The crucial role of communication and participation

Risk communication is strongly influenced by one's perception of risk. If risk is viewed as a physically-given attribute, risk communication tends to centre on 'how to explain' risk. If risk is recognised as a socially-constructed attribute, managing risk communication becomes pivotal, and focuses on the development of procedures for structuring dialogue; to develop shared understandings about risk and its acceptability. This recognises that acceptability (of risk) is as much about power, and negotiated consensus based on shared information, as it is about judgements based on 'objective science'.

The Australian guidelines incorporate the characterisation of risk communication as 'an interactive process of exchange of information and opinion among individuals, groups, and institutions; often involving multiple messages about the nature of risk or expressing concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management' (US National Research Council, 1989). The usefulness of this definition lies in its identification of the need for two-way rather than one-way flows of information between parties and perhaps more importantly, in its recognition that the dialogue may be about any (management) concern.

This raises issues about the use of 'communication and participation' to facilitate a transfer of risk management to the community without incorporating sufficient enabling provisions. Implications include the need to provide open, democratic processes which are under-pinned by enabling provisions such as functional literacy. This will highlight the quality and performance of organisations — 'report cards' will feature institutional

values related to things such as bureaucratic access, caring, competence, trust and credibility. There will be significant challenges in incorporating vulnerability (in a risk management approach), as any indicators of vulnerability will involve assumptions about underlying (social) processes.

A crucial underpinning platform of the emergency risk management process is a requirement for communication, consultation and participation. The basis for this philosophy is that where all stakeholders contribute to the decision making process, there is a much larger pool of information and expertise to enable valid solutions to be developed. Further, for any decision making process to be successfully implemented, it must engender ownership and commitment from all parties influenced by it.

The core information — hazard, community, environment

The general Australia/New Zealand Risk Management Standard applies a method which views risk as arising from the interaction between 'sources of risk' and 'elements at risk'. This method is especially appropriate for closed systems and clearly bound problems, however it is insufficient for disaster and emergency management. In the proposed method outlined in the emergency risk management guidelines, a rich understanding of risk and vulnerability is developed by studying characteristics of hazards, communities and the environment, and how these characteristics interact. This broad profiling process is crucial in the risk management context of comprehensive disaster management where such variables as economic, social, legal, technical, analytical and political factors are all considerations in the factors which give rise to risk, judgements of acceptable risk and the selection of effective intervention options.

The centrality of vulnerability

As is recognised, while hazard agents may be physical events, disaster impacts are social products — that is, disasters are manifestations of vulnerability. Further, vulnerability is differential — we are not all equally vulnerable. Within any group some are more vulnerable than others are — generally, and to specific hazards. The Australian guidelines define vulnerability as 'the degree of susceptibility and resilience of the community and environment (to hazards)'. What factors make up a vulnerability profile? Work in Australia on methods for measuring vulnerability has resulted in the development of tools such as the 'Community Vulnerability Profiles' (Table 2), which provides a useful prompt for consideration and analysis.

Closing reflections

The risk management approach adds value, but some cautions apply. First, the guidelines are only that (guidelines), and require substantively detailed supporting documentation to facilitate implementation. The development of a nationally agreed 'how to' manual should be a priority. That there are already several attempts at implementation manuals which are seriously inadequate in various ways is testimony to the market need for a quality, detailed product. Second, there is a gap in the required detail at the level of 'vulnerability indicators'. Significant work will be required to confirm appropriate indicators and identify associated research methodologies. Further, risk modelling tools need to better integrate the appropriate information (hazard, community and environment characteristics) to analyse risk and determine vulnerability. Third, the shift toward risk management has significant implications for emergency management service provisions, especially when viewed in terms of business-mix and organisational change.

FOR REFERENCE PURPOSES ONLY

RISK ASSESSMENT

Key Factors	Indicators: Least vulnerable	Indicators: Most vulnerable
A Factors operating at individual/household level		
A1 Association with hazard prone area		
I. Location of residence	Residence outside hazard prone area	Residence inside hazard prone area
II. Suitability of residence	Residence provides protection from hazard agent	Residence does not provide protection from hazard agent
III. Location of livelihood	Livelihood located outside hazard prone area and not influenced by hazard	Livelihood located inside hazard prone area or influenced by hazard
A2 Coping capacity		
I. Financial resilience/susceptibility	Wealthy, insured, access to funds	Poor, uninsured, no access to funds
II. Knowledge of appropriate protective behaviour	Adequate knowledge of appropriate protective behaviour	Inadequate knowledge of appropriate protective behaviour
III. Health	Robust, resilient	Frail, infirm
IV. Social network	Member of supporting groups	Non-member of supporting groups
B Operating at community/local government level (internal)		
B1 Public safety service provisions		
I. Community planning processes	Participatory	Non-participatory
II. Mitigation measures	In place and effective	Not in place or not effective
III. Response/Recovery capability	Tested and adequate	Untested or inadequate
B2 Social infrastructure resilience		
I. Lifelines	Robust, protected, backups	Frail, exposed, no backups
II. Items of economic significance	Robust, protected, backups	Frail, exposed, no backups
III. Items of environmental or cultural significance	Robust, protected, backups	Frail, exposed, no backups
C Factors operating at community/local government level (External)		
C1 Public safety service provisions		
I. External government planning processes	Participatory	Non-participatory
II. Mitigation policies	In place and effective	Not in place or not effective
III. Response/Recovery support capability	Tested and adequate	Untested or inadequate

Table 2: Community vulnerability profiles — key factors and associated indicators

These include:

- Increased service provision diversity (including a shift towards prevention)
- Community empowerment and responsibility
- Increased inter-agency co-operation and partnerships.

Under the broad public policy umbrella of ‘risk management for safer communities’, we are moving into the domain of client-focused service provision where several new skill sets will be required of the emergency management community, including:

- Managing risk communication processes (based on planning with, not for) to negotiate appropriate levels, and types of emergency management service provision, will require facilitation skills in order to conduct service reviews and agree service level definition with clients
- Managing contracts, where the specifications are associated

with outsourcing emergency management service provisions, will need appropriate outcomes and performance indicators.

For those who feel discomfort with the heralded changes, I would urge that they consider the positive. The approach takes us forward—we can not do today’s job with yesterday’s methods and be in business tomorrow. The management focus must be ‘how can we best reduce community exposure to major risks?’ Dated and academically narrow approaches based on a ‘hazards’ focus and limited linear strategies of ‘prevention, preparedness, response and recovery’ drawn from a teaching heuristic are not sufficient. Indeed the only reason for emergency managers to analyse hazards is to enhance their capability to manage risk. The risk management approach, centred on considerations of vulnerability and imbued with processes of communication and participation, provides a flexible and holistic framework to better advise all aspects of emergency management.

CASE STUDY

Rain floods in river valleys: Risk control, protection and insurance

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ABSTRACT hydrometeorological risk is understood as the probability of the occurrence of hazardous events and is estimated from long series of observations. Here a complete analysis of risk related to flooding in monsoon rivers has been carried out. The analysis include a study of destructive factors and a determination of risk zones concept; a regional risk classification of sections of river valleys, and a construction of risk maps in different scales for use in water and land use management; a spatial analysis of flooding with the help of scenarios produced by a multi-site stochastic model.

INTRODUCTION

Generally, hydrometeorological risk is defined as a probability of undesirable and hazardous events caused by extreme values or extreme variability of hydrometeorological variables. A wide range of phenomena related to weather and hydrological regimes need to be included in a risk assessment. High variability, regularity in extreme events, and significant influence on socioeconomic systems belong to the general features of hydrometeorological risk. Availability of long term observation records allows identification of hydrometeorological hazard in different regions.

The role of the hydrometeorological risk assessment and control in the society is essential, but it must be carried out with regard to regional peculiarities. The term 'risk' is used here as the probability of a complex chain of events, ie. an observed combination of elementary hydrometeorological events within a certain area and time frame, which is estimated based on absolute and conditional probabilities of the elementary events.

COMPLEX RISK ASSESSMENT

The summer-autumn floods so characteristic in areas with monsoon climate, cause great economic damage. Complex risk assessment of events, causing flooding and triggering erosion processes, provide important information base for economic planning and environmental management on

flood plains. The construction of a stochastic model includes the identification of possible elementary events, their probabilities and combination rules.

It is possible to carry out an efficient analysis of flooding and riverbed deformation with consideration of the character of channel-forming discharges passing through valleys within different geological and geomorphological conditions (Karasyov & Gartsman, 1996). Channel-forming discharges (CFD) stand for the main volume of alluvium transport and, moreover, the different CFDs correspond to various types of channel and flood plain deformations. Therefore there exists a close relation between the riverbed and flood plain relief layers, the gradations of area flooding parameters (return period, depths and length), the types of channel and flood plain deformation, and the layers of the passing CFD.

A certain extension of flooding of a territory corresponds to a probability of exceedance of a certain water level, which is defined by its frequency curve. With certain assumptions, it is possible to consider deformations of river beds and flood plains as discrete processes, associated with the properties of CFDs, as described by Makkaveev (1955) and further developed by Chalov & Bely (1975). Probabilities of these events are defined on the basis of the frequency curve of flood maximum discharges. On the basis of these data the probability of any combination of undesirable or dangerous effect on any economic object can be calculated as the joint probability of independent or dependent events.

RISK ZONES

In analysing flood problems, a priority is the separation of risk zones on qualitative signs of risk. Actions related to flood protection must take into account the whole complex of destructive factors such as the flooding (return period, depth, length), river bed deformations and erosion-sedimentation processes on the flood plain. Differences between zones may serve as guidelines for restrictions on the economic activity, as well as an efficiency of the different types of defensive actions, such as increasing the height of



Photo: Associated Press

A Belarusian villager uses a boat to get to her house where her husband stands in water waiting for her. Melting snow has caused the water level in rivers to rise, flooding whole villages and towns in the Gomel region of Russia, 200 kilometres south of Minsk, in March 1999

the levees, dams, channel regulations, run-off regulations.

Four zones are distinguished within morphologically uniform river valley sections with similar geological and geomorphological conditions and hydrological regime.

Zone A — a low risk: Its bottom edge is defined by specific or nonspecific nature of risk from floods, here risk is low enough that it is not specific for the given territory and must be taken into account in the general complex of protective actions against natural hazards, including insurance. The upper edge of this zone is not determined the lower corresponds to a mark of flood with a frequency of one per cent.

Zone B — an average risk: Its bottom edge is defined by controlled or uncontrolled nature of risk from floods — here risk is sufficiently great, can be efficiently evaluated and controlled by separate local managers. The territory is located outside the belt of active riverbed deformations and repeatability, intensity and durations of flooding is not too great. All of this ensures reliability and efficiency of local defensive actions, which do not render essential influence upon the hydrological regime of river. A real reliability of

protective constructions in this territory corresponds to a design assessment. Massive defensive actions and special insurance is recommended here.

Zone C — a high risk: In this zone the risk is sufficiently great that it cannot be safely evaluated and efficient risk control is possible there on the part of the whole socio-economic system only. It covers a territory within the belt of active riverbed deformation, with frequent and lengthy flooding of high depth. Intensity of specified disadvantage processes is such that local protective constructions work unsatisfactorily without the regulation of riverbed or run-off. The real reliability of protective constructions in the given area is low. Massive defensive actions is not recommend here and special insurance is possible individual only.

Zone D — a permanent danger: The riverbed itself, with rolling near-channel forms, is under permanent influence of water flow and alluviums transport. In the given area, an accommodation of special hydrotechnical erectings is possible only if protected by its own construction.

The purposes of state management on flooded territory are the following: conservation (improvement) of social

quality of population life as a whole; conservation (improvement) of environment quality; conservation (increasing) of economic development degree. For its achievement the following decisions are necessary: firm restriction of economic activity in the high risk zone for uncontrolled damage reduction; stimulation of economic activity development, associated with the protection system improvement, in the average risk zone; increasing of reliability of all objects in the high/average risk zone; efficient and equitable attraction of facilities from economic objects in low risk zone for reduction of the consequences of system catastrophes.

REGIONAL CLASSIFICATION AND MAPS OF RISK

A regional classification of morphologically uniform sections of river valleys (developed for the Primorye region of Russia) is based on the existence of characteristic features of different riverbed deformation types under different geological and geomorphological conditions (Karasyov & Gartsman, 1998). In this effort, the following main relief sections are distinguished—the upper section, which includes medium, high and low mountains; the intermediate section, which includes hills and denudation plains; and the lower section, which includes high and low accumulation plains. Rivers are sub-divided into transit (basin area of more than 10,000 kilometres square) and local (basin area of less than 10,000 kilometres square). Analysis of hydrological permitted sub-division of the floods into seven categories.

The regional classification named earlier distinguishes nine types of riverbed deformation processes. Each type is considered together with one or two morphological types of channels; possible or limited conditions for development of riverbed deformation; different potential for flood plain development processes (without flood plain, limited potential, lithology constraints, no constraints), and the type of the CFD ensemble. The classification reflects the total degree of risk of flooding and the development of the erosion processes.

On each morphologically uniform section the low, average and high risk zones, as well as a zone of permanent danger, are delineated. The following frequencies are used as zone boundaries: exceedance frequencies of 1%, 10% and 50% for limited conditions of flood plain shaping; exceedance frequencies of 1%, 25% and 50 % for conditions with lithological constraints of the flood plain width; and exceedance frequencies of 1%, 25% and 75% for conditions without constraints. Risk maps of undesirable and dangerous events, corresponding to future floods, are prepared at three levels: regional, district (basin) and large scale.

SPATIAL COMBINATION OF HYDROLOGICAL EVENTS

In the analysis of spatial combinations of elementary events during a flood two essential problems must be addressed:

the need for modelling of multi-site correlated hydrological events and a probabilistic description of damages.

The first problem is connected to determination of the frequency of a hydrological event at a basin or regional scale. This problem has been solved here by means of normalisation of non-symmetrical correlated hydrological sequences and orthogonalization to a system of uncorrelated normal distributed random quantities. This procedure yields solutions to the following two problems: First, using a random generator of the independent normal distributed random quantities, hydrological sequences of any length with desired features can be obtained. Second, a direct transformation of vectors given for any individual year permits estimating its flood frequency as a product of probabilities of independent random quantities.

Flood frequency estimations described above for several stations in a river basin, might differ greatly from those traditionally obtained. This is explained by the utilisation of independent information on less correlated data from separate parts of the basin. In general, the group evaluation of probability cannot corresponded to a particular maximum discharge at a downstream gauge station, as the same maximum discharge may be observed under different combinations of events within a basin. The same conclusion is valid also for the total flood damage in a basin.

Consequently, it is necessary to assess flood damages of all economic objects in the model area, accounting for risk zone and flood category. Modelling the sequential hydrological events for a group of stations in the area and converting them into sequences of damages yields a direct risk assessment for different flood damage volumes. Such analysis is necessary, in the first place, for insurance purposes. Preliminary model calculations have show that the possibility of spatial redistribution of flood damages is extremely limited.

For stability of the insurance system, necessary a big initial volume of reserve fund is necessary, or a significant (several years) period is necessary for initial accumulations with a restriction of insurance liability.

CONCLUSIONS

A purpose of the hydrometeorological risk concept is a rapprochement between a broad qualitative notion about the risk (as dangers) and its quantitative calculation possibilities. The risk analysis, connected to floods, takes into account the whole ensemble of destructive factors. The risk is defined on the basis of absolute and conditional probabilities of elementary events. The probability evaluation of the elementary events is executed by direct or indirect methods on the base of hydrometeorological data series.

An investigation of dependencies of risk on landscape parameters enables a regional generalisation of the risk assessments and creation of risk maps of different scales. These maps and multi-site stochastic models allows to motivate defensive and also compensating actions on flooding territory.

VII

FORECASTING, MONITORING AND EARLY WARNING



KEYNOTE PAPER

MONITORING & FORECASTING

James Purdom, National Oceanic and Atmospheric Administration, USA

NATURAL HAZARDS occur routinely. When the results of natural hazard events evolve into natural disasters they can become global in scope and exact a terrible toll on humanity. Developing a society that is resilient to natural hazards is a goal shared by nations across the globe.

While natural hazards will always exist, the disaster that follows in their wake can be lessened through assessment, prediction, prevention and mitigation. However, diminishing the impact of natural hazards is not a trivial task. It is cross disciplinary in nature — requiring interaction between physical and social scientists, government bureaucrats and the public which they serve. This interaction is complex, and includes defining phrases like hazard identification and risk assessment; research and technology transfer; and public awareness.

In the United States, approximately 85% of Presidentially declared disasters are weather related, being caused by natural phenomena such as droughts, heat waves, hurricanes, floods, and tornadoes. This vulnerability to weather related hazards in part led to the modernisation and associated restructuring of the United States' National Weather Service (NWS). This modernisation includes the use of advanced technology such as Doppler weather radars, advanced polar orbiting and geostationary satellites, automated surface observations, and advanced interactive weather analysis and information processing systems that are utilised by a trained workforce of highly skilled meteorologists. Within the NWS infrastructure, local forecast offices have extensive public outreach programmes which deal with both the education of the general public (hazards and appropriate protective action), as well as with disaster management officials (concerning co-ordination and interaction for specific weather related dangers).

The modernisation is resulting in great improvements at the local forecast level. For example in early May, 1999, devastating tornadoes moved across Oklahoma and Kansas. Some of those tornadoes were over one mile wide and had winds in excess of 260 miles per hour: rating the maximum intensity of F5 on the Fujita scale. Those tornadoes completely destroyed entire neighbourhoods and caused property damage that may well exceed

one billion dollars — indeed, in the Oklahoma City area alone damage is estimated at over 250 million dollars. Utilising the new modernisation technology, NWS forecasters were able to provide very long lead time warnings to the public; not only warning of the tornadoes, but telling people to 'take cover, get under ground if possible, these are killer storms.' The resulting death count was less than 50, remarkably low for such intense storms moving through highly populated areas. While property damage from tornadoes of F5 intensity is impossible to mitigate, why the success in this case? The NWS modernisation and restructuring encompassed hazard identification and risk assessment; research and technology transfer; as well as public awareness. An important aspect of that public awareness was public confidence in the warning.

Our ability to predict and monitor hazards varies greatly among different hazard types and from one region of the globe to another. Furthermore, regardless of our ability to predict or monitor hazards, the infrastructure to respond to different hazards varies greatly from country to country. For some hazards our lack of understanding, or our inability to monitor key variables at the proper scales, make it impossible to provide timely predictions that allow those affected by the hazard to take protective action. Near the beginning of this century one of the worst hurricane-related disasters on record occurred in Galveston along the Texas Gulf Coast: that disaster resulted in almost 10,000 deaths. Since the middle of this century that vulnerability was lessened due to improvements in observing technology (hurricane hunter aircraft, coastal radars, satellites, improved computer capacity and better numerical models), in knowledge of hurricane structure which led to better forecasts, in increased public awareness, and in a maturing disaster warning system. So when hurricane Andrew struck south Florida in 1992, the death toll was relatively low (less than 50) although the cost of that disaster was near



Figure 1: Hurricane Mitch caused massive flooding in Honduras and Nicaragua in 1998

US\$ 27 billion. But in 1998, nearly a century after the Galveston disaster, Hurricane Mitch (Figure 1) caused massive flooding in Honduras and Nicaragua, devastating the region and causing nearly 10,000 deaths. With Hurricane Mitch, insufficient observations made forecasting its track very difficult. Instead of moving northeast as was suggested by numerical weather prediction models, Mitch stalled, drifted slowly to the south, and then gradually dissipated while hovering over the north coast of Honduras. Using geostationary satellite data, forecasters were able to monitor the storm and its slow southward drift as frequently as once every 30 minutes. Furthermore, six hourly satellite derived precipitation estimations of the extreme rainfall that developed in association with Mitch were broadcast to meteorological services throughout the Caribbean and Central America. One can only speculate what differences there might have been with improved atmospheric monitoring and better numerical weather prediction guidance. But on what time scales were predictions needed, with the infrastructure that was available, to respond to the devastating flooding? And what if the meteorological services of the affected countries had the equipment, training and experience necessary to take advantage of the 30 minute interval geostationary satellite data that was available? What then?

Satellites and weather services

Meteorological satellites provide essential information for national weather services. Every day, countries all over the world use data from both geostationary and polar-orbiting meteorological satellites for weather forecasting and a variety of potential disaster

related activities. This can be credited, in large part, to a system fondly remembered as 'APT,' or Automatic Picture Transmission, which through unrestricted direct broadcast allowed the free use of high resolution NOAA polar orbiting data to anyone around the globe. This allowed scientists from many different cultures to share in common scientific quest. Unrestricted direct broadcast of data remains an essential component of NOAA's polar orbiting and geostationary satellite systems. Numerous technological improvements have occurred with meteorological satellites since the launch of TIROS-I on 1 April 1960, and the first geostationary satellites with meteorological capability almost six years later. Several countries are now operating meteorological satellites. Indeed, with the successful launch and availability of imagery from FY-2, and the operation of METEOSAT at 60 degrees East Longitude in support of an experiment known as INDOEX, advanced geostationary satellite imagery now covers the globe, except over polar regions.

Using space based technology, three hazard related areas have received considerable attention:

1. Drought
2. Floods
3. Hurricanes.

However, meteorological satellites play a much broader role in hazard monitoring than those three areas. For example, satellite data can be used for detecting and monitoring volcanic ash plumes, harmful algae blooms over the oceans, and wildfires over land, to name but a few.

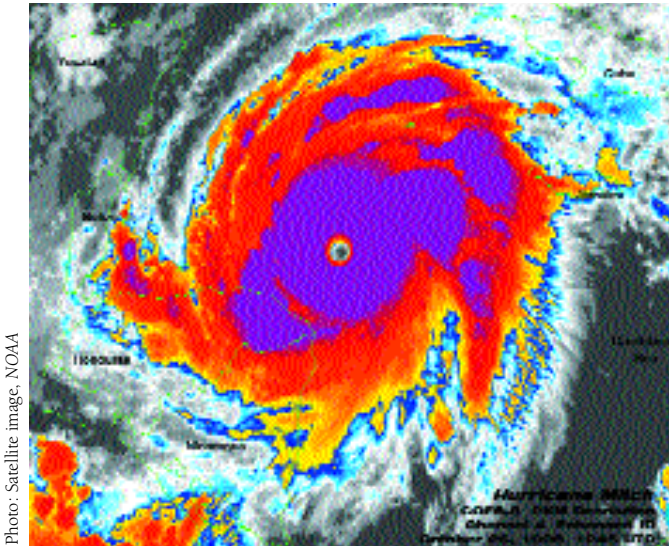


Photo: Satellite image, NOAA

Hurricane Mitch, 1998. Satellite data from the NOAA shows the eye of the storm as it moves over the Caribbean

Imagery from NOAA's polar orbiting and geostationary satellites play important roles in hazard monitoring. Well known across the international community are the NOAA polar orbiting satellites with their Advanced Very High Resolution Radiometer (AVHRR), High resolution InfraRed Sounder (HIRS) and Advanced Microwave Sounding Unit (AMSU). NOAA's polar orbiting satellites are in sun-synchronous orbits, and generally provide twice daily coverage over most areas of the earth, with the exception of polar regions where orbit overlap is greater and imagery may be available more frequently. NOAA's new generation of geostationary satellites, which began with the launch of GOES-8 in 1994, are located over the equator above 75°W and 135°W respectively. These new generation GOES satellites have both an atmospheric sounder and a high resolution multi-spectral imager. The sounder provides soundings over the US and Coastal regions once an hour, while the imager routinely views the US and coastal regions once every 15 minutes. During outbreaks of severe weather images may be taken as frequently as once every seven minutes. For research purposes, the GOES satellites have provided imagery over small areas as frequently as once every thirty seconds for tornadic storms, and once every minute for hurricanes and other intensive weather events. Many of the capabilities of these satellites for disaster monitoring are summarised in the American Meteorological Society's 'Weather Satellites: Systems, data and environmental applications' (Rao *et al*, 1990), and more recently in 'Images in weather forecasting' (Bader *et al*, 1995).

Use of satellite data to monitor disasters

Weather, and weather related hazards and disasters, cover a broad range of scales. In meteorology, the link between the synoptic scale and the mesoscale is many times a key factor in controlling the intensity of local weather. Early work with polar orbiting satellite imagery showed that important synoptic scale features such as jet streams, mid-tropospheric trough and ridge lines, and vorticity centres were readily located in the images (Oliver *et al*, 1964). The feasibility of using satellite imagery to locate and track tropical storms was immediately recognised; however, it was not until NOAA began its operational polar satellite programme that routine surveillance was assured and techniques to estimate hurricane intensity from satellites became a regular part of weather forecasting (Dvorak, 1972).

Just as imagery from polar orbiting satellites helped advance understanding of synoptic scale phenomena, imagery from geostationary satellites helped advance understanding of the mesoscale. A number of important discoveries using geostationary satellite imagery have had a dramatic impact on mesoscale meteorology and, in turn, our ability to provide short term forecasts and warnings for potential disaster related weather events. Prior to the geostationary satellite the mesoscale was a 'data sparse' region; meteorologists were forced to make inferences about mesoscale phenomena from macroscale observations.

Today, geostationary satellite imagery provides a 'reporting station' every one kilometre with visible data (every four kilometre with infrared data); those data reveal mesoscale meteorological features that are infrequently detected by fixed observing sites. The clouds and cloud patterns in a satellite image provide a visualisation of mesoscale meteorological processes. When imagery is viewed in animation, the movement, orientation, and development of important mesoscale features can be observed. Furthermore, animation provides observations of convective behaviour at temporal and spatial resolutions compatible with the scale of the mechanisms responsible for triggering deep and intense convective storms (Purdum, 1993). However, as mentioned previously, satellite data are only a part of the observational arsenal that can be focused on hazards: satellite data in conjunction with Doppler radar and advanced information analysis systems at the hands of a skilled forecaster provide a cornerstone of the natural hazard/disaster reduction system.

Meteorological satellites provide essential information for a variety of disaster related activities. The use of satellite data in meteorologically related hazard/disaster monitoring and forecasting include:

1. Drought
2. Flash flooding and heavy rains due to convection
3. Hurricane intensity and tracking
4. Nowcasting squall lines, tornadoes and severe thunderstorms
5. Seasonal to interannual climate change related phenomena
6. Icing
7. Phenomena not normally associated with disasters, such as fog, which may pose a local transportation related hazard.

Satellites also play an important role in monitoring and detecting geologically and biological related hazards. Volcanic ash cloud, which poses a risk to aircraft safety, for practical purposes may only be tracked using satellite data. Fires and biomass burning, while common practices, are now recognised as hazards: they can be detected and monitored using imager data available from NOAA's polar orbiting and geostationary satellites. Furthermore, a number of ocean related phenomena, such as harmful algae blooms and oil slicks may be detected and monitored using satellite data.

While we cannot control natural hazards, through better forecasts and warnings, the occurrence of a hazard need not result in a disaster. Hazard identification and risk assessment, research and technology transfer, and public awareness are all important components of natural disaster reduction. An important aspect of that public awareness is public confidence in the warning. In the United States, NWS modernisation is proving to be an effective tool for natural hazard reduction. Recognising the importance of that modernisation's advanced technology and its potential for further improvements in forecasts and warnings, the United States Weather Research Programme (USWRP) has been developed. The USWRP's initial focus is on improving forecasts of hurricane intensity and track near landfall.

The use of earth observation satellites for disaster management

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EARTH OBSERVATION (EO) satellites have long been used to support forecasting of intensive weather hazards such as tropical cyclones. However, although there have been numerous research and operational demonstrations that illustrate the potential usefulness of EO satellite data for a broader range of hazards, the operational application of these data to other hazards has been growing in recent years. To address this opportunity, the Committee on Earth Observation Satellites (CEOS) sponsors a disaster management support project.

CEOS was formed in 1984, in response to recommendations made by the Economic Summit of Industrialised Nations Working Group on Growth, Technology, and Employment's Panel of Experts on Satellite Remote Sensing. In CEOS, data providers and users work together to co-ordinate planned missions and to promote the effective use of EO satellite data.

The project's objective is to support natural and technological disaster management on a worldwide basis by fostering improved utilisation of existing and planned Earth observation satellite data. The strong enthusiasm, interest, and support for the project are reflected in the participation of nearly 200 individuals representing over 90 organisations. Meetings in 1997 surveyed extensive work that demonstrated the use of Earth observation data for a wide variety of disaster types and phases. Hazard teams, including both satellite agencies and user organisations, were developed in seven areas: drought, earthquake, fire, flooding, oil spill, tropical cyclone, and volcanic ash. A 1998 workshop provided an opportunity for experts to assess the extent to which satellite data could be expected to satisfy the needs of organisations responsible for managing disasters. Participants identified specific user requirements, where possible, and developed preliminary recommendations for improving the ability of current and planned systems to meet these requirements. Subsequently, each hazard team refined their findings and produced an interim report.

Teams were charged to review existing documentation and current practices in different geographical regions and compile a concise set of user information requirements for management of the hazard at different phases (mitigation, preparedness/warning, relief/response/recovery). They should identify the user level (international, regional, national, state, local, other) and type of use (research, demonstration, operational). They should identify existing practices in using satellite data in the management of the hazard; assess the potential of existing or planned satellite data to satisfy the user information requirements; analyse shortcomings and gaps; and make recommendations for improvements.

Concurrent with the work of the hazard teams, the National Oceanic and Atmospheric Administration (NOAA) hosted a project information server (<http://disaster.ceos.org>). The server is intended to demonstrate timely access to satellite-derived data

and information products to support various facets of disaster management. It has separate pages for selected disaster types, providing background and bibliographic information, and links to disaster specific internet sites that provide data and products.

Overarching conclusions and recommendations

After two years of activity, a set of overarching conclusions and recommendations have been agreed. These recommendations draw heavily upon and should serve to reinforce the experiences and findings of other studies and demonstration projects.

- There is a visible willingness within the disaster management community to give due consideration to new space technologies that will improve their operations. None-the-less, because of the difficulty in introducing new, unproven technology and the concern for complicating operations, there is a general reluctance to quickly assimilate new technologies and information into their programmes.
- It will be up to the space sector to respond pro-actively to this general receptiveness. It will need to invest effort into familiarising itself with the needs of the disaster management users by promoting mutual understanding and dialogue. It will need to create appropriate tools and perform compelling demonstrations.
- Timeliness, cost, accessibility, ease of use, reliability, repeatability, and demonstrated operational capability are the most important criteria affecting the implementation of space systems and data into disaster management programmes. For disaster warning rapid response is most important.
- Rapid satellite tasking for EO missions and fast processing and delivery of data are very important.
- An integrated approach to applications is needed, eg. to integrate non-space and space information, and to move integrated products quickly in a seamless fashion to intended users.
- The Disaster Management Support Project should focus on refining recommendations for current and future systems; considering the improved use of satellite data for application to additional hazard types; supporting outreach to users; involving service providers; and promoting development of information tools. The Project and each Hazard Team should reach out for broader geographic and disciplinary representation, especially to specific users to determine their information needs. Describing what space-based observations can and cannot do must be as accurate as possible.
- Other recommendations include smoothing the transition from research to operations; raising the issue of data policy to improve and assure access, timeliness, and affordability of data, eg. high-resolution data; moving toward a more integrated approach to mission planning; and mirroring essential information to provide more timely access to this information.

Hazard team recommendations

Drought: Satellite data are used for drought prediction, monitoring, impact assessment and response. Droughts depend on vegetation state and weather/climate conditions. For large scale and global vegetation applications, low-resolution visible and infrared radiometres continue to be the ‘workhorse’. For smaller scale vegetation applications, some medium-resolution radiometres are utilised routinely. Others should be more widely used. Data from weather satellites are used for monitoring weather and climate conditions, but there should be increased use of microwave radiometres. Data from new satellite systems should be utilised, as their data streams become accessible.

Earthquake: Current satellite technologies are applicable to a limited extent in earthquake hazards and more work is needed to fill temporal and spatial requirements. The availability of one or two metre spatial resolution satellite imagery will make a profound contribution to earthquake damage assessment and disaster response if adequate temporal resolution can be achieved. There is little anticipation that space techniques can help in effective earthquake prediction. Earthquake disaster mitigation is the most important element of earthquake disaster management and it is in this area in which satellite observations can make—and are making—their biggest contributions.

Fire: A wide range of satellite data is used to support the different phases of fire management—risk assessment, detection, monitoring, and damage assessment. Data types are different when analysing fuel, weather, or topography as well as various geographical scales.

Global data coverage from several current civilian satellites is needed for purposes such as fire scar and biomass burning monitoring. Global derived-products from these satellites are needed for updateable fire fuel maps and meso-scale weather models of dead fuel moisture. It is recommended that the continuity of these satellite systems be ensured and that a global operational system utilising data from these satellites be developed to distribute fire data and products to users on a timely basis. In addition, a constellation of new satellites is needed for local fire detection and monitoring—with an ultimate detection time of five minutes, repeat time of 15 minutes, spatial resolution of 250 metres, and a confidence rate of 95%—with real time data transmission to local users.

Co-operative possibilities should be explored to gain improved access to higher resolution data. In the event where no single satellite satisfies requirements for fires, it is recommended that an international agreement be pursued to improve the accessibility and affordability of commercial data to users. For example, high-resolution data streams are needed for burnt area assessment.

Flood: As with fire management, a wide range of data types is used to support the different phases of flood management. Data types are different for the many forms floods take—river floods, flash floods, coastal floods from storm surges, ice jams, and dam breaks as each relates differently to topography and slope instability.

There is a need for a coherent integration of technologies that are applied in flood hazard management. These include, among others, hydrology models, remote sensing data, more traditional data, and Geographic Information Systems. There should be differentiated approaches according to the typology of the event. There should be an integrated approach between flood and slope instability.

Technological improvements are needed including increased resolution of Digital Terrain Models for local application in the one-metre range. Weather satellites should have higher resolu-

tion radiometres—both in time and space. Microwave radiometres should be provided on board geostationary weather satellites.

Oil spill: Oil spill management can be supported to a varying extent by several satellite sensor types, but the Synthetic Aperture Radar (SAR) holds the most potential for improving oil spill detection and monitoring. Insufficient frequency of coverage and cost of data impede routine, large-scale operational use of SAR data.

Recognising limited availability to SAR data, there should be a joint exploitation of available C-band satellite SAR systems and international co-operation agreements for using airborne SAR systems, including demonstration projects for multi-satellite usage.

Co-ordinated satellite data ordering can improve access to satellite data with features such as fast data acquisition planning, fast data and product dissemination, and a special data policy.

Tropical cyclone: Data from weather satellites routinely track and predict the path of tropical cyclones and provide estimates of their intensities as they approach land. Improvements will come from new data sources and newly derived-products.

There is a need to reduce global deficiencies in the infrastructure for preparing and disseminating tropical cyclone warnings, particularly with regard to satellite imagery.

The link between tropical cyclone forecasts and damage predictions made by emergency management agencies should be improved. The interpretation and dissemination of information should be improved for a wide variety of users, for example, through the internet. Numerical model simulations and experiments can help specify future satellite sensors and requirements. Intermediary users can help improve the format and depiction of tropical cyclone warnings.

The value and impact of new research satellite data sets and products should be documented, validated and communicated to appropriate agencies. Ocean surface winds are derived from scatterometers and other microwave sensors, and high-density atmospheric winds from geostationary satellites. Geostationary satellites also provide rapid interval (five minutes or less) imagery and infrared derived-products. Other derived-products include microwave derived rain rates, microwave imagery, combined analyses of rainfall and surface winds, ocean heat content from altimeters, and atmospheric temperature and humidity profiles.

Volcanic ash: Volcanic ash management requires a global system since ash cloud can move rapidly through the atmosphere. In support of such a system, nine Volcano Ash Advisory Centres use data from weather and ultraviolet-sensing satellites to detect and track volcanic ash clouds.

Recommended improvements include automatic detection of volcanic eruptions with a low false alarm rate and automatic detection of ash cloud edges at least every 30 minutes. More accurate estimation of the height of the ash cloud (less than one kilometre) can be achieved by observing the visible image shadow and ultraviolet ‘ring effects’.

Footnote

Current information for the project, its hazards and information server teams, and current and retrospective examples of satellite data and information related to selected hazards may be obtained at <http://disaster.ceos.org>. For more information contact the authors. Comments are invited.

GETTING THE WORD TO THE PEOPLE

The public communication of warnings

Edward Gross, Consulting Meteorologist, USA



Photo: Tony Stone Images

TV Studio: Warning the public of an impending disaster

THROUGHOUT HISTORY, societies have been subjected to the vagaries of the environment. Natural and technological hazards result in major loss of life, social disruptions, and environmental degradation. The ability of a nation to manage emergencies, rather than react to crisis depends crucially on the availability and flow of real-time information linked through a variety of information networks. Networks today depart from traditional centralisation and place greater emphasis on international information exchange in a decentralised world community.

Warning systems must be capable of delivering critical information to emergency management officials and the general public in a timely manner. In turn, timely warnings help facilitate appropriate decisions and responses by those in danger. An effective public warning service is based on before-the-event emergency planning that produces co-operation, co-ordination and partnerships between the government and non-governmental organisations, the media and private sector—all key players in the warning process. This co-operation is essential in order to avoid confusion and to ensure that a clear and consistent message is provided to the public resulting in appropriate responses.

Warning the public of an impending disaster is the last line of defence in a nation's effort to mitigate the losses that both natural and technological hazards impose on our communities and citizens. In the United States, public warnings of one sort or another are an everyday occurrence allowing individuals to act to save their lives even with only relatively short notice. With longer lead times, people will take action to reduce losses, for example, by relocating moveable property.

National Weather Services and agencies involved in the warning process have no greater responsibility than ensuring the safety of their Nation's citizens from the ravages of natural hazards. Weather warnings and forecasts along with related hydrological and climatological products combined with, geophysical and technological warnings contributes significantly to public safety and are of enormous socio-economic benefit if properly understood and acted upon.

The needs and the difficulties of communicating these warnings to dispersed populations, many of whom work at basic levels of subsistence, requires increased focus by all organisations involved in the warning process.

Traditionally, and in some nations by law, the government, (acting as the authoritative voice) fulfils the role and responsibility of preparing all hazard warnings, whereas the private and commercial sectors are responsible for the actual dissemination of them to the public. In some cases the private sector delivers specifically tailored warnings and forecasts for private and commercial clients. Within governments there are, in most cases, separation of responsibilities both among scientific and disaster management agencies and within levels of government (ie. national, provincial and local) which ensures understandable credible communication to the public during stressful periods. Calls to action from public officials, and especially the way they are worded and disseminated, have a major effect on the reduction of injury and loss to property. The role of government is to provide the one authoritative voice in the preparation and issuance of natural hazard warnings, which must be understandable, credible, solicit the proper response and not confuse the public.

Some segments of the population require special warnings simply by virtue of their unique character. Special populations vary according to their level of risk, their particular characteristics or the amount of time they need to respond. This population includes those in schools, prisons, old-age homes, hospitals and other institutions. Such facilities require more time for warning response than after members of the general public. Consequently, it is important to specially communicate warnings to their facilities, for example, over tone-alert radios or dedicated phone lines.

Special populations with unique warning requirements can also exist in non-institutionalised settings. For example, the elderly may occupy a particular section of town. Since older people require a concerted effort to convince them to take protective actions such as evacuation, special warnings should be provided for their neighbourhood. These can include route notification or the frequent repetition of media warnings. Additionally, people who are hearing- or sight-impaired may require special alert and notification devices to receive effective warnings. People who have limited mobility or who do not read or understand the language also have special warning needs.

There must be mechanisms in place to ensure that the many disenfranchised people (ie. the poor, ethnic minorities, the aged and those with disabilities) are included in the warning process. The role of government is to ensure a responsible national infrastructure as part of sustainable development for the issuance of natural disaster warnings.

Within governments, at both national and sub-national levels, more than one agency is responsible for preparing a warning, issuing a call to action, educating the public and ensuring there is adequate communication. Hence, it is important work with and utilise the expertise of all national and sub-national agencies, the media and the private sector in the early warning process and for them to collaborate to provide preparedness education to the public.

The involvement of domestic and international media, television and radio networks, in the dissemination of weather and other hazard related information adds a new and ever improving dimension to the warning process. Greater co-operative efforts between local and national media outlets, both private and governmental, expand a nation's capability to reach the public-at-large with its forecasts, warnings and other bulletins. For the media to do its job better it is important that they have access to all 'official' hazard warnings for use both domestically and internationally. Co-operative arrangements can also assist in the direct provision of weather information via live or taped radio or

television broadcasts. They enable the responsible government organisations to carry out their responsibility to warn and inform the public more effectively while, at the same time, providing media outlets with highly desirable programme content. During emergencies and major events such as floods, hurricanes or tropical cyclones, earthquakes, volcanic eruptions etc, experts from the media, National Weather Services and other responsible organisations can interact with the public through these live broadcasts. Such presentations are an extremely effective way to capture public attention and relay critical information.

Today the media provides live coverage (images, reports, etc) of disasters, to all corners of our planet. Therefore, disaster related information broadcast must be scrutinised carefully and quality controlled in order to avoid broadcasting erroneous information. Access to all official warnings and forecasts issued by government agencies is an important foundation of a credible broadcast along with a proper understanding of warning procedures. A high standard for processing weather information is essential. The role of the media improves the status of weather broadcasting and promotes appropriate standards and best possible practices in the profession worldwide.

The emergence of modern information technology, such as the internet, paging systems, cellular telephones and other means of technological delivery, offers another avenue for the rapid, automatic, and global dissemination of emergency information. The utilisation of the internet for real-time dissemination of information, including warning is growing. Subscribers to the internet can currently access a wide array of environmental information and products.

The growth of the internet provides both opportunity and challenges to the international community in determining how best to harness its potential in the warning process while minimising the problems associated with a new and open communication technology. Among the major challenges to governments are the abilities of organisations and regions to scale and organise their internet networks appropriately to ensure that the right type of information reaches the appropriate organisations at the right time in a form that is relevant and correct.

There is a current need to examine the benefits of establishing networks of inter-connected local, regional, national and international hazard information providers for associated risk reduction. The internet offers a realistic option for the rapid, automatic and global dissemination of early warning and preparedness information, and for integrating and co-ordinating information activities across disciplines as well as across national and international jurisdictions.

The need for greater internet security is obvious in this day and age. The advent of the Intranet with its more secure internal distribution assures the information source and control of access to emergency management officials. With the next generation internet on the horizon, electronic technology will play an even more important role in the future communication of warnings and other information to the public.

An effective early warning system depends on how well the government, media and private sector work together, utilise the new technology and understand the needs of all citizens during emergency situations. Most importantly, no matter how good the technology or how accurate the forecasts and warnings, if the information does not reach the people in danger in a timely and understandable manner, then the warning system fails. Public communication and the exchange of information, therefore defines the progress towards the goal of reducing the effects of hazards and disasters in all societies.

Space Technologies for Disaster Management

Jerome Bequignon, European Space Agency, Italy

NATURAL DISASTER management, in broader terms, addresses a variety of global problems, ranging from global climate change to atmospheric chemistry. Space observing systems, especially meteorological satellites, like METEOSAT series and its successors MSG and METOP, and instruments like GOME (Global Ozone Monitoring Experiment) or the Radar Altimetre (used for monitoring and mapping of El Niño), developed by the European Space Agency (ESA) alone or in co-operation, provide objective, quantitative measurements which are decisive for the understanding and assessment of these important issues.

In a more immediate sense, natural disaster management deals with floods, forest fires, coastal zone pollution, earthquakes or tornadoes. Several studies, notably those performed by ESA at the request of the Council of Europe (EUR-OPA Major Risks Agreement), on the potential contribution of space for hazard management, have established that space technologies can indeed bring a useful contribution to the prevention and management of hazards. Space systems, such as meteorology, Earth observation, telemedicine, positioning and telecommunications, provide a global response, immune to ground disruption, in complement to conventional ground-based or airborne equipment. This contribution lies upon solid scientific grounds and a sound technological basis, obtained through numerous studies and pilot projects, carried out in particular with the Agency's satellite missions, such as the ERS series.

Emergency response

In several major disasters, European satellite missions effectively delivered valuable information to the responsible authorities. During the giant floods which struck China in 1998, radar images acquired by the SAR instrument flowing on ERS-2 were used by the Chinese Government, in complement to aerial photographs, in order to get an accurate picture of inundated areas. An estimate of the burnt surfaces was obtained after the massive fires in Borneo by combining data from the same microwave instrument and from the optical instrument ATSR operating in the visible-thermal infrared range.

Yet the crisis is only one of the phases of disaster management, and space technologies equally apply to prevention, damage assessment and reconstruction. In 1998, radar and optical images acquired by the ERS and Spot satellites respectively were used by specialised United Nations organisations and local authorities in Nicaragua and Honduras, for assessing the damage caused by Hurricane Mitch. This last action was performed jointly with the French Space Agency CNES and satellite imagery provider SpotImage.

International co-operation

This last example illustrates the need for a co-ordinated response of space agencies, and ESA naturally works at establishing this co-operation with national European space agencies, such as those in Germany (DLR), France (CNES) or Italy (ASI) as well as

with the European Commission. Such an arrangement will foster the contribution of space to hazard management in Europe, and beyond, Europe's capabilities of relief outside the continent. At international level, ESA is also working together with major space agencies, such as those in USA (NASA) and Japan (NASDA). The issues at stake are to ensure a continuity and hopefully, a better adequacy of space observation capabilities on one hand, and to ease access to space technologies for disaster management authorities on the other hand.

Partnership with disaster management organisations

In this respect, the example of Mitch has shown the need for a concerted action to bridge the gap between the space data and service providers on the one hand, and the 'users' — civil protections and governmental authorities involved in all aspects of hazard management — on the other.

A structured and lasting dialogue between the European space sector and the potential end-user organisations is being established. As a first step, ESA is performing a survey of institutional entities involved in disaster management and another one on the insurance industry in order to bring to the European Space sector a better knowledge of the parties involved in this business. This is a considerable challenge in itself, given the diversity of the many individual entities involved throughout Europe and the strong national sovereignty aspect of civil protection.

Exploitation and improvement of existing systems

The wealth of data accumulated by European earth observation systems represents an asset for disaster management in all its phases. The Agency is undertaking actions to make existing tools and products operationally useable by the users (ie. mostly civil protection and environment services). It is particularly essential that products or services derived from space systems be easily integrated into operational procedures of the entities responsible for hazard management. This activity has a strong system aspect, in view of bringing space techniques to operationally support the management of major catastrophes, and of building up a solid network of service industries. A robust set of common tools and methods along with a network of services must be made available to end-users via industrial channels, with the aim of providing tailored information. As an example, Geographical Information Systems dedicated to hazard mitigation, used for decision-making as well as for prevention, planning or damage assessment, play a central role and therefore special attention will be paid to integrating space data, in particular Earth observation and positioning, into such systems.

This is being performed by the service industry and it will continuously benefit from new requirements emerging from end users, conveyed through a long lasting partnership with them. In order to comply with the needs of hazard management, especially timeliness and reliability, ground segment facilities in Europe need to be adapted. In particular fast and cost-effective data exchange and a data dissemination infrastructure must be



Photo: Associated Press

Looking over at the washed out Saopin bridge in La Ceiba, Honduras, which collapsed earlier in the day, October 1998. Hurricane Mitch hovered 30 miles off the coast of Honduras, its downpours caused rivers to flood across the nation, forcing 45,000 people to be evacuated from coastal and low-lying areas

provided, using widely accepted standards and services. Processing facilities at ground stations are being adapted to the needs of the 'downstream' industry, together with national Agencies and space operators.

Future missions

While previous demonstration projects have confirmed the strong potential of space applications to support natural event mitigation, they have also revealed the shortcomings of present-generation space systems with respect to very demanding operational needs. A concerted effort is being made to identify common needs of the various hazard management authorities at national, regional and international level and to propose cost-effective space systems with characteristics specifically adapted to their needs. Stemming from initial proposals tabled by the European space industry which foresaw operational observation satellites for natural disasters such as forest fires, floods or coastal management, the Agency is currently working closely with the major European manufacturers and various subcontractors in order to define a European Remote Sensing Information System. This may eventually materialise in Earth Watch missions dedicated to disaster management.

The Agency is also proposing an ambitious Earth Observation programme, which foresees missions devoted to Earth sciences, known as the Earth Explorer series. Missions devoted to the

atmospheric chemistry, or to precipitation will provide a wide range of observational data necessary for basic research in the global issues mentioned above.

Conclusions

A variety of space systems and techniques contribute at all levels to the management of a vast range of natural hazards as well as to the understanding of issues such as global climate change. The European Space Agency plays an active role in a worldwide drive to make these systems more accessible to users. This is being accomplished with the satellite missions directly under its control, together with the European space system and service industry, but also in relationship with European national space agencies and the European Commission. Building long lasting relationships with the whole spectrum of disaster management authorities, organisations and companies in Europe is a key to success. International co-operation with other space agencies will allow for providing end user communities with easy and unified access to space systems. On technical grounds, adaptation of existing infrastructure and identification of common sets of tools are underway. These actions pave the way for successful future missions dedicated to disaster management. Future scientific missions will continue to contribute to long term research and development necessary to the understanding of global issues such as climate change.

CASE STUDY

Renewal of the warning system in the Netherlands

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AT THE BEGINNING of the International Decade for Natural Disaster Reduction, the Netherlands Council of Ministers decided that the Civil Defence siren network, dating from the 1950s, should be replaced by a new system of electronic warning devices. This political decision was based on the consideration that the success of a strategy of giving people instructions by radio and/or TV about how to behave in the event of a disaster situation depends on an adequate, collective attention of the threatened group of citizens. A new electronic siren network had to guarantee this collective attention.

The existing network of sirens was built as a consequence of World War II. Its characteristics were: national coverage, massive use in case of air attacks with several activation points for quick reaction. There was a continued need of the instrument, but one of a different type—a modern technology, with different operational capabilities. A new system needed first of all to meet the requirements of an industrialised society with high risks and one that would, of course, also be fully available should a hazard occur.

From a technological point of view, the existing network of approximately 3,800 electromechanical sirens was considered to be obsolete. From a more operational standpoint it was no longer capable of responding to the requirements of a modern industrialised society. The old sirens could only be activated in groups, therefore a selective warning process was impossible. Also, the mechanical sirens needed, for technical reasons, to be tested 'live' once every month, causing unnecessary acoustic nuisance. The system also needed upgrading to meet regulatory requirements stipulating that in risk areas, the siren signal must be audible in residential areas from 300 inhabitants upwards. The existing system reached less than 80% of this population.

THE NEW SYSTEM

Having decided that the old system needed replacing, the installation of a new system was planned. Forty five regional control stations and approximately 3,500 sirens were scheduled to be installed between 1993 to 1997. To gain sufficient experience of the necessary administrative preparations and the actual technical installation process, this process started with approximately 320 sirens in two pilot areas, the region of Zeeland and the Rotterdam area. In

terms of infrastructure, industrial risks, demographic characteristics, building varieties and soil conditions, these two areas were deemed to be representative of the activities in the remaining parts of the country.

Before the installation started, the following preparations had to be completed:

- Making regional siren coverage plans (geographical projection)
- Choosing appropriate locations (topographical translation)
- Getting permission from the area and/or building-owners for installation and maintenance
- Preparatory investigation for the actual construction by the main contractor
- Preparing and submission of the applications for a building licence.

The full installation followed the region's geography. Every time the sirens in a particular region were installed, the regional system was put into use. The order in which the new sirens were placed was determined by considering risk density, the technical condition of the existing network and the situation concerning coverage.

This whole process lasted more than a year and depended on the co-operation between the Ministry of the Interior, the regions of the Fire Service Organisation, the local authorities and the main contractor.

The following comparison between the most important technical, operational and functional characteristics of the old and the new system provides a picture of the major changes: new, reliable technology, adequate coverage and selective uses enables the responsible authorities to give effective substance to the following warning scenario:

When the siren sounds

- Go inside immediately
- Close doors and windows
- Turn on the radio or TV.

THE ACTIVATION PROCESS

The responsibility for adequate coverage of the new system rests with the regional Fire Service Organisation. The actual use in emergency situations will be in the hands of the local authorities, who have first responsibility for local disaster relief operations.

Old	New
Electromechanical siren	Electronic siren
Activated by telephone	Activated by radio
Group use	Individual or group use
Wartime oriented	All types of disasters
Coverage: from 1000 inhabitants	Coverage risk related (300 and 1000)
Loud testing every month	Silent testing, loud testing part of public information campaign (One to two times per year)
Regular power supply	Emergency power supply
One signal	Programmable signal
Use: 'Primarily in Wartime'	Use: 'Primarily in Peacetime'

Figure 1: Comparison of systems

The activation of the new siren system is decentralised and follows the geography of the regions of the Fire Service Organisation. Each region has its own command and control centre, from which activation can be triggered. The authority decides if and when the system will be used based on the concept of delegation, with the final decision regarding who activates the system depending on the seriousness of the situation.

The actual activation of the sirens is achieved by a radio signal through one of the communication networks of the Fire Service Organisation. A simple voice radio channel in the 440 MHz frequency band is used. The whole process of starting, transmission and actual sound production is security protected.

As the signal is determined through the system software, it can be changed quite easily in case new alarm signals are defined, so the system is adaptable in the event of the introduction of universal European or worldwide signal. In addition, the ability to select 'no signal' means that sirens can be tested without generating an actual public warning and causing unnecessary acoustic nuisance. The sirens are audibly tested one to two times per year, but this now forms part of a public information campaign.

This ability to trigger the sirens either individually or within a group structure enables the authorities responsible for the warning of the public to alarm and instruct only those citizens who are actually threatened by the consequences of an accident or disaster, so more efficient and effective communication is achieved.

PROJECT COMPLETED?

By the end of 1998, about 3,800 new sirens were in place in the Netherlands. Upon installation, a period of evaluation followed to establish if the sirens already in place were

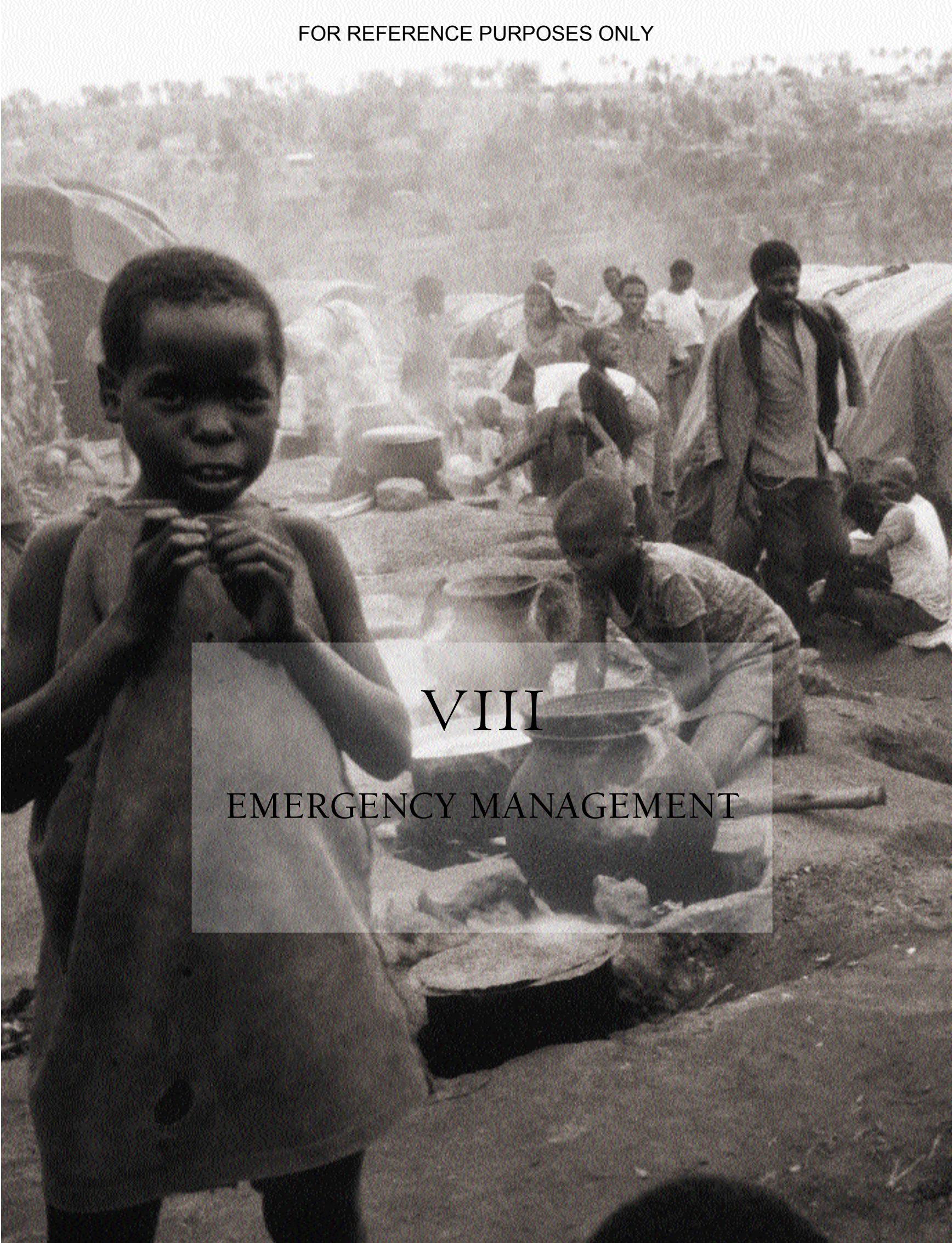


The actual activation of the sirens is achieved by a radio signal through one of the communication networks of the fire service organisation

sufficient to cover most of the country. In the four years needed to complete the project, new housing projects had been undertaken, so after placing all the originally planned sirens, an additional 600 were required to provide complete coverage. This process of evaluation and modification continues according to the requirements of dynamic population growth and distribution.

After a short period of loud signal testing, the existing routine of monthly loud testing ended and was replaced by the procedure of silent testing. This was widely welcomed by the public, and a more versatile and effective system was in place

With the new system established, the Netherlands authorities continue to strive for further improvements and refinements to the country's early warning capabilities. The development of a new signal is now under consideration — to meet an optimal combination of being able to attract maximum public attention when activated, yet minimise the historic one-sided association with the onset of war and air attacks. The ability to develop a system of warnings that can alert the public to the actual type of hazard, whether it natural, man made or other, will continue to increase the effectiveness of the new system.



VIII

EMERGENCY MANAGEMENT

KEYNOTE PAPER

HIGHLIGHTING THE NEED FOR INCREASED PREPAREDNESS

Emma Bonino, European Community Humanitarian Office, Belgium

IN 1998, NATURAL DISASTERS across the world claimed over 50,000 lives and caused economic damage amounting to nearly 100 billion euros. These are some of the highest figures ever recorded and suggest that the situation is getting worse. The close of the International Decade for Natural Disaster Reduction is an opportune moment for reflecting on prevention. This is not a time for sitting back, but for redoubling our efforts to ensure that disaster prevention and preparedness are systematically taken into account.

Bear in mind that a natural disaster occurs when a particularly violent natural event hits vulnerable people and property. However 'natural' they may be, such events are often caused, at least partly, by human economic activities. Obvious though such a definition may seem, I stress it because it points to ways of 'reducing' disasters. We may not be able to control its nature, but we can certainly take steps to reduce the adverse effects of economic activities and the vulnerability of communities.

Increasingly frequent and violent 'natural disasters'

There is no reason to believe that the number and intensity of seismic events, such as earthquakes and volcanic eruptions, are on the increase. However, some extreme natural events, particularly weather events, do seem to be increasing in number and severity. There are grounds for thinking that these hazards are linked to humankind's disturbances of the natural environment and its balances. Demographic pressure brings with it economic pressure on natural resources and the environment. For example:

- Disruption of the natural water cycle
- Landslides caused in particular by deforestation and industrial development (acid rain)

- Industrial development and its impact on the composition of the atmosphere (greenhouse effect).

Among the most extreme events, I would cite the latest manifestation of El Niño. Though the full impact has yet to be quantified, the consequences are clearly dramatic. They include not only visible and measurable events but economic crises and epidemics which, despite biological and medical progress, seem to be taking on new vigour (malaria and cholera are just two examples). Other major disasters in 1998 resulting from extreme weather events include Hurricanes George and Mitch, and the floods in China and Bangladesh.

Better development management to avoid exacerbating natural climate change

We must recognise that human activity takes place in a 'natural environment', that is constantly changing and that we have to maintain a global and holistic perspective (Lovelock). Climate change may also be a factor in increasing frequency and severity of hazards. Though the impact of human activities on the environment cannot be contested, it cannot yet be measured either, making it impossible to determine our influence on the planet's 'natural'



Photo: Courtesy of Caterpillar, Incorporated

Antonov Airlift: After Hurricane Mitch devastated many areas during 1998, including the island of Puerto Rico, emergency power was critical to restore life to normal. Capitalising on the mobilisation of power, these 40-foot ISO container units were airlifted to Puerto Rico

evolution. There have always been relatively substantial climate changes, even in this millennium (*Minor Ice Age 1400–1850*).

It is therefore vital that human beings become fully aware of their responsibilities, and take action. The Rio and Kyoto conferences were attempts to do so, albeit with inadequate results. Notwithstanding internal differences, the European Union is very committed to these steps in the right direction. Foot-dragging by others, however powerful they may be, should not deter it — the Union must sustain its commitment in this sphere and resolutely show the way.

Reducing the vulnerability of people and property to hazards

Coupled with the growing violence of some phenomena, some communities are finding themselves increasingly exposed and vulnerable to hazards. Paradoxically, in an age when science and technology have supposedly given us increasing control over the forces of nature and ever safer housing, the numbers and proportion of the weak and vulnerable are increasing all the time. The most obvious example is the anarchic development of major cities into megalopolises, but the indigence of recent arrivals from rural areas in certain smaller African cities, relative to the poor in our own cities, is no less striking.

What is in question is our development model. There is a need for a better distribution of wealth, and in particular education. People should be provided with a framework for the development of their community so that they can take account of the major risks identified by scientists and experts. They should be able to develop the means to organise themselves so that they can adapt to such frameworks and manage themselves more effectively.

Disaster prevention and preparedness: A vital aspect of any development policy

Whether we are considering the causes of disasters in an effort to reduce the harmful impact of human action on the environment or seeking to reduce their impact by making people less vulnerable, we are first and foremost addressing issues of development policy or development aid. The keys to preventing disasters and mitigating the impact of hazards lie mainly in better development policy (starting with better land-use planning policy) and a more efficient aid policy focused on sustainable development, notably by taking account of the risks, in particular major risks.

The media has done much not only to report disasters in what is practically real time, but also to develop solidarity between peoples. The worldwide response to Hurricane Mitch illustrates the scale of this movement in generosity. But the media has another role to play. It has to promote greater awareness of the need for disaster prevention and preparedness. Disasters and responses to them are newsworthy and widely reported, measures to prevent or prepare for them are not. Such measures, if carefully planned, can sometimes prevent disaster, albeit at the cost of a story. This shows just how difficult it is to mobilise people and resources on this topic. It shows that we have to use the media to get the message across.

The European Union's involvement in disaster prevention

Confronted with rising numbers of victims and economic costs of disasters, humanitarian assistance is becoming increasingly costly. ECHO, the European Community Humanitarian Office, has seen an absolute and relative increase in its spending on natural disaster relief since 1997.



Photo: Associated Press

Stockpiles of rice in Tachinkawa, Tokyo: The rice is stored to feed the population in the event of a major earthquake. Following the catastrophic earthquake that flattened much of Kobe in 1995, Japanese officials have scrambled to prepare for a similar or even stronger quake hitting Tokyo

Hence the importance of disaster prevention and preparedness. We at the commission are working to incorporate this dimension into our development and development aid policies.

In the meantime ECHO has, since its foundation, been funding prevention (primarily in the form of demonstration microprojects) and, more important still, preparedness. ECHO has responded to the worsening situation worldwide by adopting a new regional approach, the DIPECHO programme (Disaster Preparedness ECHO). The financing of a first Action Plan for three regions among the most disaster prone (South East Asia and Bangladesh, Central America and the Caribbean) was decided in July 1998. Disaster preparedness is among ECHO's priorities in 1999.

ECHO's principal concern is to plug the gaps in disaster response systems and improve external aid co-ordination. The activities funded, fall in to three broad categories — training, strengthening institutions or organisations, and microprojects. Examples of projects funded by ECHO under its disaster prevention and preparedness policy include:

Training

- Education and awareness campaigns in the Philippines to promote cyclone-proof construction methods
- Training villagers in Laos to fight forest fires and introducing new approaches to intensifying farming (rice growing) on scorched earth.

Institution building

- Enhancing the skills and co-ordination of the Venezuelan

governmental and non-governmental organisations involved in disaster prevention

- A pilot project to develop early warning systems tailored to local circumstances in ten Central American towns
- Setting up, training and equipping 100 rescue units in Ecuador in the event of an eruption of Guagua Pichincha volcano.

Demonstration microprojects

- Planting trees, to stabilise dunes and re-establishing mangroves in the coastal Quang Binh region of Vietnam
- Building dykes with local help in the Thanh Hoa province of Vietnam, to prevent floods caused by cyclones.

None of these life-saving projects cost more than a few hundred thousand euros. Some cost far less — to tackle frequent fires in shantytowns around Yangon, rainwater tanks are now kept on the roof and tipped over if fire breaks out. This shows that creativity is perhaps even more necessary than money when tackling and preventing disasters. Another example are the raised flood shelters built in Bangladesh.

My visit to Central America after 'Mitch' convinced me even more of the importance that should now be attached to disaster preparedness in all development, land-use planning and development aid policies. As a major provider of humanitarian aid and funding for disaster prevention and preparedness projects, the European Commission, in the spirit of the IDNDR and the 1994 Yokohama Conference, will continue working to promote awareness of prevention and preparedness both in the countries most exposed to disasters and within Europe.

The nature of health emergency management

Dr Reinaldo Flores, World Health Organization, Switzerland

ONE OF THE MAIN GOALS of the World Health Organization (WHO) on emergencies is to strengthen the country capacities to manage the health consequences of emergencies and to prevent disasters. To accomplish these goals the intra and inter-sectoral considerations are extremely relevant since there is no sector that could comprehensively manage all the aspects related with emergencies.

The experience on health emergency management around the world has shown that:

- WHO has co-ordinated activities with one or more of the following governmental institutions — Ministry of Health, Ministry of Internal Affairs, Ministry of Defence, Ministry of Social Welfare, Ministry of Education, Ministry of Agriculture, Ministry of Transport, and with one or more of the following organisations, systems or institutions at national level — Meteorological System, Water and Sanitation, Communication, Civil Defence, Red Cross/Red Crescent (RCRC) and other field-related Non Governmental Organisations (NGOs)
- Within the health sector at national level, the multi-disciplinary nature of emergency management has been expressed on the networking and joint activities with the responsible offices dealing with — Disaster Medicine, Sanitary Engineering, Public Health, Logistic and Supplies Management, Security, Media, Transportation, Planner Managers and Administrators
- WHO has jointly implemented projects and programmes with the following international agencies, organisations or programmes among others — United Nations Development Programme, The World Food Programme, United Nations Children Fund, United Nations High Commissioner for Refugees, International Organisation for Migration, United Nations Office for Programme Support, International Decade for Natural Disaster Reduction.

Health emergency management

Effective health emergency management depends on:

- Anticipating the different medical and health problems before emergencies or disasters arise
- Delivering the appropriate interventions at the precise times and places where they are most needed.

Take for example an earthquake scenario. It is very well known that the first 48 hours are crucial in terms of reducing morbidity and mortality by using the resources of the affected communities before any international assistance is able to reach the first entry point in a given country.

The contribution from the health sector as far as emergency preparedness is concerned could be translated in the provision of technical assistance to ensure that the community will have the necessary knowledge and resources to cope with the requirements for search and rescue, triage, first aid, Cardio Pulmonary Resuscitation (CPR) and Basic Trauma Life Support (BTLS). However, within the first 48 hours, all knowledge and resources

would not have the desired outcome on reducing morbidity and mortality if the proper organisation of the transportation, referral system, communication, access to health facilities and the function itself of those facilities are not assured.

Within the community

For that knowledge and for the resources to be effective, a community organisation framework is needed, which at the same time is ensured by the concurrence of other sectors in which health could be included—depending on the community priorities. Community emergency management programmes aiming to prepare first aid responders for the major risks, to protect the most vulnerable and to keep in mind the broader picture of community self-reliance and development, cannot succeed unless a participatory process is in place. The health sectors have many encouraging examples of articulating efforts with other sectors like education, labour (income generating projects), housing, social services (provided by NGOs) and even with special projects from universities or ministries of internal affairs and defence.

The importance of community focal points for emergencies cannot be over-emphasised. Within the community organisation setting, those people identified and trained on emergency management should have the proper support, refresher training and follow up. They usually belong to community committees or groups other than health, but their leadership and competence on the health sector should be strengthened independently, depending on whichever 'sector' they are representing or working with at the community level.

It is known that sometimes the health needs are not very high in the agenda of some communities. Then there is the need of an inter-sectoral approach for raising awareness, education, motivation and commitment on emergency management. Meetings on introduction of electricity, water and sanitation facilities, income generating projects, and of course, health related, are the ideal venues to explain to the communities their right to know the most important hazards they are exposed to, and the measures to be taken in case an emergency or disaster situation arises.

Intersectoral co-ordination

Strengthening country capacities means to support community organisation initiatives where the role of the community becomes participatory within the national government. It means to support, from the health sector, programmes aiming to increase the level of life, access to services and to the decision making process affecting the community.

The provision of a good CPR, search and rescue resource is just one step. To be complete, the health sector has to make sure that the proper shelter will be available for the affected population. A timely transportation and referral system should be co-ordinated for the victims, and the proper arrangements for mass casualty management at health facilities should be in place.

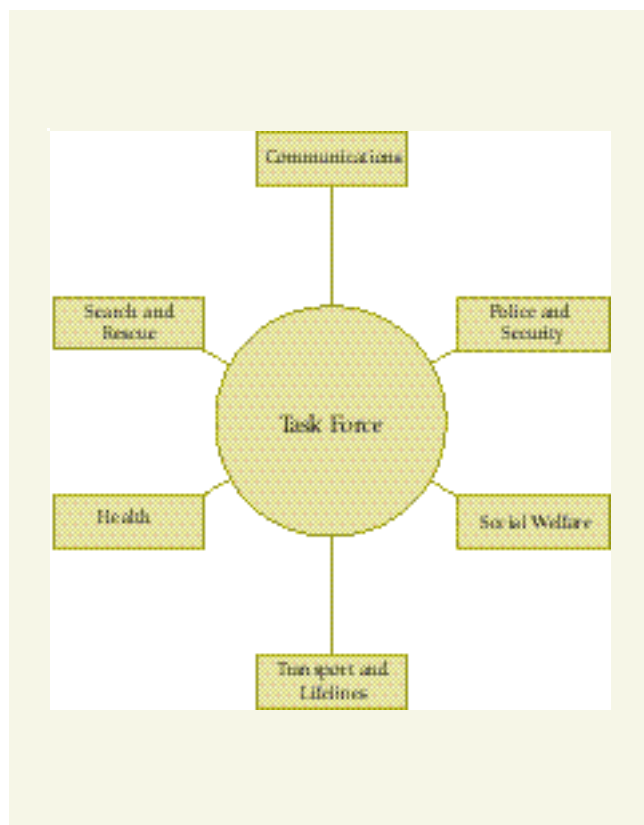


Figure 1: Emergency management co-ordination through a task force

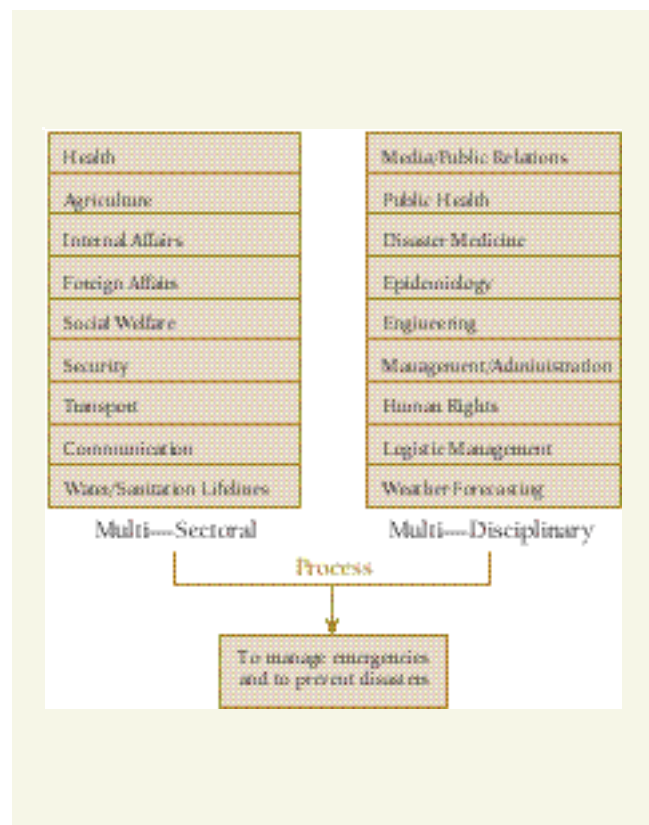


Figure 2: The multi-sectoral and multi-disciplinary nature of emergency management

Emergency management systems rely on various levels of preparedness, one we already reviewed is at the community level. Co-ordination should exist between the community and the security forces, police, civil defence, meteorological systems, health services or any institution in charge of early warning, standby procedures for emergencies and relief operations.

The transportation services for the injured should be properly notified. The community should know how to reach them and what information to provide. Those services should know exactly where to take the victims when an emergency or disaster situation is declared, and the levels of command and distribution of responsibilities should be in place.

The first responders from the health sector should be well trained on triage (sorting or categorisation technique aimed to provide the fastest care to those patients who have better survival chances) and Basic or Acute Trauma Life Support. They should have established the proper co-ordination, including knowing the roles and responsibilities of other responders like the fire department, Red Cross/Red Crescent, police department, civil defence. The health responders should be ready to lead the field or on-site health command posts and to indicate the adequate referral system to use.

Access of the injured to the health facilities has to be ensured by proper planning and simulation exercises. These should include the participation of the security and police forces as well as the rest of the emergency system (dispatching, notification, communication, code activation, public relations and media, referral health institutions, etc).

At health facilities level

It is important for emergency responders at the health facilities to know how to handle the type of disaster most prevalent in

their own community since each type of disaster is characterised by different morbidity and mortality patterns and thus has different health care requirements. For example, hospitals in the Caribbean should plan for hurricanes, but those in southern Italy should plan for earthquakes. Emergency planning for health facilities offers a new opportunity for a multi-disciplinary and multi-sectoral approach, where engineers, planners, administrators, and health personnel interact in carrying out assessment, mitigation measures or emergency plans on the three major components of health facilities emergency plans—Structural, Non-structural and Functional.

WHO and IDNDR initiatives

The support and participation from WHO to the various initiatives of IDNDR are the result of a natural bonding, bearing in mind the multi-sectoral scope of the IDNDR approach and the developmental orientation of emergency management at WHO.

In disaster prevention and relief, as well as in development, health remains the overall objective and the main yardstick of needs and operational success. Health is a cross-cutting and inter-sectoral issue, an ideal tool to identify objectives, in preparedness, response, transitions and development. Whether one approaches the cycle from the perspective of relief or from development, the public health model remains a useful tool.

International health has a comparative advantage in helping the international community understand disasters. WHO, within the framework of IDNDR, had the opportunity to identify the health outcomes of other sectors' activities for natural disaster prevention and at the same time, consistent with the nature of emergency management, WHO had the opportunity of strengthening its inter- and intra-sectoral networks during the joint activities with IDNDR.

A RETROSPECTIVE VIEW

Public understanding as a key to emergency management effectiveness

Shirley Mattingly, USA

AN INFORMED AND concerned public is a key to effective emergency management and loss reduction programmes in a community. Raising public awareness about hazards and risk helps to create a community that values risk reduction. This paper discusses examples of how public involvement generated in this decade is impacting emergency management and risk management strategies and decisions.

Building a culture of prevention

Prevention begins with information. This was the striking title of the 1998 United Nations World Disaster Reduction Campaign. The theme of the campaign was to encourage working with the media as a key element in achieving the IDNDR's goal of building a culture of prevention. Reaching the right audiences with an effective message at times when they are receptive can go a long way toward promoting preparedness and building support for reducing the impacts of disasters.

Influencing preparedness

Preparedness also begins with information. An informed public is more likely to be a prepared public. Research in the United States has indicated that, at the household level, emergency preparedness actions are more likely to have been taken by people who are routinely more attentive to the media. Actions are more likely to be taken by people who — are more concerned about other social and environmental threats; have personally experienced disaster damage; are responsible for school-age children; have stronger links with the community; have received some sort of disaster education, and can afford to take preparedness actions.

The findings of US researchers on how families and communities recover from disasters also support the thesis that an informed public improves overall emergency management. Successful recovery efforts, researchers have found, typically involve strong local community participation through public, private, and volunteer groups within the community.

Engaging the media

Informing the public and influencing public opinion are things the media do well. A proven approach to building a concerned and informed public on hazards issues is for government and scientific and technical institutions to develop mutually beneficial partnerships with the media and a team approach to emergency public information. In Nepal, the National Society for Earthquake Technology — Nepal, engaged a local journalist as a full partner in its earthquake hazard reduction project, and this alliance has been extremely rewarding and successful. Mutual benefits are not difficult to identify — the media gains timely

access to needed information, and government and other institutions get critical information delivered rapidly to threatened populations and off-duty emergency workers.

The media, and how they handle disaster and hazards information, make a big impression on public views and actions. Casualties have often been reduced significantly through the broadcast of warnings of an impending cyclone/typhoon or flood. During a disaster, the media can help victims locate family members, shelter and assistance. Media reports can help speed the delivery of needed supplies and equipment into affected areas. During non-emergency times, good science reporting increases public knowledge and understanding of the hazards facing the community and what steps people can take to prepare and protect their families.

The media can also perpetuate inaccurate information, spread rumours and report non-scientific predictions of coming catastrophes, as occurred in the Central United States in 1990 and in Tehran in 1998. They can convey misleading perceptions about the affects of a disaster and perpetuate myths about public behaviour. Some reporting appears more geared toward sensationalism and sales rather than accuracy. But the media can earn public acclaim by helping communities to better understand and reduce natural disaster impacts.

Experiencing disasters

In the past, too often it has taken a disaster to create change in public — and institutional — attitudes toward risk. For example, in Colombia, it was the destruction of the town of Armero by the eruption of the El Ruiz volcano in 1985 that created the political will to adopt a new emergency management system for the country. As a consequence of the disaster, every region and municipality must have its own inter-institutional committee for risk mitigation and disaster preparedness, involving technical and scientific experts and planning, education, and emergency response officials. In the capital city of Bogota, strong collaboration among public officials and local academic and scientific institutions has resulted in development of earthquake scenarios and loss estimations that have served as the basis for positive results in public education and mitigation activities.

The city of Tanshan, China, was levelled in 1976 by a severe 7.8 Richter scale earthquake. Entirely rebuilt, Tanshan has not forgotten the lessons of its tragedy. Its museum, monument, and preserved earthquake ruins are focal points for spreading knowledge about earthquake science, earthquake-resistant architecture and construction, and emergency evacuation, self protection, and measures to prevent secondary effects. Each year, the 28 July is designated 'earthquake day' to popularise and instil into the



Photo: Associated Press

Congressman Bud Shuster and Congresswoman Ellen Tauscher tighten bolts on a girder in a ceremony in San Francisco, USA, to symbolise the work to make the Golden Gate Bridge safe during an earthquake. This initiative was a result of the 1994 Northridge earthquake

minds of primary and secondary school students the scientific and technical knowledge to overcome the fear and mystery of earthquakes and promote adaptive behaviour. After years of effort, the city now reports a high level of awareness and the ability to mobilise the population to reduce earthquake affects.

In the United States and Japan, one effect of the 1994 Northridge and 1995 Great Hanshin-Awaji earthquakes was to enhance their collaborative research agenda. One bilateral project has studied perceptions of acceptable risk in regard to urban seismic hazard, noting that the perception of risk by citizens and earthquake 'professionals' in society diverge considerably. These kinds of studies are important to help in the understanding of how best to promote risk reduction and emergency management goals. Differing and unreconciled views on mitigation needs and priorities can lead to indecision and inaction, thus perpetuating risk.

International collaborative efforts

Technical solutions to most hazards management issues exist, but getting them used requires effectively communicating the solutions to end-users and convincing potential users that they are desirable, feasible, and cost-effective. Several significant international collaborative projects have been launched during the IDNDR to transfer hazards-reduction knowledge and experience to and among developing countries. Projects such as the United

Nations' sponsored RADIUS Project (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters), the Asian Urban Disaster Mitigation Project (AUDMP), and the Earthquakes and Megacities Initiative (EMI) aim to bring together scientific and engineering knowledge and impact public perceptions of hazards and risk and public policy and decision-making.

These projects are about bringing science to life for citizens, and getting people interested in dealing with risk.

For example, the disaster scenario development and mitigation action planning process supported by the RADIUS Project exposes citizens in selected world communities to hazard and risk assessment techniques and identification of risk reduction strategies and measures. In Antofagasta, Chile, a RADIUS workshop brought together representatives of the port and the airport, the civil registry, a local museum, the insurance industry, the teachers' association, and government officials, in addition to the Red Cross, hospital, fire, and law enforcement agencies. These community representatives all have contacts throughout the city and are now potential champions and advocates for emergency management and risk reduction actions.

In Bandung, Indonesia, 200 primary and secondary school students participated in a RADIUS Project workshop. Their great enthusiasm and eagerness to learn about earthquakes has inspired and motivated participating government officials and institutional representatives.

In the Kathmandu Valley of Nepal, an AUDMP Project area, an Earthquake Safety Day in January 1999 attracted thousands of people and strong press coverage. The Prime Minister inaugurated the exhibition, posters advertised the event, shake table demonstrations helped people visualise earthquake effects, and public awareness materials were distributed.

Similarly, the City of Los Angeles successfully organises an annual three-day Earthquake Preparedness Fair every April (California's Earthquake Preparedness Month). The event attracts thousands of families because children have fun through such activities as face-decorating and finger-painting and they learn by observing dramatic rescue demonstrations, animal handling in disasters, and other attractions.

Generating community action

The decade of the 1990s generated a focus on working to create disaster resistance and self-reliance at the community level. China's new Law on Earthquake Disaster Preparedness and Reduction, implemented in 1998, provides that government at all levels should publicise knowledge about earthquake disaster preparedness and reduction, improve citizens' awareness, and develop citizens' capability for self rescue and mutual rescue in case of earthquakes. In Shanghai, there is a strong emphasis on enhancing citizens' consciousness of disaster reduction and scientific understanding of the hazards. The local government employs television, broadcasting, popular poster paintings, earthquake rehearsals and drills to popularise self rescue and mutual rescue techniques—and other self protection measures. The entire society has a role in comprehensive disaster prevention and preparedness.

Community understanding and commitment have been demonstrated to help create and reinforce political will and commitment to take action at the local government level. Elected leaders respond to the desires and demands of their constituents. When disaster reduction becomes a public value, government commitment comes more easily. It is frequently stated that government commitment is the key to getting risk reduction implemented, especially in developing countries.



Photo: Tony Stone Images

Los Angeles earthquake: Large, elevated sections of the main highway collapsed in 1994

Emergency management in the framework of community values

In the late 1990s, emergency management has become increasingly tied to other community values and made part of a community's overall strategic approach to the future. This development links emergency management to a community's decisions about growth and development and its long term sustainability. Gone, fortunately, are the days when emergency management focused solely on immediate life saving activities.

This broader approach to risk management places emergency management in the overall context of a community's economic and social activities. In New Zealand, the management of risk is increasingly being seen as a process in which risk reduction is openly evaluated by the public at large within a community. The logical long term outcome of this new approach will be the development of communities that are more disaster resistant.

Global disaster information sharing

While risk reduction and emergency management are largely local issues, to be dealt with most effectively through community effort, the 1990s offered welcome opportunities to share information globally for the use and benefit of communities everywhere. In this age of information and global interdependency, computers and the internet contribute to the flow of technical, scientific, and policy information to help local advocates around the world enhance local emergency management efforts. Improved global communications, better weather forecasting and monitoring are enhancing warning capabilities and saving lives around the world.

International efforts are building toward the development of a Global Disaster Information Network (GDIN). A study in connection with the project concluded that sharing the maximum amount of information with the widest possible range of a community's stakeholders is needed in order to devise and adopt effective community mitigation plans. A series of important international meetings is currently underway to work on overcoming any obstacles that might impede implementation of such a global network.

Sharing successes

Great promise lies with the international, collaborative efforts that have emerged during this past decade. These projects are teaching participants how to more effectively transfer knowledge and learn from the experience of others. The Earthquakes and Megacities Initiative for example, an international scientific organisation dedicated to the acceleration of earthquake preparedness, mitigation, and recovery in large urban areas, is sponsoring a twin cities project which pairs cities in partnerships in order to learn from each other. Among the most important of the lessons being shared under the twin cities project is the experience in enhancing public awareness and involvement to try to build more disaster resistant and resilient communities.

The first step toward action is awareness. The technical knowledge exists to protect people and structures from hazards. Motivation to use that knowledge comes through public understanding of the hazards and the risks that many families and communities face.

THE RUSSIAN EXPERIENCE

Emergency response to the 1995 earthquake disaster in Neftegorsk

Dr Boris Porfiriev, Russian Academy of Science, Russia



Figure 1: The completely damaged shop building in Neftegorsk

THE NEFTEGORSK EARTHQUAKE disaster turned out to be the most devastating in Russian history and one of the most tragic in world history in terms of the fatalities rate. The 7.4 Richter scale earthquake struck late at night at 1.04 am local time on 28 May 1995 (5.04 pm Moscow time on 27 May 1995), when most of the dwellers were asleep in their apartments. As an immediate result, almost 2,000 people or two-thirds of the population of this small oil producing town located in the northern part of Sakhalin Island in the Far East of Russia were killed.

In addition, 17 large residential buildings, the local hospital, school, boiler, bakery as well as the office of the local militia (police) and the town club were totally destroyed. A few infrastructure facilities were destroyed only partially or slightly. (Figures 1 and 2: Kof, 1999). Almost 2,500 people were entrapped and almost 2,000 of those were killed at once or died in the hospitals, while the more than 380 who survived were hospitalised. Communication, electrical grid lines and oil and gas pipelines experienced multiple and serious ruptures while all the bridges collapsed. In Neftegorsk alone, the direct economic loss exceeded 400 billion rubles while the total costs associated with the earthquake impact and rehabilitation measures in the north-

ern Sakhalin soared up to 4,000 billion rubles. The exchange rate used throughout this article is US\$ 1=4,000 rubles.

Organisational response to disaster

The emergency plan to respond to a major earthquake had been developed jointly by the EMERCOM (Ministry of the Russian Federation for Civil Defence, Emergencies and Natural Disaster Response) headquarters and its regional centres not long before the Neftegorsk earthquake occurred. This relied on both the existing seismological forecasts and respective experience of the high-level field exercises held in April 1995, which expected such an earthquake to occur at Kamchatka peninsula rather than in Northern Sakhalin. Given that real events suddenly occurred at a different place and followed a different scenario, the original plan was substantially changed.

Warning and early notification of communities and authorities

The devastating nature of the earthquake highlighted existing pitfalls in preparedness and warning. The caused the disruption of communication lines, the complete destruction of command

and communication posts (militia department, emergency medical department and so on), and the deaths and entrapment of people, including emergency personnel. Nearly two-thirds of police officers and medical personnel in Neftegorsk were killed, and many others were injured. In such circumstances collective and individual initiatives played a decisive role in the initial response.

The first information about the scale of the disaster came from a police officer who was fortunate to survive after his apartment and the whole building were completely destroyed. Although injured, he managed to find an undamaged police car and used it both for reconnaissance of the destroyed area and to reach the closest settlement. The telephone there was functioning and he informed the district authorities in the neighbouring Okha City about the tragedy.

At that moment, the administration and the civil defence staff of Okha City were trying to help 37,000 of their own citizens who had experienced quakes of 4.0–5.0 degrees on the Richter scale, which fortunately created only cracks and breaks in some buildings. Having received the message from the militiaman, the city mayor and the civil defence chief of staff sent helicopter and mobile ground reconnaissance groups to assess the situation. The field reports were received and the message was transmitted to the EMERCOM headquarters in Moscow as late as almost nine hours after the earthquake. Thus regional and federal authorities were unaware about the severity of disaster during the first critical hours of emergency response, although they knew its geological characteristics with small delay.

Given this and the remoteness of the affected area, the federal and regional emergency operations that should have compensated the lacking and/or devastated local response capabilities were delayed by as much as 17 hours. This considerable delay had crucial adverse implications for the timeliness and efficiency of organisational response, in particular of the search and rescue and emergency medical care operations.

Search and rescue operations, fire extinguishing and prevention activities

Emergency groups created by less than a hundred people who had not been seriously injured and were able to get out from the rubble, formed the primary response force immediately after the earthquake. With bare hands alone they tried to find and help relatives and neighbours buried under the ruins, while some survivors were paralysed by shock and could not move. However, the efficiency of their rescue actions was expectably very low, with just a few people saved.

Teams of volunteers of the state mining company 'Sakhalin-morneftegaz' which extracted oil from the local oil fields soon supplemented these emergency groups. Miners, operators and others left their work and hurried to their homes and families immediately after the impact, bringing in mining equipment (bulldozers, car cranes and so on) to assist the survivors' search and rescue efforts. Other volunteer teams from this company used construction and transport equipment to repair roads so as to facilitate the transportation of professional emergency means and forces. They succeeded in restoring minimal community services, a temporary phone system and setting up temporary camps and kitchens to provide hot meals for the affected people. The professional rescuers who arrived later also used these facilities. However, for quite obvious reasons the rescue activities of these non-professional teams were inefficient. The cranes they used to remove the rubble were not powerful enough to lift the heavy plates. This sometimes reduced any existing empty space and made the situation worse for people trapped in the debris.

The situation changed dramatically and favourably when professional emergency teams arrived with militia and fire units from the Okha district and Sakhalin region being the first ones. Having reached Neftegorsk, the special unit of 368 militiamen organised social order maintenance, registration of the survivors and corpse identification and conducted other emergency duties in the affected area. Due to these activities, the social order was effectively maintained throughout the crisis despite the local militia building being completely damaged and most of the officers killed.

No less active were the regional fire units that not only contained fires provoked by the earthquake and preventing fire from breaking out at the base camp but extricated the victims from the rubble and removed debris. Given the lack of local fire depot, three fire squads from the neighbouring districts could start fire extinguishing operations only as late as 5.00 am on 28 May. Notwithstanding, from 28 May to 9 June the fire units stopped 13 fires in the rubble and in the base camp, and extricated 92 people, with 17 of those alive, while conducting rescue operations at one of the demolished buildings.

Despite these efforts, the situation continued to be very serious and called for urgent and massive involvement of both the regional emergency teams from the adjacent regions and federal EMERCOM units. Those should have been supported by emergency teams from the federal ministries of health, transportation and finance and co-ordinated by the permanent federal Intergovernmental Commission for Emergency Prevention and Response. After the situation was clarified, the federal crisis management centre of EMERCOM in Moscow and its Far Eastern regional centre in Khabarovsk functioned from 12.40 pm on 28 May within an emergency schedule. On the same day, the emergency teams from the EMERCOM Far Eastern regional centre, those from the Sakhalin regional and from Okha district civil defence staff were organised and started to work actively.

This provided for considerable and sharp increase in efforts to transport deliveries into the disaster area, as well as the means and forces of the regional and federal centres of the EMERCOM. Within 24 hours, the number of rescue personnel and equipment pieces were augmented by a factor of four and two, respectively. After 30 May, the total strength of operational forces and means involved, although varied through time, reached 1,600 people, including more than 600 professional rescuers, about 190 pieces of equipment, 20 aircraft and 15 helicopters. Both the rapidity and density of the emergency personnel and equipment concentration in Neftegorsk should be especially stressed.

The means and forces of EMERCOM along with the regional fire units and district and regional medical teams served as a nucleus for the search and rescue and emergency medical care operations in the disaster area. Within these forces, district and regional organisations dominated contributing more than 70% of emergency response personnel working directly in Neftegorsk. However, one should not overestimate the degree of disaster response decentralisation and rather consider this as a balanced one given that the field commanders from the federal emergency services, primarily EMERCOM with the minister as a chief officer, administered all response operations.

The concentration of considerable means and forces and their co-ordination by the EMERCOM operation centre facilitated intensive and effective search and rescue activities conducted in extremely complex environment. While during the first day, on 28 May, 150 victims were extricated from the rubble this figure increased by 30% on the next day. Within the following two days it doubled with more than 300 people being found, more than

half of them alive. Given the time lag, from 4 June only dead bodies had been extricated from the ruins, and by 10 June, when rescue operations were stopped, the total number of those extricated from the rubble had soared to 2,364 including 1,958 dead (with 268 of those children) while 406 were alive. Of those rescued alive, 31 died in hospitals, increasing the total number of fatalities to 1,989.

Medical and health care, hospitalisation and evacuation of victims

Urgent medical and health care activities during the first hours of disaster were extremely complicated given the earthquake having damaged medical facilities and killed most of the medical personnel in Neftegorsk. The primary treatment to those who had been lucky to get out from under the debris was provided early in the morning on 28 May by combined medical teams. These came from the hospitals of the cities of Okha in the north and Yuzhno-Sakhalinsk in the south of Sakhalin Island. More than 100 patients received emergency medical care before the medical teams from Khabarovsk and Moscow arrived.

When these teams appeared, the total number of physicians working in the disaster area more than doubled. Two mobile medical posts with six changing medical teams functioned directly on-site in Neftegorsk, while another mobile facility with 40 physicians and 28 nurses operated in Okha City. Consequently, the number of individuals treated increased on the evening of 28 May to more than 120 (107 of whom were seriously injured) and were then evacuated to Okha City. Starting 29 May the high-level professional assistance to the affected people had been provided primarily by the team of well-equipped and experienced physicians from the federal All-Russia Emergency Medical Care Centre 'Zaschita'. They set up the field hospital as close as 20 metres to ruins and conducted 42 urgent amputation operations including 15 to children. In total, medical care was provided to 510 victims including 180 children.

In turn, the regional authorities organised evacuation and hospitalisation of 203 patients in clinics of the neighbouring Okha City. In addition, 181 of those were accommodated in the more distant regional hospitals in the mainland with the most seriously injured moved to a Moscow clinic. The regional authorities also provided help to the homeless with 123 people being relocated to temporary shelters in the cities of Okha and Yuzhno-Sakhalinsk.

The federal and international relief aid and primary recovery from disaster

The federal government served as a key crisis management agent while providing national disaster relief aid to the affected people. Early in the morning on 28 May the Cabinet issued the executive order, which established the special intergovernmental commission for disaster alleviation headed by the EMERCOM minister. This commission co-ordinated the activities of the federal, regional and local executive bodies involved in response to, and primary recovery from, disaster including provision of international relief aid. The latter was of a particular concern of the commission, given that by 13 July about 441 tons of humanitarian aid came from Russian regions and from abroad. These included 118 tons of equipment and materials, 114 tons of medical supplies, 76 tons of food items and 35 tons of clothes provided by more than one hundred foreign countries and international relief organisations.

The same executive order entrusted the Ministry of Finance to allocate to the EMERCOM an additional 30 billion rubles to

support urgent search and rescue and medical care operations. Meanwhile the State Committee for Material and Technical Reserves, the Ministry of Transport and the Railway Ministry were responsible for providing and transportation of rescuers and equipment. Within the federal relief aid framework each affected person should have received one million rubles in a lump sum with the first 93 men and women actually having received this as early as on 1 June.

Co-ordination activities of the federal intergovernmental commission were supplemented by operation measures of the special operation commission that included the chiefs of the ministries and state committees of health, transport, railways and construction and was headed by the first deputy of the prime-minister. This commission left Moscow for Sakhalin soon after the EMERCOM operation team to conduct on-site surveillance and consultations with the regional and local authorities. As a result of this work on 2–3 June the federal government issued five acts.

Given the complete destruction of Neftegorsk these provided for the decision not to rebuild the town while its surviving residents were relocated to the other cities and towns in the Sakhalin region. For that the Sakhalin regional and the Okha City district authorities along with 'Sakhalinmorneftegaz' allocated funds for building 83 apartments, which, however, were insufficient for the 500 affected families. Financial support was also earmarked to relocate another 183 families who wished to move to the mainland. In addition to that, the governmental regulations and orders channelled the flow of financial aid of 107 billion rubles earmarked for the affected area and established some extra compensation for burial expenses, for a lost breadwinner and house and property loss. By 6 June these allowances and compensations, although incomplete in terms of volume, had been issued to 889 victims.

The alleviation measures also covered the affected communities primary recovery in the earthquake's aftermath, rehabilitation works at the oil and gas facilities in the affected area, re-establishing of the closed seismological stations, and more accurate and detailed seismological zoning of Sakhalin Island. In particular, the federal government provided tax and some other privileges totalling 465 billion rubles to 'Sakhalinmorneftegaz' to compensate its expenses on rescue and rehabilitation of the damaged oil and gas mines. These expenditures surpassed 100 billion rubles in 1995 alone and should have reached almost 1,000 billion in the next two years.

The full implementation of these plans was considerably limited by the lack of funds resulting from a deep and lasting economic crisis in Russia in the 1990s. Suffice to note, that two months after the earthquake, half of the victims were still waiting for full compensations while only 10% was received from the earmarked federal relief aid. The situation worsened and became dramatic in 1996 when another earthquake of 6.1 on a Richter scale struck in January in northern Sakhalin and severely destroyed 14 houses, leaving 800 families homeless. In early 1996 the overall demand for recovery funds to cope with the 1995 disaster alone soared to 458 billion rubles.

Lessons for the future disaster reduction policy

The lessons from emergency response to and primary recovery from the Neftegorsk earthquake disaster show that the natural disaster reduction policy in Russia proved to be more efficient than previously.

Adoption of the federal law on Protection of Communities and Regions in Natural and Technological Disasters in 1994 that



Figure 2: The partially damaged school building in Neftegorsk

fostered the integration of all-level emergency services within the Unified State Emergency Prevention and Response System of the Russian Federation should be considered as a key factor of this progress. In particular, the interaction between fire, medical, militia and search and rescue units both from adjacent and more distant regions of Russia, including Moscow, demonstrated their increased mobilisation preparedness and response potential. Despite remoteness of the affected area, serious problems with communication, transportation and special rescue equipment, these teams functioned operatively thus providing for substantial decrease of the possible losses, first of all human lives, with almost 400 of those successfully rescued. This corroborates that the lessons of the earlier major emergencies and disasters both in Russia and in the world were not overlooked.

However, the efficiency of response to and primary recovery from Neftegorsk disaster should not be overestimated. Given the short time of operation of the integrated emergency prevention and response system and its organisation pathologies, and the lasting economic crisis in Russia, one should hardly be surprised by the loopholes in the national disaster policy that decreased such efficiency, especially at local and regional levels. This made



Photo: Associated Press

Rescuers with Russia's 'Emergency Situations Ministry' carry a Colombian girl, injured after an earthquake, to an ambulance in the town of Armenia, 3 February 1999. Russia sent 76 people and nearly 30 tonnes of equipment to help Colombia dig out from the rubble of its recent earthquake. Russia's Emergency Situations Ministry, has sent crack rescue crews all over the globe to help out in times of need

inevitable and crucial the federal authorities intervention, especially that of the EMERCOM central headquarters, although the federal relief aid and compensations to the most affected communities and industries were far from sufficient.

Given the intrinsic interlacing between development and disasters in general, these considerations should become a part of the national development and security strategy for the 21st Century with natural disaster reduction policy as its organic component. It means that the lessons should be drawn and motivation provided to development and implementation of politically realistic and economically viable mitigation strategy to reduce the risk of natural disasters.

This involves more intensive progress of the national emergency prevention and response system by introducing more solid legal basis, flexible organisation frameworks, safer standards and technologies, especially information intensive, and production and emergency personnel retraining and upgrading using international co-operation experience accumulated during the IDNDR. In spite of the hard times currently being experienced the necessary prerequisites and opportunities always exist for those who possess goodwill, industriousness and readiness to act.

Preparing New York City for the hurricane threat

Jerome Hauer, Mayor's Office of Emergency Management, USA



New York City during severe flooding, approximately 50 years ago. Photographs like this are being used by the OEM to emphasise the threat posed by flooding to today's population

COASTAL STORMS POSE interesting challenges to emergency planners in New York City. On the one hand, the region seldom experiences the full impact of a hurricane, yet the City's coastal location and large population make it necessary for officials and at-risk residents to take early and decisive action well before such a storm arrives. In New York, the Mayor's Office of Emergency Management (OEM) has been working on hurricane and coastal storm readiness for nearly three years. The planning effort has encompassed all phases of hurricane preparedness including evacuation and sheltering contingencies, as well as public information and recovery efforts.

The issues confronting coastal storm planners in New York City start with demographics. Unlike many other coastal communities throughout the United States and the world, where residents are relatively affluent, the communities along New York City's coastlines are of a lower socio-economic status due, at least in part, to the erection of public housing earlier this century. As a result, New York's coastlines are densely populated and its residents are more apt to seek public shelter.

Although the city plans to encourage all at-risk residents to seek shelter inland with family or friends, a 1993 study by the US Army Corps of Engineers found that during a category four hurricane — the worst-case scenario for the region because the colder waters off the northeast United States will not support a category five storm — the city should expect more than 200,000 residents to seek public shelter following an evacuation order. Working with the American Red Cross, the New York City Board of Education, the City University of New York and private schools, universities, and institutions, OEM planners have identified enough interior floor space, in shelters throughout the city, to protect those evacuees.

However, city planners were still faced with the issue of distribution. Suppose evacuees crowded into the shelters closest to the evacuation zone and left those further inland empty. That would leave a serious shortage because it will be only through utilising all available resources that the city will be able to confidently protect the more than 200,000 citizens projected to seek public refuge. To address this issue — as well as to ensure that

sufficient parking is available to those evacuating by car—we have developed a system of Reception and Evacuation Centres.

City officials will announce publicly the locations of Reception Centres (little more than evacuee staging areas), which have ample parking and are well served by public transportation. Once people report to those Reception Centres, they will be transported by bus to shelters, which are referred to in the New York City Coastal Storm Contingency Plan as Evacuation Centres. During an evacuation, officials will open centres only on an as-needed basis and will be careful to utilise all shelter resources citywide. We are confident that although this system requires the city to provide transportation for evacuees from the Reception Centre and the Evacuation Centre, it will allow us to maximise sheltering resources and personnel.

To ensure successful evacuation operations we realised that we would have to address regional concerns, pre-position city agencies to support evacuation, utilise all necessary city assets, and have clear and efficient ways to communicate evacuation messages and traffic updates to the public.

Regional transportation issues affect evacuation planning and decision making. The roads throughout the New York City area are old and crowded. Additionally, neighbouring communities will be using many of those same roads for their evacuations. Decisions made by officials in those jurisdictions regarding the timing and extent of evacuations as well as the closure of transportation facilities such as bridges, tunnels and elevated roadways due to the onset of pre-landfall hazards (high winds and flooding), will significantly impact the city's evacuation operations. To address these issues, OEM has been planning with regional emergency managers to ensure co-ordination throughout the evacuation process.

Additionally, we have worked with the New York City Police Department (NYPD)—the agency responsible for traffic management—and the New York City Department of Transportation (DOT)—the agency that controls traffic signals throughout the city—to pre-identify possible trouble spots and ensure that traffic out of at-risk areas moves as efficiently as possible. NYPD will pre-deploy traffic control personnel to critical intersections and DOT will time traffic signals to provide for the best movement out of at-risk areas. We also have begun to inventory agencies that control electronic 'smart signs' that we will be able to use, to provide evacuees with the most updated traffic and sheltering information during an emergency.

Small accidents—so-called 'fender-benders'—which are nothing more than a nuisance during day-to-day life, have the ability to close evacuation routes and endanger thousands of people. New York City will pre-position tow-trucks, which can be deployed quickly to accidents along critical evacuation routes. Also, as the storm nears, the city will consider amending regulations to prohibit commercial traffic into the area, to minimise the possibility of a serious accident tying-up traffic and shutting down an evacuation route.

It also is worth noting that we have examined lane reversals, a popular technique in many communities for expediting evacuations, but have decided in almost all cases against implementing them. Except for one instance—and in that case only for several hundred yards—we have concluded that closing roads into evacuated areas and allowing motorists to drive the 'wrong way' down unused lanes would create more confusion and bottlenecks than would be worthwhile.

Hundreds of thousands of New Yorkers' use public transportation to commute to work daily. During an evacuation, these transportation assets will be critical to ensuring that all citizens

are able to leave at-risk areas and seek shelter elsewhere. We have worked closely with the Metropolitan Transportation Authority (MTA)—the agency that controls our subways and public buses—as well as DOT—the agency that oversees the myriad private bus companies that service the region—to ensure that dedicated public transportation resources will be serving our Reception and Evacuation Centres.

However, prior to a hurricane or severe coastal storm, New York residents will need to use public transportation for their own reasons, unrelated to the evacuation, therefore regular bus and subway service cannot be curtailed too sharply. Recognising this, we have developed a timing matrix with MTA and the private bus companies that calls for increased deployment of transportation resources in support of the evacuation effort as the storm approaches.

During our coastal storm planning efforts, we realised that nursing homes, hospitals and homebound individuals pose a significant challenge to evacuation planners. Because these institutions and individuals usually need the most warning before they can evacuate, we must alert them early on that a storm is approaching and what protective actions, if any, they should take. Although we have direct fax links to all the hospitals throughout the City, we needed a way to reach nursing homes and the homebound quickly and efficiently.

To address this issue, we developed and tested a telephone matrix that allows us to reach all New York City adult-care facilities, nursing homes and home-care providers with a single call. With the system, which starts with a single call to the New York State Department of Health—the organisation that regulates those entities—we are able to contact more than 500 institutions in less than three hours.

Another issue facing coastal storm planners in New York City is the apathy of some of the most at-risk citizens. Residents who lived through Hurricanes Gloria (1985) and Bob (1991) believe they have experienced the full fury of a hurricane. The reality is, however, that neither storm's path traversed directly over the city. In 1985, Gloria arrived at low tide, a factor that significantly reduced its impact on coastal communities whereas Bob lost intensity and drifted east prior to landfall. The last major storm that seriously battered the region was the New England Hurricane of 1938 (category three) and even that storm's path was not the worst-case for city residents.

To emphasise the threat that coastal storms and flooding pose to city residents, OEM has launched a public information campaign that has used old photos of damage caused by coastal storms. The ads ran in buses and subways throughout the city and directed citizens to their local library or to OEM's World Wide Web site for more information.

We also are aware that New Yorkers may be hesitant to evacuate if they are not convinced that their belongings are safe. To increase public confidence and encourage compliance with evacuation orders, we will deploy a visible police presence to evacuated areas.

Finally, following a serious hurricane, the City will have to seamlessly integrate state and federal assets as they arrive. We have begun to work with our Federal and State partners so that aid and recovery operations following a storm will commence as quickly as possible. We continue to meet with officials from the New York State Emergency Management Office (SEMO) and the Federal Emergency Management Agency (FEMA) to discuss how aid and resources might be delivered following a storm and methods for best integrating those resources into the recovery process to help the city return to normality quickly.

CASE STUDY

Planning for emergency power

John Swanson, Caterpillar Incorporated, USA

ELECTRICITY IS NEVER more precious or more scarce than after a disaster. Lights are out, telephones disabled, businesses shut down. People may need food, water, heat and medical attention. There can be no real recovery without power, yet no one can predict when utility service will come back.

Today, back-up power plays a critical role in recovery from all manner of disasters. Permanent back-up systems can sustain facilities that safeguard public health, safety and welfare, even through extended utility outages. On a wider scale, mobile generators of all sizes can help life return to normal by powering schools, stores, offices, factories and homes, while rebuilding goes forward and the utility restores the grid.

Especially in the early stages, the speed of recovery depends on how well local authorities and private enterprises have planned for emergency power. Provision for electricity should consist of much more than a few sentences in any disaster management plan. Procedures should also be spelled out as meticulously, and as completely, as possible.

Global supplies of mobile generator sets have roughly quadrupled in the past ten years. Therefore, those who plan effectively can readily secure almost any amount of necessary short-term emergency power from units suitable for small offices or homes, to two-megawatt power modules able to supply large buildings.

Planning cannot prepare for every contingency, but it can ensure that emergency personnel know in advance what essential facilities and services will need power, how much power, and how to ensure its availability.

EXPECTING THE UNPREDICTABLE

Emergency response experts advise against trying to plan for a specific event, such as a wind storm, fire or flood. Instead, they recommend looking at the common results of any disaster. Significant among these is loss of electric power.

Extended power failures have many causes, some natural and others manmade, some predictable and others difficult even to imagine. For example, few could have foreseen the April 1992 flood that shut down utility power for weeks in the heart of Chicago, USA. The flood began when construction workers installing support pillars in the bottom of the Chicago River punctured the roof of a freight

tunnel beneath the city. Water soon flooded the entire system of tunnels and made its way into the basements of buildings that housed electrical systems.

Similarly, few could have predicted the extended power outages in central Auckland, New Zealand, that began in February 1998. There, four main power cables serving the city failed because of overload. The outages affected some 50,000 inner-city workers and 6,000 residents and also threatened butter, meat and other perishables in thousands of refrigerated containers awaiting shipment from the city's port at the peak of the export season.

In September 1998, weather forecasters predicted the assault of Hurricane George on Caribbean islands, but not the extent of the destruction. Puerto Rico and other islands lost all electric power.

Mobile diesel-powered generator sets were essential to recovery from all these events. In each case, demand for generators overwhelmed local supplies, and units were shipped in from considerable distances. New Zealand and the Caribbean islands received units on shipboard and by airlift. In any similar situation, the logistics of supplying power is difficult, but an effective plan makes the process easier and recovery faster.

PERMANENT BACK-UP

The first imperative in emergency power-planning is to outfit essential facilities with permanent back-up power, and to make sure existing back-up equipment is in good condition. Essential post-disaster services include:

- Medical care
- Drinking water supply
- Police and fire protection
- Refrigeration
- Communications
- Pollution control (especially wastewater treatment)
- Transportation (especially airports and seaports)
- Weather forecasting
- Temporary relief shelter
- Emergency response command and control.

At the very least, back-up systems should be sized to carry critical loads defined as the power required to deliver all the facility's necessary public services. Some facilities, such as waste-water treatment plants and hospitals, are so impor-



Photo: Courtesy of Caterpillar Incorporated

Remote via chopper: Plans for emergency power may include transporting power to remote locations. Within a contingency plan, the capability for mobilising power systems for back-up support to a remote hospital or emergency facility, should be included and detailed

tant that back-up systems sized for full load deserve serious consideration.

All back-up systems should be covered by a complete and consistent planned maintenance programme that includes regular inspection and operational testing.

MOBILE POWER

Because a major storm or flood can do severe damage, it is wise to plan for scenarios in which even back-up power systems fail. This was the case during the 1992 flood in Chicago, where many back-up systems were installed in basements and sub-basements that filled with water.

Mobile power equipment should be sized in the same manner as permanent back-up power. Other considerations for each facility include:

Location: Space must be available for parking the generators outside buildings. If a facility has a large power requirement but lacks space to install a large power module (up to eight feet wide by 40-feet long), two or more smaller units will perform just as effectively.

Accessory requirements: Cable must be provided to connect the generators to the building's electrical system. Transformers, load banks, bus bars, distribution panels, feeder panels, fuses, outlets, load centres and other accessories may also be necessary.

Fuel requirements: During an emergency, diesel fuel supplies and delivery may be sporadic. A fuel tank with capacity for at least 24 hours of run-time is advisable.

Staffing requirements: If on-staff personnel are not experienced with power-generation equipment, it is necessary to arrange for professional assistance to install and operate the mobile units.

SOURCING EQUIPMENT

Once power equipment and staffing needs have been determined, the next step is to identify and interview suppliers. Often, the same supplier will offer permanent back-up systems for sale or lease, as well as mobile power units for rent. Supplier selection criteria should include:

Inventory: The supplier should have all necessary equipment in stock—generator sets and accessories—or be willing to commit to getting it on demand. Suppliers who do not have the equipment in-country must have the capability to import it in an emergency.

Service and support: The supplier should be willing to deliver the power generating sets and, in some cases, additional equipment like power cable, transformers, etc. In addition, suppliers should train local personnel in the equipment operation or, if necessary, provide staff for operation, service and maintenance.

Location: At minimum, the supplier should be strategically located to serve major population centres. The ideal supplier will have multiple locations from which to deliver equipment and dispatch support staff.

Experience: Longevity in business can be a good indicator of a supplier's reliability. Suppliers should be willing

Photo: Courtesy of Caterpillar Incorporated



Connections: Within a temporary or permanent installation, a service person or contractor will make bus bar electrical connections from a genset to a building—all part of the considerations for planning purposes

to discuss their track record for delivering and installing equipment under tight deadlines, as well as their experience in emergencies. Reputable suppliers will always provide references.

Terms: When renting power units for emergencies, it is not always possible to secure an absolute guarantee for the availability of equipment. However, some suppliers offer contracts that provide a ‘right of first acceptance’. In this arrangement, a party pays the supplier a retainer fee for an allocation of specified equipment. In return, the supplier agrees to not release that equipment to another entity without the first party’s consent.

PLANNING IN CONTEXT

Arranging for equipment is only the first step in emergency power planing. The true test of a plan is how well it functions in practice. A power outage alone can create major logistical challenges as public agencies and businesses rush to provide temporary power. For example, an outage affecting a large city, such as Auckland or Chicago, can require the shipment of hundreds or even thousands of mobile generators within days.

The challenges multiply after a natural disaster, as delivery of power must co-ordinate with distribution of many necessities such as medical supplies, food, clothing, household goods and building materials.

An effective plan assigns priorities to all major goods and services and their delivery. In a world that increasingly

depends on electricity, a strong argument can be made for giving top priority to mobile power. The sooner power is installed, the more efficiently all other materials and services can be delivered. Emergency planners must ensure that power for all purposes—public and private—arrives where it is needed as quickly as possible.

Puerto Rico’s experience after Hurricane George is instructive. Soon after the storm, relief efforts were stalled by trees and power lines blocking roads and preventing the movement of people and supplies. In addition, the storm blew down one of four large cranes in the port at San Juan, creating a bottleneck in off-loading emergency generators arriving on shipboard.

These experiences suggest that plans should carefully address the mechanics of power delivery, especially when equipment must come from outside the country. For example, provision should be made for staging areas for generators at airports and seaports. On-the-spot decisions may need to be made about whether to ship units from overseas on container ships (lower cost), or roll-on roll-off ships (they can be unloaded even if port lifting equipment has been damaged).

Not all barriers are physical. Slowdowns in customs can significantly delay delivery of power. Planners should consider proposing special legislation to allow generators to be imported in emergencies. Provisions allowing temporary, duty-free imports of equipment can greatly expedite delivery. Contacts established with freight companies during the planning phase may increase availability of ships or air transport when a disaster occurs.

Finances are another stumbling block to be avoided. As part of planning, emergency management agencies should agree on payment terms with mobile power suppliers. This may include issuing a letter of credit from a financial institution or budgeting the necessary funds.

FINE-TUNING THE PLAN

An emergency plan is a living document—it should be revisited and updated periodically. The plan should also be tested through simulation drills. In one common drill, participants are presented with a specific scenario and asked to respond to it according to the procedures outlined in the plan.

It can be useful to involve the local electric utility in drills. During an actual emergency, co-ordination between utility staff and emergency personnel can improve the utilisation of mobile equipment. For example, if emergency personnel know when utility power is about to be restored in a given sector, they can plan to release mobile power units to other areas where they are needed.

Disasters are by definition unpredictable—even the best plan will not eliminate the need for good judgement and resourcefulness. However, a plan immediately moves disaster recovery several steps forward. It makes critical actions nearly automatic and provides a basis for sound decision making as the event unfolds.

IX

DISASTER PREVENTION AND SUSTAINABLE DEVELOPMENT



KEYNOTE PAPER

RE-ORIENTING DISASTER MANAGEMENT TRAINING

Astrid von Kotze, University of Natal, South Africa

CONFRONTED BY yet another occurrence of flooding in the aftermath of yet another drought, the farmer does not ask herself ‘what is the theory pertaining to recurrent hazard threats’, but ‘how do I escape yet again, and what can I do to ensure that I will not find myself in this situation again?’ Similarly, people working in disaster management might learn from locals as they mobilise practical knowledge and experience, in order to deal with their life-threatening position.

For example, while it is useful to know about weather patterns like El Niño, it is equally crucial to understand that in order to rescue the most important assets that provide the means of livelihood security, women may put their lives further at risk. Many such crisis situations could have been avoided if long term development measures and risk-preventive action had been undertaken. A recent communication by the IDNDR recognises this link between natural disasters and sustainable development. It asserts that ‘the greatest potential for loss reduction is typically during the mitigation phase’ (IDNDR, 1998).

This keynote paper makes some suggestions how and why traditional disaster management training has to undergo a radical shift in content, process and format if it is to undergo a re-orientation from predominantly emergency preparedness and response, to mitigation and prevention. The paper outlines briefly some of the characteristics of ‘mainstream’ disaster management curricula, and contrasts them with an approach that favours risk reduction. This involves a new understanding of risk—firstly, risk as perceived from the perspectives of those most at-risk from accumulated threats, and secondly, risk as linked closely to vulnerability assessment within the context of livelihood analysis.

Finally, this paper makes two pleas—one for a participatory multi-sectoral approach to disaster mitigation as part and parcel

of any training for sustainable development, and the other that risk reduction/disaster mitigation should be seen as the responsibility of each and every citizen. For this to happen, researchers, policy-makers, trainers and the public need to realise that the reliance on impersonal ‘objective’ and seemingly neutral information about natural hazards and disasters is a characteristic of the scientific technological culture of the west and not necessarily in the interests of those developing countries commonly termed ‘the South’. Hence, a real commitment to improving conditions in the South is contingent upon a better understanding of how economic, political and environmental decisions made by the wealthier nations may impact negatively on increasingly vulnerable conditions in the South.

Disaster management training for hazard control

Generic disaster management assumes that disasters disrupt an otherwise functioning social, economic and political reality, and the purpose of disaster management is to restore that reality after the impact of a disruptive destructive force such as an earthquake, a flood, an atomic leakage and the like. Accordingly, training of personnel working predominantly in emergency aid and relief organisations is characterised by three things—firstly, disaster management is defined as a separate, discrete field of knowledge



Photo: Red Cross

Medical assistance from the Red Cross in Ethiopia after flooding in 1997

and training is offered in specialist courses. Secondly, although the training process is 'interactive', it relies very heavily on presentation-style, information-giving processes, in which scientific experts attempt to transmit a maximum of data in an attempt to make-up for what is perceived to be a deficit in knowledge. Thirdly, the emphasis of courses is usually on emergency preparedness and response, with mitigation defined predominantly in terms of (expensive) technical interventions to contain and manage the hazard.

These three characteristics are more generally consistent with 'the mainstream'. With some variation, decisions are made and policy is defined by western, well-educated, often white, men, who have a deep belief in scientific rational knowledge systems rather than local, situated ways of knowing and understanding.

Adopting a risk reduction focus

Training with a risk reduction focus moves away from a generic hazard-oriented emphasis, towards a greater understanding of different local perceptions of risk, and towards risk reduction actions that are developed within the contexts and available resources of specific locations. Such a learning orientation is different in a number of fundamental ways:

Firstly, a risk reduction approach to training operates from the basic belief that reality, as it is, is in need of change, and interventions should therefore not simply aim at restoring what was. Disasters are seen not so much as disruptions of an otherwise functioning world, but as the result of fundamentally unsustainable social, economic, political and environmental conditions and practices. Histories of unequal distribution of access and assets have caused the vulnerability of the majority of people, particularly in the South. Widespread poverty and environmental degradation are often the result of exploitative decisions made by wealthier nations and minorities within a country. Therefore, risk reduction involves attempts towards creating a more equitable society.

Risk is commonly defined as the probabilities of physical harm due to given technological or natural hazard processes. But the world is marked by what Giddens calls 'manufactured risk': 'risk created by the very progression of human development, especially by the progression of science and technology' (Giddens, 1997). The emphasis on a natural hazard phenomenon shifts the gaze away from people who are at-risk, and those who are to blame. Instead of accepting responsibility for creating conditions in which the impact of a hazard can lead to disastrous consequences, disaster managers call upon scientists to find a solution to tame the hazard.

Secondly, a risk reduction approach is concerned with weighing up different perceptions of risk, focusing particularly on women's perspectives. Within a given social system, different experiences, cultural values and beliefs give rise to different perceptions of risk. This was recognised in a recent information package issued by the IDNDR: 'there is a need to identify and understand people's perception of risk, develop better channels of communication and popular consultations, and rely on local resources and traditional support systems' (IDNDR, 1998). Local perceptions of risk are often embedded in language. For example, in southern African languages there is no word for abstract concepts such as 'risk', 'hazard' and 'disaster'. Instead, there are metaphors and specific descriptors of life- and livelihood-threatening factors within specific historical, geographic, social and cultural conditions. Importantly, each hazard is but one danger in a field of many other threats and uncertainties such as 'the risk of chronic food insecurity and hunger, the threat of armed robbery, the prospect of sexual assault, the risk of becoming another traffic fatality, the ever-present threats of HIV and TB' (Holloway, IDNDR Conference 1998). Risks are not perceived as discrete problems, but in relation to each other and other factors.

In this link of perceptions to everyday lives and livelihood strategies, physical, emotional and other risks are understood to be created and effected in social systems (Beck, 1997). Thus, risk

assessment processes must consider the social systems within which these might have arisen and/or are experienced. In a risk reduction approach, the primary emphasis is thus moved from hazard to vulnerability. This recognises that a given hazard does not have an evenly destructive impact. What creates the crisis is the inability of a given element at risk to resist the impact of the hazard. For example, employed urban citizens are less at risk from the impact of a drought than unemployed and/or elderly tenants on a severely eroded piece of land. In the South, risk assessment involves calculating the potential impact of yet another threat on already vulnerable conditions within the whole picture of the environment, social networks and systems, and economic relationships. Vulnerabilities are then weighed up against factors of resilience, ie. the strength and capacity to resist the impact, both in the short, medium and long terms.

In order to assess vulnerability it is crucial to make visible the various livelihood activities of different members of households and communities, both during 'normal' times and times of stress. Such an assessment shows how each threat to livelihood security must be seen in the context of the various productive and reproductive tasks undertaken. Furthermore, stress factors imposed by various hazards need to be considered in terms of the various resources and capacities which an individual, household or community can mobilise in order to cope with the stress.

Thirdly, a risk reduction approach to mitigation is based on and committed to the principles of participation. Its primary focus is on people as active agents in the production of knowledge and life. Because people in at-risk communities have struggled with the threats to their lives and livelihoods, and wrestled with how to juggle their multiple responsibilities against their inability to resist another shock, they have an intimate knowledge of their social reality. Better than anyone they understand the dynamics of locally experienced, inter-related tensions and forces. But also better than anyone they know about immediately available means of escaping or dealing with the emergencies, at least in the short-term. This is the case particularly with regard to women who are outsiders to the dominant institutions in society, but intimately connected to daily struggles. Taking the everyday experiences and the standpoint that best reflects women's interests is an important part of assessing risk. Mitigatory interventions should then be actions that best support the efforts of women to secure their livelihoods without putting additional pressure on them when dealing with further risk-factors.

Development workers and policy makers alike need to learn about local knowledge systems, and since much of this information is not written down, nor readily available, they have to learn approaches and methods to facilitate the (re-) production of such knowledge. This demands that trainers are less hazard experts than experienced facilitators in participatory processes, and educators with a strong moral and ethical standpoint. They need to have excellent communication skills rooted in a deep appreciation for local cultures and values, and be able to conduct livelihood analyses with participating households and communities. They would also encourage broad lateral thinking skills that allow all participants to generate ideas that can lead to risk reduction strategies with a sense of alternative outcomes to the previous status quo. Rather than planning how to manage emergencies, such facilitators would work towards planning sustainable development processes that are mindful of regionally specific impending hazards, such as recurrent droughts, flooding or landslides.

However, development workers, educators and field personnel also need to know when and how to give information that goes



Photo: Red Cross

Relief workers — Madagascar, 1997

beyond what local people know. Local situated knowledge is no longer enough to explain the new risks and afflictions, and scientific data and technological information are necessary in order to support local initiatives. For example, explaining how the price of a product from a village is affected by local, national, and global market forces and illuminating how global environmental policies affect local weather patterns, is important information to give.

Lastly, mitigation as fundamental transformation is a long-term effort, embedded in multi-sectoral development initiatives, rather than a short-term solution necessitating expensive foreign aid usually provided by single-sector agencies. Development processes can only become sustainable if everyone is seen to benefit equally from them. The development focus of risk reduction necessitates shifting not only the content and process, but also the format of education and training. Any kind of education and training programme attended by development workers, community educators and policy makers, in every imaginable sector, should contain a component of risk analysis and mitigation.

It is conceivable that a focus on risk and risk reduction forms part of a diploma in agriculture, as much as an advanced diploma in health, a bachelor in public administration, as much as a masters in environmental studies.

In this way we might move a step closer to acknowledging that disaster reduction is a responsibility of every citizen, irrespective of where she/he lives and works.

ENVIRONMENTAL MANAGEMENT & DISASTER PREVENTION

Holistic risk assessment and management

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THIS ENVIRONMENT CAN be understood as a system of complex relationships highly sensitive to variations of any of its components—the soil, the water, and the air allow not only the possibility and space for life, but are also directly or indirectly agents of hazards and damages. The trend to consider human beings as potentially harmful, external agents to the environment has led to an incomplete understanding of environmental impact. Such an approach rejects that natural and manmade events can intensely impact not only human beings but also renewable and non-renewable resources.

In the international arena, it is widely accepted that during the upcoming decades and due to the inertia in the biogeochemical and the socio-economic systems, some environmental trends will not change, unless unexpected events with the necessary intensity to modify them occur. In general terms, such trends include an increase in global warming as a result of the greenhouse effect; endemic water pollution; a relative increase in agricultural production and in energy consumption as a consequence of population growth (although the per capita increase is smaller); greater environmental degradation in developing countries; and an increase in the occurrence of disasters of both natural and manmade origin (Biswas *et al*, 1987).

Crisis scenarios

The environment can be understood as a system whose elements are in permanent interaction, or as a network of active relationships among such elements, which determines the conditions of their existence and the totality of the system. A crisis emerges when changes, transformations, or alterations that cannot be absorbed by the system—because of the lack of flexibility or adaptation capabilities—occur within the dynamics or process of interaction (Wilches-Chaux, 1989). This crisis, which might result from a chain-reaction of influences, is known as a disaster, a designation that depends on the social value that the community assigns to it. In all cases, it refers to a negative environmental impact.

Except in the case of short-term approximations, the evolution of complex social and biogeochemical systems cannot be adequately depicted by linear functions, nor by soft and continuous curves. Usually, the real evolution of these systems contains positive feedback and shows non-linear and even discontinuous behaviour, making difficult its prediction, although in retrospect it can be easily explained (Merkhofer, 1987). The concepts of vulnerability, or the predisposition to being affected, and resiliency, or the capability to recover, play a fundamental role due to their significant relationship with the possible occurrence of discontinuities. When altered by a sufficiently strong disturbance, a system may change from an almost constant state to another. Such a change depends not only on the magnitude of the event, but also on the presence of system instabilities that are difficult to perceive.

Crisis scenarios are the manifestation of existing conditions of risk, which consequently depend not only on the action of an external disturbing or trigger agent such as an accumulative degrading event or process, but also on the conditions of vulnerability. The conditions of vulnerability are agents that facilitate the development of a crisis scenario once the trigger event occurs, or when the critical point of degradation processes is surpassed. The social and environmental conditions that characterise the vulnerability or frailty of a human settlement for example, usually result from the models of development adopted and the debt that has been generated with nature, which obey to a process of incubation. In other words, crisis scenarios and even disasters are non-resolved problems of development that must be analysed from the perspective of political economics, and not only from a technocratic viewpoint. Vulnerability in its diverse manifestations is nothing but a deficit of development. It represents a negative green account towards which preventative management efforts with a planning perspective must be guided, as to reduce or avoid negative social, economic, and environmental consequences. Cardona (1995) argues that, methodologically, the potential presence of a crisis scenario during the development process can be expressed as: $Cp = Ta \times Ic$, where 'Cp' (Crisis potential) represents the possibility of the occurrence of a crisis, 'Ta' represents the probability of occurrence of an external trigger agent, which might be a disturbing event or the surpassing of a critical threshold in the process of continuous degradation, and 'Ic' represents the instability conditions or vulnerability of the system exposed to the trigger agent.

The conditions of instability or vulnerability are weaknesses or deficiencies that may be, among others, of ecological, demographic, social, economic, institutional, political, cultural, and/or ideological character. These characteristics are related to the fragility or susceptibility of the elements and activities or relationships that contribute to the generation of a crisis when an event or process that is difficult to absorb, occurs.

Environmental degradation and risks

Even when it has been common to recognise from the urban perspective, that the process of environmental degradation may become a trigger of supposedly natural events that affect the habitat of human settlements, disaster prevention and mitigation have not been explicitly associated with environmental degradation. Environmental experts have paid little attention to the topic of disasters, perhaps because of the bias towards the emergency response that over time has characterised the discussion of disasters. Some researchers limit their definition of the habitat to artificial aspects of the environment, and in their conceptualisation of the ecosystems do not integrate the human settlements, which could be understood in a holistic way as socio-ecosystems,

allowing a synthesis and a more integral vision of the urban and environmental question. Unfortunately, a similar position is taken by experts in risk reduction and disaster prevention, who facilitate an incomplete and reductionist perspective on the question of risks and the urban habitat by failing to incorporate in their models and conceptual frameworks those aspects related to environmental management and protection.

In other words, it could be argued that besides technological risks, many of the so-called natural disasters have a manmade origin, whether because environmental degradation may stimulate or induce natural hazards or because the increase of the vulnerability of human settlements notoriously influences the occurrence of disasters. These are usually incorrectly characterised as natural disasters.

In South America, for example, the Andean region is highly exposed to the processes of soil instability or landslides. Because of its orographic complexity it also presents a high number of rivers of torrential behaviour that continuously present flash floods and avalanches, resulting from the damming in the upper basins. In most cases, this type of event results from the environmental unbalance that leads to the degradation of nature and also affects human settlements. Hydrographic basins deteriorate, and consequently the hydrologic cycle is interrupted, water is exhausted, the soil dries up, and crops lose their irrigation source. Both deforestation and fires have been destroying the vegetation that protects soils and stabilises the climate, causing erosion and instability in the mountainsides; agricultural soils are vertiginously drained by the unstoppable passing of water runoff, generating the sedimentation of valleys, watercourses, dams, and cities where the sewerage systems have surpassed their capacities.

To destroy the vegetation is to strip the fauna from its niches and habitats; the disappearance of mangroves from the coastal areas facilitates flooding and diminishes fishing; the annihilation of the paramoem, the high treeless plateau — reduces the sources of water. Lakes, marshes, and downstream watercourses are being dried up and embanked to prepare land for inhabitation and agriculture. Mining has sterilised the land and contributed to the sedimentation of watercourses and the destabilisation of mountainsides. In the inter-Andean region, these processes cause intense hydrogeodynamic events, such as landslides, floods, and avalanches that destroy housing units and infrastructure works and result in loss of life. Industrial and agricultural activities carried out in poorly chosen sites pollute cities, valleys, water, vegetation, and the atmosphere, and can potentially become serious technological hazards for neighbouring human settlements. Urban sprawl has been polluting the best agricultural pasture, and forest soils, while generating subnormal human settlements in degraded areas, as a result of social maladjustment in the land tenure structures (Blanco-Alarcon *et al*, 1989).

Hazards, risks and disasters

The term hazard is frequently used to describe the latent danger that characterises a wide variety of phenomena, which range from those whose occurrence is considered to be exclusively of natural origin, such as earthquakes, hurricanes and volcanic eruptions, to those whose origin is considered to be exclusively human, such as wars and technological accidents. In between both extremes lies a wide spectrum of phenomena such as famine, floods, and landslides that result from a combination of natural and human factors.

When considering urban and social factors as components of the ecosystem in every case a crises, more that generating a disaster, is in itself a disaster. Therefore risk evaluation or the estimate



Slums without sanitation, in a tsunami prone area in the Pacific Ocean coastal area of Tumaco, Colombia

of the possible occurrence of future crisis or disasters whether of natural, social or socio-natural origin, must be an integral part of development planning. Disasters are situations or social processes that unchain as the result of two concomitants and mutually influenced factors. On the one hand a hazard, characterised by the imminent or actual manifestation of a trigger agent, and on the other, the vulnerability of the elements exposed to that trigger agent, that is, those conditions that favour or facilitate the severe effects that, once materialised, the hazard will have over the urban, environmental, and social context.

Vulnerability: Deficit of development

The vulnerability of ecosystems, or of human settlements, or of the urban environment represented by centres of population concentration, is intimately linked to the social processes developed in the cities and is usually related to the frailty, susceptibility, or lack of resiliency of those elements exposed to different types of hazards. The convolution of these two circumstances determines the degree on the conditions of risk of the elements exposed, which are consequently intimately linked not only to the degradation of the urban environment, but also to that of the natural environment that has been intervened or is in the process of being transformed. Therefore, environmental degradation, impoverishment, and crisis situations are nothing but environmental events, and their manifestation is the result of the social construction of risks, that is, the incubation of vulnerability and/or hazards.

Little has been done to create an adequate theoretical framework that relates environmental degradation to the generation of risks and crises, perhaps because such a relationship is widely accepted or is simply considered being as self-evident. The current parameters for the transformation of society and the environment indicate that it is harder each time to separate the so-called natural hazards from other human and environmental trigger agents. Consequently, it is widely accepted that environmental degradation generates risks, as it represents a reduction in the (natural, physical, and social) productivity of nature and society. To review the origin of crises or disasters and to admit that they represent the materialisation of the conditions of risk that arise from the action of



Very often, flash floods are a consequence of hydrographic basins degradation

hazards and the exposure of vulnerable elements may facilitate finding the relationship among these macro concepts. For example, to admit that, in many instances, hazards may be classified other than strictly natural, that is, as socio-natural, manmade-pollutant, or manmade-technological, allows room to reason that hazards arise from the interactive processes between human beings and nature. It also leads us to think that environmental degradation generates conditions of risk, as it contributes to an increase of the vulnerability of human settlements or ecosystems and of hazards themselves (Lavell, 1996).

Integrated risk assessment: New approaches

Risk is a curious and complex concept. In a sense it is unreal in that it is always concerned with future, with possibilities, with what has not yet happened. If there is certainty, there is no risk. There is a fairy-tale sense to it — the ungraspability of something that can never exist in the present but only in the future. Thus risk is a thing in the mind, intimately linked to personal or collective psychology even though as engineers we often try to give it the trappings of objectivity. Another reason for its strangeness is that risk is a composite idea. It brings together three separate aspects — likelihood (or chance), consequences and context. All three contribute to any assessment or qualification of risk (Elms, 1992). The context of a risk analysis (quality of management and the actors concerned) gives bounds, reasons, purpose and interactions. Whatever is being done must be congruent with the context and take account of it in all its relevant detail. Otherwise the whole analysis is likely to prove irrelevant and useless.

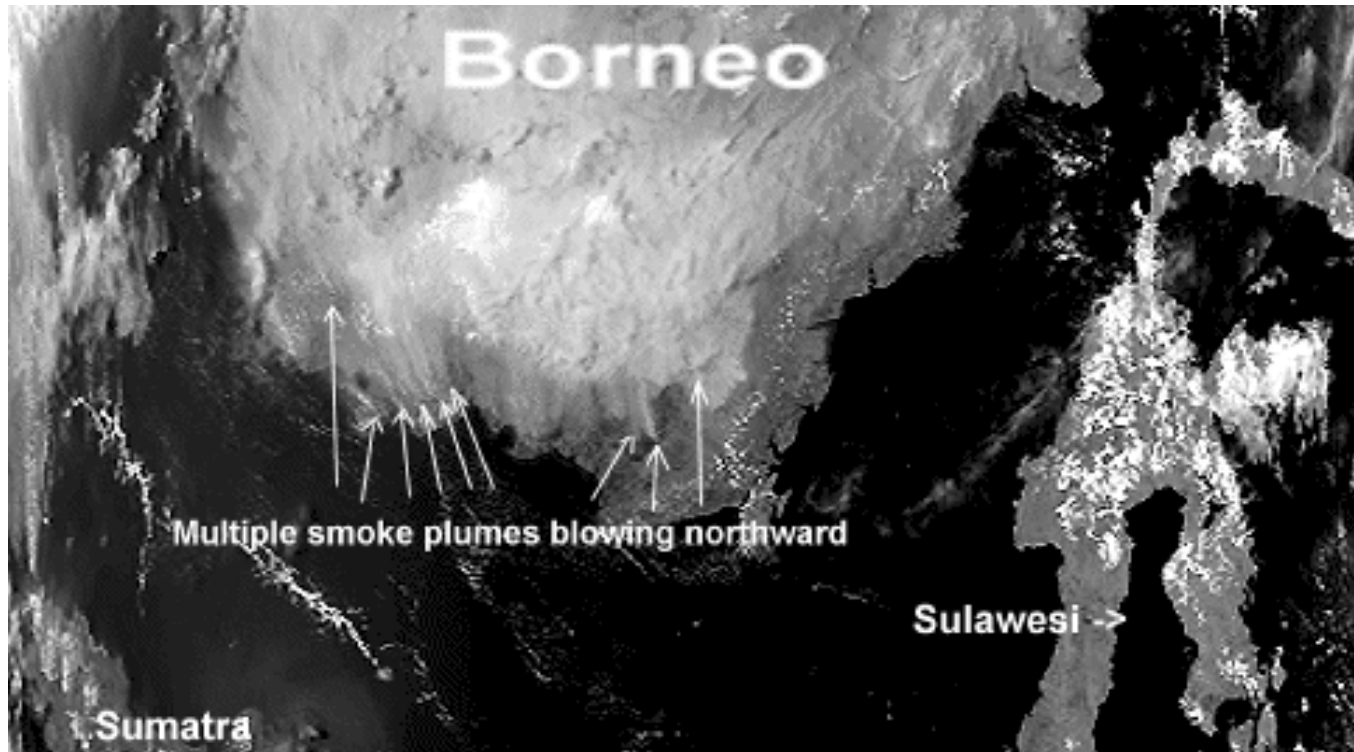
In an informal sense, risk analysis has been used throughout the history of mankind. Risk is always associated with decision. Something has to be done; an action has to be taken. It might be

trivial or of great importance. In either case a choice has to be made as to what to do. The outcome is in the future, and is uncertain. In the last years, risk has been understood as potential economic, social, and environmental consequences. Therefore, to estimate risk according to this definition it is necessary to take into account, in a multi-disciplinary way, not only expected physical damage, casualties, or equivalent economical losses, but also social, organisational, and institutional issues among other development aspects. In urban scale, for instance, vulnerability, as internal risk factor, is related not only to material context exposure or physical susceptibility to be affected, but also to social frailties and the lack of resiliency of a prone community. Lack of institutional and community organisation, weakness in the emergency response preparedness, political instability, and the lack of economical health of a city might contribute to higher risk. The potential consequences are related to the event impact, the capacity of the city to sustain that impact, and the implications of the impact to the city, the country or the region.

Disaster risk indexes based on several geological, structural, economic, social, political, cultural or any other characteristics of a city, for instance, may be very useful to guide risk mitigation decisions. Recently, a model based on linear analysis of multi-disciplinary factors has been used to estimate and rank a relative earthquake risk composite index for some cities (Davidson, 1997). Also, other indexes based on fuzzy sets and neural networks have been used to analyse the risk of cities or part of a city in a holistic way, considering loss estimation models or earthquake damage scenarios as starting point. This type of approach may take into account more consistently the non-linearity of parameter relations of context and the complexity of the social dynamic system (Cardona, 1999).

Climate Forecasting Applications

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THE DYNAMIC INTERPLAY of atmosphere and ocean in the boundless dimensions of time and space causes variability of different magnitudes in climate patterns around the globe. The extreme events in this continuous variability greatly impact the society and the environment. The devastating impacts of El Niño 1982–83 and 1997–98 are well documented. For several decades the prevalent view was that it is not possible to predict weather and its variations beyond the intrinsic limit of two to three weeks. However, unprecedented developments in climate science over the last two decades have now made it possible to predict climate variability with a significant lead-time, in some cases up to one year. Although it is unlikely that any two weather maps will ever be exactly alike, the climate does exhibit a pattern of broader repetitiveness (Rasmussen, 1984).

El Niño Southern Oscillation (ENSO) associated climate variables that are larger in amplitude and global in scale exhibit one such pattern. Taking advantage of this feature, significant achievements have been made in probabilistic forecasting of seasonal and inter-annual variations in climatic conditions associated with ENSO. Acquisition of this capability in recent years has potential value to decision making for the benefit of affected regions. As the tropical atmosphere responds directly to changes in oceanic variations, seasonal mean climate is highly predictable in tropical regions in general and South East Asia in particular. This article focuses on some of the issues connected with ENSO forecasting and its applications in the South East Asia region.

El Niño and La Niña impacts in South East Asia

The extreme climate events such as El Niño and La Niña affect the society and the environment in southeast Asian countries in a significant way. During an El Niño year, rainfall in most parts of the region tends to be below average leading to droughts, and tropical cyclone occurrences and associated flood incidences tend to be less. The most dramatic and disastrous effects of El Niño 1982–83 and 1997–98 in Indonesia were manifested in the large-scale forest fires. On the other hand, during a La Niña year, the rainfall is above average with increased frequency of tropical cyclones and more incidence of floods. A La Niña year, however, also provides opportunities in the agriculture sector for advancing the planting season, leading to an early increased harvest as well as possibilities for harvesting one additional crop.

Potential application of improved climate forecasts

The existing early warning system in most countries is based on monitoring rainfall, water levels in reservoirs and the vegetation index which can give a one-month lead time before harvest, to enable government institutions to implement contingency plans for food security in case of an impending drought. In case of floods, the lead time available is a couple of days to enable agencies to plan for emergency operations.

The advancements in climate science have now made it possible to indicate expected behaviour of weather parameters such as rainfall, temperature and tropical cyclone occurrence in

probabilistic terms with a considerable lead time. The climate forecasts can enable individual stakeholders and critical resource sector institutions to make appropriate adjustments to minimise negative consequences and capitalise on potential benefits of extreme climate events. These adjustments may include restructuring the cropping pattern, reorienting or modifying water resource management and undertaking other appropriate disaster preparedness and mitigation activities.

Experiences of using probabilistic forecasts

The experiences of managing the consequences of the 1997–98 El Niño and 1998–99 La Niña events has underlined the fact that the maximum benefits of the applications of forecast products can not be realised without a thorough understanding of the human, social and economic systems within which climate forecasts will be applied. Clearly, there is a critical gap between the climate forecasts and their application for decision making. There is a need for developing methods for impact pre-assessment (or consequence analysis) based on empirical analysis of past disaster events which would indicate the existing vulnerabilities on a geographical scale at which the counter-measures would be most effective. Physical climate variability and application of forecast products need to be integrated as a comprehensive climate forecasting and application system to take full advantage of the lead-time for adopting effective disaster and resource management practices.

The direct application of global ENSO forecasts by decision makers without adequate understanding of their implications at the local level may sometimes lead to inappropriate policies and decisions as was evident during the 1997–98 El Niño and 1998–99 La Niña events.

The Philippine experience during the 1997–98 El Niño event shows that direct application of the climate forecast without an adequate impact pre-assessment led to the initial declaration of 29 provinces as drought-affected, yet only six of these provinces actually experienced drought. An increased likelihood of below average rainfall was interpreted as leading to devastating drought but in reality, the monsoon paddy crop in some parts of the country performed even better due to the decreased number of tropical cyclones with optimum rainfall conducive for crop growth (Flor, 1998).

The Vietnam experiences during the 1997–98 El Niño and 1998–99 La Niña events show that there was inadequate appreciation of linkages between global ENSO parameters and local weather variables. For instance, a prolonged drought during 1997–98 caused a crop loss of as much as VND 5 trillion (US\$ 385 million). Most of the intervention was centred on providing immediate relief to affected farmers, despite the fact that enough lead-time was available to plan and undertake pro-active measures (DMU, 1998).

In Indonesia, La Niña 1998–99 was perceived largely as a flood inducing agent and excessive imports of rice were planned. However, the rice production during wet-season 1998–99 increased due to favourable weather provided by La Niña resulting in crash of paddy prices to the disadvantage of farmers (ADPC, 1998).

These experiences indicate that there is a need to better understand the linkages between regional climate forecasts, their implications for local weather parameters and specific local impacts on critical resource sectors.

Towards a better integration of climate forecasts and their applications

An effective integration between physical climate prediction and its application would require significant work in three distinct

but inter-related areas — Physical Climate Prediction; Consequence Analysis or Impact ‘pre-assessment’; and Institutional Response to Extreme Climate Events.

Physical climate prediction

The global ENSO parameters impact the strength of regional monsoon pattern in South East Asia. The behaviour of monsoon in turn impinges on local weather variables such as typhoon incidence, rainfall distribution, temperature and humidity. These weather parameters influence the climate sensitive sectors like agriculture, water resources and public health. The direct application of global ENSO parameters into local decision-making poses serious difficulties. The policy planners and end-users are not able to utilise the information like the sea surface temperature (SST) index and thermo-clime depth in the tropical Pacific for making resource management decisions. Clearly, the local decision-makers’ specific interest is to know what are the specific impacts attributable to precursor, growth and decay phases of ENSO on local weather variables such as onset and strength of south-east and north-west monsoons.

Hence, there is a need to down-scale and de-segregate the specific impact of ENSO parameters on monsoon patterns and the impact of monsoon patterns on local weather variables. There is a need to establish linkages between global, regional and local climate/weather variables and their impact on given socio-economic system in a particular area. The disaggregation of ENSO-associated potential impacts on temporal and spatial basis would provide better resolution to climate forecast products that will enable end-users to undertake pro-active response measures. The following specific issues need to be addressed:

- What is the suitability of current climate and weather forecast products for consequence analysis (impact pre-assessment) and decision making in various user departments?
- What are the opportunities and constraints in producing and disseminating end user friendly climate forecast products?
- What are the opportunities for institutionalising the application of climate forecasts through greater involvement of experts from other disciplines such as agro-climatology, natural resource management, public health and water resource management?

Impact ‘pre-assessment’ or consequences analysis

The existing methods used by different departments and agencies rely on monitoring of concurrent indicators during the course of the monsoon season like rainfall, crop condition, water level position in reservoirs, etc. This system gives a relatively small lead-time to make resource management and disaster preparedness decisions. The ENSO climate forecasts now available can potentially provide information on possible onset of monsoon and its behaviour during the entire season with enough lead-time so as to facilitate the pre-assessment of the potential impacts on critical resource sectors. Few methods for such impact pre-assessment exist now and constitute a critical gap between climate forecasts and their application for decision making. In the wake of 1998–99 La Niña event, the Asian Disaster Preparedness Centre (ADPC) in collaboration with the National Disaster Management Co-ordination Board of Indonesia and the National Oceanic and Atmospheric Administration (NOAA) took the initiative to undertake a rapid pre-assessment of the affects of La Niña on Indonesia.

The main focus was on the agriculture sector. This was a successful experience and indicated that documentation and empirical analysis of past sectoral impacts and their management experience in a given area can pave the way for establishing and



Photo: Rex Features

Polution and haze caused by raging forest fires in Indonesia has carried over the ocean to Malaysia

institutionalising consequence analysis or impact pre-assessment system in different sectors.

The following specific issues need to be addressed:

- What kind of consequences can be anticipated (pre-assessed)? Natural disasters, floods, droughts, fires, reservoir levels, crop production, public health problems, etc
- Where are the opportunities (within the existing institutional context) to establish systems for impact pre-assessment? What is the kind of interagency co-ordination required for doing this most effectively?

Institutional responses to extreme climate events

The possibility of establishing an impact pre-assessment system enlarges the scope of better institutional responses to extreme climate events. However, there is a need to understand the status of the current institutional network of climate sensitive sectors such as agriculture, forestry, public health, water resources, etc to institutionalise pre-assessment and pro-active response efforts. The following specific issues need to be addressed:

- How, and to what extent, is probabilistic forecasting information used by resource managers in national, provincial and local governments?
- What are the kinds of risk management and/or contingency plans adopted by various institutions to deal with forecasted extreme climate events (El Niño or La Niña) and their anticipated consequences?
- Does the increased use of probabilistic forecast information on weather variables and its pre-assessed potential impacts actually lead to decisions, which have superior outcomes from an overall societal perspective?

Conclusion

Over the last two decades, regional and global climate forecasting capabilities have reached an unprecedented level. However, a lot remains to be done for the application of these new capabilities to the maximum benefit of the society. This will require a significant dialogue between, and amongst, the climate science community and the existing and potential end-users of climate information. Following the 1997–98 El Niño and 1998–99 La Niña events a number of sector-specific and cross-sectoral initiatives have come up at the national and regional levels to address this need.

At the regional level, one such initiative is the Program on Understanding Extreme Climate Events (ECE) in South East Asia managed by ADPC in collaboration with NOAA and supported by the United States Office of Foreign Disaster Assistance. In its pilot phase, the programme works in Indonesia, the Philippines and Vietnam and aims at improving our understanding of extreme climate events and their affects on the society and environment in these countries. The programme endeavours to provide an interface between the scientific and research community, generating information on extreme climate events and the users of this information, such as national governments, NGOs, national and regional press bureaus, etc.

There are other initiatives in the South East Asia region that focus on specific sectors such as forestry, agriculture etc. Each of these initiatives constitute small steps towards improved understanding of extreme climate events and will offer benefits to a wide range of stakeholders. However, it will require multi-dimensional and innovative institutional arrangements to take full advantage of improved climate forecasting.

Veterinary Disaster Management

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Photo: Pan American Health Organisation

Cattle are the principal (80%) source of draft power in developing countries. Following disasters, if livestock are not replaced, farmers can neither sow nor harvest grain. Re-stocking livestock that were killed in a disaster is a major contribution towards re-establishing economic independence in many countries

THE CARE OF LIVESTOCK in disasters is essential to sustainable development, because livestock and horses are the principle sources of essential nutrients (protein) and draft power in developing countries. Animal husbandry systems also contribute significantly to the economic and political strength of developing countries, and represent a large portion of each country's Gross National Product, cultural heritage and identity. In many areas the long term stability of the environment also depends on sustainable agriculture, which is based on traditional livestock husbandry systems and social structures and is under threat from growing population pressure and certain forms of development.

The two major causes of disasters affecting livestock in developing countries are epizootic disease and geophysical events. Throughout history epizootic diseases, such as Foot and Mouth Disease, Rinderpest, African Swine Fever, and Rift Valley Fever, have killed large populations of animals and reduced the production efficiency of many animals. In addition to epizootics, and sometimes exacerbating these, numerous geophysical disasters affect livestock agriculture every year. These geophysical events

can also cause direct loss of animal life and spoilage of processed foods for humans.

The close dependence on agriculture in many developing countries means that following a disaster, a country must aim to re-establish its agriculture as quickly as possible and also to implement long-term changes in the structure of animal agriculture which will make societies more disaster resistant.

Vulnerability of the livestock industry to natural disasters

The principal animals of interest in developing countries are livestock, including poultry and equines (horses, donkeys, mules). These animals are important as a source of wealth, food for humans and power for work and transportation. The principal issues that surround the loss of livestock in disasters in developing countries are a shortage of human food, spoilage of human food, and a loss of economic viability and employment in the agricultural sector. The livestock industry is also more labour intensive than many other sectors of agriculture. Therefore, any given disaster may affect relatively more people in the livestock industry than other sectors of agriculture.

Economic impact

The cost of disasters on the livestock industry and national economy should take into account the replacement value of livestock and lost production. Livestock are a source of income to their owners from the sale of live animals and their products, fees for services (draught, transport) and as a source of raw products that are processed on and off-farm. Livestock are the principal source of agricultural power for harvesting and transportation in many developing countries. Examples of production losses are, a lack of milk, calves and manure from cattle; eggs and fertiliser from chickens; piglets and land reclaiming potential from pigs.

Geophysical disasters

The most important causes of decreased animal (livestock and equine) health in disasters result from poor nutrition and sub clinical disease. These impacts result from contagious disease and geophysical events. The detrimental impact of disasters on animal health may decrease in the value of a herd by up to 30–70% due to losses from death, weight loss, reproductive losses and additional health care expenditures.

Floods

The greatest problems that producers report on flood-affected cattle are contagious disease, including epizootic and zoonotic diseases, including vector-borne diseases, hydatidosis, and visceral larval migrans. Prolonged flooding also reduces the reproductive efficiency and viability of the calf crop by 25–40%. Flooding also reduces the nutritional value of pasture to grazing animals, and, therefore, increases the rate of rotation approximately four to five fold. If grazing is continued at the same density as before a flood, this can lead to a vicious cycle of flooding, decreased soil quality, overgrazing, and increased susceptibility to environmental degradation.

Droughts

Farmers wanting to protect their animals from starvation and dehydration in droughts will move them for long distances to where feed and water may be found. On these journeys, animals may be exposed to unfamiliar diseases and predation, and consume energy that would otherwise be available for growth, reproduction and milk.

When livestock are killed in droughts the recovery of these herds is prolonged. It may take several years (decades) until herds reach their original size again, because farmers are forced to slaughter animals at a younger age as a source of nutrition and sales for cash.

Epizootic diseases and pests

The economic implications on international trade of epizootic disease in any country are huge, because these are often associated with trade restrictions. The diagnosis of an epizootic disease in a country may bring with it complete ban on exportation of livestock and products, and an increased dependence on imported goods. The loss in export revenue from Foot and Mouth disease in South America is in excess of US\$ 500 million a year. It has been estimated that an outbreak of FMD in the United States would have an estimated cost of US\$ 7 billion.

Epizootic diseases are also costly because they cause increased morbidity and mortality in animals, and, therefore, also reduce productivity and the economic value of the livestock industry and availability of indigenous sources of food for a nation. Some epizootic diseases are zoonotic and have additional direct public health importance. Many agents proposed for bio-terrorism are zoonotic diseases with a primary animal reservoir. Therefore,

epizootic diseases are an important contributory cause to human malnutrition, health and safety.

An increased incidence of contagious disease appears to correlate well with years in which other natural disasters occur. For example, in years of increased rainfall due to El Niño there are also often increased numbers of reports of infectious disease. Examples are Rift Valley Fever in Africa, Foot and Mouth Disease in South America, mongoose and human rabies in Cuba, and human leptospirosis in the Caribbean. In these years and when vector control efforts break down, vector-borne diseases, such as Venezuelan Equine Encephalitis, also increase.

A role for veterinarians

The responsibility of veterinarians is to participate as a member of the emergency management team and to work from within integrated programmes involved in all types of disaster reduction programmes. This is only likely to be accomplished by being present in a country before a disaster strikes.

The role of a veterinarian in this integrated effort of emergency management is similar to other aspects of disaster management, which is to protect public health and property. In the case of disasters in developing countries, the attention to animal agriculture is an effective method to improve the care of a country's citizenry (public health), economy and environment.

The four phases of emergency management

Mitigation: The best mitigation of disasters in developing countries is to strengthen the animal health services of those countries. Mitigation (strengthening the veterinary profession) against epizootic diseases is a global issue in which every country plays a role. Mitigation involves a presence and support of countries with epizootic diseases by offering training, expertise, and resources to eradicate diseases that are a threat to the world's animal agriculture.

Effective financial mitigation includes insuring entire countries' livestock industries against catastrophic losses, and international mutual trade arrangements with neighbouring countries. Mitigation programmes for geophysical disasters also involve implementing early warning systems of pending floods (river water flow meters), food storage banks for droughts. Construction of livestock holding facilities using indigenous technology, which has developed over the centuries, can also prevent losses from common natural hazards, such as hurricanes and earthquakes.

Preparedness: An effective disaster preparedness phase starts with the development and implementation of timely (seasonal) education that is community based. Examples include weather forecasting and river-flow monitoring that can be used to advise farmers on the optimal time to move livestock to safety.

Response: In the response phase-donations for animal health care need to be identified and dealt with appropriately, so that the animal and plant health of the affected country are not further compromised, and so that diplomatic relations between donor and recipient countries are not harmed.

Facilities provided for displaced subsistence farmers should provide separate facilities for animals. Animals should be vaccinated and treated if necessary upon arrival at a facility. Human vaccination programmes could be co-ordinated with those for animals as the concurrence of vaccination programmes for both has been shown to have a high compliance rate for humans.

Following floods, large numbers of carcasses can be scattered throughout the countryside. It is often not possible to bring these to a common site for disposal so on-site disposal is often the only practical solution. Many carcasses in remote areas will be



Photo: Sygma

Livestock disasters are not limited to developing countries: A herd of cows frozen to death during ice storms in Canada, January 1998 when temperatures dropped below -40°C . The loss of cattle represents loss in economic power to the owner, as well as a loss of food supply

scavenged, whereas carcasses lying close to human or animal habitation, or water sources, should either be removed or destroyed rapidly. Composting on site may be the most practical alternative in many cases to dispose of a large number of carcasses.

To prevent problems associated with overgrazing of pastures, parasite control programmes should be enhanced and additional feed, eg. damaged crops that can no longer be used for human consumption, should be provided.

Recovery: An effective recovery phase from disasters starts with effective mitigation programmes. Trade and mutual aid agreements between countries should be implemented in the recovery phase, and the focus should be on improving existing systems. Replacement livestock must be of the appropriate type, disease resistant, and climate adapted.

Steps in the development of disaster reduction programmes for the livestock industry

The process of developing international disaster reduction programmes for livestock is similar to other emergency management planning processes, it just has different players.

- Establish a national committee for veterinary disaster management. This committee should have the expertise to address contagious disease and geophysical disasters
- Review existing national and international laws, regulations and policies and determine how these can be adapted to meet the needs of a national disaster reduction programme
- Develop a matrix that clearly defines the relationship between veterinary services, and public health and environmental impact agencies
- Establish a chain of authority and a chain of command for how members of the disaster response force communicate with one another and with all other agencies active in all stages of the

emergency management cycle. Examples of such agencies include emergency management, military services, those with diplomatic ties, international trade partners and departments of finance

- Establish a committee that reviews the impact of disasters and assesses the potential impact of disaster on the livestock industry of the country
- Identify resources (laboratories, veterinary schools, animal and human health departments) that could play a role in the response to disasters and characterise their function in the cycle of emergency management
- Identify and make arrangements with national and international resources which could provide immediate and long term response and recovery funds and resources after a disaster.
- Establish a network of private resources willing and able to assist in the response recovery from disasters
- Establish a committee that oversees the development and maintenance of resources through written and verbal agreements in non-disaster times
- Maintain census data and maps on livestock populations and public health indices that are related to food production (child mortality, infectious disease, per capita protein consumption).
- Develop effective communications with farmers and their representatives in the livestock industry
- Rehearse and practice plans at least annually.

Disaster relief

International disaster relief can play an important role in a country's recovery from disaster and subsequent development. In an ideal world, disaster relief funding to support, rebuild and develop the livestock industry in a country should also be seen as a form of humanitarian assistance, which benefits public health and a country's social and economic power.

CASE STUDY

Some lessons for a national approach to building for safety in Bangladesh

Robert Hodgson and M. Carter, University of Exeter, UK

BANGLADESH'S SITUATION on the Ganges-Brahmaputra delta makes it prone to severe wind and flood hazards. In addition, there is a significant earthquake risk due to its proximity to the north east India seismic zones.

Around 90% of Bangladesh's 120 million citizens live in rural areas. Unreliable and extremely low incomes (daily labour rates can be as low as US\$ 0.50–0.70 per day), poor rates of literacy (below 30%), inadequate access to building land and rising material costs all conspire to ensure that many rural people live in homes that do not protect them adequately against the common climatic conditions, let alone against the excesses that this tropical zone can produce.

Exeter's Housing and Hazards Group (H&H) was set up to explore ways of making better homes affordable worldwide. Participatory dissemination and communication programmes in northern Bangladesh have been followed by surveys of the long-term affects on the target population. Links with the Bangladesh University of Engineering and Technology (BUET) and with Grameen Trust, a national non-governmental organisation, will provide a framework for developing technical research, and also for communicating that research, using the lessons learned from the pilot projects.

DISSEMINATION PARAMETERS

Many different house-building styles and materials are used in Bangladesh, often varying considerably within a single village. This makes it impossible to identify or specify a single house-type that would satisfy the needs of each family and impractical to communicate with each homeowner individually.

Housing is a universal need and, faced with such a wide-reaching lack of adequate shelter, a dissemination process should be capable of developing and expanding itself to reach all corners of the nation. Initial recipients of the concepts must understand them fully and be motivated to develop and communicate the ideas to others so that the message expands organically.

Experiences from elsewhere confirm that people understand and retain complex concepts best by repeatedly practising them. Therefore, the H&H pilot study organised a series of rural action-learning workshops in which

participants in one village were invited to share ideas and to make practical trials of possible improvements to existing construction practice.

THE WORKSHOP APPROACH ADOPTED BY H&H

The pilot H&H field study sought to develop a mechanism whereby ownership of technical innovations might be passed to the participants. Although many simple innovations had been implemented by individuals in the village, the resulting experiences were not shared with others. The workshop process developed that sharing role and created a vehicle for introducing new concepts.

A volunteer living in the village trained facilitators to run a series of seven workshops at weekly intervals. Each was conducted separately for male and female groups in recognition of the cultural difficulties in arranging mixed activities. Thirty-eight villagers participated (18 men and 20 women) with an average attendance rate of 70% over the seven weeks. The participants included professional builders, thatchers, home owners and members of disadvantaged groups (poor and women-headed households).

Since the workshop approach was unfamiliar to participants, the first was designed to encourage participation. People were encouraged to discuss the features of their own homes and the advantages and limitations of the materials used therein. From this, subsequent workshops focused on different aspects of home design and construction.

Finally, the workshop groups contributed to the construction of a full-sized demonstration building which they then assessed. The building, while conforming to a common structural type of the area, incorporated a range of technical improvements which could be costed and were found to add a mere eight per cent to the basic building costs. Villagers could thus monitor the subsequent success of those improvements for themselves.

FOLLOW-UP SURVEY OF H&H STUDY IMPACTS

The pilot study finished just as the start of the summer rains precluded any further house-building that year (May 1997). Eighteen months later, a survey assessed the long-term

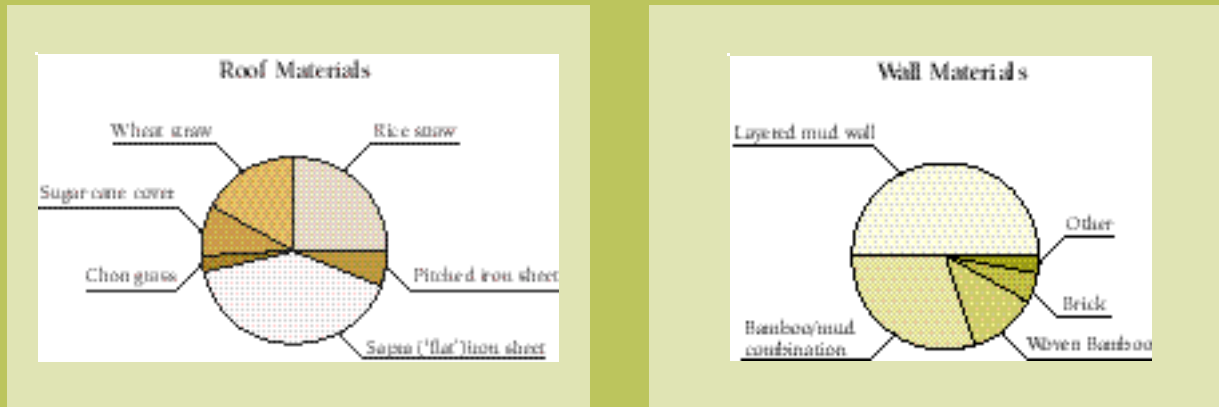


Figure 1: Construction methods used in the houses surveyed

effects of the pilot. All the original workshop participants were contacted and interviewed individually and in groups during a period of two months during late 1998. This timing was in some ways appropriate, in that Bangladesh had suffered one of the worst floods in living memory during the preceding summer and many people, even in northern Bangladesh, were having to rebuild their homes.

Twenty-eight of the 1997 workshop participants had undertaken building works since the workshops, twenty of them in response to damage by some natural hazard. However, only eight of those had used the H&H techniques developed by the workshops. The greatest uptake of H&H concepts was among those who had made planned maintenance or improvements. Six other participants said they would have used the improvements but had not thus far needed to do any building ('if it isn't broke, don't fix it').

The principal reason for this relatively disappointing uptake appears to have been financial. In the wake of a disaster, money is in short supply and material costs often inflate. Therefore, with the best will in the world, people must watch every taka (penny) and simply cannot afford even the additional eight per cent cost increases.

The 1997 demonstration building has survived well. Its current use as a sewing training centre limits access to it by many local people. Interestingly, it seems that size is a significant limitation in its usefulness as a demonstrator — people have commented that 'This is a rich man's house — we cannot afford a big house like that'. The fact that the demonstration building is structurally identical to their smaller houses seems to be outweighed in their perception by its size.

APPLICATION OF APPROACH IN OTHER PARTS OF BANGLADESH

These pilot programmes have demonstrated the usefulness of a community action approach and have also shown the need for repeat programmes to maintain contact with the community and to reinforce the key messages. An appropriate next question might be — how could the approach be developed within a national framework to give all rural residents access to improved technologies?

For the lessons from the pilot programmes to have relevance, it is necessary to consider the appropriateness of those experiences in the national context. A survey of 54 typical, low-income homes in the area is summarised in Figure 1. Generally speaking, about half of the buildings had layered mud walls with the remainder having walls made from bamboo or mud and bamboo. Just over half of the roofs were thatched and the rest were predominantly of shallow-sloped corrugated iron sheet. Thus, four basic combinations of these variables exist with a much larger range of sub-combinations. Individual circumstances commonly result in a mix of neighbouring house-types. H&H figures are remarkably similar to national statistics published by the World Bank and thus the pilot programmes can be used with some confidence to point the way to a national approach to housing development in Bangladesh.

Repetition and reinforcement of the messages implies the need for village-based building technologist (para-architects). The creation of a cadre of such people would put building development on the same footing as community health with its para-medics. The training of para-architects could include the setting up and development of community building for safety programmes using the techniques pioneered by H&H. They would also act as key interfaces with national research programmes as well as collectors of data on regional material costs.

Although para-architects would need common training and retraining as the programme developed, they need not all belong to the same organisation. Rather, staff from existing NGO or other community-based projects could be selected for training. The important factor required is a strong understanding of local community dynamics.

AFFORDABILITY

The second pilot study has made it clear that significant uptake of improved building technologies will occur only if they are seen as affordable within a range of expenditure options facing the rural home-owner. There is still much work to be done in clarifying those expenditure options and the resulting individual priorities. With a better under-



Differing house styles reflect large variations in their owner’s wealth — even at one location

standing of what people can afford, it will become possible to determine ways of making technologies available within those constraints.

Simple improvements are intrinsically low-cost. The demonstration building showed how a mere eight per cent additional outlay might increase the building’s life by 100%. Further advocacy is necessary to increase awareness of those benefits and perhaps modify individual priorities. For example, treatment of bamboo posts is an effective technology which on its own would only add one or two per cent to the cost of a new building, seemingly an insignificant increase. However even this is not the full picture since to retro-fit treated bamboo posts to an existing building could add as much as 25% to the cost of planned maintenance for that year, clearly a significant additional cost.

Until recently, house provision for the poor was seen as being within the remit of non-governmental organisations (NGOs). Although there are many model low-cost houses, there is no generally agreed approach to either their design or to distribution. In general, they are much more expensive than a locally-built home and can be afforded only if given with a loan or as a grant. Many owners accept them as an asset to be sold later and replaced with a ‘normal’ house. Only by making homes truly affordable will this problem be avoided.

Several NGOs now give loans for home construction. However, survey respondents were wary of taking on loans, especially for assets which they perceive as non-productive. They have had experience of difficulties with repayment

Theme	Attendance	Main activities
Welcome	38	Registration, expectations/objectives, discussion of housing needs
Hazards	27	Discussion of vulnerability and disaster response
Building with mud	28	Practical exercises building mud walls
Building with bamboo	24	Practical exercises treating and framing bamboo
Roof construction	25	Practical exercises building a roof, discussion of long term budgets
Credit & maintenance	25	Credit role-play and Maintenance discussion, planning of maintenance routines
Conclusions	28	Assessment of demonstration building, costing exercises

Table 1: Topics covered by the H&H workshops

after, for example, illness. This points to a need for a package of measures, which might include credit and insurance as well as subsidies for more expensive components, to provide as many options as possible for the range of individual circumstances.

Future work therefore has to focus as much on affordability and on communication of building methods as it does on the development of those methods. Research on technologies will only be effective if it is conducted in the understanding of the many non-technical constraints on the home-builder.

CO-ORDINATION OF A NATIONAL APPROACH

Housing should be seen as an important element in developing a modern, productive society. The UK building standards, introduced over a century ago, can now be seen to have played an important role in enabling British residents to create a healthy, protective home environment for themselves. The introduction of those standards was symptomatic of administrative awareness of a need to improve conditions in the periurban slums of that time; a similar concerted initiative is needed now for Bangladesh.

Implementation of improvements in the housing stock has to be seen as a long-term investment. Step-wise advances have been found to be more effective than complete (and unaffordable) solutions. Therefore, each step needs to be planned and co-ordinated to ensure that it is socially and economically appropriate as well as technically sound. This implies co-ordination across the whole range of administration and research community of the country.

Homes can be built to withstand floods and cyclones and it is clear that the principal reasons for inadequate housing among the rural poor are not technical. Low income and lack of knowledge play a much greater part. To address this issue properly will require co-ordination on a level which has so far eluded the development activities of Bangladesh but is a goal worth pursuing to make a real impact on the mass of the population.

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SCIENTIFIC KNOWLEDGE,
TECHNICAL EXPERIENCE
AND TRADITIONAL WISDOM

KEYNOTE PAPER

SCIENTIFIC KNOWLEDGE, TECHNICAL EXPERIENCE AND TRADITIONAL WISDOM

Badaoui Rouhban, UNESCO, France

SCIENCE AND TECHNOLOGY help us to understand the mechanisms of natural hazards having atmospherical, geological, hydrological, and biological origins and to analyse the transformation of these hazards into disasters. Scientific knowledge of the violent forces of nature is made up of an orderly system of facts that have been learned from study, experiments, and observations of floods, severe storms, earthquakes, landslides, volcanic eruptions and tsunamis, and their impact on humankind and his works.

The scientific and technological disciplines which are involved include basic and engineering sciences, natural, social and human sciences. They relate to the hazard environment (ie. hydrology, geology, geophysics, seismology, volcanology, meteorology, and biology), to the built environment (ie. engineering, architecture, and materials), and to the policy environment (ie. sociology, humanities, political sciences, and management science).

Over the last three decades, scientific knowledge of the intensity and distribution in time and space of natural hazards and the technological means of confronting them has expanded greatly. The dramatic advances in the understanding of the causes and parameters of natural phenomena and in the techniques for resisting their forces were presented by a leading scientist in the mid-1980s as the rationale which made propitious the launching of an international decade devoted to reduce significantly the consequences of natural hazards. The Resolution of the United Nations General Assembly, which proclaimed the International

Decade for Natural Disaster Reduction, called for a concerted worldwide effort to use the existing scientific, technical, and traditional knowledge in each country, adding new knowledge as needed, in order to underpin the adoption and implementation of a public policy for disaster prevention.

The overall goal set for the Decade was the conduct by countries of a national risk assessment and the initiation of a risk mitigation strategy including improved capability for monitoring, forecasting, and warning. To meet this goal, each nation would fully utilise existing knowledge on the lithosphere, atmosphere, and biosphere, and the know-how on disaster protection gained in prior years. They would build effectively and creatively upon past accomplishments in order to meet the projected needs for safer communities during the 1990s and into the 21st Century.

Progress in the science and technology of natural hazards and of related coping mechanisms have made it possible over the past years to introduce significant changes in the approach to the

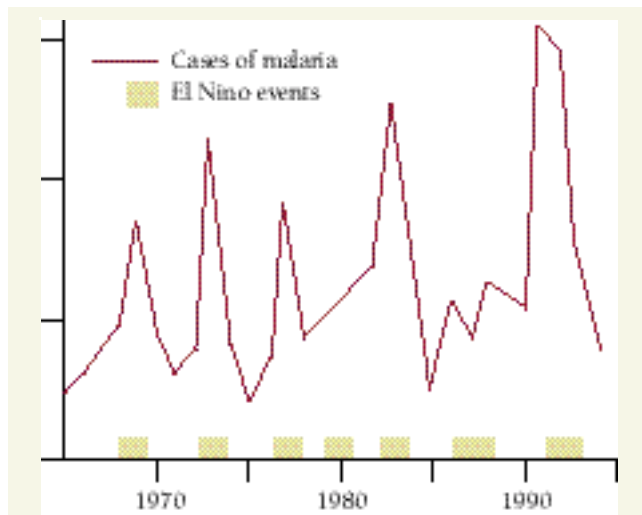


Figure 1: The influence of El Niño events on the occurrence of Malaria in Columbia. Information for Figures 1 and 2 are courtesy of the GOOS Project Office, IOC/UNESCO

problematic of natural disasters. Major progress has been made in the development of global meteorological models and their application to large-scale weather prediction. Although earthquake prediction is still not possible, a considerable ability exists today to make more accurate forecasts and to give warning of several impending hazard events. Warning of violent storms and of volcanic eruptions hours and days ahead saved many lives and prevented significant property losses. Modern technologies have been developed that reduce the exposure to natural hazards of the physical and built environment and other elements of socio-economic life. Owing to progress in design and construction engineering, earthquake-resistant structures, including high-rise buildings, critical lifelines and industrial facilities, are technically feasible and have become a reality. One component of these breakthroughs in disaster reduction, in some instances, has been an enhanced capacity to control or modify the disaster events themselves.

Solutions offered by a disaster mitigation effort based on sound scientific and technological parameters may fail because they do not fit with the local traditional wisdom. A technical know-how adapted to indigenous wise practices can magnify protective measures. Traditional local knowledge about natural hazards, especially among older people, enables, in many cases, some communities at risk to capitalise on technology in achieving self-protection. Ethnic groups in hazard-prone areas have generated a vast body of indigenous disaster protection knowledge. This knowledge is the sum of facts that is known or learned from experience or acquired through study and handed down from generation to generation. For example, people have learned from experience over the years that the locations that are most susceptible to natural disasters are those that are — close to the water's edge; on unstable slopes, in the flood plain of rivers; in, or adjacent to, an active fault zone; on soft and/or unstable soil; on the flanks of an active volcano; and near an urban-wilderness interface. They know the nature of the disaster agents that stem from each natural hazard and are familiar with their warning signs. Every society harbours its own distinct way of determining ways to act and react in relation to hazards. Indigenous knowledge is a precious national resource that can facilitate the process of disaster preparedness in cost-effective, participatory, and sustainable ways. Hence a blend of approaches and methods from science and technology and from traditional knowledge opens avenues towards disaster preparedness.

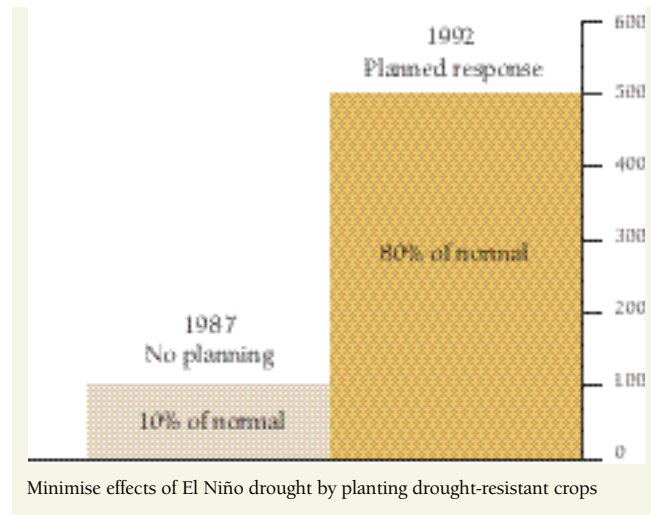


Figure 2: El Niño causes drought in northeast Brazil. Without planning for El Niño effects, the grain harvest is very poor; with planning, the fall in the grain harvest is much less

Despite the ample availability of knowledge and know-how, our society continues to be increasingly vulnerable to natural disasters that are more destructive than ever. The route to a solution is far from clear. Urban community vulnerability is escalating. The behaviour of human and material elements of some populous areas at the occurrence of hazards is characterised by inherent uncertainties.

There are still large gaps in the knowledge of this behaviour. On the eve of the 21st Century, science and technology should address such gaps. They will, therefore, remain absolutely essential for devising and applying appropriate risk adjustment. Research activities in the physical sciences should be carried out and focus on those areas where uncertainties still exist in the ability to detect and predict future natural disasters. Further development of research includes activities aimed at an increase in the knowledge base in specialised fields; an improvement of monitoring systems and data bases; an increase in the effectiveness of communications to communities at risk; and development and demonstration of new means of combating disasters.

Science needs to be seen as only part of a continuum of action extending from the design of inter-disciplinary research to the communication of results to diverse non-specialist user groups. In this vein, scientists will have to share with policy-makers and others, the responsibility for scientifically-sound risk assessment and management. They should be conscious of the needs to bring to bear the insights and methods of many disciplines. The global challenge of disaster reduction is a significant engagement on the part of scientists and technicians in an integrated approach to risk management. They should militate for more interaction among sectors and disciplines with respect to both the analysis of the risk and the response to that risk. Networks of researchers, engineers and social scientists must be set up and undertake to promote a combination of indigenous technology with advances in science and technology and to develop area-specific technological solutions. It is obvious that social and cultural considerations are as much a part of an enduring and equitable solution as science and technology. Above all, scientific and technological solutions to the complex problems of disasters must be rooted in social realities, in the fullest sense of the term. Without science and technology, and their blending with traditional modes of protection, there can be no world safer from natural disasters.

Reducing Vulnerability of Infrastructure

Stephen Bender, Organisation of American States, USA

FROM MID 1997 TO EARLY 1999 a devastating set of disasters struck Latin America and the Caribbean. These events struck areas that were the sites of damage from previous natural events, yet billions of dollars of new damage were recorded.

How is it that following previous devastating disasters, repairs could be made to infrastructure, and development projects undertaken for up to 15 years, only to have the next event reveal the same type of vulnerability that existed before the previous disaster? Vulnerability is a precondition for disaster. Vulnerability, like natural resource degradation, is the result of choices made by societies (Bender, 1994a). Why is vulnerability to natural hazards, rather than the actual impact of disasters, emerging as a more important factor in understanding the environmental implications of economic development policies of some lesser-developed countries (LDCs)?

The heart of the environment: Development relationship

The issue of vulnerability goes to the heart of the environment-development relationship:

- Sustainable economic development is impossible in conditions of vulnerability to natural hazards
- More attention needs to be paid to the absolute conditions of vulnerability and less to the relative conditions of wealth (Bender, 1994b).

Natural hazard management is a part of models invoking environmental management as a basis for sustainable economic development. The vulnerability posed by natural hazards is being used increasingly to describe an important component of the sustainable development agenda (Cartagena, 1994). That vulnerability, whether unresolved or unrecognised, is a subsidy, which constitutes part of the actual total cost of maintaining infrastructure. A disaster makes manifest vulnerability and the lack of investment to reduce risk. A disaster is payment for carrying the subsidy (Bender, 1994c).

The environmental movement has brought two indispensable views to development in the region:

1. The discussion of process, and of the structure and function of ecosystems — including natural phenomena which present hazards — related to development efforts
2. The temporal dimension of development efforts as represented by the inter-generational implications of sustainable development (Bender, 1994d).

The environmental movement has contributed to understanding vulnerability, most notably through environmental impact assessments (EIA) (*The World Bank*, 1989). Examining the structure and function of ecosystems brings to light not only perpetrators and victims of past hazardous events, but also the conditions of vulnerability that will lead to future disasters. Knowledge of the social sciences, natural sciences and engineering can now reveal not only why vulnerability exists, but also the investments, which if chosen, can reduce that vulnerability. It is now possible to

understand not only the vulnerability of structures but also the structure of vulnerability.

With specific reference to natural hazards and their relationship to the environmental agenda and sustainable development, two observations are emerging:

1. Sustainable development in and of itself is not a picture big enough to address vulnerability
2. In democracy-challenged societies, vulnerability reduction to natural hazards is a critical issue which must be publicly addressed.

Traditional measurements of development have looked at gains conditioned by the past at a fixed point in time. Sustainable development models demand an examination of desirable future conditions towards which present development must contribute. Accounting for resources used and those yet remaining must be accompanied by recognition of the vulnerability, which will be carried forward, thereby conditioning future development options. Sustainable development is not the first development-related concept to be promoted as a guide to the future. What it lacks, however, is a comprehensive underlying value system which guides societies in resolving the question of who is to benefit and who is to pay. Naming future generations as beneficiaries, as evident throughout history, is not specific enough to make decisions as to what resources will benefit whom and which populations will remain vulnerable.

Underlying principles of disaster management and sustainable development

Post-disaster humanitarian assistance and risk management as practiced in the past have been based in large measure on an assumption of indiscriminate impact on unsuspecting or at least generally vulnerable populations and their infrastructure. The disaster event is the entry point for relief, reconstruction loans, and compensation through insurance. Far too often, vulnerability has to be manifested through a disaster to be perceived yet vulnerability assessments can make this perception possible before the event takes place.

Free market systems are relatively unencumbered to define winners and losers related to vulnerability in economic, political and geographical terms. In addition, international and regional bodies are relatively free to set the terms and conditions for disaster assistance. Civil societies interested in vulnerability reduction are therefore confronted with the concept of acceptable loss. Their needs are juxtaposed against the bottom line approach to costs and benefits, cost recovery and economic sustainability in a financial sense. Out of this situation the following observations can be made:

- Information about hazardous events, vulnerability, risk and impact is much more readily available
- International environmental management paradigms focusing on the causal relationships of natural events, the hazards they pose and the loss they generate are being shared with LDCs

FOR REFERENCE PURPOSES ONLY

SCIENTIFIC KNOWLEDGE, TECHNICAL EXPERIENCE AND TRADITIONAL WISDOM

- Atmospheric, solid earth and social scientists, and engineers are looking at policy and programmes in a more integrated fashion
- Communications media have assumed the role of the great pursuer of mortal blame agents in disasters as celestial blame agents fall away.

It must be noted that as vulnerability and the resulting risk pose an emerging theme related to social order, there is little reason to have expected that they would be addressed in any serious way in previous decades. International agencies have conditioned themselves and their beneficiaries to address the specifics of national development agendas through funded programmes, technical co-operation and training. Recipient countries have learned that priority issues receive international support. Vulnerability reduction of specific populations and their social and economic infrastructure to natural hazards has not been a development priority.

In fact, vulnerability has been addressed only tangentially in the past 30-plus years through three traditional strategies evolving out of the experiences and developing expertise of the international community in dealing with large scale human suffering and/or risk management following World War II:

1. Military style humanitarian assistance following major disasters evoking an international response
2. Economic cost/benefit analysis and risk reduction conditioned by the probability of the event and the expected financial loss
3. United Nations-style Decade programmes focusing on a specific development issue, such as water in the 1980s and natural disaster reduction in the 1990s.

The legacy of the first strategy still permeates and dominates most disaster relief. Disaster assistance is triggered by the onset of the actual event, and is usually structured in a centralised, vertical fashion, heavily dependent on command and control structures. Only on a collateral basis do emergency management agencies address disaster prevention, the structure and function of economic and social sectors, and vulnerability reduction in the context of mainstream development issues.

As for the second strategy, risk management in financial terms, an evolving part of public and private lending and investment policies and practices, is now part of global, and some national, development policies. Financial investment analysis is presently the dominant conditioning factor for determining acceptable risk. Financial risk reduction takes into account possible loss balanced by compensation payments (including insurance), profit margins and alternative investments. Typically, concern for economic risk—a composite look at possible loss in a broader sectoral or integrated national economic view—will not supersede concerns for the financial outcome of the investment project. Additionally, physical risk to population and infrastructure, particularly to the poor, may not be considered important if financial well-being is assured, or large-scale reconstruction loans are envisioned.

In the past, cost/benefit models were used to identify the efficiency of investment and to choose between alternative investment projects in terms of location and participants. More recently, with the scarcity of public sector financial resources, cost/benefit analysis is used to measure the efficiency of the investment with an eye towards the sustainability of the resulting cash flow. Cost recovery and positive income streams are priorities. But when cost/benefit analysis related to discussions of vulnerability reduction are used to identify the point of efficiency of investment and acceptable loss, there is a danger that much existing vulnerability, particularly vulnerability of the poor, will be left unattended.



Only a few possessions left: Economic disaster hits the community as a direct result of the Oklahoma tornado in May 1999, USA

For the third strategy, a research and action decade addressing a particular development issue, such as the IDNDR, has usually been built around international contributions and execution of funded activities. The objective, explicit or implicit, has been the supposed resolution of the particular issue at the end of the ten-year period. But as Mitchell pointed out before the IDNDR began, the task of hazard reduction frequently involves surmounting problems of divided responsibilities and differing priorities among public agencies (Mitchell, 1988).

The practice of post-disaster humanitarian assistance and risk management

Interestingly enough, one dramatic result from the development models used in the region is the present excessive vulnerability of populations and economic and social infrastructure to natural hazards. The situation is manifested, in part, by the fact that the total declared economic losses due to natural disasters in Latin America and the Caribbean (vastly under-reported) since 1960 is greater than the total receipt by the corresponding countries of international non-reimbursable development assistance (non-military). As a result of these various disasters, thousands of homes and schools collapse, hundreds of thousands of people are made homeless due to earthquakes and hurricanes, crops of subsistence farmers fail due to floods and drought, thousands of kilometres of the Pan American Highway are rendered impassible due to landslides, earthquakes and floods, and electric power is rationed for weeks on end in capital cities and other urban areas due to drought.

Efforts are being made to expand the concept of wealth as a measurement of development by using monetary units to express a country's natural resource endowment and its depletion (World Bank, 1997) as well as to focus on issues of risk and vulnerability (Washington: OAS, 1994). Sensitivity to health and safety hazards has put risks and environmental quality among emerging concerns of industrialised and developing countries alike. These efforts are being carried forward by environmental groups scrutinising the impact of global climate change and regional trade pacts, among other issues; economists promoting 'green accounting' as part of national accounts (accounting for the existence of natural resource stocks and their depletion); and the disaster management community, as exemplified in the IDNDR.

These concerns illuminate a gradual shift of the predominant social conflict at a global level in the early part of this century from a focus on distribution of wealth among different social groups, to a focus on distribution of power in politics and economics shortly after mid-century, to a present emerging focus on the distribution and tolerance of risks by different social groups, regions and future generations (Beck, 1992).

This three-stage evolution may be best expressed for Latin America and the Caribbean as characteristics of the over-arching theme of dominant economic and social systems since the early 1960s. It captures the sense of now dealing with shifts to free-market economies, smaller government, and more decentralised decision making, public participation, regional capital markets and trade, and environmental sustainability of economic and social gains.

For some countries vulnerability reduction of specific populations or segments of economic and social infrastructure as a stated goal is too political. Few policies are presently seen as politically acceptable if they mean to irrevocably commit international and national public and private funds to meet specific vulnerability reduction targets (*Government of Colombia*, 1990). General calls for creating a regional travelling disaster response group in the Plan of Action of the Hemispheric Summit of Miami (9–11 December 1994) and incorporating disaster preparedness, prevention and response plans into national development plans as set out in the Plan of Action of the Hemispheric Summit in the Santa Cruz de la Sierra, Bolivia, (7–8 December 1996) have not yet met with the necessary support for implementation.

Where we are now

Major changes are occurring in the development context of the region, and each is larger than the vulnerability reduction issue:

- Emergence of independent, decentralised and democratic governments
- Economic policies sensitive to international, regional, and national environmental management concerns
- Dramatic shifts in the source and destination of capital for economic and infrastructure with the emergence of trade corridors built in response to internationally negotiated trade pacts, the 'global economy', and the free market system.

In this context, three types of disaster management actions are taking place:

1. International humanitarian assistance focusing on national complex emergencies and catastrophic events
2. Regional, bilateral and national assistance in the case of reoccurring disasters at the national and sub-national level
3. Strategic investments for least vulnerable economic infrastructure for the next century.

It's the vulnerability...

As we look forward to the next quarter-century of development for the region, three considerations are in order if vulnerability reduction is to be achieved:

1. To what extent must the structure and content of disaster management, particularly at the international and national levels, be remoulded as an integral part of mainstream development activities from planning and loan preparation to local implementation in all sectors?
2. What are the limitations of cost/benefit analysis in justifying investments in vulnerability reduction and in their absence what justification will be used for such investments attending to the needs of the poor?

3. What legacy of action will the IDNDR leave with international and regional organisations, institutions, corporations, and national and local governments and businesses, building on the thousands of contributions to the decade by local communities in the region.

Forecasts are principally a tool of disaster management, not vulnerability reduction. They give warning of impending destruction, and with enough anticipation, are useful as a tool in lessening the impact of a particular event. To lessen the possibility of disaster, prediction of an event of a certain severity and geographical scope must be interpreted through the perspective of what is vulnerable and what actions should be taken.

It is a mistake to accept forecasts as the key to action. Vulnerability assessments are the key to effective action. These assessments can be based on historical events, on the largest expected event, on an event whose cost of reducing vulnerability is commensurate with the resources and decision-making apparatus at hand, or on a forecast.

Forecasts do not alter vulnerability. They facilitate making vulnerability evident. Traditional disaster management actions — preparedness, relief and rehabilitation — must first and foremost be recast as a complement to a set of actions focusing on vulnerability assessment using hazard information and risk reduction in line with political, economic and social goals in development. Different event levels can be analysed in the absence of forecasts, and disaster reduction can be undertaken.

The most desirable national or local strategy is the incorporation of risk reduction into specific economic and social sector development planning and implementation by a sector itself. An alternative strategy is addressing vulnerability analysis and risk reduction through environmental management mechanisms. To be effective, such mechanisms must have the proven capacity, or at least the possibility, of affecting change within the different sectors' development planning and implementation processes. The least desirable strategy is to place responsibility for vulnerability reduction in a disaster management system that stands apart from both environmental management mechanisms and the sectors themselves.

If benefits and costs are to determine who and what is to remain vulnerable, then the ratio of the two must be determined through visible, transparent, democratic processes based on hazard information, vulnerability analysis, and risk reduction benefits and costs. There will definitely be many cases where financial and economic benefit/cost ratios indicate a less than desirable return on investment. Such cases, usually involving the poorest segments of the population and their assets, will have to become a component of an already recognised set of 'social' development actions. Issues such as health, education and job creation are now seen as where long term economic wellbeing and short term humanitarian interests dictate use of public and private resources to replace vulnerability with investment.

Throughout this decade, many communities have come to analyse their vulnerability to natural hazards. They understand which actions they might undertake themselves and which depend on action through larger institutional and societal mechanisms. This understanding has come about to some degree through the use of environmental management mechanisms, and in a more limited set of cases, through activities of a specific economic or social sector. However, to go forward into the next decade and beyond, international, national and local level public and private sector entities must adopt vulnerability analysis and risk reduction as an integral part of the development agenda, and commit the necessary resources to reduce vulnerability.

Mitigating Seismic Risk

Haresh Shah, World Seismic Safety Initiative, USA

WITH EVERY PASSING DAY, seismic risk is increasing worldwide. Unprecedented population growth, accompanied by almost uninterrupted economic prosperity since World War II, has led to a significant increase in the level and concentration of people and properties exposed to earthquake risk. Despite the roughly constant levels of worldwide seismicity from year to year, the spectacular growth in exposure has contributed to a dramatic increase in economic and life losses over the last four decades.

Even in highly developed countries such as Japan, the nature of urban risk was vividly demonstrated by the 17 January 1995 earthquake near Kobe. Earthquake engineering researchers and professionals are forced to chase a moving target as the nature of this risk evolves. The populations of the seismic regions and of the world are exploding, urbanisation is accelerating, and cities are becoming increasingly interconnected and internally complex. The physical make-up of human developments and the lifestyles of their residents are unlike anything that existed in the past. All of these extraordinary changes affect earthquake risk, and therefore necessitate frequent re-evaluation of the issues that shape the character of the problem and the potential solutions. It is for these reasons, and to support the efforts of the IDNDR, that the International Association of Earthquake Engineering (IAEE) initiated an undertaking called the World Seismic Safety Initiative.

The founding of WSSI

Scientific knowledge, technology, and management tools do exist today to mitigate the unbounded increase in losses due to natural disasters. However, social, political and economic constraints hamper implementation of knowledge. This is especially true for developing countries. Closer co-operation between governments, local communities, business, NGOs and various international organisations is definitely needed to achieve the goals of IDNDR. The IAEE made an important decision to be pro-active in helping to implement the aims of IDNDR. A document titled 'A Time for Action — World Seismic Safety Initiative' was developed in 1992 in co-operation with the Earthquake Engineering Research Institute (EERI). Based on the recommendations in that document, the IAEE decided to establish WSSI at the 1992 World Conference on Earthquake Engineering in Madrid, Spain. The goals of WSSI are:

- Disseminate state-of-the-art earthquake engineering information throughout the world
- Incorporate experience and research findings into recommended practices and codes in earthquake-prone countries
- Advance engineering knowledge through problem-focused research
- Urge governments and financial institutions for establishing policies to understand and prepare for future earthquakes.

Since its inception in 1992, WSSI has provided an organisational framework capable of raising financial resources, has undertaken projects that require multinational efforts and has provided encouragement to member countries to apply better engineering

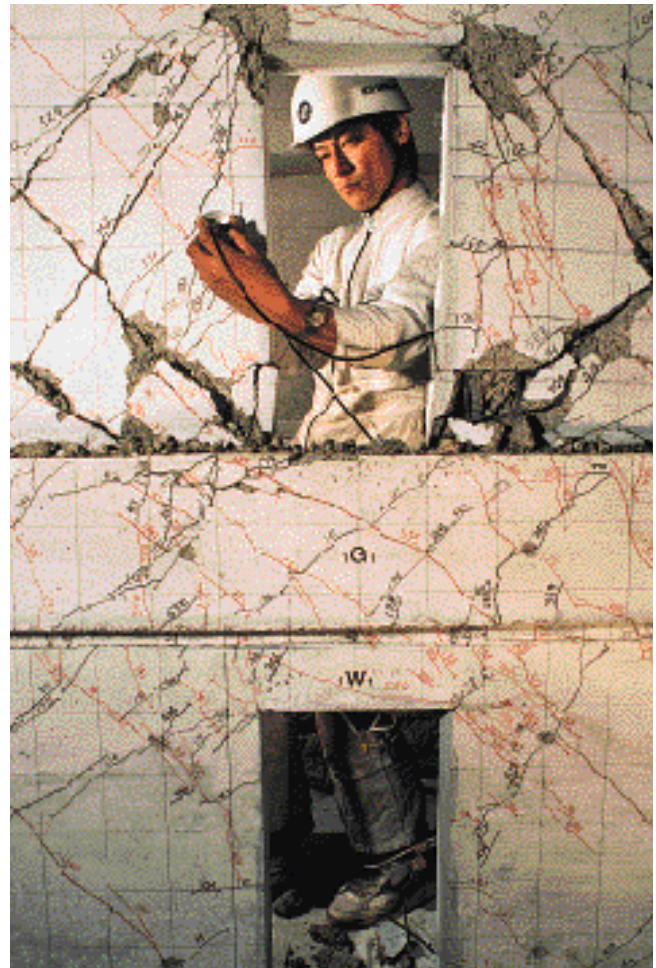


Photo: Tony Stone Images

Technician assessing damage to wall in 'earthquake' test, Japan

practices. WSSI is built from regional bases to facilitate development of shared hazard information by best utilising existing communication and resource networks.

A time for action

True to the spirit of its founding motto, 'A Time for Action', WSSI has initiated various activities and projects. It was decided early that WSSI should not undertake large, capital intensive projects but try to achieve steady and visible goals at regional levels in developing countries. WSSI would initiate and sponsor projects to transfer and share technology; develop professional engineering practice; and address crucial research questions that constitute gaps in our knowledge of how structures respond to earthquakes and how these structures can be built to withstand them.

The first and really epoch-making activity of WSSI was the workshop on 'Seismic Risk Management for the Countries of the Asia-Pacific Region', 8–11 February 1993 in Bangkok, Thailand. This workshop was a spectacular success, far exceeding anyone's

expectations. Thirty participants from twenty Asia-Pacific countries attended. The main purpose of the workshop was to assess the needs and resources of these countries and to develop efficient strategies to make a difference. Participants reported on the state-of-the-art of earthquake engineering in their countries. They also commented on how available knowledge is used (or not used) in developing earthquake disaster mitigation strategies in their home countries. It became evident that many of the countries were willing to do things that would mitigate the effects of future events. Many of these countries are rarely heard or represented in the international earthquake community. The main strategies for effective implementation that evolved at this meeting were as follows:

- WSSI should help raise public and government awareness of earthquake risk in developing countries. Towards this objective, the importance of holding High Level Meetings in each of the participating countries was recognised. Such meetings should be attended by government officials, business leaders, representatives of social and cultural institutions, mass media, and technical and scientific leaders
- WSSI should help in creating a local information network. Towards this objective, a regional network called WSSI Asian Resource Network (WARN) was formed
- WSSI should be a catalyst for action in earthquake risk management, education, and awareness. This could be accomplished through regional workshops.

Eight high level meetings were held between 1993 and the present. Typically, these meetings would span two days and include a private meeting with senior government officers, financial and business leaders, representatives of social and cultural institutions, media, WSSI resource people, and invited engineers and scientists from the host country. They also included a public forum with lectures to technical and professional organisations of that country. Such meetings were held in Singapore, Malaysia, Nepal, Bangladesh, Sri Lanka, Myanmar, Vietnam and Uganda.

In the spirit of being a catalyst, WSSI also organised or co-organised various workshops and courses around the world. These promoted both general initiatives, like the *'Earthquake and Megacities Initiative'*, and more specific locational workshops such as *'Urban Earthquake Risk Management—Preparing for the Big One in Tokyo'* held in 1995. Workshops have certainly increased the presence of WSSI worldwide and have helped to increase awareness of earthquake disaster reduction strategies in the Asia-Pacific Region.

In addition, various directors of WSSI have lectured on behalf of WSSI in various parts of the world. For example, a one-day lecture series was given by members of the WSSI Board to the Structural and Civil Engineering Association of the Philippines. These lectures were held in Manila in conjunction with the Second Board of Directors meeting in February 1994.

In the spirit of creating an information network, WSSI in co-operation with the United Nations University (UNU), the International Centre for Disaster Mitigation Engineering (INCEDE), and Stanford University established a Global Network on Natural Disaster Risk Management (GLO-DISNET) on the internet on August 1994.

WSSI has also initiated projects in the interest of assisting individual countries. The usual role of WSSI in such projects is to provide needed data and capabilities to review the completed work. For example, upon the request made by the Indonesian Director, Mr T. Boen, WSSI has provided the needed resources to develop a revised seismic hazard map of Indonesia. Such a map will be used in revising the Indonesian building code. Also, a joint programme between the International Association of Seismology and Physics

of the Earth's Interior (IASPEI) and WSSI was initiated to develop a global earthquake risk map. WSSI would provide expertise on vulnerability whereas IASPEI would provide expertise on hazard. The idea of this effort is to use macro and aggregate data bases rather than detailed geological, seismological, or engineering data bases. WSSI assisted the Meteorological Service of Singapore in developing and installing a system of five seismographs for earthquake monitoring. Similar assistance is also being provided to Malaysia and Brunei. WSSI helped Uganda set up a national organisation called the Uganda Seismic Safety Association and has been a strong supporter and promoter of the RADIUS project.

These initiatives have resulted in concrete new developments. Indonesia has updated its seismic hazard map and will develop a revised earthquake code. Countries in South East Asia are reconsidering their earthquake insurance tariffs. Pakistan, Nepal, Thailand, and Singapore have formed national organisations for earthquake engineering research and practice. Many more countries are considering such a move, including Vietnam, Malaysia and Fiji. There is a new resolve and an awareness of these issues in both the Asia-Pacific region and the Central Asian Republics.

In order to monitor progress, a second workshop was organised in Bangkok between 17–20 January 1999. Some 18 countries, many of which were also present at the 1993 Bangkok Workshop, were invited to participate. The main purpose of the second workshop was to evaluate the effectiveness and impact of IDNDR programmes, including efforts of WSSI, towards earthquake disaster mitigation. The second Bangkok workshop provided a qualitative review of the programmes made by various countries during the decade. Each country representative presented the status of public, private and government programmes on earthquake risk management in their respective countries. They attempted to delineate the impact made by WSSI and other programmes on their country. While some participants felt that their country's earthquake engineering capabilities had not advanced, it was observed that fairly large gains can be made with a relatively small effort in countries that have a limited background in earthquake risk management.

Future plans

While the IDNDR approaches its conclusion, the need for assistance to manage earthquake risk will not end. WSSI is committed to working in partnership with other professional organisations to continue its efforts to reduce life and property losses around the world. Towards that end, WSSI has made various decisions on how it plans to continue beyond the IDNDR.

Continuing to work as a legal non-profit organisation, WSSI will hold meetings in countries that need the awareness most, strengthen its role as a catalyst and an advocate for earthquake risk reduction efforts and forge partnerships with organisations with mutually complementary objectives for collaborations. This will establish the WSSI fellowship, providing the opportunity for highly motivated individuals to further the goals of WSSI.

WSSI has made significant contributions at regional and international levels. The philosophy of WSSI is not to set over-ambitious targets, but to work on well-defined regional projects that include experts who are dedicated to the ideals of IDNDR and to the goals of WSSI. To date, WSSI has been successful in spite of its very limited resources. The future success of WSSI depends to a large degree on the positive and enthusiastic participation of NGOs, governments, individual engineers, scientists and professionals from all fields dealing with the problem of earthquake disaster mitigation. As the WSSI motto states, the time for talking is over, the time for action has come.

THE ROLE OF TRADITIONAL MECHANISMS

Warning and evacuation effectiveness in Malaysia

Associate Professor Dr Chan Ngai Weng, University Sains Malaysia, Malaysia

LIKE MOST DEVELOPING countries, Malaysia is caught up in a policy of rapid development. This includes the import and application of new technologies in all fields, including flood forecasting, warning and evacuation. If applied properly, technology can effectively reduce loss of life, livestock, crops and property damage. However, sophisticated (imported) flood warning and evacuation systems (FWESs) are alien to the public, who are accustomed to traditional FWESs. Hence, without proper education, the effectiveness of more sophisticated systems is diminished. In contrast, traditional FWESs have been employed for centuries and the locals understand them well as they are used to them. Because of their long adaptation, locals respond effectively in times of flooding. Exchanging old for new systems without sufficient warning or training can endanger lives.

Officially, the government is responsible for flood management and many strategies have been employed to reduce the impacts of flooding, with a certain degree of success. However, official response to floods is limited by a reactive approach based on evacuation, relief and rehabilitation, the low salience of floods on government agendas, the lack of interaction and co-operation amongst government agencies dealing with floods, the bureaucratic nature of government agencies, and a reluctance to relocate amongst the population.

Malaysians living in floodplains are accustomed to floods and have developed traditional adaptations and responses to reduce the effects of flooding. These responses have been effective but their extent is generally limited because they are fragmented and unco-ordinated. However, incorporating these traditional systems into official systems would greatly reduce flood losses. The Malaysian government is currently moving towards a comprehensive approach involving the people and incorporating their traditional knowledge and systems into the modern sophisticated systems of flood management.

One of the commonest failures in disaster management concerns the lack of understanding (often by governments) of the social and cultural/traditional mitigation measures of the local community (Davis, 1985). The sociological literature on hazards recognises the importance of traditional response to hazards (Douglas, 1992). Modes of human response to hazards synthesised by Burton et al (1993) also recognises cultural adaptation, and suggests that the roots of decision-making in the face of potential hazard may be deeply embedded in traditional formations (Horlick-Jones and Jones, 1993). One's cultural background is, therefore, a structural influence which shapes one's perception as well as behaviour in response to hazards. Often, despite having the most sophisticated and modern response systems, overall disaster reduction is ineffective largely because the people

at the grassroot level (ie. the victims) do not understand these modern systems and hence do not know how to respond effectively to them.

Traditional measures

The capacity to anticipate, cope with, resist and recover from the effects of flood hazards depends largely on an individual or household's adaptability and resilience. Many Malaysian families have evolved responses to reduce and mitigate flood hazards. Because of higher levels of exposure to flood risks, floods have become, and still are, an integral part of Malay culture and an accepted part of their lives. Disasters often act as 'agents of change', resulting for example, in innovations in hazard-resistant architectural and construction designs (Davis, 1983). In Malaysia, probably the most unique adaptation that has evolved in response to flood disasters is the Malay stilt house (Figure 1). The stilt house originally evolved as an adaptation to the occupation of swamp-land and frequent flooding in riverine/coastal areas (Chan, 1997). This permanent form of flood proofing is still predominant in the traditional rural areas where frequent flooding is prevalent. Another common form of traditional adaptation is that of 'clustered houses' joined by wooden walk-ways to further strengthen the houses against fast river currents during flooding (Figure 1). Rumah Rakit or literally 'Raft Houses' are yet another unique form of traditional adaptation to flooding (Figure 2). These houses are built on rivers and rise and fall with the river level. These houses are inhabited by fishermen and are found dotted along the major rivers in the country.

Some traditional Malay houses are in fact 'portable'. In Kelantan State, some villages have wooden houses that can be carried and moved like a sedan chair. During the dry months, these houses are located near rivers for accessibility but during the monsoon months (November to March), they are moved to higher grounds to prevent flooding. Other traditional forms of architecture built to defend against flooding are as follows — the raising of the floors by successively building higher levels over existing ones; planting trees in front of houses to reduce the impact of river currents during flooding; piling tree trunks along erosive banks of rivers, also to reduce impact of river currents; building annexes and livestock barns (eg. chicken coops) in the path of river currents; canals are also a form of adaptation; and concrete or cement flood barriers surrounding houses (including thresholds at the doors) can prevent moderate flooding.

The use of the sampan or Malay canoe has probably saved many lives during the course of Malaysian history. This is the predominant traditional mode of transportation in rural villages. It also doubles up as the major means of livelihood as fishermen use



Figure 1: The traditional Malay 'stilt-house' as an effective defence mechanism against flooding. The houses are 'clustered' and joined by wooden walk-ways to further strengthen the houses against strong river currents during flooding

them to go out to the river and the sea for fishing. In times of flooding, villagers will use the sampan to bring their family to safety by paddling downstream. Sampans have also been used as a means of conveying flood warning to downstream villagers when the river at a certain upstream village has reached a critical level. Now, many sampans are equipped with a motor and this has markedly increased their speed and effectiveness.

In rural villages, especially where padi farming is the main occupation, the locals have double use for their padi fields. The fields are usually located much lower than the land on which houses are built because wet padi needs to be inundated by water all the time (except during harvesting when water from the fields is drained). Fields are also located on the lowest land for the purpose of irrigation. Therefore, when the rivers overflow their banks, padi fields act as a form of retention ponds. School fields, fish ponds and manmade lakes are all forms of traditional retention ponds employed by villagers long before engineered artificial retention ponds.

The locals have also used 'traditional flood gauges' for river levels to make decisions with regard to issuance of flood warning and evacuation notices. In Kuala Krai town in Kelantan State, locals have built a series of steps from the bank of the Kelantan River all the way down to the river. This is now famous as the Tangga Krai or Krai Steps. The villages can read the level of the river simply by noting the number of steps inundated by the river. Through past experiences, a certain critical level whereby flooding is most certain to occur is determined. The step at which this critical level is reached is painted red. Over the years, the State Drainage and Irrigation Department has found the steps useful and has incorporated it as a form of official flood detecting device. The department has since installed stick gauges along the steps which can be easily read as a form of flood warning device. For example, when the height of the river reaches 27.4 metres, then flooding will occur in Kuala Krai. The 'Alert', 'Warning' and 'Danger' levels at the steps in Kuala Krai are 19.8, 22.9 and 25.9 metres respectively. This means when the river at Kuala Krai is at the warning level, all downstream areas are likely be flooded and

hence a warning will be issued to downstream stations. The waters at Kuala Krai will reach Kota Bharu town in six hours. Before the extensive use of telephones in the years before independence, villagers used coloured flags (and later balloons) hoisted above the tallest tree on a hill top to indicate the three levels at Kuala Krai to downstream villages, ie. green, orange and red, depicting alert, warning and danger. Nowadays, the use of telephone, faxes and telemetric stations relay these messages to downstream areas much more effectively. Hence, the incorporation of a traditional mechanism into official FWESs works well here.

Informal FWESs of the traditional kind have been practiced by floodplain inhabitants in Malaysia for centuries and are still an important part of seasonal response to monsoonal floods (Chan, 1995c). Formal FWESs were only established fairly recently and have incorporated many of the practical aspects of informal FWESs.

There is a considerable volume of literature supporting the beneficial effects of warning systems on reducing flood damages (Neal and Parker, 1989). However, despite improvements on warning systems over the years (including recent inclusion of remote sensing technology and Geographic Information Systems), official FWESs have not been as effective as they ought to be. This is especially so in the remote rural areas which still rely heavily on traditional FWESs.

Evacuation systems are also non-structural/non-engineering flood mitigation measures of which the principal aim is to save lives. The life saving benefits of timely evacuation before the onset of disasters are well documented (Smith, 1992; Alexander, 1993). In Malaysia, tens of thousands of people are routinely evacuated during the seasonal monsoon floods which hit many parts of the east coast every year.

The overall effectiveness of FWESs depends not only on government official FWESs operating at the macro political economy level, but also at the institutional level and most importantly at the micro level of the individual. Traditional FWESs at the individual/community level have evolved through generations of flooding experience. Malay peasants whose ancestors have lived with floods just as they do now, have developed crude warning



Figure 2: Traditional 'Raft Houses' or Rumah Rakit on the Kelantan River near Kuala Krai, a flood-prone town

and evacuation systems which are still practiced in the remote villages and still play a vital role in saving lives. A simplified version of this kind of traditional warning and evacuation mechanism is illustrated by the following account:

Kampung Tendong (Batu) is one of tens of villages located on the floodplain of the Kelantan River near the town of Pasir Mas. It has a total of slightly more than 200 houses and a population of slightly more than 1,000 inhabitants. Its ketua kampung (village head) Haji Ali heads a village committee on flood warning and evacuation (Figure 3). Haji Ali has appointed several of his residents who live nearest to the river (those who get flooded first) as flood wardens. These wardens report to Haji Ali as soon as the flood waters rise above the banks of the river. Haji Ali alerts all villagers about the river breaching its banks. However, no evacuation order is given yet. Some families, usually those living nearest to the rivers may decide to evacuate to their relatives' place in other kampungs. The wardens usually move their wives and young children but they stay behind because of their duty. Once the river has over-topped its banks, the rise and fall of the river levels are then monitored day and night by the wardens. When the water level has reached a certain height (usually above the normal stilt height of about 1.5 metres) and is still rising—the wardens abandon their posts and report to the ketua kampung who then orders all villagers to evacuate (usually to the mosque or school which are usually located on the highest ground in the kampung). The ketua kampung then informs by telephone or dispatch rider the other ketua kampungs of nearby villages about the flooding in his kampung. This process is then repeated by the ketua kampungs of other villages when their villages are subsequently flooded.

The traditional warning and evacuation mechanism has worked well, mainly because local expertise and self-reliance are employed as important inputs. Supplemented by modern technology such as the telephone and the use of sirens, informal FWESs are used effectively by many kampungs in the east coast of peninsular Malaysia. This is because the mechanism is an 'active' system whereby people can actually see the flood and they need little

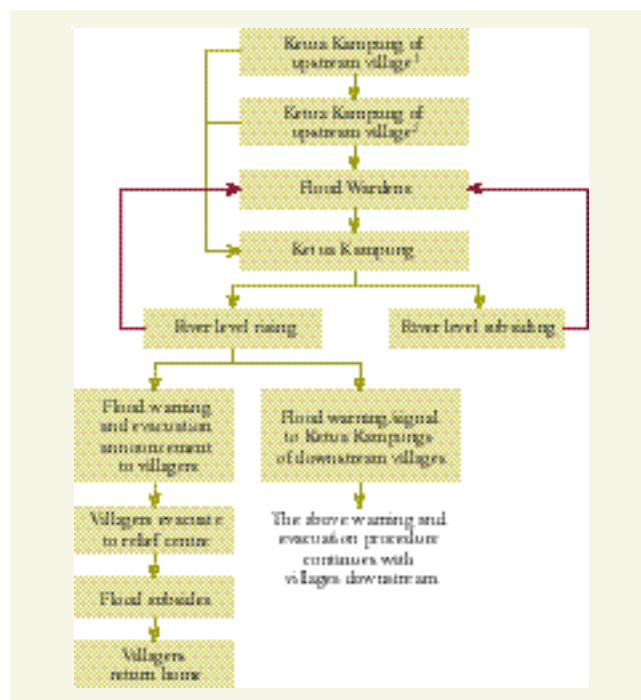


Figure 3: The traditional flood warning and evacuation mechanism practiced by Malay peasants living in remote villages in Peninsular Malaysia (the ketua kampung is the one who first makes the announcement for evacuation)

convincing to take responsive action to save their lives and those of their families. This is in contrast to a formal FWES whereby the flood forecast is made by the DID based on rainfall and river levels. People living in villages downstream who are warned about impending floods actually do not see any heavy rainfall or the river rising above the danger level. Furthermore, a radio broadcast of impending floods without the actual signs of flooding does little to convince people to evacuate. This situation is certainly not helped by the many 'false warnings'. As people living in flood-prone areas are flooded so often, they are 'hardened' by years of experience and begin to rely on themselves and the traditional mechanism which has served them for so long. The main shortcoming of the traditional mechanism is the short lead time before flooding occurs, which often is only minutes.

Conclusion

In Malaysia, there is no lack of official effort to reduce flood losses. However, the authorities have not totally exploited the usefulness of a rich variety of traditional flood reduction mechanisms which they can incorporate into official systems. This has led to, among other things, the reluctance of flood victims to co-operate and respond effectively to official FWESs.

Comprehensive flood hazard management in Malaysia can only be tackled effectively if the population is convinced that official response systems really work. More importantly, traditional systems in which the population has confidence must be incorporated into official systems. There is little hope that a wide-scale import of systems can work no matter how sophisticated the system might be. When introduced, new systems must be adjusted to incorporate traditional response systems that the people understand and have confidence in. It is only with a multi-disciplinary approach encompassing modern and traditional response systems, that overall flood hazard reduction can become more effective.

Developing a disaster prevention strategy in Jamaica

Barbara Carby, Office of Disaster Preparedness and Emergency Management, Jamaica

IT WAS AS THE RESULT of a major flood in 1979 that an official agency for disaster management was established in Jamaica. Although set up in response to these floods, the Office of Disaster Preparedness and Emergency Management (ODPEM) as it is now known, is devoted to comprehensive disaster management—encompassing prevention, mitigation, preparedness, response and recovery. An organisational structure appropriate to this comprehensive approach was established with a department dedicated to information and training, another to mitigation, planning and research, one to preparedness and emergency response and one to support services.

In 1997 the El Niño conditions led to a severe drought necessitating trucking of water to areas most affected. Because of the shortage of potable water, the population resorted to water sources which could have been polluted. The National Drought Management Committee promoted a 'safe drinking water campaign', encouraging the population to purify water for domestic use by boiling or adding bleach. Flyers were distributed in newspapers and messages were disseminated via electronic and printed media, as well as in schools and at health facilities. This public awareness campaign averted outbreaks of gastro-intestinal diseases and typhoid which is endemic in some areas of the country. As a result of this severe drought a national drought management plan was developed, encompassing monitoring, forecasting, preparedness, mitigation, response, relief and rehabilitation.

Preparedness and mitigation: The case of Portland

The parish of Portland, located in the northeast of Jamaica, receives the highest rainfall in Jamaica. Characterised by steep slopes, deep valleys and many rivers, in the past five years it has experienced three floods which resulted in severe damage. The vulnerability of the population is increased by building houses close to rivers and on steep slopes. In January 1998, five people were killed by a debris flow which buried the building in which they were sheltering. Flooding caused extensive damage to housing stock and agriculture, estimated at some US\$ 10 million. Approximately 5,000 people were affected by flooding or landslides, many of whom had suffered in the previous incidents. It was decided that victims who had lost their homes should be relocated. These people qualified for a 'starter' housing unit from ODPEM. As there is no law requiring relocation in Jamaica, victims were relocated on a voluntary basis. The majority of them did not own the land on which they lived and were able to enter into lease agreements elsewhere. Relocation of landowners proved more difficult and procedures for those cases have not yet been completed.

Experience in Jamaica has shown that public acceptance of relocation is low. In this case, to increase the probability of acceptance, candidates were asked to find their own alternative locations. Twenty families accepted the offer and found potential sites.

To prevent relocated people settling in high risk areas, a multi-disciplinary team composed of geologists, hydrologists and planners carried out vulnerability analyses of sites chosen by the families before approving them for relocation. This team was drawn from ODPEM, the Mines and Geology Division, Water Resources Authority and the Parish Council responsible for the area. Once the technical team approved the site, victims were able to access a housing unit or grant.

This planned relocation is a mitigation activity carried out in an attempt to break the cycle of victims being repeatedly affected by the same hazard because they continue to live in the same vulnerable location. Portland is also the focus of another intervention by the ODPEM. A project 'Vulnerability Reduction for the Rio Grande Valley' has been funded by the European Community. The project will see the establishment of a community-operated flood warning and disaster management system. A community disaster management committee will be trained to monitor rainfall and river data and to forecast flood conditions. It will also be responsible for alerting, evacuation and management of response. A multi-agency team will produce hazard maps which will guide development in the area. The local planning authorities, as well as communities, will be able to use these maps and data to guide development in high risk areas, and as a basis for mitigation activities. The final component of the project is public awareness and training in which the communities will be sensitised to the inter-relationships between environmental degradation and increased impact of natural hazards and will be trained in the use of hazard maps in community planning. This project has been accepted with enthusiasm by the communities.

The importance of pre-disaster planning in post-disaster response was also demonstrated in Portland during the 1998 floods. Community disaster groups, trained in the basics of disaster management, had been established in many of the mountain communities. During the intense rains and flooding, large landslides destroyed roads and many communities were completely cut off from vehicular access. The disaster management committees organised runners to bring information on damage from these communities into the Parish capital. Later, when relief flights were arranged, these groups were responsible for transferring food and relief supplies from helicopter drop zones into villages assisting with registration of victims and distribution of relief supplies. Their involvement proved invaluable and reduced delays in response as external relief groups did not have to be organised after the disaster. Members of the committees also provided psychological and spiritual support for victims and their families and enjoyed a high level of trust by the communities.

The Rio Cobre flood warning system

The Rio Cobre is one of the larger rivers in Jamaica, running to the island's south coast. It threatens densely populated areas as



Damage caused by the St Mary's flood rains, 18 May 1999

well as agricultural land. An automated flood warning system comprised of automatic reporting stream and rainfall gauges has been installed in the river valley. The real-time data is telemetered into the offices of the Water Resources Authority in Kingston which then alerts ODPEM if flooding is probable. From time to time the automated system malfunctions, usually due to damage from lightning. There is, however, a system consisting of staff gauge readers who monitor the river heights and report to the Water Resources Authority via the nearby Police Station or by telephone. Flood warnings are then issued based on river height. This system successfully engages the local community in preparedness, monitoring and alerting activities.

Communicating the importance of preparedness, prevention and mitigation

Conception of an approach and even establishment of a structure for implementing that approach is of course no guarantee of success. Progress to date has required unrelenting effort by ODPEM. However several factors assisted the organisation.

The National Disaster Management Structure: The National Disaster Management Structure as outlined by the National Disaster Plan includes 60 entities drawn from the public and private sectors and non-governmental groups. Each of these entities is assigned a role encompassing pre- and post-disaster activities. Involving all the actors in pre-disaster activities and giving them responsibilities is one way of encouraging their acceptance. Despite this team approach however, some organisations do not always fulfil their roles, regarding disaster management as being of lesser priority or being the sole responsibility of ODPEM.

Involvement of policy-makers: Support of disaster management by the policy-makers and political directorate is critical to the success of any disaster management programme. Support should be practical in the form of provision of financial resources for programmes, but moral support is also important. In Jamaica, the National Disaster Committee meets at least once annually with the Prime Minister and senior government officials. This provides the chance for all members of the team to air their concerns at the highest level and gives the Head of Government a chance to review progress made over the past year. It also signals the importance placed by the government on preparedness and mitigation.

Regular contact and involvement: ODPEM is the only agency with the exclusive mandate for disaster management; other organisations have their own areas of emphasis and priority. In order to maintain their focus on disaster management, partners are involved in meetings, in all planning activities, in training and in simulation exercises. This constant involvement of members of the national disaster management team keeps interest high espe-

cially among the critical agencies. Because of the size of the island, its relative lack of resources and its peculiar vulnerabilities, ODPEM is integrally involved in all hazard-related activities. Thus it works closely with the national environmental agency as well as the physical planning agency. These agencies involve ODPEM in evaluation of environmental impact assessments which require hazard assessments and disaster plans before approval, and in review of applications for development.

The importance of preparing the population cannot be overstressed. It is the acceptance of the paradigm 'prevention pays' by the population that will ultimately decide the success or failure of disaster management programmes. ODPEM uses a number of strategies to sell the message of preparedness and mitigation. Anniversaries of major events are commemorated each year, usually through the involvement of the media and Parish Disaster Committees. One week in January, designed around the anniversary of a major earthquake, is declared Earthquake Awareness Week during which earthquake awareness is stressed. June, the beginning of the north Atlantic hurricane season is designated Disaster Preparedness Month, during which preparedness for hurricanes and other hazards is highlighted.

In addition, there is an on-going programme of public awareness which reaches schools, commercial interests, government agencies and communities. Pamphlets, posters, booklets and news releases, seminars and community meetings all help make the public aware of preparedness and prevention measures for a variety of hazards. Parish Disaster Committees also carry out their own public awareness programmes.

The Jamaican media gives a high level of support to all aspects of the disaster management programme, helping to spread the message 'prevention pays' even when there is no disaster event. Without their help, it would be impossible to reach any significant numbers of the population on a sustained basis.

Community involvement: Experience in Jamaica has shown that communities will take responsibility for disaster management, and vibrant community groups can be formed once there is strong community leadership. Involvement of communities before disasters reinforces the importance of preparedness and mitigation.

The Jamaican programme has always used local expertise. Although various projects have benefited from international financial support and use of short term expertise, the structure is locally based. This gives several advantages, one of the most important being an understanding of and commitment to the success of the programme. Use of local expertise has also provided continuity. The country has been able to build a pool of readily accessed expertise available for disaster management. Another advantage of this heavy reliance on local resources is availability for immediate response. This is important as Jamaica is accessible only by sea or air from neighbouring countries. Delays will inevitably be incurred before assistance can reach the country after a disaster.

Preparedness, prevention and mitigation all bear positive results for the economies of countries in terms of reducing damage and disruption. Ultimately, however, the most important reason for emphasising these aspects of disaster management is the saving of lives. In 1951, Hurricane Charlie struck Jamaica causing 152 deaths. Then Hurricane Gilbert struck in 1988 causing 45 deaths despite the increase in population and the higher percentage of people living in high risk areas. Improved tracking and forecasting systems allowed better alerting and warning of the population; the emphasis placed on preparedness, prevention and mitigation allowed a knowledgeable population to take the necessary precautions to protect itself.

CASE STUDY

A perspective of disaster management in Turkey: Issues and prospects

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TURKEY RANKS HIGH among countries that have endured significant loss of life and property due to earthquakes and other natural disasters. This accumulation of experience and practice in disaster management has led to the establishment in 1959 of a ministry to handle all disaster-related matters.

The disaster management system in Turkey is defined in terms of an elaborately drawn up system of statutory regulations in accordance with a comprehensive law passed in 1959. The system is centralised in character, and is handled largely by the government and its agencies. In principle, the state has assumed the role of a generous insurer who promises to replace dwellings and places of business should these be destroyed by natural disasters. The central authority has also undertaken the responsibility in all matters of pre-disaster planning, and post-disaster relief, rescue, medical care, temporary shelter, and food supply. This institutional character supersedes the initiative and power of local governments, and limits community participation.

Given the size of Turkey, and the fact that the main hazard type is the earthquake, it is unusual for a given disaster to be considered a national event. Statistics of dwelling units made uninhabitable by natural disasters during the last 70 years is listed in Table 1.

There have been nearly 130 damaging earthquakes during the period 1903–98. These have caused the death of 72,000 people, injured some 130,000, and destroyed about 500,000 dwelling units and other building structures. Viewed within the context of loss of life and injury, earthquakes account for about 90% of total hazard losses. Measured in terms of direct economic losses, natural disasters have accounted for one per cent on the average of the GNP, with earthquakes accounting for eight per cent. A sizeable part of the population (66%) lives in high earthquake-risk areas which also contain major economic investments and other costly lifeline construction elements.

A comprehensive approach to disaster management in Turkey was developed in 1959, through legislation to enable the administrative structure of the government to manage disasters in a timely and efficient way, so that losses and human suffering are minimised, and rehabilitation can be implemented effectively.

The basic premise of the 1959 law is to enable the government to cope with disasters through the instrument represented by the Provincial Committee with its composition described in Figure 1. Turkey is divided into some 80 administrative units called provinces. These are governed by governors who are appointed by the national Government.

In Turkey the disaster management system is highly centralised because it is essentially the responsibility of the central, and not of the local governments. The governor of a province can demand assistance from other provinces that have not been affected by the disaster. Funding for relief items comes directly from the central government. The local authority, by contrast, is headed by the mayor, an elected politician. It is the local government that issues building permits, supervises construction, and plans urban development, all of which play a crucial role in mitigation of losses.

There is no single national co-ordinating agency for disaster management in Turkey, but a blueprint represented by the law. Rescue and relief operations are the direct responsibilities of the provinces or districts with assistance provided by the central government or externally, and the central government is responsible for reconstruction and rehabilitation. Locally elected governments are responsible for mitigation, such as the implementation of the earthquake resistant building code in construction within their jurisdictions. Each ministry to which reference is made in the parent law has a unit responsible for disaster management rather than there being one national co-ordinating agency with proper legal mandate and power. The Turkish Red Crescent Society, the General Directorate of Civil Defence (part of the Ministry of the Interior), and the armed forces also play a role in rescue and relief operations.

THE NATIONAL PREPAREDNESS PLAN: LAW NO. 7269

This law provides implicitly the basic constructs of what may legitimately be called the national preparedness plan. Other than it and its statutes, there is no explicit national preparedness plan for Turkey. The relevant ministries, provincial administrations and sub-districts are required to

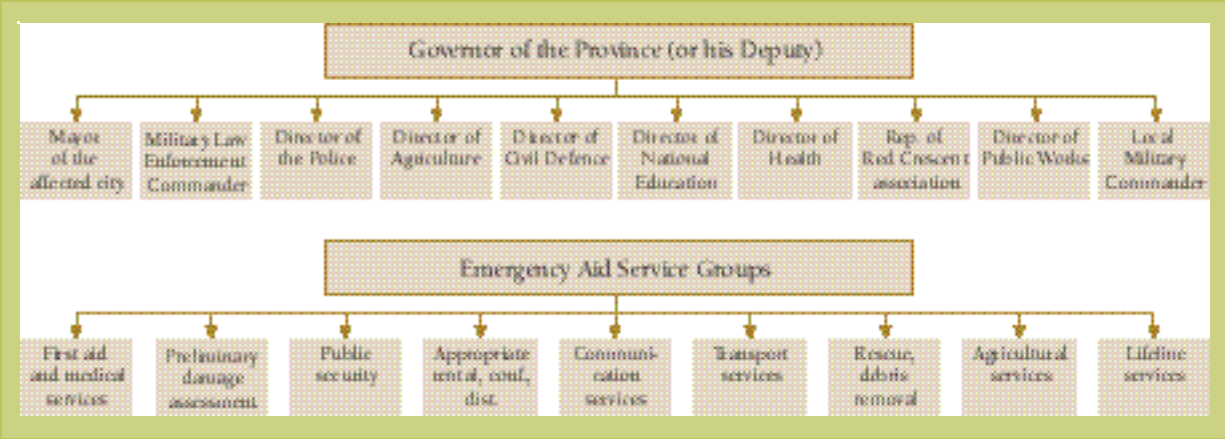


Figure 1: Organigram of the Provincial Rescue and Relief committee

Natural Disaster Type	Per cent of dwellings destroyed
Earthquake	61%
Flood	14%
Landslide	15%
Rockfalls	5%
Fire	4%
Avalanche, storm, rain	1%

Table 1: Dwelling units destroyed by natural disasters in Turkey

draw up their own emergency preparedness plans, and there is even a regulation that helps local authorities in preparing these. A need exists to harmonise central plans with provincial plans.

Seven by-laws regulate how the national preparedness plan is enforced:

1. The Fundamentals of Emergency Aid Organisation and Planning Associated with Disasters
2. Basic Principles of Determining the Degree by which the General Public is Affected by Disasters
3. The Identification of Disaster Affected Individuals to Be Assisted
4. The Remissions of Loaned Sums for Expenditure in Connection with Buildings to be Built as a Consequence of Disasters
5. Valuation of Leftover Buildings, Lots, and Lands Appropriated after Disasters
6. Expenditures from the Disasters Fund Established Accordance with Law No. 7269–1051
7. Structures to Be Built in Disaster Areas (Seismic Design Code)

Local disaster planning: The planning phase of natural disasters finds explicit reference in Article Four of Law No. 7269. The principal task for disaster planning is entrusted to the Provincial Committees headed by governors. Governors have been granted broad powers and responsibilities for emergency management.

Damage assessment surveys: Assessment of building damage in a disaster-stricken area is performed primarily

by teams of the General Directorate of Disaster Affairs. Survey teams from other institutions may be seconded.

Permanent rehousing: One of the major objectives of post-disaster surveys is to provide the affected populations with permanent shelter. This is accomplished in accordance with the guidelines contained in Law No. 7269 as follows:

1. Determination of Individuals to Be Aided
2. Provision of New Settlements
3. Allocation of Building Materials
4. Construction

For reconstruction of the stricken area, one of the following methods may be chosen:

1. Construction tendered to contractors
2. Construction by the ministry itself
3. Aided self help

CRITICAL ASSESSMENT

The law has a broad base in that it addresses all forms of natural disasters. Principles and criteria for allocating state funds to affected citizens have been clearly spelled out.

Financial measures: A feature of Law No. 7269 was the establishment of the ‘Disasters Fund’. Relatively free from the customary restraints of national budget resources, the fund is to provide the required financial support for agencies involved in the disaster continuum, with ensured quick release of funds.

Revision of legal documents: Many regulations and other instruments concern planning and actions to be taken in the response, recovery, reconstruction, mitigation and preparedness phases of regional and local disaster management. The existing legal documents are continuously revised and assessed.

Relative political stability: The disaster management system is relatively immune to reappointments caused by political changes because provincial governors are civil employees, and not political figures.

Training of government officials: GDDA and AFEM, the European Disaster Training Centre, also embodied

within the Ministry of Public Works and Settlement, organise courses for officials involved in disaster management.

Weaknesses: Hierarchical nature. The hierarchical, top-down nature of the disaster management system tends to discourage local initiative, and can undermine the role of local authorities who must face the affected people.

Linkages between central and provincial government: Experience has shown a lack of adequate co-ordination between central and provincial administrations during the period immediately following a natural disaster.

Local officials: In some cases provincial officials charged with disaster management are themselves outsiders in the province, and may be unfamiliar with the local situation. The rapid turnover of government officials in some provinces may make rescue plans obsolete.

Financial limitations on disaster mitigation: The responsible agencies must be accorded the necessary financial means for fulfilling their mandates. Not always the case.

Land use: A major deficiency that needs to be addressed is the lack of accurate zonation maps for a better evaluation of the natural disaster hazard on a local scale so that a more rational use of the land can be planned by local governments.

Construction: A major deficiency relates to the supervision of building construction, and the legal responsibility for substandard building practices. Building code requirements cannot effectively be enforced in rural areas which are outside municipal boundaries.

Paternalism: This is the most pervasive feature of the system, and the most difficult attitude to correct. The disaster management system in Turkey does not contain instruments or mechanisms that would enable the active participation of the communities at risk. It is highly paternalistic, and gives assurances to the people that the all-powerful state will eventually replace all lost property, rebuild every shop, and rehabilitate affected economic investments through low-interest loans, debt annulments and free credits.

The concentration of population and economic activities in hazardous localities has increased the vulnerability of a larger segment of the Turkish society. This was not the case when much of the current legislative fabric was formulated nearly 40 years ago. Social and economic development have been adversely affected by disasters. This situation increases vulnerability and threatens the environment.

Areas of possible improvement in the disaster management system: Based on the analysis of the Turkish disaster management system summarised in the foregoing paragraphs, a number of areas may be formulated where capacity improving targets exist.

- Natural or technological disaster mitigation must be made an integral part of national and local-level sustainable development planning activities
- The framework of country-wide institutional disaster preparedness must be enhanced
- A pilot project for preparation of regional disaster preparedness plans inclusive of scenarios involving technological disasters for major urban or industrial centres should be initiated

- The GDCD must be reinforced to have an adequate number of well-trained and equipped units ready to intervene quickly
- Provincial search and rescue teams must be trained continuously, and be enabled to assume responsibilities beyond the boundaries of their own areas in case they need to be dispatched to other provinces
- The involvement of communities at risk in the disaster management system must be ensured
- Financial losses accruing from natural disasters must be distributed to a broader base through mechanisms of insurance.

Possible objectives, strategies and components of a comprehensive programme: The social and economic impacts of major future disasters can be reduced through tools of disaster management. Stages of disaster management (from prediction/forecasting, preparedness and mitigation to rescue and relief, rehabilitation and reconstruction) must be implicitly made an integral part of the operations of many agencies.

The primary strategy of the national programme is to enhance the disaster management capacity of Turkey through a combination of training, pilot provincial disaster preparedness studies, procurement of equipment and technology, an in-depth review of legislation and investigating the mechanisms for effective community participation.

The direct beneficiaries of the programme would be the population at risk, irrespective of gender.

CONCLUSIONS

Turkey is among those countries that have suffered great loss of life and property due to natural disasters. This has enabled the acquisition of practical experience in disaster management, culminating in 1959 in the establishment of a ministry to handle all disaster-related matters.

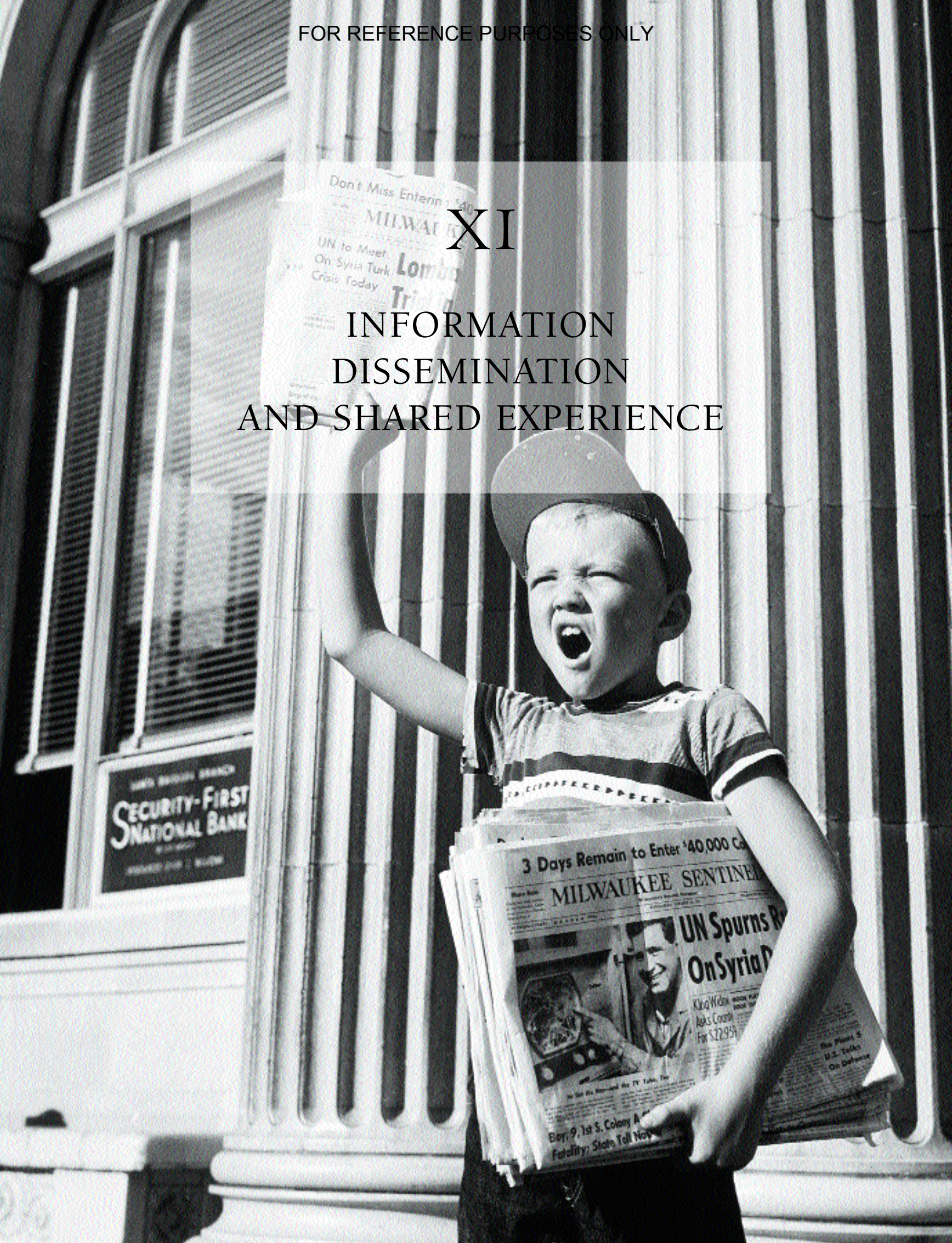
The disaster management system in Turkey is defined in terms of an elaborately drawn up system of statutory regulations in accordance with the disaster law. The system is centralistic in character, and is administered largely by the government and its agencies. This institutional character undermines the initiative and power of local governments, and limits community participation.

The purpose of this paper has been to provide a thorough review and a critical assessment of the disaster management capacity of the country. The prevalent form of natural disaster in Turkey is the earthquake, which has shaped the institutional response to all disasters. The state has assumed the role of a generous global insurer, promising to replace destroyed dwellings and small businesses. The central authority has also undertaken the responsibility for pre-disaster planning, post disaster rescue, relief, medical care, temporary shelter, and food supply.

The time has probably arrived for fundamental changes in the system that will transfer greater responsibility to individuals, with emphasis on local governments. Steps are needed in building supervision, urban planning, insurance, and quality professional services.

XI

INFORMATION DISSEMINATION AND SHARED EXPERIENCE



KEYNOTE PAPER

INFORMATION DISSEMINATION AND SHARED EXPERIENCE

Dr Juha Uitto, United Nations University, Japan

INFORMATION IS ESSENTIAL for effectively reducing the risk stemming from natural disasters. This fact was recognised when IDNDR was launched. The objectives included devising appropriate guidelines and strategies for applying existing knowledge; fostering scientific and engineering efforts to close gaps in knowledge; disseminating existing and new information; and developing programmes for demonstration, education and training.

The strength of IDNDR has been its ability to raise awareness of natural disasters and their impacts on the development efforts of societies affected by them. Yet losses from natural disasters, whether earthquakes, climatic hazards or others, continue to rise as we approach the new millennium. At the same time, hazards are becoming harder to manage as human societies are getting more complex and inter-linked.

Information dissemination and mutual learning from past events and experiences will be increasingly important in order to manage disaster risk. Knowledge and information are needed at all levels and at all stages of the disaster management cycle, from general awareness, to preparedness, response and long-term recovery.

Disasters always take place in a societal context. Therefore, disaster risk management must be fully aware of the social, economic, cultural and political forces prevailing in the society. The information needs also vary depending on the societal context. The UN General Assembly Resolution that established IDNDR pays specific attention to the needs of the developing countries. However, during implementation, the focus has too often been on the search for standard structural solutions that could be applied anywhere. This has unfortunately reduced the impact of the Decade. There are few occasions where technologies can be taken out of their societal context and

successfully applied without modification in a different country or area.

Information dissemination must be well targeted and cognisant of the particular context to which it is aimed. Sharing of lessons and experiences is certainly extremely valuable, but at the same time there is need to remain cautious about the universality of their application.

Defining the context

Natural disaster risk management must be placed into the overall developmental context of a society. Disasters destroy development efforts of countries and take valuable resources from needy purposes (Velasquez *et al*, 1999). Disaster management also operates in an institutional and social context and its effectiveness depends largely on how well it is integrated in the administrative and organisational structures, how inclusive it is in political terms, and how the flows of information are organised. It follows that disasters cannot be seen as purely natural events that can be dealt with by technological or structural solutions alone.

Natural disaster risk is a function of the hazard itself, the vulnerability of the population exposed to the hazard, and the specific mitigation measures that a society has taken in relation to the hazard (Wisner, 1999). The hazard itself may be seen as a natural

phenomenon, although it may also be partly determined by anthropogenic causes. This would be the case, for example, in the increased storm activity or droughts caused by global climate change. The other variables in the equation are distinctly human. Human exposure to natural hazards has increased significantly with haphazard growth.

Mitigation measures and policies obviously also form a societal category. How a society has decided to organise its disaster risk management, preparedness and recovery is again largely dependent on economic, cultural and political factors. These also influence the effectiveness of these policies and measures, as well as their coverage and inclusiveness in a society.

Information dissemination

Proper information at the various stages of the disaster management cycle can play a central role in reducing the vulnerability of people and groups, and enhancing the effectiveness of the mitigation measures. This information needs to be properly organised and packaged, taking into account the needs of the various target groups and stakeholders. It is essential that the information that is disseminated is also understandable and relevant to the recipient.

In devising information dissemination strategies, it is first important to understand the risk. The types of hazards that threaten the society in question obviously affect the information needs and dissemination strategy. A major earthquake, which occurs infrequently, but with potentially catastrophic consequences in a developed country, poses different requirements for information dissemination than a more frequently recurring hazard, such as seasonal flooding. Coping with these two hazards requires quite different strategies when it comes to preparedness, response and recovery. Consequently, the information needs are also different.

Accuracy of information is important. However, gaps in knowledge should not prevent communication on urgent matters. It is better to have at least some information to base decisions on than none at all. In disseminating the information, the level of accuracy can be communicated to the recipients to establish their understanding of the matter.

It is equally important to relate the information needs and dissemination strategy to the differing stakeholder needs. The various stakeholders may include a variety of groups with different educational and professional backgrounds, as well as interests. They may include policy-makers, disaster managers, academics, journalists, the private sector, NGOs and people's voluntary organisations (PVOs), and citizens (some with special needs). These groups will have different expectations and needs regarding disaster information. While a scientist may hope for accurate data concerning an undersea earthquake in order to model the progression of a tsunami, the people living in the threatened coastal area only require an early warning of the approach of the wave.

The different backgrounds and positions in the society and in relation to the hazard of the various stakeholder groups act as impediments to communication. For example, professionals in disaster management are used to a certain language containing jargon that is often incomprehensible to the layman. The professional background of a person also influences his or her perception and understanding of a problem. In discussions around IDNDR, we have frequently encountered cases where engineers and social scientists misunderstand each other's messages due to different theoretical frameworks, perspectives and use of language.

If highly trained professionals have problems of communicating with each other, the gap is often more difficult to bridge

between disaster managers and academics, on the one hand, and citizens on the other. This problem becomes especially pronounced when there is a large educational gap between the groups.

There is, thus, a need to tailor the messages to the specific needs of the various groups and to utilise various media and actors depending on their outreach and appropriateness. Taking the example of the Bangladesh floods, most of the affected people are resource poor and lacking in formal education. Communication and information strategies must take these factors into account and package the information in such a way that it becomes relevant to the day-to-day lives of the people. It may also be more effective to utilise NGOs or community-based organisations (CBOs) in awareness building and communication, rather than formal top-down government structures.

It must be recognised that people living daily in an environment are the best experts. They know the local conditions, the hazards, the problems, and the resources available. It is, therefore, important to bear in mind that information dissemination is not a one-way street. On the contrary, for any disaster mitigation programme to be effective it is important to learn from the local people and to involve them fully in the development of disaster risk management plans.

Sharing experiences

Much can be gained from sharing experiences in disaster risk management. Important lessons can be learned by analysing concrete experiences with actual disasters. These can point to weaknesses in organisation, faults in response, problems with medium to long-term recovery, as well as positive solutions and ideas. Similarly, information on new ideas and innovative solutions should be effectively shared with others who could benefit from these. The goal is to identify what works and to find the best practices.

Sharing experiences and ideas should not involve only what is usually understood as the disaster management community (disaster managers, emergency services, concerned researchers, and the like), but should include also other sectors, including policy-makers, NGOs, PVOs, and CBOs active in the field. Inclusiveness will reduce friction and enhance co-ordination and co-operation between the different actors.

Learning must be mutual. Sometimes it would appear that the industrialised countries with their advanced technology and highly educated manpower would always be the sources of knowledge from which the developing countries should learn. However, this type of one-way, north-south relationship, is hardly the optimal solution. In fact, south-south co-operation and mutual learning can often be much more efficient, because of similarities in the level of infrastructure development, technology, and social and economic conditions between the countries. Furthermore, industrialised countries can also learn from the developing countries, for example, when dealing with particularly vulnerable groups.

Attempts to utilise and transfer uniform technology and standard management plans from one context to another are all too common. This type of mechanistic approach is bound to fail, because it does not take into account the specific characteristics of the society where it is to be applied. Physical conditions (including the hazard), existing infrastructure, available financial resources, level of education (both of the disaster managers and the general public), organisational structures, management style, and culture in general, are all important considerations when devising a strategy for disaster management. Even two developing countries in the same region have such varying

conditions that no standard solutions can be devised. What works in Indonesia could be totally wrong in Nepal.

Therefore, it is essential to consider the social, economic, political and cultural factors when sharing experiences and lessons with other countries, cities and organisations. Sharing of information and transfer of technology are very important, but they cannot be utilised blindly.

The role of the internet

The World Wide Web is growing at a remarkable pace globally and is seen to offer outstanding opportunities for information dissemination, communication, and exchange of ideas and experiences. ReliefWeb (<http://www.notes.reliefweb.int/>) and GLO-DISNET (Global Network on Natural Disaster Risk Management, <http://www.geic.or.jp/partners/glodisnet/>) are excellent current examples. In addition, specific initiatives can use the web as a communication forum, such as the Quipunet conferences described later in this chapter.

While internet-based information dissemination and sharing holds much promise, it is not without problems. The obvious problem relates to the use and accessibility of the web. Although the penetration of the web has been impressive, it has been highly uneven. While most developed countries have widespread access to the web, many developing countries have no or little access. Africa in particular is severely lagging behind due to faltering infrastructure and sometimes government policies. Even in those countries where internet connections do exist, the use is often prohibitively expensive. In a country like Uganda, where a university professor's monthly salary is only a few hundred dollars, internet access costs about US\$ 1 per minute rendering the service virtually unaffordable.

Furthermore, internet usage and access varies considerably between professional categories. Academics all over the world are now used to utilising the internet for both e-mail communications, as well as searching and posting information on the web. However, the use rate by other professionals, such as emergency managers, is significantly lower. Needless to say, the utility of the WWW becomes even lower if we consider the average citizen, especially in the developing world.

Another problem is information overflow and lack of verification. The web is replete with information, which is largely unorganised. It is often difficult for the user to identify the relevant web sites. Similarly, the information placed on the web does not go through the normal filtering channels, such as peer review. Therefore, it is difficult to establish the accuracy and legitimacy of the information.

What is clearly needed is a clearing-house mechanism for sorting out and categorising the available information for its utility and reliability. Furthermore, it is necessary to bear in mind the limitations of reaching target audiences only through the internet. The ReliefWeb provides a service by which information is disseminated also by fax to those registered users without access to the internet.

International efforts for dissemination and communication

There are a number of international efforts that have sprung up to facilitate information dissemination and sharing of experiences in support of IDNDR and beyond.

Both RADIUS (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters) and WSSI (World Seismic Safety Initiative) are described in detail within this volume. The Earthquakes and Mega-cities Initiative (EMI) has been established

as an international collaborative effort involving a large number of international professional and academic organisations. The first workshop establishing the initiative was held in Seeheim, Germany, in 1997 (*German IDNDR-Committee*, 1997). EMI has established a twin-city system, which is directly aimed at mutual learning between cities with similar hazard situations. The twinning arrangements provide an excellent opportunity to analyse how two cities with similar hazards, but different capabilities due to their level of economic development (eg. Kobe, Japan, and Manila, Philippines) plan, react and respond to disasters.

The common denominator for all these initiatives is their focus on earthquakes. However, it must be realised that earthquakes represent only one sector of the hazard scene and affect only selected parts of the world. Other hazards, such as storms, floods, wildfires, landslides, volcanic eruptions etc, deserve equal attention.

In its Natural Disaster Risk Management programme, UNU has attempted to give due prominence to all types of hazards by focusing on the impacts of disasters and the vulnerability of populations exposed to them. The project on 'The Geography of Urban Disaster Vulnerability' is concerned with the social and spatial dimensions of vulnerability to natural disasters in an urban setting, looking into the social and economic determinants of urban vulnerability and how they affect responses to and outcomes of natural disasters (*Uitto*, 1998). The project further attempts to develop methodologies for the analysis of disaster vulnerability and disaster risk management. The project has established case studies in six mega-cities, all carried out by local groups utilising a similar methodology and research protocol modified to reflect actual local situation.

Conclusions

Information is power, also in coping with natural hazards and managing disaster risk. Dissemination of information on effective disaster risk management strategies and successful experiences is seen as a central function for the international community active in the field.

Modern communication tools, such as the internet, can be powerful aids in this process. However, it is necessary to remember that they are not a panacea and they cannot replace other more traditional means of communication. Access to and reliability of information on the web are still problems.

Key issues in information dissemination and exchange include equity and inclusiveness. This principle should encompass relationships both between countries, as well as between different groups and individuals within a country.

For disaster mitigation to be effective, there is need to involve all sectors of the society. Knowledge is neither a monopoly of certain experts. Regular people, NGOs, PVOs and CBOs all possess knowledge that is needed for promotion of better practices. Their information and knowledge needs to be disseminated and respected.

Mechanistic approaches to disasters and how to deal with them will not be successful. There is urgent need to realise that disasters do not take place in a vacuum. They involve people, organisations and societies that have their specific social, economic, cultural and political characteristics. These need to be taken into account in planning disaster mitigation measures.

The international community needs to take an active role in making the world a safer place for all people after IDNDR. North-south and south-south co-operation, sharing of information, and mutual learning will play an important role in this process.

Information, information and more information

John Owen-Davies, AlertNet, UK

LONDON — AS THE WORLD enters a new millennium, one of the more pressing problems it faces is how to contain complex humanitarian disasters. In the past two decades, natural and manmade disasters have become tragic staples of daily life, be they hurricanes in Central America, refugees fleeing fighting in Central Africa and the Balkans, cyclones battering Bangladesh or earthquakes ripping through parts of Asia.

After learning of the latest disaster from television, newspapers or the radio, most people turn to other matters, assuming that a well-oiled relief machine will go into action. Reality is often very different. To many insiders, the multi-faceted disaster prevention and relief industry is beset by problems including poor co-ordination and communications, deep-rooted suspicion and the stretching of a dwindling pot of cash given by a general public beset by 'donor fatigue'.

Some humanitarian non-governmental organisations (NGOs), with funds from government agencies, complain that they are expected to act as 'eyes and ears' in disaster zones in places such as earthquake zones in north eastern Afghanistan, thus jeopardising their humanitarian ideals. These same organisations are also grappling with problems of security for their workers in hostile environments, such as Chechnya, and demands for increased accountability, particularly for the money they hand out in disaster zones. The picture looks bleak. But there is a common thread — it is the need for accurate and speedy information.

Some leading relief operators have long recognised the need for such information. But information is only part of a solution for dealing with complex emergencies if temporary 'band aid' results are going to be avoided.

There are no simple solutions. 'It must be said that relief agencies no longer have privileged knowledge of what is happening in the field,' Urs Boegli, head of media services for the Geneva-based International Committee of the Red Cross (ICRC), told a conference in London. 'When I started working for the ICRC, reporters were queuing up in front of our field offices because we went further and we knew more...Some (reporters) know more than relief workers or at least as much. This reality should serve to foster dialogue,' he added.

We are living in what has been called the Information Age, which has seen the advent of a cultural revolution. And, like all such revolutions, there are political implications. Communities struggling with this new age — which can also be described as the 'Age of Confusion' or the 'Age of Information Overload' — include humanitarian NGOs in problem areas and governments.

In this new era, information technology is the underlying theme, but the major issue remains how the technology is used. 'In a world of the increasingly interconnected "infosphere" of ubiquitous communications and information, governments and their various agencies have lost their monopoly and control over information. Power, force and information no longer define the nation state', a Western communications official said. The

so-called cultural revolution had a clear impact for NGOs in the Great Lakes crisis of 1996–97, which saw the rise of information-smart commanders with highly sophisticated strategies of information control. This shattered assumptions by the humanitarian community of information superiority.

The exact shape of the cultural revolution is still unclear. The challenge is adapting to the speed, size and scale of its spread. This is the current issue for the so-called wired elite. A next major global challenge will be how to bridge the gulf between the information-rich and the information-poor on a national and global basis.

The 1990s have been a disaster watershed. And, if projections for the first two decades of the new millennium are anything to go by, there is worse to come. The scale of the challenge is evident from estimates that by 2012 of the 7.4 billion world population, an estimated 1.7 billion people — nearly double today's numbers — will be trapped in impermeable poverty, mainly in large conurbations in the Third World. This, together with a possible severe adjustment to the nation state system, increased alienation and insecurity and easier access to weapons of mass destruction, gives great cause for concern.

Major players in the disaster prevention and relief industry, including governments and NGOs, now realise that keys to success and saving lives include access to fast and accurate information, and the sharing of information. This information 'transition' has not won general acceptance and is unlikely to do so given the secretive nature of various organisations in the field. 'The well functioning of modern societies is based on the good and fast circulation of information. This is even more relevant in the case of a society vulnerable to natural hazards,' the UN's IDNDR Secretariat said, '...accurate information and its regular delivery is of importance in all sectors of decision-making as people's lives are at stake,' it added.

A senior official with an international relief organisation said: 'A key to the co-ordination of international (disaster) response is through open sharing of information'. 'Shortcomings and even disorganisation or some degree of chaos are inherent in any disaster situation, even in the most developed country. Any attempt to hide shortcomings will only stimulate the curiosity of the international mass media and undermine the international community's confidence in the assessment of needs provided officially,' the official added.

1998, was a worse-than-average year for natural disasters — some 50,000 people were killed and economic losses exceeded US\$ 90 billion. Compared with 13,000 killed and economic losses of about US\$ 30 billion in 1997. These statistics, from a major insurer, do not include manmade disasters. Each year, on average, disasters of all kinds kill more than 133,000 people and leave more than 140 million homeless.

There are some fundamental questions to be asked here. Why these massive tolls when more information on disasters, both

potential and actual, are being produced than ever before? While in the midst of a global information revolution, with some disasters being reported almost in real time, there are countless meetings and conferences on early warning, disaster prevention, disaster relief and so on.

Considerable emphasis has been placed in recent years on early warning systems and indices for potential disasters from earthquakes and volcanic eruptions to civil strife. There is considerable doubt among much of the humanitarian community about the effectiveness or usefulness of early warning systems and, instead, they put an emphasis on 'early response'. Randolph Kent, a British-based expert on disaster issues, wrote: 'In part, early warning systems are regarded as a means to wrap the aura of science around the self-evident and, in part, as a method of predicting the obvious and accepting that the unobvious is too difficult to predict'.

Nevertheless various agencies have made forays into the future as evidenced by a variety of agency-supported seminars and published papers. The output of these activities, however, does not seem to be directed towards mainstream activities or systematic follow-ups. 'They appear to be left on the periphery since speculation seems to be intellectually challenging but generally is perceived to have little direct consequence upon the roles and responsibilities of most humanitarian organisations,' Kent added in a paper entitled *'Humanitarian Futures in the Year 2012 — Practical Perspectives'*.

The truth is that many NGOs and other organisations in the disaster-related field get their early warning reports from major newspapers and magazines, as well as from their own profiles of specific regions or countries.

Problems in the disaster relief industry are made more difficult by divisions between some of the disciplines in disaster management — including academics and NGOs and, sometimes, between donors, UN bodies and NGOs.

The overall answer for these woes comes down to communication and information. But this is easier said than done in a business that often has sets of rigid, pre-set ideas among different players on how things should be conducted.

The Geneva-based International Federation of Red Cross and Red Crescent Societies (IFRC) is among major players which see information as one of the ways ahead. 'We are in the information business,' a senior IFRC official said.

It was in this atmosphere that AlertNet (www.alertnet.org), an online news and communications service for the international disaster relief community, was launched in 1997 by The Reuters Foundation, the humanitarian and educational arm of Reuters global news and information group.

When people talk of information and communication they are referring generally to the internet and the media. Both are powerful but are far from universally accepted. There are suspicions, often deep-rooted, on both sides. The internet has grown tremendously since 1981, when there were 235 inter-linked computers. This grew to 300,000 in 1991 and then again to 100 million in 1998 following the introduction of the World Wide Web and web browsers six years earlier. But even if the number reaches one billion by 2005, as some experts predict, a large portion of the world will not participate. Three-quarters of the people in the world do not own a telephone and certainly not a modem.

A fundamental issue for NGOs in the field is time. It is not possible to wait for comprehensive information, which is only available in retrospect; NGOs are still reassessing their failures in the Great Lakes crisis of 1996–97. Information and data were mismanaged and assumptions of information superiority were



Good communication in rural areas is possible with the BayGen Freeplay wind-up, portable radio, invented in the UK by Trevor Baylis

shattered by a systematic campaign of disinformation and information control on the ground.

NGO communications were intercepted, their staff intimidated and their movements restricted. The use of surveillance techniques was justified by Rwandan Vice President Kagame. 'NGO information is not just humanitarian information, it is also military information,' Kagame was quoted in a report — 'New Challenges and Problems for Information Management in Complex Emergencies' — by Nik Gowing, a senior presenter with the British Broadcasting Corporation. The report was published in May 1998.

In response to the pressures on them, some leading humanitarian NGOs believe information technology is a 'false god' — technology is their security risk. Many NGOs believe use of the internet in disaster zones is of little value. They see e-mail as more cost- and time-effective as a means of communication.

On the horizon is a host of new technologies that will give NGOs and the media opportunities available previously only to governments. New satellites systems such as Globalstar are now live. In the future, this and other systems with hundreds more satellites planned, may provide an ubiquitous information environment with instant data and voice communications on a global basis. But while the latest gismos are awaited with relish by many people, it is often forgotten that such technologies may have little impact in remote or poor areas of the world. Wind-up radios and short-wave radio have important roles to play and are likely to be around well into the new millennium.

To return to the present. Journalists and humanitarian organisations generally have a love-hate relationship, sometimes due to wrong perceptions. On the journalists' side there is a feeling that the NGOs are sometimes amateurish in their approach and that one of their main aims is to attract more donations. Some aid workers say they are unimpressed with journalists who flit in and out of disaster zones, akin to 'war zone tourists'. But this does not address the fact that some journalists covering wars and disasters are full time foreign correspondents who have lived in a specific region for several years and will continue to do so long after the last emergency relief worker has left.

Relief organisations can learn from the media, especially foreign correspondents to whom accountability and security are important.

That aside, the overall message is clear — information, information and more information.

Future opportunities for communication for disaster reduction at community level

Professor Peter Anderson, Simon Fraser University, Canada



THE ABILITY OF COMMUNITIES to mitigate disasters, rather than merely react to them, is critically dependent upon the availability of reliable data and information from detection and monitoring systems, specialised databases, decision support systems and knowledge repositories that increasingly are being linked and integrated through local, national and international networks.

Information plays a critical role in all phases of disaster reduction activity from hazard identification and risk assessment, through mitigation, preparedness, response and recovery. Further, given the nature of hazards and the geographic span of their effects, close inter-relationships often exist among those detected at local, national and international levels. Consequently, it is vital that those involved in disaster reduction activities be given access to the widest possible range of information pertaining to such hazards and associated risks. Once such information has been collected, interpreted, evaluated and critically analysed, it is equally important that disaster managers be given access to the most effective means through which to communicate results to colleagues, policy makers, practitioners, and most importantly, when warnings must be issued—to the public and emergency responders. In this way, information exchange becomes the basis of progress towards reducing the effects of disasters in all societies.

Much information already exists within countries and internationally to help reduce risks associated with hazards, although no single country can meet all of its own information needs. These factors were wisely recognised long ago and enshrined in the guiding principles of the IDNDR in 1989. Those principles focus on improving the capacity of each country to mitigate the effects of natural disasters expeditiously and effectively by devising strategies for disseminating and applying existing scientific and technical knowledge, fostering scientific and engineering endeavours aimed at closing critical gaps in knowledge. It is also aimed at developing measures for the assessment, prediction, prevention and mitigation of natural disasters through programmes of technical assistance and technology transfer, demonstration projects, and education and training.

However, when these principles were drafted, few foresaw the impact of emerging digital information technologies and networks on disaster reduction activities across the world, nations and, more recently, within individual communities.

The emerging development of new electronic networks such as the internet provides a timely and revolutionary option for rapid, automatic and increasingly near global dissemination of hazard-related data and for integrating and co-ordinating information across disciplines, national and international jurisdictions

and disaster management phases. These developments are being accelerated by a number of factors, including trade liberalisation, domestic telecommunications restructuring, plummeting costs, rapid capacity increases of information technology and electronic communication, adoption of common technical standards and the extension of services through satellite and terrestrial cabled and wireless facilities. All countries, but not necessarily at equal rates, are growing increasingly dependent upon distributed electronic information networks. For most, these networks are now deemed essential for economic growth and social well-being.

For disaster management purposes, if properly designed and implemented, these same networks can now be used before, during and after disasters to ultimately improve mitigation practices. This potential emergency information infrastructure role was recognised in the early 1990s, and has now progressed to the planning stage for global disaster information networks.

In the early stages, the emergence of electronic mail formed the basis for the distribution of documents and current news about hazards research and disaster management activities. The first and quintessential application of email specifically devoted to disaster management was Disaster Research (DR), an electronic newsletter, now moderated and distributed by the University of Colorado's Natural Hazards Research and Applications Information Centre. DR continues to provide information about hazards research, recent incidents and post-event reports, institutional and legislative developments, new information sources including internet sites, scholarship and research funding, job openings, upcoming events, etc. Subscribers can also post enquiries to the entire readership.

A number of unmoderated and more specialised e-mail-based services also emerged during this period to encourage exchange of information and ideas including those pertaining to specific hazards or topics. Two early examples are the Volcano Research Discussion Group and Networks in Emergency Management (communication-related). For those able to access these services, electronic mail gave emergency managers and planners the ability to gain direct access to scientists and specialists. The use of electronic mail also started to break down traditional barriers to information sharing, providing a common means of information exchange for all.

Operationally, the Office of the United Nations Disaster Relief Co-ordinator (UNDRO) began a gradual shift away from heavy and expensive reliance upon telex and facsimile towards using its own electronic mail list to distribute disaster situation reports and appeals for assistance directly to humanitarian agencies, governments, researchers and the public.

Another text-based service built around electronic mail called USENET enabled conferencing around special topics called 'news-groups' that allowed readers to view and respond to messages on-line without having to individually subscribe to them. 'Misc.emerg-services' was one of first such news-groups to encourage discussion around topics such as use of technology, incident response experiences, upcoming events, etc. Organisations also began storing disaster-related information on their servers and permitting public access to it through the use of the internet 'ftp' protocol. Unfortunately, information was difficult to retrieve as there were few useful tools available to help to guide readers to where it resided across the internet.

In 1992, new text-based information browser software called 'Gopher' provided a means to organise, index and retrieve information in a standardised way across the internet. The key feature was that links to the information displayed in menus didn't have to point exclusively to files on one particular computer server,

but rather, could also point to information on other computers anywhere on a global network. Another attractive feature was that gopher client software could be run on computers that didn't have more expensive windows or graphics user interfaces.

By 1994, a number of computers with gopher software were archiving or linking large numbers of documents on disaster-related topics. They included university servers such as the Emergency Preparedness Information Exchange (EPIX) at Simon Fraser University in Vancouver, Canada; non-government organisation (NGO) servers, most notably Volunteers in Technical Assistance in the US; United Nations (DHA and WHO) and international organisational servers (IFRC and PAHO) and national level organisational servers such as USAID and Emergency Preparedness Canada.

The most dramatic use of gopher, however, took place in January 1994 during the Northridge earthquake relief and recovery efforts. The California Governor's Office of Emergency Services made extensive use of the internet to distribute up-to-the-moment situation reports, road and weather conditions information, disaster relief centre openings, media briefings, and other agencies' notices on health care, housing, damage claims and other information intended for the public. To reduce loading on its server and regional network, this information was replicated and made available on the EPIX server in Canada.

During 1994, another innovation quickly elevated the internet to the Decade's most important means of regional and international information exchange. Originally developed at CERN near Geneva, it consisted of a new set of protocols that built on the success of gopher, but added a graphical interface to permit 'point-and-click' file downloading, simple file formatting for text and image display and file transfer. The new system became known as the World Wide Web (WWW or web) and within a few months, audio and video capabilities turned this simple application into a multimedia information system. With browser software made freely available over the internet, demand and growth of service grew and continues to grow at an exponential rate.

Today, the outcome is abundantly clear. Most key institutions involved in promoting disaster reduction activities have their own servers or have rented facilities to do so. Information previously only available in printed form such as bulletins, situation reports, newsletters and brochures are now routinely posted on the web, sometimes exclusively. Full text reports and discussion papers, along with new electronic journals are also being added while powerful internet database and search engines are helping to automate cataloguing and retrieval.

Everyday, new forms of information appear, increasingly in real or near-real time broadening the basis for improving hazard detection and warning. This information is collected through a variety of terrestrial and space technologies ranging from seismic sensors to remote observation satellites. It is then converted and distributed over the internet to specific sites or to the internet population at-large. Some sites such as the UNs ReliefWeb, the US Federal Emergency Management Agency's Global Emergency Management System, the US Natural Hazards Centre, EPIX and HazardNet serve as points of contact for integrating the information services and networks evolving over the internet.

Most UN and larger international disaster organisations make extensive use of the internet as a backbone network for their own intra-organisational needs. For example, since 1996, the International Federation of Red Cross and Red Crescent Societies has been developing a global intranet system to enhance the essential information infrastructure capacity and services within National Societies at the local, national and regional levels, especially in disaster-prone regions. Similarly, a number of national



Global communication is now available, from Eskimos in Alaska to...



Photos: Tony Stone Images

...tribesmen and radio phones in the Yemeni desert

and international organisations are contributing to improving disaster awareness and capacity to respond in countries by developing collaborative regional networks and services, most notably in the Latin American and Caribbean regions. Further, specialised sub-networks are evolving within hazard-specific disciplines.

A growing number of organisations are now improving the robustness and reliability of networks for emergency use. The value of the internet for warning and response continues to grow. In 1995, exactly one year after the Northridge earthquake, the web instantly demonstrated its value as a community self-help network and principal means of disseminating information immediately following the Kobe earthquake in Japan. Within hours after the event, through public bulletin boards, the internet became a meeting point for community response. Before the traditional media had comprehended and reported the magnitude of the event, digitised maps and photographs had already been posted on the web. 'Information volunteers' visited shelters, collected messages from survivors and sent out specifics about needs. They also collected and posted regional data about food and water and later about jobs, schooling and housing. Private companies and universities offered server facilities and a means for registering and tracking survivors.

This pattern continues to repeat itself where public access to the internet is available, and increasingly in a more comprehensive and multimedia fashion through the combined efforts of UN, government, non-government, international organisations and individual volunteers. Examples include storm warning, tracking and impact analysis in the later 1990s (especially with Tropical Storm Frances and Hurricanes Georges and Mitch) and floods in the Red River region of North America where internet participants could track the impending danger through satellite imagery, web postings from community and emergency organisations, live 'web camera' video feeds, as well as through local and regional broadcasting stations relayed over the Net.

However, despite these developments, many organisational, access, standards, design and contextual problems still need to be addressed to ensure that the benefits of information exchange are distributed more equitably throughout the world and that the

implications that flow from increasing dependency upon networks are understood and addressed. Even when available, communities are still not effectively utilising the wealth of information that resides with various hazard and disaster management organisations or necessarily exploiting existing and emerging technology to enhance information exchange and management to aid disaster reduction activities.

Many supporting disaster management and response agencies are often too busy dealing with disaster issues or incidents and haven't time or personnel to learn how to assimilate new technologies into their operations. Uneven training and skill levels among organisations can present difficulties for implementing multi-organisational information exchange strategies. For some organisations, information management is simply not viewed as a core requirement.

Other problems persist in affordability of, and physical access to, networking infrastructure, especially in developing countries. Even within many of the most industrialised countries, major disparities exist among community neighbourhoods and between urban and rural areas.

Contextual problems also persist. Information is often not available in indigenous languages. Vendors and system administrators may have little or no disaster-management experience, and thus may not share the same perspective or goals as end-users. Different information needs and priorities exist among disaster management organisations, and hence expectations differ. Finally, every disaster has its own information characteristics and the partial ad hoc nature of response may make information requirements difficult to define in advance.

Notwithstanding these issues, many of the technical foundations for improving disaster reduction within communities may already be in place or are likely to evolve within the next few years. The internet and other new forms of information networking mark the beginning of a new phase in disaster mitigation. To maximise their benefits will require considerable time and effort to ensure appropriate training, user confidence, appropriate trust arrangements among information providers and an understanding of inherent networking limitations.

REPORTING ON A DISASTER

Improving awareness

Timothy Radford, The Guardian, UK

PROFESSIONALLY, NEWSPAPERMEN love disaster—it is their business—but don't rely on them to be very different from the rest of the community. The independent commercial media survives and thrives by reflecting the community it serves. If a community is complacent, then there is fair a chance that its journalists, too, will take the placid line. 'Where could one be better off than St Pierre?' asked the local paper of St Pierre, Martinique, in the last editorial before 8 May 1902. That was the day of one of the worst volcanic eruptions of the century, in which a froth of superheated pyroclastic rock and gas, travelling at 190 kilometres per hour, or 50 metres per second, blew over the Paris of the Caribbean, instantly cremating around 29,000 people. Don't blame the newspaper—somebody—a volcanologist, a governor, an authority—had told it there was no need to panic and nothing to fear. By the time everybody discovered they were wrong, there was nobody left to conduct a recrimination.

Needless panic, on the other hand, is bad for business. Newspapers and commercial radio stations depend on advertising, and on audience—they cannot afford, in the interests of sensation, to drive both of them away. So the hapless editor of the St Pierre paper was caught up in one of literature's great plots; one of the doomed chorus in the biblical story of Noah, or of Lot in the plain of Sodom and Gomorrah, condemned, whenever anyone cried 'Repent, the day of judgment is at hand' to answer, pantomime-style 'Oh no it isn't!' In essence, disaster is a good story, but only when it happens to someone else. People show a remarkable reluctance to believe that terrible things could happen to them. Modern disaster movies are, in this sense, very instructive—the tension in disaster movies usually comes not from the calamity itself, but from the fact that in the opening reel, there is always one voice crying 'Beware' not to mention 'Repent' or even 'You'll all die, I tell you!' The owner of the lone voice knows—and the audience knows with him—that he is right—doom is less than 90 minutes away. Nobody else in the plot seems to know this at all. That is why it is such a satisfaction watching the heedless get their comeuppance on a wide screen, with wraparound Dolby sound, accompanied by preposterous, computer-generated special effects. This is sometimes called the Jaws Syndrome, although the basic device is much older. Ibsen used the trick in his play *An Enemy Of The People*, for example—something nasty lurked in the water, but with such investment in the tourist trade, why would anyone want to admit such a thing, especially as nobody had yet died? Only one man had the courage to speak the truth, and he was reviled for it, but in the end... In short, the drama of a disaster, as a theatrical event, depends on there having been at least one good opportunity to avert it.

Why is it that, even when disaster is a foreseeable event involving real lives, the media takes no serious interest whatever in the business of generalised warnings? There are several reasons. One

depends on the quality of the disaster. The other depends on the quality of the warnings. Britain—to take a comfortable case—experiences hazards from time to time—earthquakes are relatively frequent but slight, though there have been cases of Richter scale six; floods are relatively common, but are usually confined to comparatively small areas of river basin; windstorms happen, sometimes with tremendous destruction; avalanches have taken lives in Scotland, even tornadoes have passed by. But in all cases so far, loss of life is relatively small. The presumption—for newspaper, radio and television journalists—is that hazards will throw up human stories, of courage, comedy, exasperation and occasionally tears—when a tornado struck a small Sussex seaside town, wrecking houses and very nearly wrecking lives, most of the coverage centred on the damage, to Britain's most famous astronomer, of his backyard telescopes. The unwritten, unspoken assumption is that real disasters are things that happen to someone else. This, surprisingly, is a widespread assumption. New Zealand is a tectonically-active island arc on the Pacific ring of fire—it experienced—before humans arrived—one of the most violent volcanic eruptions ever measured; it is exposed to tsunami, earthquake and windstorm dangers. Awareness of the most probable natural hazard is reasonably high, and precautionary principles operate as a matter of habit.

Country people are aware of the dangers of forest fires in hot dry weather, and in the earthquake zones, buildings tend to be made of wood, to high standards, and of one storey. Even so, life proceeds on the assumption that disasters are for other people. Shortly after the 5.8 Richter scale earthquake which claimed 12,000 lives in Agadir, Morocco, in 1960, New Zealand's chief volcanologist was thrilling audiences with the news that New Zealand experienced one such shock at least every week. The point, of course, was that the worst of the energy was released in areas so thinly populated that it was unlikely anybody would be hurt at all. By implication, New Zealanders were prepared for 'normal' hazards, rather than catastrophic ones. They expected and were prepared for the expected, not the unexpected. This, however, is not the philosophy behind the UN's International Decade For Natural Disaster Reduction, which cannot claim to have drawn much in the way of media attention in the decade itself. This is, at least partly because of the quality of the warnings. Disaster scientists and engineers are like scientists and engineers everywhere—they prefer the cold language of technical fact and statistical probability, secured from accusations of error by a thicket of protective caveats. This—like the language of lawyers that goes into the small print of contracts—is exactly the language the rest of the human race has difficulty listening to. So there is an immediate problem—of one group which apparently chooses not to be understood, addressing an audience that would on the whole prefer not to hear; the effectively mute, speaking to

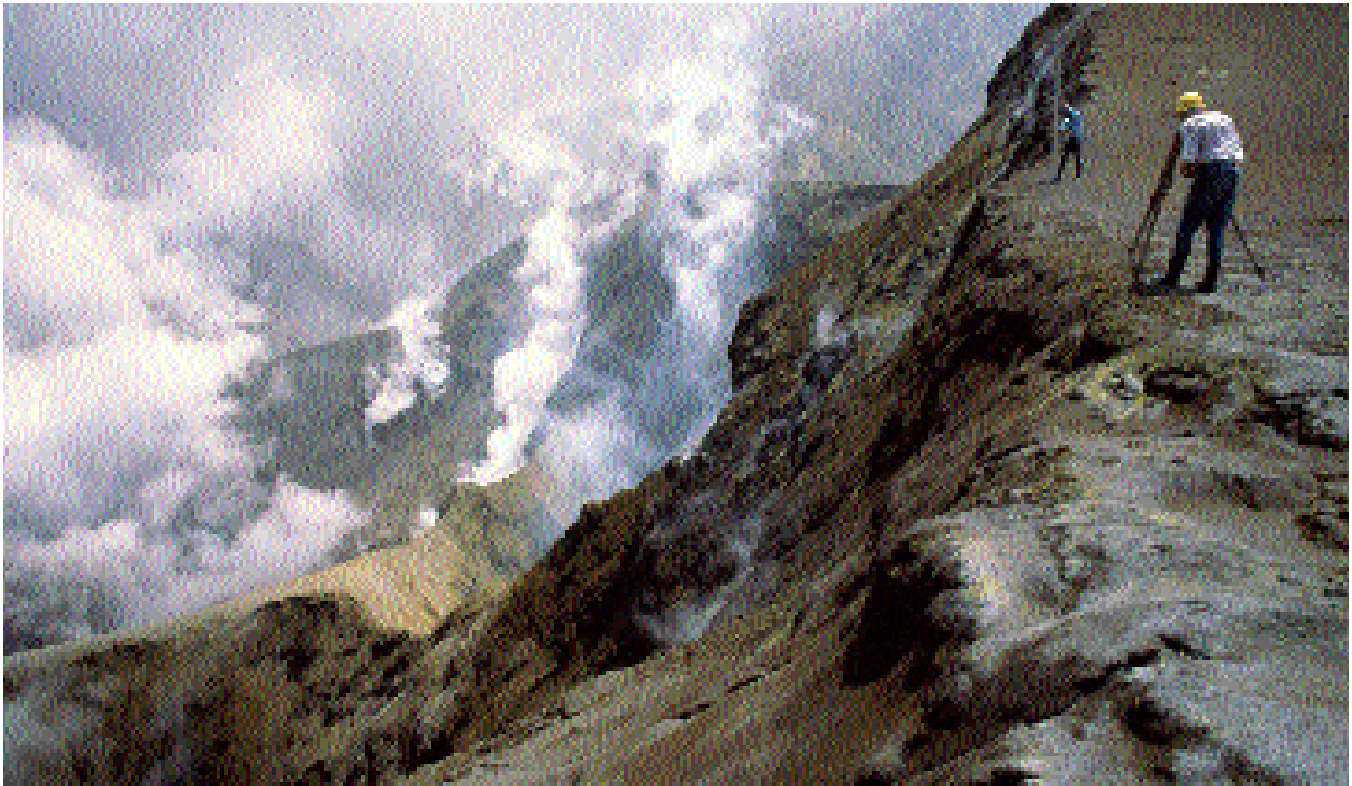


Photo: Tony Stone Images

‘No need to panic and nothing to fear’: Volcanologists measuring the crater of a volcano in New Zealand

the selectively deaf. There is great virtue in language of vividness and clarity.

Moses could have said (to take a well-known but not necessarily precise historical version) to Pharaoh: ‘The consequence of non-release of one particular subject ethnic population could result ultimately in some kind of algal manifestation in the main river basin, with unforeseen outcomes for flora and fauna, not excluding consumer services’. He could, but he did not. What he actually said was ‘the waters which are in the river... shall be turned to blood, and the fish that is in the river shall die, and the river shall stink.’ Pharaoh did not listen, and there was blood in the land of Egypt, and much more besides. Had he listened, of course, the logic of the story is that Moses would have been proved wrong, but that is the whole point of warnings — they are prophecies made precisely to mitigate or avoid the disaster they foretell. In that sense, hazard scientists are the only scientists who must feel a moral obligation to be proved wrong. And in that sense, their greatest triumph comes from not making the headlines. An earthquake in Britain or New Zealand that kills nobody rates only a few cheery anecdotes in a few newspapers.

Similarly the successful evacuation of hundreds of thousands of people from the cyclone-threatened coastal zones of the Bay of Bengal barely rate a line except in the local papers. If people don’t die in their thousands, it is not a disaster, and therefore not news. The preparedness message gets only a limited airing. There is a second, related reason — newspapers and television, and their readers and viewers, actually like to see disasters as Acts of God — the Pharaoh factor — or gestures of anger by Nature herself. This is not the media’s fault — humans are like that. People who should know better are somehow astonished each year that floods might occur in cities built on flood plains. People who build houses overlooking storm beaches because of the spectacular views are often touchingly surprised to find the same spectacular view advancing into their front gardens, or front windows. So there is

a deep-rooted and widespread conspiracy among both the media and its consumers not to consider natural disasters as things which might have been avoided.

Penelope Ploughman, in an article in *Disasters* (Vol. 19, No. 4) says that after Bangladesh cyclones killed 10,000 in May 1985, the print media concentrated on natural and moral disorder, lack of national leadership as well as ‘the limits of human knowledge and power, the irrationality of natural events, divine providence, the inevitable repetition of such disasters, and poverty and the lack of resources’. Note the words ‘irrationality’ and ‘inevitable’. They are of course, the basis for a kind of alibi. Pharaoh, in the story, had no such alibi — what happened to him and his chariots has been the basis of both historical disaster conjecture, and a cautionary tale to the rest of humankind, ever since. The lesson of the plagues of Egypt is precisely one the disaster community needs to take aboard — that people are most interested in disaster preparedness in the moments after one has just happened. But this is sometimes seen as presenting insuperable temporary difficulties for hazard scientists — disasters are dislocating. They disrupt communications, and they kill or stun and certainly bewilder those who have just felt their force. The people in the disaster area have barely an idea of what hit them, and they are aware only of the damage to themselves and the people next door. The people outside the region know only that something terrible has happened — they have no idea of the extent of the damage, the precise form it took, or the extent of the suffering it caused. If the people inside the perimeter of death do not know, and those nearest to them do not know, the argument goes, why should a scientist whose business is truth and fact, rather than alarm and conjecture, be expected to become an instant authority? My answer to this, as a member of the UK committee of the IDNDR, and a newspaperman, is that newspapers and broadcast journalists have an obligation to report immediate and serious news immediately and seriously, even if they have more conjecture to hand than facts.



Photo: Rex Features

Reporting from the scene: What should be said to the media?

For once — for that awful stunned moment that, worldwide, seems to follow every catastrophe — people are anxious to hear about a disaster. If they cannot hear the facts about a particular earthquake or tsunami in a city faraway, then they will want to know about what earthquakes and tsunamis can do, in cities of that kind, and what kind of experiences people caught up in such trauma might have, and by extension, what kind of help they will need. So if a journalist cannot produce the facts, he is under pressure to conjure up a kind of what-might-be-expected scenario.

Any hazard scientist or engineer, however distant from the event, will have a better idea of the reality of calamity than a journalist, and should join in this conspiracy to inform. There are several good reasons for doing so. Only one of these is personal. 'If I do not help him,' the sensible earthquake engineer should say to himself, 'he will only ask that charlatan at the institute down the road'. The other is that it is the perfect opportunity to stress the importance of a prepared community — the expert's soundbites — and they had better be vivid, terse and unforgettable comments, of the Moses variety — can be couched in terms of 'if, and thus'. I once prepared a kind of idiot's guide to what the innocent scientist should say when someone shoves a microphone under his nose, and asks him a question about unknown damage to a place he has never visited. An extract from it went — Question: 'But surely, an earthquake of this magnitude is relatively mild?' Answer: 'If hundreds of you are crowded into block of flats just made of breeze blocks piled on top of one another, and the ground starts moving up and down suddenly, you have a problem. If another set of waves come along a second or two later and start shaking the ground from side to side you have a calamity...'. Note — you have told the interviewer that a) earthquakes are bloody dangerous, b) that bad building standards have got something to do with it, and c) earthquakes involve the earth

quaking, and all that in one answer. Note even better — you didn't use phrases like 'local authority-determined building standards' or 'longitudinal oscillation subsequently affected by shear wave radiation'.

There was a lot more of it. The purpose was not simply to help disaster experts give newsmen what they wanted; the purpose was to help disaster professionals seize and make the very most of the only chance they are going to get, before the cameras and notebooks, to talk about disaster prevention to a listening audience. Within 24 hours of a catastrophe somewhere in the world, the pictures will start to arrive and the human stories will start to emerge. Most people will by then still not know exactly what happened, and how it could have been prevented, but by then it won't matter. Preparedness is an important condition but it cannot compete, in news terms, with say the desperate hunt for a child buried alive beneath the rubble, or the stunned faces of mothers in a desolation of streets, or the spectre of epidemic to come. The message of preparedness will matter more than ever before, but who will be listening? The business of preparedness is dull stuff compared to the dramas of life and death. Science and engineering are matters of thoroughness, sobriety and thoughtfulness. Public education, of the other hand, is a matter of opportunities seized, and language vividly used. Some people see a contradiction in all this. Moses didn't, and he managed to get at least some people to the land of milk and honey. Pharaoh and his soldiers, on the other hand, perished in what some people consider to have been the first historically reported case of a tsunami. There is often a fear among scientists of being seen to have overstated any particular set of dangers — however, with hindsight it is clear that it would have been very difficult to overstate the dangers that actually faced the people of St Pierre in 1902. Words like 'worst-case scenario' don't even begin to cover it.

HAZARD WARNING

Media: Accelerate of damage?

Dr Marion Pinsdorf, Fordham Graduate School of Business, USA

PROFLIGATION OF MEDIA, around the globe, around the clock, competing aggressively for attention and market share has quite simply demolished institutional command and control of information. The compelling need to be first, but not necessarily right, seriously undermines veracity particularly in medical, scientific, and environmental coverage.

Junk media thrives on junk science. Fear-inducing, interest-grabbing headlines drive out reasoned, objective analysis. Compounding the problem—electronic media feeds on dramatic visuals. A plant explosion, oil-drenched wildlife, fiery plane crashes, even a fairly simple building fire attract extensive coverage like catnip. One battle-scarred communicator flatly warns—Just don't count on the news media for clarity.

In crisis situations, fear, rumours, hype and unknowns accelerate the chaos. If not managed adroitly this can prove very expensive to companies, especially to victims of natural and other disasters.

It behoves any prudent executive, particularly in such hot topic or publicly sensitive industries as high-tech, the environment, biomedical research and others, to exercise internal damage control. A vulnerability audit can identify what procedures and operations would inflame public action if revealed or if they failed? All this sounds like Management 101. The question then is why are such dangers overlooked and how can they be analysed and assessed.

Executive mindset, heeding public perceptions even if wrong or at variance with expert opinion, and using analytic techniques such as reading fever charts of change, monitoring the chain of causality or chaos theory are crisis-tested techniques of internal damage control.

First, mindset. Public crises in essence are the moment of brutal truth which reveal deeper processes often very suddenly to a critical, frightened public. Spinning and reeling around realities, image-cloaking truth, gluts of wishful thinking, or just plain words, words, words deter objective analysis. They blind too many executives to harsh realities. A foolproof recipe for faulty decision-making. Crises can be anticipated and mitigated even avoided but only by the executives who are wise, competent and open enough to heed and connect the warning signals. Awareness works. Neglect can kill.

All of this demands of managers acute, intensive analysis, considerations of culture and sheer incompetence. When to say nothing or avoid saying too much. To heed fears bred in the mind as well as by machine.

Reality: Weak match for perception

Tell it like it is, is an honourable aim for communicators albeit too often abused and discounted. The critical question? Which is, is. Experts armed with 'dull' facts, figures and sound science may rate a risk, low. But is such reality any match for public

perceptions that distort, that often greatly and falsely exaggerate dangers? Just consider the lack of a link between disease and silicon breast implants or wrongly perceived asbestos dangers and the problem emerges. Such fears are poor advisers.

Daniel Goleman writing in the *New York Times* reported such a mismatch between actual and perceived risks—between the public's fear and the experts' rankings. Although some risks vary little, others vary widely. League of Women Voters rated nuclear power first, the experts twentieth; x-rays twenty-two vs seven, respectively.

The challenge? Even faulty perceptions determine action. After years of asbestos scares, New York City parents demanded schools be closed until classroom asbestos was removed. Statistically, children were at greater risk playing on city streets without summertime supervision. Didn't really matter. The parents won. Schools were closed.

What creates such wide disparities which drive public policy, action, media coverage and litigation? 'Outrage factors'—risks imposed rather than accepted voluntarily, unfairly shared. Also, whether or not people feel they can control the risk. Natural risks are more feared than manmade, exotic technologies more than familiar ones. Statistically, more World War I soldiers suffered, were maimed, even died from trench foot, but new, uncontrollable, manmade gas created the most enduring fears and reactions. Or more people died worldwide from Spanish Flu or Flanders Grippe (forty million in 1918–19) than any other scourge in history, but this was soon forgotten in the awesomeness of war deaths.

Another accelerator is crisis without frame—no definite beginning or end. These incite great fear, as Yale sociologist Kai Erickson documents in his book *Listening to Victims*. Air tragedies begin with a crash and end rather definitively with the cause assigned. But when will Bhopal or the Chernobyl meltdown really end? When will a generation not bear physical scars?

How to handle all this? Surely not by dismissing public concerns as merely misguided, wrong or uninformed. Dismissal only heightens outrage, distrust and fear. The more insistent the drumbeat, the greater fear-inducing coverage, the greater the likelihood that perceptions will translate into foolish actions. A Three Mile Island neighbour, so fearful and distrustful of official announcements, drove 150 miles then wondered why he did.

Jargon-laden public announcements send reporters chasing human-interest stories—seldom to the organisation's advantage. Particularly in nuclear physics at Three Mile Island, or in complicated chemistry at Bhopal, or in biochemistry of animal cloning or serious, rampant diseases, early, human-friendly explanations are essential, followed by close monitoring of possibly false information. Politicians more than most understand it is critical to



Photo: Tony Stone Images

Wide-spread environmental damage: The Exxon Valdez oil spill in Alaska

correct misstatements in the next news cycle. The longer they're out there, the more they're believed.

Why do executives and the public alike overlook danger, fail to take precautions, or just don't see? Partly, fatalism. If it happens, it happens. What can I do? Partly, they play 'Rashomon', seeing only what they want to. Sometimes the risk is virtually invisible. Or the public, lied to so often by authorities or drenched by media hype warnings, just tune out. Don't worry about radiation you people downwind of atomic tests in Utah. Or Desert Storm veterans assured for years that their ills were in their heads—just post-action stress—not their bodies. Do you Tuskegee Airmen really think your government would knowingly infect you? Others distrust or cannot accurately evaluate scientific data. Statistical probability looks very different when it's your child.

Other times blind faith or over-optimism quells realistic assessment. During a discussion of David E. Kaplan's and Andrew Marshall's book, *Cult at the End of the World*, one religiously devout MBA student refused to lend any credence to the material. 'It's just evil, I don't want to know about it.' 'Are you so sure evil will never intrude, that your career will be all honesty, decency, and smooth sailing?' No answer, but I could feel, 'Oh, you cynic of little faith'.

How to handle such different rankings of risk? First, just acknowledge they're out there. Both have some validity. Some discrepancies are based on values, some on facts, and others on fears and limited personal experience. All must be blended into the mix of any effective message, warning or corporate announcement (Goleman, 1994).

Looking for trouble

Always. Vigilantly. Intelligently. Realistically. Seeking out trouble and correcting it before it surfaces publicly is the only viable option left today. Rather to be a successful, though scorned Cassandra, than a melted down Icarus.

Key to success here is listening to a loyal Devil's Advocate. Not poisoning the in-box with good news only. A recent advertisement was headlined: 'Oddly, the most dangerous people in business are the ones who always tell you exactly what you want to hear'.

Conversely, build a staff of sycophants—clone weaknesses rather than compensate for them. Choke off dissenting information

particularly from the technologically trained or subordinates. A Challenger Ten tragedy can result. Engineers were flashing 'no go' fearing O-ring material could not expand sufficiently in low launch temperatures. Unheeded. Unheard. O-rings didn't expand. Tragedy. Other techniques evolved by crisis gurus include:

- Reading the fever chart of trouble—managers emulate acute medical diagnosticians sensing trouble—employee anger, violence, even sabotage—then apply the appropriate organisational medicine.
- Chain of Causality: No crisis is uni-causal. Always a chain of events, some even trivial alone, build up over time or quickly, into a major problem. Explaining the near tragic crash of a 747 over San Francisco, an expert explained—'Major accidents are usually preceded by a series of seemingly unrelated incidents' (Carley, 1999). Considering costs, damaged executive egos or corporate image, it takes great managerial courage to say 'stop'. Consider the Bureau of Alcohol, Tobacco and Firearms (ATF), the gang that couldn't think straight in planning their raid on the Branch Davidians at Waco, Texas.

No ATF executive even thought of questioning or interrupting this chain of causality:

- Planned the raid solely to erase damaging public images
- Gathered information too narrowly and evaluating it too wishfully
- Flawed decision-making
- Careless managerial oversight
- Ran the operation without contingencies
- Depended on surprise as a key element, threw it away, then rushed the raid
- Post-raid deception and altering of evidence
- The ultimate cost was more than 80 lives, including nearly one-third of the agents involved—four killed and twenty wounded. The subsequent 51-day FBI siege or great testosterone contest cost US\$ 13 million, the seven-week trial added US\$ 1.3 million and still rising. Most of the senior ATF management was dismissed.

Or consider this fable of assumptions at Valdez, Alaska. A mariner, reportedly unable to drive an automobile, a recovering alcoholic recently out of a rehabilitation programme is put in command of one of the company's large tankers. He takes it through one of the most pristinely beautiful environmental areas in the world. He



Photo: United Nations

A wall of 100 television sets in the United Nations Public Concourse displays different television programmes from around the world

turns navigation over to an officer allegedly not yet certified for this ice-clogged area. Because of labour complications, relations are not the best between the captain, mate and crew.

The tanker runs onto a reef. The captain is then said to attempt the dangerous procedure of trying to shake the huge tanker — the length of three football fields — off the reef. The Coast Guard assumes throughout the passage that no news is good news. After the grounding, folks in the field, through use of weasel words that anyone can interpret in any way are strained in an increasingly positive mode as they climb the pyramid to headquarters. Allegedly, executives, thousands of miles away, decide there's no need for the chairman to hurry to the site.

When media hype is at full frenzy assume other operations are squeaky clean — but are they? Soon another spill. Soon another ship adrift. All flashed instantly around the world. Great visuals. Of course, this is no fable, but *Exxon Valdez*, an incident that tarnished the corporation's previously good public reputation and image.

Chaos theory: Random, seemingly unrelated events can coalesce into a major disaster or an opportunity for effective crisis management. A less linear and predictable chain of causality.

Consider these events which occurred at Chernobyl. Succinctly put, command management at the nuclear plant simply concealed past accidents and problems anywhere. The closed nature of Soviet society facilitated the secrecy and encouraged risky short cuts and reporting false information to superiors. Design, safety testing and warnings were compromised. No bad news 'guaranteed' safety. Neighbours believed they had nothing to fear from clean, low-cost nuclear power, a panacea of safety, ecological cleanliness, and reliability. Many died or are suffering for that belief. Like NASA, the organisation created the expectation of a risk-free, workday environment. But little was done either in design, testing, training or operations, to assure that safety.

The deliberate policy was downplaying danger; surrounding tragedy with silence. But censoring mistakes and accidents assured the same mistakes were repeated again and again. Initially wary engineers slumped into casualness and complacency. No accidents; no problems; no need for vigilance.

A Chernobyl executive, determined to distinguish himself in this prestigious sector, defied the laws of physics. His extravagant confidence, his techno-hubris infected everyone around him. Some treated the reactor as scarcely more 'complicated than a samovar'. This clustering of random dangers, this code of absolute silence predetermined that the worst would happen eventually.

Complicating the danger was communications — lack of. Only carefully censored, massaged versions were passed down. No one was fully informed, not even those at the razor's edge of operations and danger. When disaster struck, they acted slowly as if still wishing to deny reality. By wasting precious moments and stalling the evacuation, many more innocent residents were exposed to radiation. The cluster of random elements coalesced tragically. Looking pragmatically at other trends and events may aid executives also.

Terrorism of the mind, not just machines: Y2K crashes, stockpiling caches of weapons, foreign terrorists blowing up aircraft, government buildings or individuals get great public attention. Yet terrorists of the mind, particularly in millennium groups espousing hateful thoughts in barricaded and armed compounds, may prove a very much greater threat. Repeatedly, history has demonstrated the worst trouble comes from unexpected, overlooked sources.

Attention is being paid. *The New York Times Magazine* featured a coast-to-coast guide of millennial Chicken Littles, apocalypse now groups, some benignly, seeking new enlightenment — from arriving space travellers, others preaching violent regional race



Photo: Rex Features

The media widely reported the threat of biological warfare during the Gulf war

conflict (*Heard, Klebnikov, 1998*). Communicators must cull the true threat from just talk, the masochist from the terrorist, the sincere leader from the potentially violent leader. Despite all the encounters and sects past, surprises must be expected. But poking a finger in the eye of the already isolated and angry only provokes violence and fatalities. Talk is cheap in comparison.

Overkill: Communicators pride themselves of telling all, telling it fast. Sometimes that's counterproductive, an unnecessary fanning of scattered embers. Instead one crisis guru counsels — communicate incrementally on a need to know basis. He cites a financially strapped airline that discovered a flight attendant in a major hub had highly infectious tuberculosis. The airline wanted to warn every passenger, employee, pronto. Whoa! Best way to accelerate fears and court Chapter 11 (bankruptcy protection). Guru advised — First, test those most frequently in contact with her — crew members, support staff, friends, then, if other cases show up, frequent passengers on her flights. Denouement? No other cases. No public announcement necessary.

Sheer incompetence

Every great crisis must have great causes even if they are invented, systematised and proclaimed post facto. Granted human error, pilot lapses are quickly announced to prevent the time, expense and pain of looking deeper, further. When supervision is absent or lax. When routine maintenance is treated as a cost, not prevention. When the competent and the caring shrug or walk away from the ensuing routine spells.

Hyperventilating media

Perhaps the greatest conundrum is to realistically evaluate media's constant drumbeat and hype when it seizes on the big story then repeats, expands, and speculates on it. Are they manufacturing

fear? One simple example easily settled — weather. Ever monitor increasingly strident, fear-inducing weather forecasts? Stock up on bread, milk and candles. Expect to be without electricity. Don't travel unless you absolutely must. Was this hype for market share? Reality? Caused by indefinite and changing weather conditions? This truth is quickly revealed. Lots of rain and wind, but no power outages or snow. Given all such obscuring spin, misinformation and hype to increase marketshare just how do we get to bedrock, the truth in more complex, long-term issues?

Counter actions can be taken. Profound concerns voiced. Copious misinformation balanced with sensitivity. Secrets, governmental concealing with dogged reporting. Some reporters worry that the more they write about biological warfare, 'the more it gives people ideas'. That adds responsibility to 'shun the melodramatic'.

'When there's an awful lot of smoke on a subject and hysteria... It's difficult to determine what's fire and what's smoke.' 'There are people who for all kinds of reasons, bureaucratic or personal self-aggrandisement, are selling bioterrorism' (*Pogrebin, 1988*).

Can wisdom particularly in the media catch up with science? Is knowledge being produced largely to be sold? Has use replaced exchange? C. G. Jung in 1955 put all this in perspective — a wise guide for executives and communicators still.

'The voice of the intelligence is soft and weak. It is drowned out by the roar of fear. It is ignored by the voice of desire. It is contradicted by the voice of shame. It is hissed away by hate, and extinguished and silenced by anger.' (*Jung in Kinsella, 1989*).

That's the nub of the problem. Not to stymie progress or tilt at eliminating risks and uncertainties, but 'rather to evaluate, control and choose, as rationally as possible, among probabilities, risks and uncertainties' (*Geneva Association, 1998*). To cope with would be accelerates of chaos.

Internet Conferences

Alberto Delgado and Martha Davis, QUIPUNET, Peru

QUIPUNET IS A NON-GOVERNMENT organisation that, via the internet, links Peruvians who have left their country to become scholars and professionals at universities and corporations around the world. More than 200 volunteers, from professionals at large corporations like IBM and Microsoft to students at Harvard and Massachusetts Institute of Technology, and professors and researchers on four continents are linked by Quipunet to share some of that expertise in Peru and other Latin American countries.

Quipunet has worked with the IDNDR to organise a series of conferences in parallel via electronic mail and on the World Wide Web. The website (www.quipu.net) has a historic database of all papers and comments, written by experts throughout the world. It also offers additional services such as participants lists (by country and organisations), archives, a pressroom, illustrations, maps and national campaigns reports.

Solutions for cities at risk

The first of the series of events organised in conjunction with the IDNDR was the 1996 Solutions for Cities at Risk conference. There were a total of 500 participants from almost 60 countries. The conference spanned September and October 1996 and addressed a number of topics from disaster management scenarios and case studies in community involvement to the use of early warnings, environmental degradation and urban risks.

The conference had the specific aim of providing a forum to discuss experiences and share information on natural disaster management in cities. Specific objectives included the exchange of practical solutions that city authorities and concerned citizens could adapt to local needs, bilateral networking among professionals of different sectors and countries, and the creation of new partnerships and exchanges between participants and/or organisations concerned.

Although much of the conference was undertaken in English, almost 50% of the material was translated and made available in Spanish, thereby ensuring that the discussion was accessible to a broad range of participants. This was indeed the case as throughout the two month period, the conference website attracted almost 80,000 visits. Approximately 75% of the participants represented global and regional institutions, government authorities, NGOs, development agencies, banks, city organisations and independent consultants. The remaining 25% represented universities and research institutes. The post-conference survey showed that over 95% of participants thought that internet conferencing was a useful tool for natural disaster reduction efforts.

Floods, droughts, issues for the 21st Century

In 1997, Quipunet aimed to build on the success of the first conference and to develop the skills acquired and learn from the experiences of the previous year. The subject matter was flood and drought, with a subtopic concerning El Niño, which was captivating the thoughts of many participants in their daily work.

The conference was just five weeks long but this time period still provided the opportunity for eminent specialists from the public and private sectors and academia to present their views.

The conference again provided a prevalent feeling that problems were being shared and solutions were being developed at a global level. The world certainly seemed to be a smaller place as Quipunet started to assemble the web team, with representation from Australia, Costa Rica, Peru and the USA. The virtual workplace (where the server resides) was located at San Francisco State University and the web page developers were a group of students at the Computer Science Department of the National University of Trujillo in Peru.

Participation increased by approximately 40% on the previous year to almost 700, with representation from 60 different countries and many professional sectors. These numbers, and particularly the increasing trend, gave real encouragement and indicated the value of internet conferencing as a communications tool for the exchange of expertise, and as a net-working tool for all those directly or indirectly involved in natural disaster reduction.

Prevention begins with information

The third internet conference built on the success of the previous two and increased its global reach, with participants from around 100 countries. The rapidly increasing worldwide usage of the internet helped generate this increase in the number of countries connected to the virtual conference.

Topics discussed included the media, the disaster prevention message and how to convey this message. The conference enabled media representatives and experts from the disaster prevention field to exchange views and opinions. The development of Quipunet's volunteer network team enabled the entire conference to be completely translated into Spanish.

The future of communication

Through this virtual way of conferencing, information exchange and discussion are enabled at all levels, whether local, regional, national or international, at very little cost. Provided participants have the necessary equipment for access to electronic mail or the internet, hosting a conference electronically makes attendance easier and far more cost effective. This is particularly important for those individuals who do not have the means to incur costly travelling and accommodation expenses to attend an event far from home. Expertise and opinions are focused and may be shared with the broadest possible audience. This allows for maximised networking opportunities and for information to be circulated where it may not otherwise reach.

Quipunet conferences continue to attract increasing numbers and as the Decade comes to a close, the need to promote disaster preparedness, share ideas and develop solutions continues. The internet offers a tremendous opportunity and one which Quipunet, like many others, has decided to embrace in the effort to reduce the negative effects of natural disasters.

CASE STUDY

IDL processing helps NESDIS 'Save lives and property'

Jon Snyder and Chris Duda, Research Systems Incorporated, USA

IDL SATELLITE-DATA PROCESSING is allowing scientists at the National Environmental Satellite, Data, and Information Service (NESDIS) in Suitland, Maryland to deliver timely, accurate information and live up to their promises. 'Our motto is—We Save Lives and Property,' says Physical Scientist Chris Duda. Duda and the Environmental Products Group at NESDIS use IDL, the Interactive Data Language, to interpret Advanced Very High Resolution Radiometer (AVHRR) satellite data and produce sea surface temperature (SST) anomaly charts.

These regularly-updated SST charts are important to weather services for short- and long-term predictions of global weather patterns. 'We provide operational support for meteorologists and oceanographers,' says Duda. 'The Hurricane Centre is one of our big customers.' Accurate weather predictions help people know when and where life-threatening weather will strike. In addition, monthly and yearly SST averages help researchers understand the dynamics and consequences of global weather patterns and phenomenon such as El Niño.

In recent years, attention around the world and at NESDIS has turned to the El Niño phenomena. Current readings show that the El Niño-influenced waters have warmed 5°C above normal, higher than has ever been recorded before. Since the warm, El Niño water evaporates more than the normal, cooler water, some parts of the world have extra moisture in the atmosphere during El Niño years. This causes more frequent and intense hurricanes for the tropics, more rain for the western seaboard of the United States and more snow for the Rocky Mountains. Some regions of the world become drier than normal and may even experience drought, which increases the possibility of annual forest fires burning out of control.

IDL for exact data processing

IDL's built-in data processing algorithms provide the power to interpolate and filter the satellite data. Fourteen times each day, the AVHRR data is transmitted from a geostationary and a polar orbiting satellite to Earth, where they are collected by mainframe computer. Twice weekly the

Environmental Products Group 'composites', or gathers, the readings.

IDL programs then analyse the data and produce mapped images of SST anomalies. 'IDL has quick, well documented routines for the data interpolations,' says Duda. 'By using it we quickly get accurate climatory averages at the desired grid points.' IDLs integrated math routines provide the interpolation and mapping algorithms needed to process SST observations from the satellites. IDL is also used to filter noise from the satellite data. 'IDL interpolates the information to exact points,' says Duda. The uninterpolated data has a resolution of approximately 36 kilometres, or a swath of about 0.33 latitude and longitude.

According to Duda, 'Using the SST fields derived from the NOAA polar orbiting satellites, we can make near real-time assessment of the anomalous warming associated with El Niño.'

Once the data has been analysed, SST charts showing averages and revealing anomalies are produced. According to Duda, 'IDL is the driving force behind our web-based graphics.' IDL's suite of customisable map projections give the Environmental Products Team the basis for generating new, updated charts within 12 hours after starting the data analysis. In the past, the process took at least a week. 'One of our goals is to produce as near to real-time anomaly analysis as possible'.

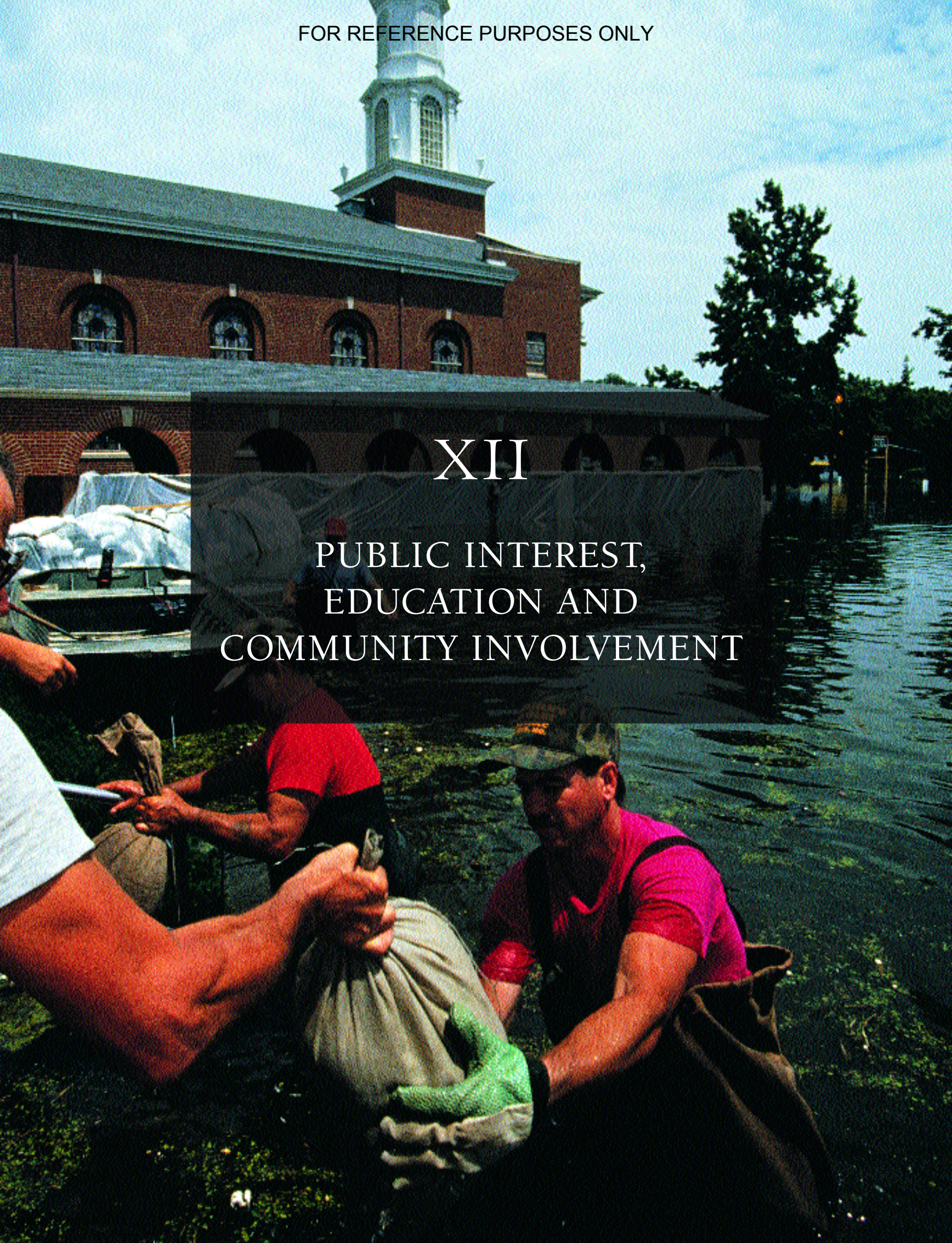
Saving lives and property

For ship reports and hurricane tracking, NESDIS' SST charts provide a great resource for navigating safe courses. For industries like fishing, up-to-date SST charts help determine where the sought-after fish will most likely be. Farmers rely on long-term predictions to decide on crop rotations and when to harvest—their source of information needs to be accurate. Regions in which the economy flourishes through tourism, and is based on the weather, can plan accordingly.

Most importantly of all, according to Duda, NESDIS will continue to help predict weather disasters and save lives and property in communities around the world.

XII

PUBLIC INTEREST, EDUCATION AND COMMUNITY INVOLVEMENT



KEYNOTE PAPER

PUBLIC INTEREST, EDUCATION & COMMUNITY INVOLVEMENT

Joseph Chung, UNDP, Fiji

PUBLIC INTEREST, EDUCATION and community involvement encompass a broad spectrum of issues and problems. While the entire range can only be suggested here, the important outcome is the reduction of the vulnerability of people at risk, and the principal concern must be their welfare.

The term 'disaster' is not determined by the natural event such as cyclone or earthquake, but by how people are affected by it. A disaster conjures up a picture of death, suffering and loss of property and livelihoods. The term development can mean bringing 'a better life for people', or 'poverty alleviation' or 'economic growth and prosperity'. When we talk about environment we immediately place people in the environment and consider how it affects their livelihoods or how poor practices can cause adverse impacts and distress. People are therefore at the core of most matters related to disasters and development, including the environment where these processes occur.

This paper concentrates on challenging situations confronting small island developing states. The implications and disaster management challenges for islands can be argued to be more difficult and more severe than larger countries. Greater attention should be paid to the vulnerability of Small Island Developing States (SIDS) and their people because they are highly susceptible and at greater risk than larger countries.

Special consideration for small island developing states

The overall vulnerability of SIDS to natural hazards is increasing, as a corollary of increased urbanisation and population growth, deforestation, and, for some, political instability. The process of development itself is a cause, compounded by fragility of the island environments, their narrow economic base, the small size of the scattered and isolated communities, and the degradation of the traditional coping mechanisms. The vastness of the Pacific region and remoteness from other countries and within each country, usually results in the high cost and delays in the delivery of a unit of either relief or development assistance. Pacific

islands have disproportionately high concentrations of population, economic and commercial activities, and infrastructure in coastal areas, and are therefore particularly vulnerable. The impact of disasters on small islands is often proportionately very high, affecting the entire country and causing devastation which takes a long time from which to recover. This places considerable stress on their economies and severely disrupts development efforts.

Experience in the Pacific island countries shows that regular disasters necessitate considerable external intervention through relief and rehabilitation. The response to disasters has long been through the distribution of relief. More recently, the need to consider long-term disaster mitigation and preparedness has been promoted and fostered through regional disaster reduction programmes. Among the first requirements are to strengthen institutional capacity through human resources development, establish effective emergency operational procedures and introduce disaster mitigation activities at national and community levels. Risk and vulnerability analysis and hazard mapping, as well as establishing disaster management information systems at national and regional levels, are further prerequisites for effective vulnerability reduction. Incorporating vulnerability reduction measures into the development activities of governments and communities is not easy because few governments have yet to develop procedures or programmes and there are often competing priorities within key (and usually vulnerable) sectors of the economy. However, from the author's experience and work in the Pacific islands, governments of small Pacific island states are increasingly aware of the importance of linking disaster reduction measures with social and economic development in order to minimise the vulnerability of people and their livelihoods.

The hazards

The Pacific islands are exposed and susceptible to a large number of natural hazards. These are predominantly:

- Tropical cyclones with accompanying storm surge and salt water sprays
- Droughts and floods which are either seasonal or El Niño induced
- Earthquakes, tsunamis and volcanic eruptions
- Landslides as secondary hazards caused by heavy rainfall and earthquakes
- Slow inundation due to sea-level rise is a special concern for the atoll countries and predominantly coastal dwellers of SIDS.

Of these hazards, tropical cyclones are the most frequent and have the most damaging effect. Drought and flood are also frequent events causing substantial losses and hardship. Although damaging earthquakes and volcanic eruptions do not occur frequently, they can cause large scale disasters. Not all countries are equally affected and the level of preparedness and response varies immensely between countries. It appears that the overall vulnerability of islands to disasters is increasing, with a subsequent rise in disaster costs.

Most Pacific islands have limited natural resources, and this too increases vulnerability, especially for food and water supplies. Their small size leads to lack of diversity in land-based enterprises. The ecosystems are highly vulnerable to disturbances and variations due to climate differences, natural events such as hazards and manmade changes.

Politics

At the global level, small islands have limited political clout. At national and local levels, there is usually little political will by governments to address the issue of long-term disaster reduction by implementing known and proven mitigation measures. Unless a disaster occurs, it is almost impossible to address the issue of reducing vulnerability through pro-active implementation of proven disaster-mitigation measures. One has a better chance of being successful if these measures are included immediately after a disaster when rehabilitation and long-term development of vulnerable sectors begins. Also during the post-disaster phase, the latter can easily be ascertained, and both the assisted and assisting are more receptive to 'doing the right thing' to reduce future losses if similar events re-occur.

Traditional coping mechanisms

Most Pacific islanders live in rural areas and live in a semi-subsistence way. It is true that traditionally, Pacific communities had developed many ways to help withstand the impacts of natural hazards. These measures have been weakened or replaced by the processes of economic and social change, including urbanisation. It is useful to describe some of these changes and to learn from them, even if it is not possible to wind back the clock.

Agriculture and food

Traditionally, it was common practice for Pacific communities to store surplus food as security against unforeseen events such as natural disasters and tribal wars. Food was also grown for major ceremonial occasions. Many traditional ways of food preservation were commonly practiced until recently, within the lifetimes of people living today and in some places, this is still being done, though in most countries this is no longer practiced. This also applies to the loss of crop diversity, planting of 'famine food' and drought-resistant or flood-tolerant crops with selection from a

wide range of crops with different growth periods and storage life after harvest. Related to food are the traditional farming patterns that determine when to prepare the land, when to plant what crops so that they can have maximum growth period and/or be able to avoid the known hazardous events thus enabling harvest to take place.

An unforeseen 'manmade' disaster struck Samoa in 1993 when a virus known as the 'taro leaf blight' affected all the taros in the country. Taro (a root crop) is the country's staple food and a major export. To date, the problem still exists and the lucrative export market has been lost to Fiji and other Pacific islands. Although Samoa has other staples such as breadfruit, banana and yams, taro was the dominant, monocultured crop. The lack of crop diversification and its impact on subsistence and commercial activities will be felt for many more years.

Equally important is the harvest of seafood. In the past, customary restrictions were often placed on harvesting certain species to allow for breeding and regeneration, ensuring availability in the future. These controls are no longer, or seldom, practiced. As a result, reefs are over-fished, people have to go further out to sea to get a good day's catch, or do without. A case in point is the Aitutaki Lagoon in the Cook Islands where the giant clam was plentiful. But there was no restriction in the quantity or the size of the clams that could be harvested. There are no clams left today; this process took place over the last decade or so. The erosion of traditional systems or the lack of effective legislation can increase a community's vulnerability. Food security is becoming a major problem in the small Pacific islands.

Social and community support

Most communities, modern and traditional, rally around each other when disaster strikes. For example, in the highlands of Papua New Guinea, when food was destroyed by frost in 1972, the villagers lower down the mountain who were not affected provided those afflicted, with food relief. Similar traditional support and networks still exist today in the PNG highlands and in other parts of the Pacific. If necessary they can be reactivated during disasters. The social structure of many villages is still intact and the leadership and cohesion provides people with an effective coping mechanism and self-reliance.

A vivid example that the author personally experienced was in 1979 following Tropical Cyclone Meli which struck the Eastern Islands of Fiji. 'Meli' was so powerful that schools and churches made of concrete and steel were levelled and villages in its path had no dwellings left. The death toll was high. One of the destroyed villages surveyed for emergency relief needs immediately afterwards, said that they did not need food, water or other relief items, but wanted some temporary shelters, since all the houses and most of the tree foliage had been blown away. They also needed some carpentry hand tools, nails and wire strappings to enable them to start rebuilding their village.

The village chiefs had organised the village into three working groups. Women and children were responsible for food preparation by salvaging damaged food crops and fetching seafood. The young unmarried men were to harvest, and prepare for sale, damaged and matured Kava (*Piper methysticum*), their main cash crop, and also to begin planting food crops. The other men were to begin reconstructing their village using available traditional bush materials and materials purchased or donated to them. They showed that they were able to cope in spite of the scale of the disaster, that the village organisational system worked, and that they were fully prepared, organised and determined. In a way it was unfortunate that their self-reliance was not realised because

generous donor countries provided emergency food, water and shelter and the national government assisted with rebuilding all of the affected villages using prefabricated imported houses. Efforts for self-help and community involvement are often ignored by well-intentioned assistance, thereby creating greater dependency and hence vulnerability.

The first responders to disasters are the members of the local community themselves, and a well-structured, prepared and alert community can respond better than others. When Tropical Cyclone Ofa struck Samoa in 1990, it was the first major disaster for almost a century. The initial response of the people was shock and confusion—people left wondering about what had happened and at a loss on what to do next.

The Samoan village however is still highly structured and hierarchical. Soon the Pule'u'u (elected village 'Mayors') and traditional leaders (Matai) had the villagers organised to clean up and rebuild their lives using whatever tools and means they had. They did not wait for government to provide emergency relief assistance, although this was soon made available. The proper use of existing systems, either traditional or introduced, during an emergency can and does enhance rehabilitation.

Current practice

When a disaster occurs anywhere in the world, the media brings it to one's living room. If the affected country asks for international assistance, teams are mobilised to assess damage and needs. Within days, emergency relief can be on its way. This is humanitarian assistance to alleviate suffering and to avoid loss of life. A good example of this was what occurred after the Aitape Tsunami which struck a group of villages in the Sandaun Province of PNG in July 1998. Through the power of the media and the rarity of such a tsunami event, 'global assistance' flowed in from governments, community groups and individuals. The author led a UNDAC assessment team to the area; the volume of emergency assistance, for a small number of victims was, in his experience, unprecedented.

The area of impact was about 50 square kilometres. The number of people affected was estimated at 10,000, with over 2,200 deaths and about 600 badly injured. The millions of dollars of material, financial and technical assistance provided and pledged, caused management and logistics difficulties to the government at the time. Intervention of this scale, unless closely co-ordinated and controlled, can assume a life of its own resulting in wastage—especially when the national government and also the affected communities have little say in what they get.

Depending on the political relationship between the assisting and the assisted, money and other scarce resources are usually not the limiting factor when it comes to providing humanitarian assistance. As a result, emergency relief is often very high and can undermine available resources for the rehabilitation and development to come after a disaster. Bilateral donors, NGOs, UN agencies and others treat emergency response and long-term rehabilitation and development activities as clearly different and separate processes. Their organisational structures are also divided between relief assistance and development aid. However, in the minds of the affected communities, there is no such demarcation and almost immediately after the event, they are thinking about recovery and their future livelihoods.

The best time to identify the most vulnerable communities and sectors of the economy is after a disaster. At this time it is also best to agree upon and implement vulnerability-reduction measures to reduce future losses. This often means the reallocation of committed development funds or accessing new ones.

Getting commitments and needed development resources and political agreement following a disaster is often easier than in normal times. This is an advantage if we are to reduce the vulnerability of communities and their livelihoods.

Designing better post-disaster aid programmes

Disaster management is a complex subject with no single or simple solution. It is closely linked to social and economic development and environmental management. At the heart of all disasters is the real need for humanitarian assistance to save lives and reduce suffering. This is definitely necessary and will continue. However, some of the direct consequences of this are increasing dependency, lack of self-determination of communities, the erosion of already existing coping systems and their replacement by a 'culture of relief'.

Opportunities to improve the situation and resist future adverse impact are often neglected or not well understood. Hence there are many questions to be answered about the best way to provide such humanitarian, rehabilitation and development assistance to vulnerable countries and communities. There is a need to critically analyse the way aid programmes are being delivered to communities if their development and livelihood are to be sustainable.

Is the current system of needs-identification and delivery of disaster-related aid programmes the best way? Should the assessment of humanitarian assistance be the prevalent post-disaster activity in lieu of assessing and designing development aid that will reduce the vulnerability of the weaker sectors, or providing scientific and technical support to better counter similar future occurrences? The delivery of disaster relief is the easy way out of the problem, and often the only way, leaving victims to take care of their own rehabilitation.

Redesigning development programme and reallocating resources to build a more resilient community should be normal post-disaster activity. In order to pitch development and mitigation efforts at the level appropriate for the affected community, proper analysis of the hazard occurrences and risk and vulnerability should also be an essential post-disaster activity.

The social issue of culture, custom and norm of vulnerable communities should be understood and respected when delivering relief assistance. What is the traditional way of allocating existing human and physical resources in the aftermath of a disaster? What is the relationship within and between the different neighbouring communities? Is there a system of mutual assistance and how does it work? Can relief aid be the means to further strengthen a community's social structure and not create greater dependency and division? If so how can this be done by the community itself. Community involvement should also include identifying the inhabitants' own vulnerabilities and strengths. If the community's traditional coping mechanism has weakened, can the situation be reversed or be replaced effectively to enhance future involvement?

Any community that has the capacity to cope and manage its own disasters should also be able to reduce its own vulnerability. It is the reduction of vulnerability and strengthening the capacities of people that are the key elements in successful disaster management strategies. This sounds so simple, but vulnerability is a complex issue because it deals with human society with its inherent complexity, diversity and its lack of homogeneity. There are so many factors which make people vulnerable and there are many indicators of vulnerability. Society is in a constant state of change and to reduce its vulnerability will require a number of different mitigation measures applied over a long time.

INTEGRATED COMMUNITY DISASTER PLANNING

The Philippine Experience

Lourdes Masing, International Federation of Red Cross and Red Crescent Societies, Malaysia



Photo: Associated Press

Residents of San Miguel, 380 kilometres southeast of Manila, salvage whatever they can from the ruins of their homes after Typhoon Babs hit this tiny island on 23 October 1998

THE STRATEGY OF THE 1990s of the International Federation of Red Cross and Red Crescent Societies (IFRC) is a strong commitment to reduce vulnerability among communities and increase their capacity to cope with the impact of environmental and natural disasters. The strategy is in accordance with the objectives of the IDNDR 'to reduce, through concerted action, the loss of life, property damage and social and economic disruption caused by natural disasters'. It is in response to these objectives of two international organisations that community-based disaster programmes were planned and implemented after improving and developing the institutional capacity to respond effectively. A wider and more innovative community-based disaster preparedness programme was planned and implemented by the Philippine National Red Cross (PNRC).

The vulnerability of communities to environmental and natural hazards is best demonstrated in the Philippines. Poverty remains a major problem as progress is oftentimes thwarted by the impact of disasters. Rapid population growth has contributed to the depletion of its natural resources. To respond to the needs of the vulnerable population, the PNRC implemented the Integrated Community Disaster Planning Programme (ICDPP) in four provinces which belonged to the group of 20 considered by the Philippine Government as the most marginalised and disaster-prone areas. It was first piloted in a mountain province, then in a coastal province, and then two other provinces with combined mountainous and coastal terrains. The ICDPP aimed at sophisticated and broader objectives to attain sustainability of the Programme.



Photo: Associated Press

Residents cross a submerged road as mudflows continue through the town of Bacolor, 50 miles north of Manila, following heavy rains brought by Typhoon Niña on 5 September 1995

The ICDPP is an improvement on the earlier disaster preparedness programmes in its innovative, holistic, and systematic approach. The ICDPP focuses on prevention, mitigation and preparedness. It also helped develop decision-making and advocacy to issues that affected the community through active involvement in a participatory process in all aspects of the Programme.

Objectives

The objective of the ICDPP is quite broad. Detrimental effects of environmental and natural disasters are minimised; the coping capacity of communities strengthened, and their vulnerability to disasters reduced. These are achieved through the promotion and development of disaster awareness as a sustainable part of community development; disaster planning methods and tools made available to the community; and a participatory process involving all communities of the local government units for disaster planning and emergency response integrated into the overall community development process.

The ICDPP, which is now into its third and fourth provinces, has remained focused on these objectives so that the systems, methods and tools which were being utilised can be replicated anywhere.

We would therefore like to share the phase-by-phase approach followed and the significant lessons learned from the ICDPP.

The step-by-step approach and significant lessons learned

Information dissemination: A proper and deep understanding of the Programme is important to generate close co-operation, co-ordination and networking with all concerned in the course of its implementation. Time was set aside to properly disseminate the Programme. Courtesy calls were made on the local government officials at all levels of the local government units (province, municipality and barangay 'village'). Council meetings at all levels became opportunities to provide vital information on the Programme and to identify the role of the local government units in the overall disaster management programme of the government. Local

technical staff of government agencies were also invited to lay down the groundwork for future co-operation and networking.

More work on dissemination was done in the targeted barangays. Contacts with formal leadership were not enough. In rural Philippines, especially in the upland areas, informal leadership through heads of the tribes and clans and religious leaders can play as strong a role as the formal leadership in community-based programmes. Their interest and understanding of the benefits of the programme for their constituents are essential to the success and sustainability of the programme.

The community organising process: A community does not automatically become involved in any activity. The staff and volunteers were therefore engaged first in community organising. They integrated themselves into the community, talked to various people and made themselves as visible as possible. This led to more discussions about the Programme in community assemblies, house to house visits, in informal talks among people at work, doing some recreational activities or even while attending ceremonial functions.

The staff and volunteers assigned to the targeted barangays were provided with information to better understand the community, their customs and traditions, the forms of social interaction, means of livelihood, sensitivity to the problems and needs, language spoken, topography of the area and cultural sensitivity. They integrated themselves into the day-to-day life of the community. Establishing rapport was a must. Knowledge of local interest such as new trends in agriculture, fish conservation, etc could improve their relationship in the community.

Total understanding and knowledge of the Programme is a must. Rural communities are as educated as the lowland counterparts and the upland communities targeted have high levels of literacy.

The use of high technology: The great impact of natural and environmental disasters to vulnerable populations necessitates the use of technology to document events and validate them. The use of more professional and scientific approaches are needed to develop systems, methods and tools that can be used in the reduction/mitigation of the impact of disasters. This is a step ahead of other community-based programmes.

The disaster history of the barangay: The gathering of information on disasters which occurred in living memory and even of disasters learned from old folks was done in a participatory process. A list of questions were prepared to conduct a systematic gathering of information. The moment the questions were released, they caught the people's interest and became the talking point of the community for quite sometime. Discussions were in groups and never with individual people. The outcome was unprecedented. The information generated was factual and the effects of disasters handed down from several generations were shared. The interest and enthusiasm in sharing and discussing information resulted in the development of the disaster history of the barangay, which proved to be an important tool to have for both disaster planning and development planning. It is updated after every disaster to indicate its effects and the areas affected.

Other information to substantiate the oral information from the community can be taken from the records of the local government units and other line agencies, or even from the newspapers.

Maps: In the process of gathering information and data, the people's perception of their vulnerability was assessed. The awareness of the risks around them was a positive factor in a programme like the ICDPP. They became receptive to the introduction of new ideas, methods and tools which they learned and internalised as a part of their daily life.

The community's perception was called 'low technology'. To determine the veracity of the perception, it was validated using 'high technology'. The barangay map was reproduced. Sketch maps are used in the ICDPP. The validation of the community's perception was the start of the hazard mapping which was later finalised after the vulnerability and capacity assessment. Tools like the Global Positioning System (GPS) and compasses indicated the exact location of risks that were identified.

The marriage of the low technology represented by the perception of the local community and its validation by high technology using maps, GPS and compasses was an important development towards a more scientific way of studying vulnerability in the community, and an important tool in the disaster planning development processes.

However, Filipinos do not have a culture of map reading. While maps were accepted, reading them was quite difficult to the average rural Filipino. Other types of maps, such as three-dimensional maps, were therefore introduced. After every disaster, the disaster history and the hazard map are updated along with the barangay disaster history.

Vulnerability and capacity analysis: While perceptions of risks and other vulnerabilities have been gathered and validated, the vulnerability and capacity analysis (VCA), included all aspects of the community — physical, economic, health problems, environmental problems, etc. New risks were identified. The identification of resources was equally important. No matter how poor and vulnerable a community is, it still has capacities.

Two important tools were produced in the VCA. These were a socio-economic profile of the community and a hazard and resource map. Again, these are important tools in the formulation of community projects and services.

Formulation of projects and services

Community disaster planning: All activities were always participatory. Any results from any activity were shared with the community. This frequent sharing and consultation was very productive. Interest and co-operation were maintained. It was also observed that such sharing drew closer relationships between the formal leadership and the community.

The results of the VCA were again presented and discussed with the community. Representatives were chosen to draw the disaster plan.

The participatory involvement of the community brought about long-desired projects and activities which had been ignored by local government units. With the results of the VCA, an integrated and holistic disaster plan was drawn covering all aspects that touched the inhabitants' daily lives. When presented with the disaster plan, they prioritised projects and services according to the need. Officially, it was turned over to the barangay council for inclusion in the Barangay Development Plan. Projects and activities were classified according to those that could be done among themselves and those needing external assistance.

The involvement of the community in the planning process is critical. Given the results of the VCA and knowing what they wanted and needed, the determination of projects and services essential to the development of the barangay and their prioritisation is a tangible sign of empowerment. Decision-making at the grassroots level is an important development. It gives substance to empowerment which in turn becomes concrete as it is supported with the methods and tools provided in the Programme.

Community disaster planning provides a wider field by which the community could manoeuvre to develop a holistic and integrated approach to prevention, mitigation and preparedness.

Mobilisation: The active involvement of the community in all stages of the Programme made it easier for the leaders to organise and mobilise the community in the implementation of the projects/activities identified. Prioritisation was essential to maximise utilisation of resources, especially funds. Priority projects/activities were then identified and groups were organised according to interest. Neighbouring barangays who were affected by the projects/activities gave intentions of their support in terms of manpower and resources available in their communities, such as labour and wood. Men, women and children were all involved. Food was provided by the Programme. The implementation of various projects and activities saw the active interplay of government agencies, non-government organisations, academics and the barangays.

Science and technology: Infrastructure in rural communities is often dependent on rural capacities and knowledge. In the ICDPP, the people saw the importance of improving rural capacities and knowledge. It was therefore a major breakthrough when technical and scientific assistance was sought from the agencies concerned from various departments of the local government units for projects and services identified. Academics were also involved for the reforestation projects, as other NGOs became engaged for income generation and skills training for sewing and handloom weaving.

Networking: The ICDPP paved the way for the greater utilisation of the technical and scientific resources of various agencies. This eventually led to extensive networking. As the ICDPP became known, more offers of assistance were extended to the barangays in support of the projects. Even international rural development organisations offered their services on socio-economic and environmental programmes, the local university participated in reforestation and the Bureau of Mines worked to explain why there are sinking areas in the barangays. Communities have started to network with these agencies and have realised the benefits.

Official turn-over of project to the community: The projects and activities were completed by the people themselves, after which it gave them a keener sense of achievement. It should be borne in mind that while they were doing these projects, they were working in a programme. The feeling is that these are owned by the Red Cross or any agency funding the project. This sense of real ownership will help in the sustainability of the Programme.

Evaluation: Evaluation of the various activities was performed regularly. Mistakes committed were corrected immediately and designated dates for annual evaluations were agreed.

Conclusion

The impact of disasters in recent times has been unprecedented in spite of all the advances that have taken place. There is a need for improved systems, methods and tools for communities to be able to cope with the devastating effects of disasters.

There is also a need for disaster plans to be integrated into the overall Barangay Development Plan for sustainability. The bottom-up approach will go a long way in strengthening the decision-making and empowerment of the community to decide priorities of their needs.

The ICDPP could be one of the answers for this kind of support. The ICDPP is a holistic, integrated, innovative and sophisticated programme that has taken off and inspired other community-based disaster programmes. The ICDPP encompasses the four fields the IDNDR targeted during the decade — disaster legislation, structural, non-structural and science and technology.

RATIONALE AND CHARACTERISTICS

Community models of disaster preparedness

David Simpson, Texas A&M University, USA



Photo: Associated Press

A gas main bursts even as water from broken water mains flood a portion of road in the Grenada Hills, Los Angeles, USA
The earthquake struck in January 1994, causing major damage and at least five deaths

THE FOLLOWING PAPER EXAMINES the rationale and primary characteristics of community-based models of disaster preparedness. The first two sections discuss some of the underlying rationale, while the remainder describes the characteristics that are common to these efforts. The research providing a context for comparison was conducted in 1994 and 1996, using case studies of fourteen community programmes (1994), and a mail/telephone survey of 48 programmes (1996), all of the programmes were located in California.

Problems with governmental approaches to disaster preparedness

The focus of disaster planning within government institutions tends to centre on the response and recovery aspects of an event. Emphasis is placed on the ability to effectively respond — to put out fires, rescue those in need, and provide essential shelter and relief. Detailed plans and checklists, often written to satisfy regulatory requirements, have usually not had a significant test or

simulation. It may be that the Multi-hazard Functional Plan, or MHFP as it is called, may look good on paper, but in the middle of a disaster those bulky plans are more likely to be used as doorstops than as useable plans.

Practice-oriented literature on disaster response, points to the problems of ‘over-planned’ responses (Lewis, 1988). By initiating too much structure and procedure, the response plan is not followed because it is impossible to predict all the needs and circumstances in a disaster. People will devise systems that get the job done, inventing new systems if necessary. Flexibility must be maintained in the response process.

Another significant problem in disaster planning by government institutions is the separation between ‘official’ activity and the role of individuals and volunteers. It is a rare community that integrates community-based organisations into its city response plan, even though observations of disasters have repeatedly shown there is a great propensity by individuals to help in the time of a crisis. The literature also indicates there are emergent organisations that

arise out of need (Wenger, 1989, Nehnevajsa, 1989) and individuals are more likely to be of assistance in their own local area.

Arguing for a community-based approach

To meet the community needs during the critical response period (the first hours and days following a disaster), an alternative planning framework should be considered. The emphasis should be on the individual, neighbourhood, and community-based organisations to provide 'first-responder' capability.

The first responder argument is compelling for a number of reasons; the first of which is the enabling of culturally sensitive planning and response. Local organisations and residents are able to communicate with residents who might not be proficient in English. Communication with non-English-speaking populations was found to be a problem by disaster assistance teams following the Loma Prieta earthquake (BAREPP, 1991).

The second reason is local awareness. Neighbourhood groups in particular will be more likely to know who in the area has special needs. For example, hearing-, sight-, or physically-impaired residents, or anyone requiring special assistance can be located more quickly. Neighbourhood groups can assist in the evacuation of these residents, or identify their location if a rescue is needed. Awareness also means knowing where equipment and resources are in the area (who has tools, or medical training, for example), and familiarity with local structures so utilities may be turned off.

Finally, there is the need for local residents to be trained in activities they will do anyway. With basic training in emergency first aid, fire suppression techniques, and simple search-and-rescue procedures, residents can accomplish vital response activities in the crucial period following the onset of a disaster. There are additional reasons that support community-based models, indicating that they:

- Give people a sense of control over the event. The feeling of control simultaneously decreases denial and raises hazard awareness
- Can reduce injuries and damage through education, and skills training to do search, rescue and medical triage and other response activity
- Utilise peer networks for information transfer. Research has shown that family and friends are the more trusted information sources (Perry and Greene, 1983)
- Can provide a political constituency for preparedness, and can serve to increase elected officials' awareness of the merits of community-based planning
- Offer a structured manner for dealing with volunteers.

The following sections use case study and survey results to classify and discuss the variety of community-based preparedness and response programmes.

Understanding community-based earthquake preparedness programmes

There are a number of similarities among the programmes, an important one being the community's desire to develop it themselves. None of the programmes was mandated; they were a response to local concerns. As local creations, they also have differences that make them unique to that community. With respect to programme initiation, however, there are a number of commonalities.

Community/grass roots impetus: In most programmes, the initiating agent was the concerned community. Private individuals and groups approached the local government, seeking the tools, techniques, and knowledge that would empower them in

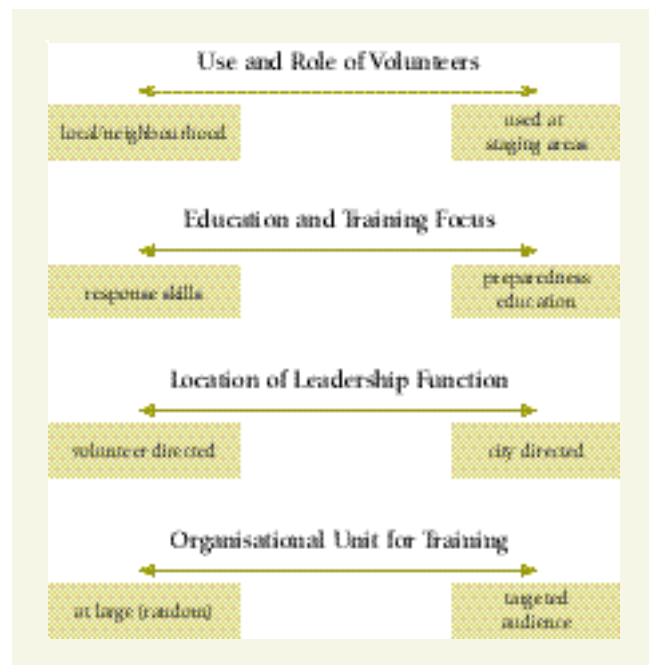


Figure 1: Programme characteristics continua

a disaster. They wanted to be able to respond in their own neighbourhoods, without relying on the local government.

Use of existing community networks: Where available, pre-existing local community organisations have helped in the formation of disaster preparedness groups. The process differed from community to community, but examples of these are Parent-Teacher Organisations, neighbourhood associations, and crime watch groups.

Local government assistance: Assistance from the local government agencies typically took the form of training, in some cases programme administration, and various levels of funding.

Examining the structure of these organisations we find that the format of the programmes tends to be similar, where the following elements are common:

- An emphasis on education and training
- Organisation of neighbourhoods is on a block-by-block basis
- A city staff person assists programme co-ordination
- The strength of the organisation is typically dependent upon the enthusiasm of the individual neighbourhood.

Excluding the City of Sunnyvale (whose programme started in 1988), all of the San Francisco Bay Area programmes were a response to, or their creation was accelerated by, the 1989 Loma Prieta earthquake, or the 1994 Northridge earthquake. Following the Loma Prieta earthquake, there were 14 programmes. After Northridge, an additional 28 were created (Simpson, 1998a).

With regard to the training and education, the structure, as well as course content, are similar in each programme. Training is offered in 'modules', that generally cover the following areas:

- Earthquake preparedness 'basics' (information and education related to earthquakes)
- A 'how-to' course on ways to organise the neighbourhood
- Response skills classes such as first aid, CPR, search and rescue, or fire suppression.

Due to the nature of the skills training, most programmes have close ties to the fire department both organisationally as well as operationally.



Photo: Courtesy of Dr. Ian Davis

With few exceptions, the funding of this activity is a 'low ticket item', meaning the expenditure is minimal compared to most city departmental budgets. Average annual funding for these programmes was US\$ 3,000; with a high of US\$ 330,000 and a low of US\$ 500. Research supports the argument that the programmes induce hazard-reducing activity on the part of the community residents, activity that the city cannot afford to fund on an individual basis (Simpson, 1996).

Classification of community-based programmes

It is possible to classify the main components of the community programmes according to several key elements:

1. Location of the programme leadership
2. Programme goals and training approaches
3. Use of volunteers
4. Targeted organisational unit.

These elements can be thought of as continua, with programmes having characteristics that might place them anywhere along each of the axes in Figure 1.

Location of programme leadership: Programme leadership can have a significant impact on the direction of a programme. Location can be considered in two ways:

1. The actual direction or co-ordination of the programme (when or if a city staff member serves the leadership function); or
2. Provision of programme policy guidance.

The day-to-day co-ordination of the programme can be influenced by its location in city government. In 60% of the programmes in the Bay Area, the programme is administered from the Fire Department. In 11% it was the City Manager's Office, in others it was controlled by community volunteers (7%), or the Police Department (7%). The rationale for basing these functions in the Fire Department is due to the fact that much of the training is conducted by the fire departments (Simpson, 1998b).

Policy guidance has also been addressed differently. In Alameda, Berkeley, Dublin, Oakland, and Sunnyvale, the city council and city managers have guided the programmes. The control takes place through formal and informal channels; formally, by using the budget process to control funding and informally, by city council members responding to constituent pressure. In San Francisco, Sunnyvale, and others, the programme director is responsible for policy.

In other programmes, the volunteers determine policies. In Albany, it is an executive steering committee composed of

community volunteers and in others, it is a board elected from a pool of community volunteers. The differences in the policy guidance can be significant if the programme co-ordinators and the citizens in the community have different opinions regarding the direction of the programme.

Programme goals and training approaches: All of the programmes seek to provide community residents with the knowledge and tools to be more self-reliant. The differences are more apparent when looking at the training programmes. The San Francisco, Berkeley, and El Cerrito programmes emphasise the disaster response capabilities of individuals and response units (neighbourhoods, or in some cases, the city). The training programmes are focused on skills training, followed by hands-on applications in drills.

In other programmes such as Albany, Sunnyvale, and Oakland, there is a mix of education in terms of promoting household or neighbourhood preparedness activity, and in the development of specific response skills. In still other programmes, such as Mountain View, the focus is more on education and promotion of household and individual preparedness activities such as the storage of supplies, and the knowledge of how to react and assist once an emergency takes place.

Use of volunteers: The role that volunteers play in the administration of the programmes can also influence their development. Volunteers in some programmes must complete a certain level of training before they are allowed to become a member of the city's response team. In other programmes, volunteers are utilised to conduct the education and training once they have undergone training themselves. In Albany, El Cerrito, Berkeley, and Oakland, trained citizens are expected to respond to the needs of their own neighbourhood first, and then check on the next closest neighbourhood.

This 'neighbourhood first' philosophy is found in 71% of the programmes, while another 13% have their citizens report to predetermined staging areas. For example, in the San Francisco and Los Angeles programmes, trained volunteers are expected to report to staging areas to await direction and co-ordination from emergency services personnel. In 5% of the programmes, citizens are expected to be 'on their own'.

Targeted organisational unit: The unit within which the trained citizen is expected to operate, once a disaster has occurred, can shape the nature of the programme. In some programmes, residents are offered classes open to anyone in the city, which is true in El Cerrito, Dublin, and Alameda, and for some training segments, in Oakland. Other programmes specifically target the neighbourhood to train as a unit (search and rescue, or fire suppression), which is true in Albany, Oakland, and Sunnyvale.

Conclusion

Evolving agreement among cities creating community-based programmes is that the key to success will be the development of realistic response strategies that can be carried out under adverse conditions, while also understanding that local residents will be first responders. Therefore the training and information should be basic, easy to learn, and clearly understood by all participants prior to a disaster. The confusion that will follow a disaster will not allow 'on-the-job' learning. If a plan is not understood or followed, an ad hoc system will develop in its place. If flexibility is not planned into the response, then any ad hoc response will be wasteful of resources. Community-based preparedness groups are a potential source of localised response planning that can meet these needs for flexibility.

A VIEW FROM THE IDNDR'S OUTFIELD

Africa: Risk prone, but not disaster-affected?*Doctor Ailsa Holloway, University of Cape Town, South Africa*

THE CLOSURE OF THE DECADE provides a timely opportunity to critically reflect on the progress made in global disaster reduction over the past ten years. It is also occasion to revisit the original mission of the IDNDR—specifically its objective to reduce the impact of natural disasters in developing countries, where human and other losses are greatest.

This chapter reflects one perspective from an outfield of the IDNDR. It examines the Decade and its engagement with Africa. In this context, it questions the reasons why a continent so burdened by multiple risks has not appeared to engage energetically with the IDNDR, that is, compared with disaster reduction efforts generated in Europe, the Americas, Asia and Oceania.

The disaster disconnect

There are many underlying reasons for Africa's limited involvement in the Decade. In-part, this 'lack of engagement' is explained by the profound disconnect between the reality of Africa's disaster profile—compared with the disasters that the IDNDR has targeted. Most noticeably, the disconnect is driven by significant disparities in the elements underlying disaster risk in Africa, compared with other continents.

First, much of the initiative in natural disaster reduction has its origins in northern countries—or in regions regularly buffeted by sudden onset threats such as hurricanes, cyclones, volcanic eruptions, earthquakes or floods. While much of Africa also faces these types of occurrence, its risk profile differs considerably—that is—if we define risk as being the product of both hazard and vulnerability processes.

During the past decade, Africa has been battered by many threats, including armed conflict and fiscal austerity programmes associated with economic reform. Moreover, most of the natural threats faced in Africa are not dramatic sudden-onset events. Rather, they are relatively silent and insidious encroachments on life and livelihood, which increase social, economic and environmental vulnerability to even modest hazard occurrences. Here, recurrent drought, progressive land degradation, desertification and HIV/AIDS—among other communicable diseases—are responsible for incalculable human, crop, livestock and environmental losses. Across much of rural Africa, disaster risk is driven primarily by the processes of progressive environmental and socioeconomic vulnerability, rather than the behaviour of natural hazards.

In this context, perhaps the message of natural disaster reduction has not worked quite as well in Africa, as it has in other continents. Stereotypically, even if unintentionally, the IDNDR message is associated with images of averting sudden-onset large-scale natural events which may or may not happen at some future point. In a region where a ready-made stack of urgent survival issues exists, and where these large sudden-onset occurrences are relatively rare, one could hardly expect natural disaster

reduction to be viewed as a priority by the media, by educators or by policy makers.

Second, the natural disaster reduction message argues compellingly that investments in mitigation and preparedness are necessary to ensure sustained economic, social and environmentally responsible development. Such investments avoid or minimise the unaffordable human, property and environmental losses caused by the interplay between natural and other forces. Implicit in natural disaster reduction advocacy is the emphasis on averting losses triggered by future large-scale natural uncertainties.

Yet, in many parts of Africa, people live with the daily threats of food insecurity and hunger, the risk of armed robbery, the prospect of violent sexual assault, the risk of becoming another traffic fatality, as well as the ever-present threats of HIV, tuberculosis and malaria. In this context, the Decade's emphasis on preventing large-scale future losses has less relevance in an environment where every day is accompanied by significant natural and manmade dangers.

A third intriguing disconnect between the experience of disaster risk in Africa and that reported elsewhere is illustrated by systems for reporting disaster loss. The information pack distributed for Natural Disaster Reduction Day 1998 provides a clear example. Statistics, compiled by Munich Reinsurance, estimated a total of 538 disaster loss events in 1997, claiming around 13,000 deaths and US\$ 60 billion worth of losses. Of these events, 36 were attributed to Africa (compared with 182 and 172 loss events reported for Asia and the Americas) (Berz, 1998). Economic losses for Europe, the Americas and Asia were respectively costed at US\$ 10 billion, US\$ 9 billion and US\$ 8 billion, while total African losses were projected as lower than those recorded for Australia (Berz, 1998).

A superficial (mis)interpretation of these loss statistics would suggest that Africa as a continent at-risk is in-fact safer than Australia, at least if insured disaster losses are considered!

The figures cited reflect primarily insured losses of physical infrastructure in countries where sudden onset geomorphic, meteorologic and hydrologic events repeatedly strike areas that are densely populated. This particular perception/definition of 'disaster' does not resonate well with the configuration of disaster occurrence across Africa. Here, 'small-scale' disasters like house-fires cause the widespread destruction of non-engineered and non-insured homes in sprawling informal settlements. Similarly, 'creeping emergencies' such as drought, in Africa's isolated hinterlands, are not easily measured in conventional disaster loss tracking systems.

Reducing disaster risk: The development connection

If we carry forward our argument that natural disaster reduction in Africa is indeed a key cornerstone of sustainable development, then perhaps it would have been more effective to root our



Photo: Rex Features

Consequences of drought in Africa: Dead cattle and famine

disaster reduction advocacy efforts in the sorts of issues that resonate with the concerns that confront people today—rather than weight our advocacy process in favour of what are perceived to be uncertain future threats.

On one hand, this would have presented a more difficult challenge both for our region's hazard scientists and emergency managers. It would have meant engaging directly with today's complicated social, economic and environmental agendas, and drawing links between ongoing developmental efforts and natural risk reduction. It would have meant learning the language and vocabulary of fields as diverse as land reform, gender equity, ecotourism, poverty reduction and democratic governance. It would have meant demystifying and reworking much of our existing meteorological and hydrological hazard science so that it became much more accessible and understandable to other players, and resonated better with today's priorities. It would have entailed a more thorough exploration of the social, traditional and linguistic contexts which shape perceptions of hazards, risks and disasters, as well as influence attitudes and behaviours.

On the other hand, our region's development agendas would possibly have been the most effective drivers for natural risk reduction advocacy in Africa. Moreover, they would have provided sustainable and affordable platforms for the selective integration and adaptation of risk reduction science and technology.

Nearly two years ago, southern Africa's largest non-governmental organisation involved in the water sector was invited to participate in a regional drought risk reduction initiative. 'No' was the reply. 'We are committed to sustainable community water supplies in rural areas—not emergency drought water programmes'.

Today, the same non-governmental organisation is driving a regional rainwater harvesting programme across southern Africa—to improve the sustainability of water supplies to households in recurrently drought-prone areas. Its engagement with drought reduction is not motivated by a concern for disaster aversion—but rather by a concern that meteorological/hydrological drought threatens the sustainability of accessible rural water supplies.

This was and remains Africa's risk reduction opportunity. Across the continent, there are multiple avenues with which to minimise natural disasters. These existing development vehicles are largely

directed towards reducing today's risks, irrespective of whether the perceived threat is violent crime, unemployment, chronic hunger and food insecurity, or progressive land degradation and erratic water supplies. Programmes, as diverse as agriculture extension services, revolving credit schemes for women and alien vegetation eradication programmes (to remove non-indigenous vegetation which deplete ground-water reserves) are all examples of activities which provide immediate socioeconomic benefits, as well as short-term and long-term resilience to natural and other threats. Yet, they are seldom promoted as 'hazard' or 'disaster' reduction activities—but rather as development initiatives.

The El Niño connection: Making science meaningful

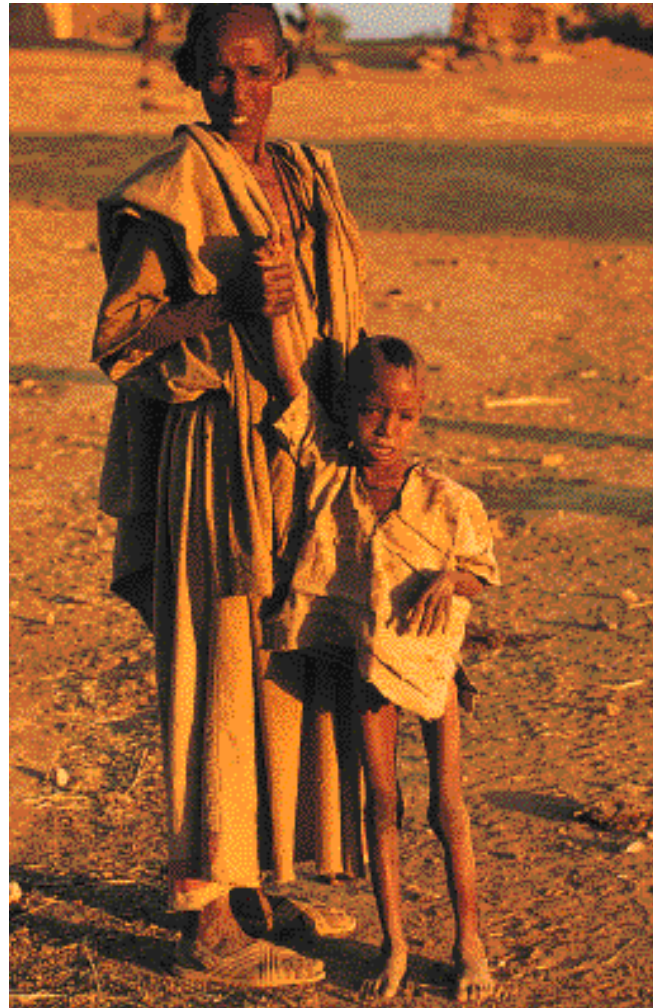
One of the strange benefits of significant hazard occurrences—such as recent El Niño/La Niña events, is that they build awareness of the important role played by the national meteorological service in forecasting weather events that have significant economic and social impacts. In this context, the continent's national meteorological and hydrological services increasingly are perceived as key players in making information on natural risk accessible to policy makers and civil society at-large.

In a continent where food and water security remain pressing concerns, there is particular sensitivity to the risk of recurrent drought. Yet, one of the key challenges remains reconciling the probabilistic nature of current drought forecast capacities with growing public demand for precise and certain data. This has clear educational implications at all levels—from extension workers and subsistence farmers—to senior policymakers—all of whom pressure national meteorological services repeatedly for precise answers on the certainty of a drought occurrence (*Thomson et al, 1998*).

With rising public awareness of the availability of data on climatic and meteorologic trends, there are growing calls across the continent for a range of disaster-related information. Long-range forecasts on rainfall and temperature are increasingly sought to guide sustainable agriculture and water resource management options. In coastal regions, concerns about rising ocean levels in the next millennium must be balanced against immediate employment/income needs when expanding tourist and other infrastructures along beachfronts and estuarine areas. In addi-



A mother and child in Ethiopia show the horrors of starvation, however caused. Unfortunately, such suffering is all-too-common



Photos: Rex Features

In a similarly advanced state of starvation, these two unfortunate people in Somalia show that disaster is no respecter of national boundaries

tion, there are growing demands for more precise local interpretation of global weather phenomena such as the El Niño.

Reconnecting: Future prospects

As we look into the future, characterised by more variable and extreme weather patterns, shifting trends in rainfall distribution, and dramatic urban population growth, we can expect new risk patterns to emerge. In this context, the issue of urban growth in Africa is a critical consideration, with the total population residing in large scale cities (greater than one million people) projected to increase from 33 to 216 million from 1990 to 2020 (*Erbach and Gaudet, 1998*). As seen elsewhere, increasing urban density brings with it the risks and vulnerabilities associated with megacities, including the prospect of significant infrastructural and economic loss from sudden onset threats—as we have observed in the Americas, Europe and Asia. Moreover, in many parts of southern Africa, progressive processes of land degradation and soil erosion are associated not only with increasing drought impacts—but also with the growing threat of flash floods—after long dry spells.

Such processes challenge the future of sustainable development in Africa, just as they do in other continents. And, for many years in Africa, there have been developmental efforts to minimise the vulnerability of those at risk from these and other threats. Irrespective of whether it's wetland conservation, improved food security for female-headed households, or better land use planning, existing development mechanisms are all

potential and cost-effective vehicles for containing natural, as well as other risks.

The IDNDR has provided, for the first time, a platform which links contemporary hazard science together with the agendas of sustainable development and social equity. If Africa has seemed a passive bystander to the Decade, it is not because of disinterest in the relationship between natural risk processes and disaster occurrence. Rather, it reflects a commitment to pursue risk reduction more from a developmental framework, and less from a hazard reduction perspective.

Perhaps this is occasion to applaud the many unacknowledged development initiatives which have reduced the impact of weather-induced threats across Africa's rural communities in the course of the Decade. Not labelled as 'disaster reduction' programmes or projects, they have protected water supplies, conserved natural resources, diversified income sources, and contributed to food security. They have successfully averted human, livestock and crop losses. Their largely unrecorded contribution is consistent in every way with the objectives of the IDNDR.

It is this quiet capacity to weave natural risk reduction into an existing social, economic and political fabric that distinguishes Africa's engagement with the Decade. As elsewhere, it will be this continuing commitment to risk reduction as a development imperative—rather than an emergency response invoked in the aftermath of a disaster—that will determine the impact of natural and other threats in the years to come.

CASE STUDY

Practical experiences in preparing a community for a disaster

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THE PHILIPPINES, COMPOSED OF 7,100 islands and islets and located in the south east of the Asian continental landmass, is one of the most disaster-prone countries of the world.¹ Every year, different types of natural hazards and human made disasters occur, affecting thousands of families. These calamities usually result in significant economic losses to the country. Despite the country's proneness to hazards, most disaster management agencies, both government and non-government, were focused mainly on emergency response and gave little attention to the preventive and preparedness aspects.

The lessons learned from the devastating effects of the earthquake in 1990, the Mount Pinatubo explosion and the flash floods in 1991 prompted the government and non-government organisations (NGOs) to give special attention to preparedness work. This paper deals with how a community-based NGO prepared a village for the disasters that normally confront the poor residents. This paper also shows how the community took on the preparedness activities and the actual implementation of its counter-disaster plan. This case was documented through personal visits, discussions with the NGO and the community representatives, plus a review of government records on the specific events cited in this study.

INVOLVEMENT OF TABI, A LOCAL NGO

Tabang sa Biktima² (TABI) is an NGO formed in 1984 by representatives of People's Organisations (POs), NGOs and concerned citizens, who jointly carried out relief operations for the victims of the Mayon volcanic eruption.³ They established TABI to assist vulnerable communities in the field of health and emergency response in the Bicol region. As such, it organises community-based health workers groups and Disaster Response Committees (DRCs). In organising DRCs, TABI follows its own guideline in community-level disaster management planning. This guideline has six stages: involvement; community profiling; community risk assessment; detailed formulation of counter disaster plan; implementation and monitoring; and, evaluation and feedback (Figure 2).

In September 1993, TABI was requested by another NGO to assist Fabrica, a village in the town of Bula, Province of Camarines Sur (Figure 1).⁴ The request was for a health

and nutrition seminar. TABI then drew up a community profile through meetings with community leaders and visits to the area, prior to the conduct of the seminar. The profile showed that there was also a need for disaster management training because of the perennial flooding of the village.

Fabrica is a community with a total population of 3,679 individuals (*National Statistics Office Data*, 1995). Two rivers, one traversing the whole northern border and the other in the south west, encompass the village. The main source of livelihood is farming and fishing. Most of the farmers are tenants and farm workers. Many houses are made of concrete and wood, the others are of bamboo and nipa shingles. Aside from flooding, problems of health and rat infestation confront the community.

In consultation with the village residents, TABI conducted a seven-day health and nutrition seminar leading to the formation of a community-based health committee. The training was scheduled on a staggered basis (two-days per month), so as not to unduly interfere with the regular production and other socio-economic activities. The health and nutrition course had not been completed when a typhoon struck the area.

AN UNPREPARED COMMUNITY

On 5 December 1993, Typhoon Lola (local code name Monang) with maximum winds of 173 kilometres per hour and a recorded rainfall of 199.8 millimetres over a 24 hour period struck the Bicol region. Typhoon signal number three was hoisted over Camarines Sur including Fabrica (*PAGASA Weather Bulletin*, 1993). Rain was recorded non-stop for 51 hours. Many parts of the five provinces of Bicol Region were inundated by floods from 24 hours to one week (*Office of Civil Defense*, 1994). Damage to infrastructure, agriculture, livestock and fisheries for Camarines Sur Province alone was estimated at Php 482.99 million. In this province 168 people were reported dead, five of these were children from the Fabrica community (*Office of Civil Defense, PDCC*, 1994). Many of the families lost their personal belongings and most of their farm animals.

The following factors were identified by the government as contributing to the disaster wrought by Typhoon Monang—limited radio airtime hampered information dissemination;

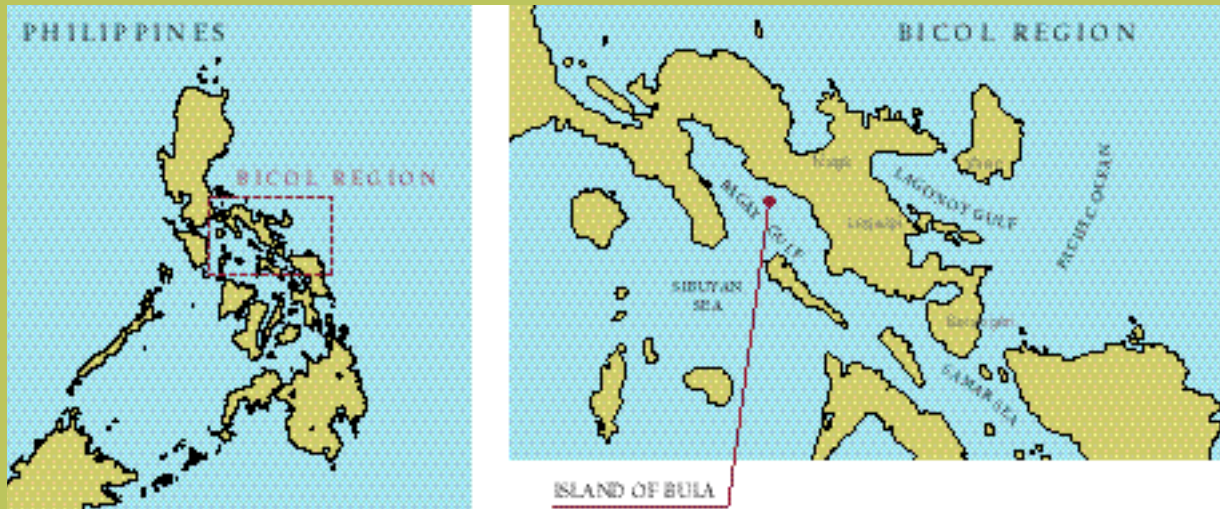


Figure 1: Map of the Philippines showing the Bicol Region and the location of the island of Bula

the only telephone of the provincial office of Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA),⁵ which connected the weather station to other agencies and media; early warning did not reach many farflung communities such that classes and offices were not suspended, thus many children were trapped in schools by the flash flood; public ignored storm warning signals; and, lack of knowledge on disaster preparedness and prevention on the part of the people resulted in their failure to respond (Balang, 1995, Molina, 1995). According to the residents there had been similar typhoon signals issued in Fabrica before, but they were not so much affected, so they did not heed the warning for Typhoon Monang. They also noted that everyone only acted to save themselves.

TABI undertook emergency response for Fabrica and the neighbouring villages after conducting community damage needs and capacities assessment. After the disaster, a series of meetings was held in the community to reflect on what had happened.

DISASTER PREPAREDNESS AT COMMUNITY LEVEL

By January 1994, a month after the disaster, when the affected families had reached a level of normality, TABI and the community agreed to hold a disaster management seminar. TABI carried out a training needs assessment to determine the appropriate course content. The training was composed of two parts — the Disaster Management Orientation (DMO) and the Disaster Preparedness Training (DPT). Again, the schedule was staggered to enable the participants to continue their livelihood activities, which they needed most especially after such a catastrophic event.

Among the twenty-five individuals who finished the training were ten women who volunteered to form the core or nucleus of the village disaster response committee. The others were members of the existing village council and

health committee and were not expected to give full attention to disaster preparedness work. The seven areas that composed the whole village were represented in the Disaster Response Committee (DRC).

According to the DRC members, led by Ms Imelda Dacara, 'The training helped us to sharply analyse the existing vulnerabilities in our community, one of which is the geographical characteristic of our area. Now, we understand why we experience recurring floods. During the training, we came up with a hazard map and formulated a community counter disaster plan (CDP). It was emphasised in our CDP that the typhoon signals through the radio were warnings to be heeded and that if the rains continue unabated for twenty-four hours, we should be ready to evacuate. We also agreed that when the floods on the roads overflow to the sidewalk, we should proceed to the predesignated evacuation site'.⁶ In addition, she said that since preparedness is important, it is essential that each family should own a banca (local canoe) as a means to ensure safety during flooding. Co-ordination with the local government on what it can do to help the poorer families, who can not afford to build their own banca was also part of the CDP. Further, the plan encouraged the growing of medicinal herbs and vegetables in their yards and the planting of wind-resistant trees in specified areas. These were measures identified in the plan to contribute to the community's health and safety. Regarding relocation of the whole village as a possible alternative, the community deliberated on it, but unanimously refused the option. One of the reasons cited by the community in opposing the relocation plan of the government was that the proposed site was too far from their source of livelihood.

The DRC conducted consultations among families of the village to echo their learning from the training and get their feedback on the counter-disaster plan. Once finalised, the plan was implemented by the DRC, which ensured that each family understood and followed the provisions in the plan. The functions of the DRC include the promotion of

the community counter disaster plan; echoing of learning to other members of the community; issuing early warning; co-ordinating with the village and town councils, organising the handling of relief delivery operation when needed, monitoring of projects and activities; leading in the community drills on preparedness. and co-ordinating with TABI.

A PREPARED COMMUNITY

On 2 November 1995, Supertyphoon Angela (local code name Rosing), with winds of 205–250 kilometres per hour hit the country. The Bicol region was the most devastated area, where floodwaters reached up to 15 feet in some places. More than 73,292 units representing 76% of all houses damaged were in Bicol. Nationwide destruction was estimated to reach Php 2.18 billion; casualties were 490 dead; 2,801 injured and 190 missing (*Office of Civil Defense*, 1995). This time, no one was killed in the village of Fabrica.

According to the residents, when news about the impending typhoon was aired, the DRC reminded them to follow the development over the radio. Those who did not own a radio were informed by their neighbours. When the waters from the rivers reached the road and started to overflow to the sidewalk, the women and children proceeded to the designated evacuation place, the San Roque Portico Village Chapel. They carried with them their personal belongings. The men followed much later bringing with them their farm animals on boats. The poorer families were evacuated in large bancas provided by the local officials. This arrangement was previously agreed between the DRC and the local government. Some well-to-do families living in concrete two storey structures did not leave their houses. However, when flood waters reached half of the second storey, they were forced to destroy part of the roofs so that they could climb through and perched on these. They did not save their valuables.

The experience brought about by the typhoon tested the community’s level of preparedness. They saved their lives and much of their assets necessary for living, however, many of the houses made of bamboo and nipa shingles were not spared. Others who refused to leave their houses realised the usefulness of the CDP.

LESSONS

Previous disasters provide opportunities for preparedness work, both at the institution and at the community level. Maximising this opportunity is crucial to save lives and property against future disasters.

Preparedness measures, which includes the formulation of counter-disaster plan and the training of community representatives, provide an added dimension to community life.

Counter-disaster planning helps to consolidate a community’s efforts in preparation for the coming hazards to protect the whole community. It also provides them with guidelines for operation and clarifies roles and responsi-

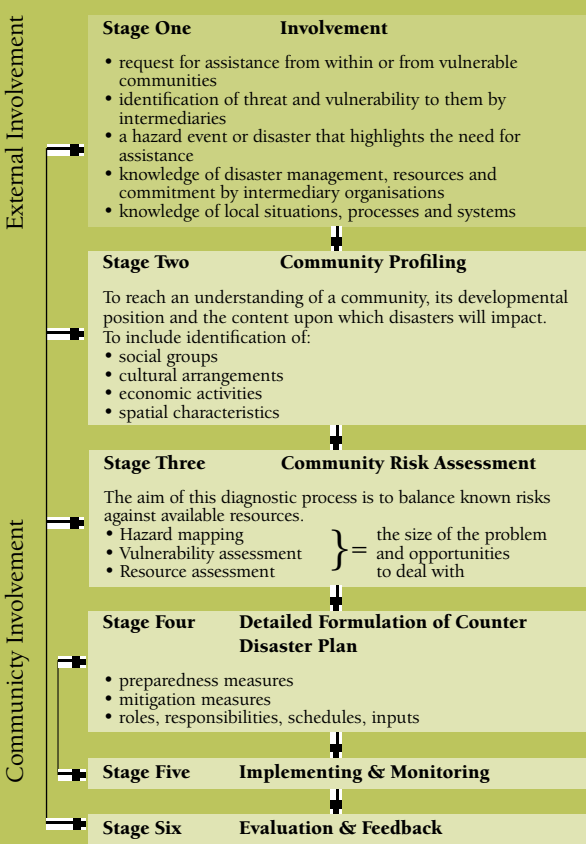


Figure 2: Community-level disaster management planning

bilities before and during disasters. Training enhances the people’s capacity to plan activities, analyse the situation, lead the community, and issue early warning. An aware, alert, healthy and informed community can overcome risks and mitigate the effects of disasters

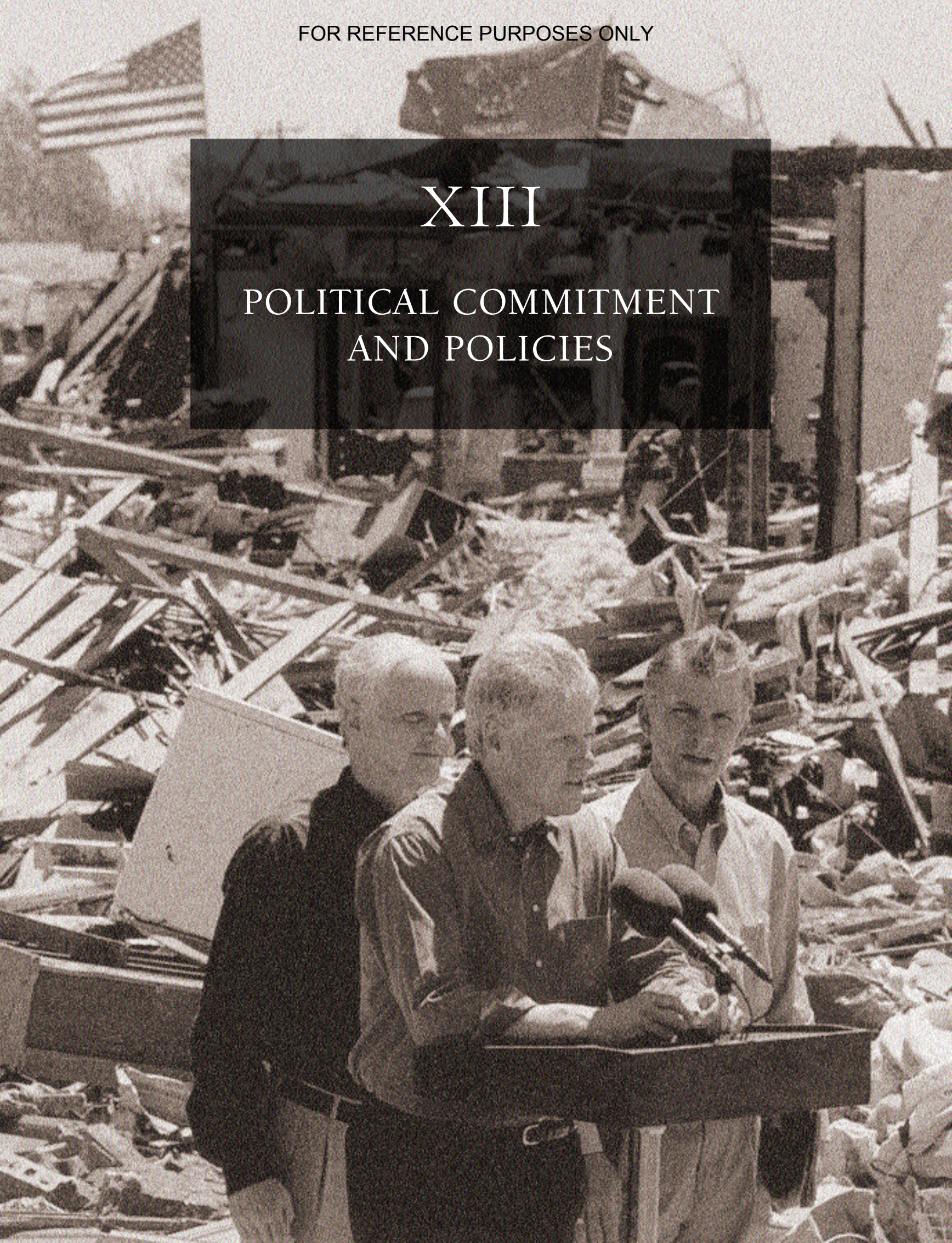
In order to enable a community to fully protect its people and properties, poverty alleviation measures should also be introduced. In the case of Fabrica, the poorer residents were not able to strengthen their houses before the disaster struck. These were then destroyed. Due to lack of resources, no major infrastructure project to prevent flooding was undertaken.

External intervention, in this case by the NGOs, is only effective and sustainable if it is acceptable to the community. Acceptance is possible if intervention is based from an assessment of the community’s hazards, vulnerabilities, needs and capacities. Maintenance of the preparedness plan greatly depends on the level and capability of the community’s organisation.

The women’s role in disaster preparedness and emergency response is as valuable as that of the men. In Fabrica, the women took the lead in these aspects since the men were busy attending to the family’s economic needs. Disaster preparedness is everybody’s responsibility and concerted effort of both men and women will eventually lead to ideally prepared communities.

XIII

POLITICAL COMMITMENT AND POLICIES



KEYNOTE PAPER

POLITICAL COMMITMENT

Neil Britton, Ministry of Emergency Management and Civil Defence, New Zealand

GOVERNMENTS HAVE SPECIAL RESPONSIBILITIES to ensure that appropriate risk reduction and disaster preparedness activities are adopted and implemented. Lessons of the Decade can be turned into meaningful policies to better integrate disaster management within other relevant social structures. However, integration requires political acceptance that disaster management is more than preparing for and responding to impact.

Lindell (1997) identified three major roles specific to hazard management. Five additional roles can also be identified which, considered together, underscore the reality that disaster management is core government business:

Major roles

Best use of scarce resources: Revenues used for response and recovery come largely from public treasuries, therefore government has a responsibility to ensure that this resource is used appropriately.

Disaster resilience: Effective disaster management reduces the likelihood of, and impact from, disasters. It also reduces the probability that members of the community who are not directly affected by the physical impact will be indirectly affected by the interruption of normal flows of goods and services. Hence, it is in a government's interest to minimise community disruption, maintain essential goods and services, and ensure continuity of community.

Sustainability: Different levels of government are potential disaster victims because of their resource investments in vulnerable infrastructures located in hazard-prone areas. As a consequence, it is important that governments adopt hazard adjustments to protect their own human, material and financial investments.

Additional roles

Risk management co-ordination: Effective risk and disaster management is dependent upon strong co-operation and co-ordination among and within levels of government, the volunteer and the private sector. The most likely sector to achieve this is

government because of its mandate to legislate requirements and promote community values.

National-level issue: Disasters are low-probability/high-consequence. Disaster is therefore not only a specific sectoral issue, but a problem for entire communities and nations. Its co-ordination requires national-level planning and execution.

Regulatory requirements: Government has three distinct sets of offices that distinguish it from other sectors. The role of the legislature is to make the law; the executive is responsible in formulating proposals for new laws and for implementing the law; and the judiciary is responsible for interpreting the law and its application in individual cases. These functions provide the machinery through which government maintains community values.

Economic management: Disasters destroy decades of human effort and investment, and threaten sustainable economic development by placing new demands on society for reconstruction and rehabilitation. They are costly in immediate losses and in long-term consequences. Disasters halt and, in some cases, reverse economic progress. As the nation's economic manager, it is prudent for government to minimise circumstances that may disrupt markets.

Developing national strategies: Vulnerabilities change and it is essential to understand and address them as best we can. Every nation is likely to face more — and worse — disasters in the future. Developing appropriate counter-measures requires a systematic and co-ordinated approach. Government, working with other groups, is the only sector that has a commission to develop national strategies with the power to bind, commit public resources and to influence private resources.

What role should disaster management perform in society?

The conventional role of disaster management relates to ensuring the safety and security of a nation's citizens, property and infrastructure from large-scale disruptions, or 'social harms'. Disasters challenge a community's ability to cope because they cannot be adequately handled through the 'everyday' social routines.

Associated with the hazardscape are risks. For many actions a risk is known and may be dealt with matter-of-factly or at least tolerated. However, the nature of risks associated with a range of potential social harms is often difficult to assess and appreciate. The consequences may be equally difficult to perceive. Faced with such difficulties, individuals and communities often underplay the social harm involved.

Since there will always be social harms that cannot be managed by routine frameworks, it is necessary for communities to develop other specific means to manage them. Nevertheless, steps taken to manage risks of extreme events can be justified to the extent that they deliver a net benefit to society. Attempts to manage risks will invariably impose costs as well as benefits. Disaster management should not look solely to minimising losses (for example, of life, property and well being), but also to maximising gains. As such the answer to the question posed at the beginning of this section is encapsulated in the propositions below.

Proposition one

Disaster management should aim to enable communities to maximise gains and minimise losses when dealing with potential large-scale unanticipated events that pose extreme risks to them.

Integrated and risk-based disaster management: Disaster management needs to be undertaken within, and in support of, the wider social, cultural, environmental and economic fabric of communities. This poses two specific challenges:

1. Interest in these events is primarily about the probabilities and magnitudes of their consequences. It is not always possible to avoid adverse impacts entirely, but instead they must be reduced to acceptable levels. Accordingly, a risk management approach is appropriate for disaster management. While aspects of risk management are not new, the application of risk management as an over-arching framework is in its infancy.
2. The risk management process must include an analysis of options to deal with identified threats (*Standards Australia*, 1999). However, options impose their own costs. Communities need to be aware of costs as well as the anticipated benefits in both short and longer terms.

The challenge lies in developing reliable means of assessing likely social, cultural and economic costs of hazard events and of the different means of treating them. Such assessments will enable more informed decisions about what mix of disaster management activities may best contribute to a community's social, cultural and economic goals.

A way of achieving, at least in part, the aim in Proposition one is the second proposition below.

Proposition two

Through a risk management approach, disaster management should balance the social, cultural, environmental and economic goals of communities and the costs and benefits of different strategies to achieve those goals. In this way a community can determine appropriate levels of risk in relation to 'extraordinary' events commensurate with the needs and circumstances of the community.

Proposition two does not fully answer the question of how to achieve the aim of Proposition one. If it was a complete answer then in all likelihood it would already have been implemented. Part of the reason why it has not been implemented lies in the conventional approaches to promoting disaster management. Such approaches imply it is an 'add-on' or a separate process. Disaster management would be better promoted as an implicit part of everyday decision-making within communities.

Broad awareness and integration of disaster management can be achieved. Changes in how societies view the world, provide opportunities to use a number of relevant drivers. The challenge for disaster managers is to develop practical mechanisms to utilise these drivers. The key drivers currently available are:

Sustainability: Since the release of the Brundtland Report in 1987, sustainable development has become an entrenched concept within most developed countries. A sustainable approach to hazard management should help to ensure that decisions about economic and social development do not inadvertently increase the risks from social harms to current or future generations. This does not mean that risk exposure in some instances will not increase. However, where it does, it will be through explicit consideration.

Resilience: Resilience concerns the ability of systems to absorb change, to regain stability after an adverse impact, or to shift to new points of stability. For disaster management this means focusing more effort on reducing the vulnerability of a community to 'extraordinary' events. It also requires more emphasis on planning for, and undertaking, post-event recovery which makes communities less vulnerable to future events. Communities with weak or un-diversified economies are more vulnerable to hazard events. Similarly, communities with poor social cohesion are less likely to be able to pull together to help themselves in the face of hazard events. Resolving these issues may lie within broader economic and social policies.

Integrated management: means embedding disaster management thinking within all decision-making affecting the wider social and economic goals of communities. Equally important is checking that reducing a community's vulnerability to a hazard does not inadvertently increase its vulnerability to another.

Governance: Many everyday decisions add to or lessen the vulnerability of communities. To be successful, disaster management must be accepted as a core part of governance within public institutions and also, wherever possible, private institutions. Consistent with a risk management approach, decisions should be made following wide consultation and the establishment of a clear mandate. Where appropriate, national aspects of disaster management should be dealt with in a way that allows local solutions to local problems. This localised ownership of decisions should lead to better outcomes through the pragmatism and understanding of those most affected, thereby strengthening a community's resolve about the decisions.

Partnerships: Disaster management cuts across all sorts of national and local activities. Effective horizontal and vertical partnerships must be created and maintained. Significant linkages and relationships are required throughout the wider community to achieve effective disaster management. However, many disaster management agencies have difficulty in gaining acceptance among other agencies that are influential in the adoption of risk management. This is primarily due to a misconception that disaster management is solely about preparing for and responding to events. It is therefore important that the wider interests of disaster management are communicated on an ongoing basis, and that those working in the field strengthen existing partnerships, as well as forging new ones.



Photo: United Nations

Commemorating the 50th anniversary of the United Nations

Economic efficiency: Public policy must almost always be economically efficient. For disaster management this requires consideration of many issues including: Intra- and inter-generational equity; transaction costs; incentives for appropriate behaviour; moral hazard issues; and least-cost policy tools.

Paying for effective risk-based disaster management programmes will require governments to eliminate some disaster practices that are inconsistent with other policy decisions. In many ways, the issues centre upon a 'responsive versus responsible government'. For instance, it is necessary to address the 'Sit-Back-And-Wait' (SBAW) effect of victims 'training' governments to reimburse impact losses in return for good public relations irrespective of precipitating circumstances. Wherever possible, mechanisms should be used that direct costs on those who impose them. Economic efficiency arguments do not preclude regulation where it proves to be the most cost-effective. Far from undermining the social welfare function of governments, these arguments strengthen the case for having effective, targeted interventions.

These drivers are part of a framework within which disaster management can operate. However, tensions will exist between different drivers. For instance, decisions promoting sustainability may not always seem the most economically efficient, and vice versa. However, this does not mean that the drivers themselves are flawed. Rather, they provide contexts within which trade-offs can be made to balance different needs and expectations within society. The second part of the answer on how to achieve the aim in Proposition one is summarised in Proposition three.

Proposition three

Key drivers already present within societies should be utilised to ensure that disaster management becomes part of routine decision-making. These drivers are: Sustainability; Resilience; Integrated management; Governance; Partnerships; and Economic efficiency

Government's role in effecting improvements: The impetus for improvement must come from the higher echelons of government and the agencies overseeing disaster management. The need for fundamental improvement does not mean discarding all that is currently in place. Nor does it ignore the fact that significant progress has already been made. What it does suggest is that

attempting incremental improvement without an overarching framework, clear goals and principles, will result in later problems. Bringing key agencies and the wider community on board necessitates convincing those groups of a broader context for doing so.

Central government, in partnership with other levels of government, must lead the way. It is incumbent on advisers at all levels of government to spread this message. They must also continue to stress that, while response and immediate post-impact recovery are politically visible, more is to be gained by reducing risks through sustainable hazard management and long term recovery activities. At the same time they must convince major businesses to think like-mindedly, especially those providing infrastructure and other essential services.

Agencies overseeing disaster management must translate the core concepts into practical models, practice guidelines and policy proposals that can be implemented both nationally and locally. Large gaps in knowledge about hazards and risks need to be filled. Much of the available information is not reaching decision-makers, or it is often provided in a form that cannot be readily used. New collaborative efforts between research and practitioner groups are required. Associated with this is the need to develop practical tools in areas such as economic analysis, risk modelling, and strategy, and plan development. There is also a need to establish professional development programmes for practitioners that cover a wider range of disciplines.

It is imperative to evaluate progress in order to confirm that disaster management is actually assisting communities achieve their long-term goals. It must be possible to substantiate the anticipated long-term net benefits, noting especially that communities may experience significant 'adjustment pain' in the short term. There should also be the flexibility to modify proposals when confronted with contrary evidence. While undertaking this reform, it is incumbent on governments to ensure that transitional arrangements are well managed so that the capacity to respond to a major event is not lost for the duration of the transition.

Effecting improvement requires some fundamental thinking, careful planning and solid, co-ordinated management. Government must want and lead this improvement. Accordingly, the fourth and final proposition is:

Proposition four

Disaster management needs to undergo fundamental reform to meet the needs and expectations of society in the next millennium. The key roles that governments can play are to: Lead the thinking on improving disaster management; and ensure that this thinking translates into effective systems at all levels within society.

Conclusion

Moving toward an integrated risk-based approach to disaster management is essential but not easy. There are significant gaps in our understanding of some key issues that must be understood in order for disaster management to be successful. If messages are not communicated well enough, public and political pressure will continue to emphasise immediate response and recovery, undermining more comprehensive strategies offering greater long-term benefits.

Through linking developments with wider social, cultural, economic, environmental and governance trends, opportunities exist for disaster management to make a more meaningful and cost-effective contribution. The immediate challenge is to develop consensus on factors that will influence disaster management in the next decade.

THE ESSENTIALS

Turning political commitment into sound practice

Mike Evans, Cranfield University Disaster Management Centre, UK



UN Secretary-General Kofi Annan and Tony Blair, Prime Minister of the United Kingdom

‘WHEN THE SITUATION was manageable it was neglected and now that it is thoroughly out of hand we apply too late the remedies which then might have effected a cure. There is nothing new in the story. It is as old as the Sibylline books. It falls into that immense dismal category of the fruitlessness of experience and the confirmed unteachability of mankind. Want of foresight, unwillingness to act when action would be simple and effective, lack of clear thinking, confusion of counsel until the emergency comes, until self preservation strikes its jarring gong — these are the features which constitute the endless repetition of history.’ (Churchill, *In the years leading to 1939*).

Providing for the security and protection of its citizens is one of the primary duties of any government — at all levels. Few would disagree with that statement, but how effective are governments at providing that security? All too often, governments pay

attention to the military aspects, but they neglect the ever present dangers of disasters, whether from natural or man-made sources. There are no internationally-agreed standards for disaster management institutions, structures or legislation. There are some agreements on codes, for example for buildings or the transport of dangerous materials, but these are far from inter-continental. Disaster management costs money and, in situations of competition for scarce resources, despite the risks, it is frequently placed well down the agenda for action. This can and will, eventually, cause unnecessary loss of life, jobs, property and environment.

National disaster management should be regarded by all governments as a primary duty. Only national governments have the resources, or access to resources, to do this. The scale and scope of essential disaster management measures needed will be directly related to the perceived risks, both from governmental and public

perspectives. To implement the measures is rather like taking out an insurance policy for which, of course, premiums have to be paid. However, those premiums need not be unaffordable, many measures already exist and just need focusing or consolidating, many others can be created and maintained at relatively low cost. So what are the essentials? What are the basics that any government should have in place? There are eight well-proven measures which, if adopted, will significantly reduce risk. Many countries already use some or all of them, often as a result of greater awareness generated by IDNDR. In other cases they may need to be created from scratch. Most are relatively low cost. All of the measures should be seen through a looking glass labelled 'development'; the processes of sound disaster management and national development are inextricably linked.

The first essential is to have a clear national statement of political commitment to disaster management. It must have executive authority. That is, it should come from the top. However, it must be preceded by consultation at all levels. It should be in the public domain, recognising responsibility and accountability. It should contain the basis for legislation and regulations and it should outline the organisational structures and systems. It need not go into details of specific responsibilities, these can be left to a national strategic plan, but it will provide the authority for that plan. Nor need it address resource allocations; those, too, should be left to plans, but it will provide the authority for financial backing for downstream activities. It is important to achieve political consensus in this statement, ideally through an understanding that disaster management is a cross-party issue.

There is something of a chicken and egg relationship between the national statement and the next essential, legislation. Some countries have no specific disaster management legislation, such as a disaster management act, but all have some existing legislation that contains matters relating to disaster management. Whether or not disaster-specific legislation is needed is influenced by the degree of risk, by the size of the country, not only geographically but also in terms of population and complexity, and by the quality of the existing disaster related regulations. The weaker the existing regulations, the stronger the case for disaster-specific legislation to create the base from which other regulations can follow. The key areas that must be covered by legislation are; who is responsible for what, the powers of the components of the structures, accountability, resource management, standards, procedures and assistance arrangements, both national and international. Related and supporting legislation will cover areas such as transportation of dangerous materials, land-use regulations, building codes and industrial operating licensing to list but a few. However, the great truism about legislation is that it is only as good as its enforcement and that, as they say, is a very movable feast. Rather than place effort into creating new legislation, many countries would find it far more cost-effective to put the emphasis on rationalising what is already in place and into enforcement.

One cannot leave the area of legislation without addressing the Hydra of corruption. This can be so pervasive that it can ruin any attempts at sound and responsible disaster management and it can and does turn potential donors away. It is a major area for enforcement.

There should be a focus for disaster management issues in any country. Many have disaster management units, some call them offices or bureaux. Some countries have no such organisations. These units or offices should exist at national level and at each level of provincial and local government down to community level. Clearly, they will reduce in size and cost as they cascade down, for example at community level there may be only one or

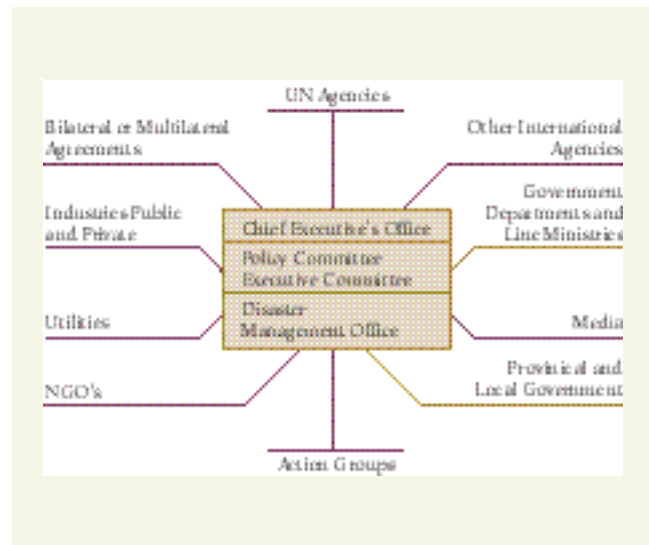


Figure 1: A typical national framework

two people involved and then only part-time, whereas at national level there may be a full-time staff of several people. Affordability plays a large part, weighed against the perceived risk. The other major factor in shaping a unit is to decide what functions it is expected to fulfil. These can include planning, coordination, communication, incident management, public awareness, media handling and assessments among others. The unit should not decide policy but implement it. They will, of course, need resources with which to achieve the given functions, though these need not be expensive. The most expensive element tends to be the wage bill. Having decided what the unit is to do, the next step is to decide where to place it. There are broadly three options; stand-alone, in a line ministry or in the prime minister's, president's or vice-president's office. Once again, the risk level is a major factor, but it is generally true that the nearer it is to the centre of executive government and the further away it is from sectoral departments with their vested interests, the more chance it will have of succeeding and, importantly, vice versa.

The disaster management unit or office is only one part, though a very important one, of a larger national framework. This framework is the fourth essential. It should be specified in the national statement and strategic plan. It should include, from the top, a national policy-making body (often at cabinet level) served by an executive (often at permanent secretary level), provincial and community committees. All of these bodies should meet routinely at specified intervals. The disaster management specialists will serve as advisers at each level, possibly also with executive functions. The responsibilities of these various bodies will be laid down in legislation. They should, wherever possible, use existing staff and resources. That not only makes it more affordable but it also helps to limit the potential for growth of another layer of bureaucracy. Senior members of the emergency services will often be members at each level. Some countries place executive authority in the hands of elected people, for example mayors, others use heads of emergency services, usually the police or appointed officials. There is no 'correct' template for this. However, it should be borne in mind that elected people often do not have the professional skills required to manage a major incident and they may tend to be over focused on their electoral constituencies. A typical national framework is illustrated in Figure 1.

It follows that all parts of the structure must be able to communicate effectively with each other under worst-case conditions.

The fifth essential is to develop integrated plans. They should start with a national strategic disaster management plan that will contain details of aims and objectives, key risks, institutional structures, responsibilities, warning systems, communications systems, procedures for dealing with disasters, requirements for emergency operations centres, media handling, recovery resources and procedures, public awareness policy, contact lists, training and post-disaster enquiries. Think of the national plan as a barn roof under which all other plans reside — an umbrella would perhaps be a better analogy if it did not have the unhappy connotation of providing shelter for culpable officials.

A vital component of a national plan is to establish a published and practiced system for dealing with disasters. The key question to be addressed is who is in the leading role at each level. Uncertainty over this is probably the biggest single factor in ensuring failure. Once such a system has been agreed, it is essential to keep to it. That is not to say that it should not be modified and improved in the light of experience, on the contrary, but it must not be flouted at the first sign of a disaster. Often the most guilty are politicians who want media attention at the scene and who serve only to get in the way of professional responders. Helpful and caring VIP visits are one thing, ego tripping is another.

Beneath the roof of a national plan, the downstream plans will usually take two forms; generic and scenario specific. In the former, they relate to a single organisation or department of government and they deal more with procedures than action plans. For example, they will cover on-going assessment, pre-planned equipment allocations, conduct of operations rooms, action cards, alerting procedures, liaison arrangements and stand-by communications among others. Scenario specific plans will invariably be multi-disciplinary, hence the title, Integrated Plans. All stages of development plans must involve both those who will be responsible for their execution and the beneficiaries. Consultation and consensus are the keys to success. It is often said that policy or directives flow downwards, and planning flows from the bottom up. It is generally true. Integration can be achieved through that consultative process, but, that said, the core planning team should be kept as small as is reasonably possible, otherwise it will become bogged down. Key members of the planning group will usually be the lead government department, emergency services, representatives of UN agencies and NGOs. The integration of plans should be checked and this is best done by the disaster management units at each level. The purposes of integration are to eliminate wastage and duplication and to bring available resources to bear with the best possible effect. This is sometimes called a combined response, reflecting the synergy which can be achieved if all of those involved act in concert.

Whilst sound integrated planning is probably the most powerful preparedness tool, it is a complete waste of time if the plans are not practiced. Training is the sixth essential component. The usual process is for any given agency first to train its own people before venturing into the joint training and exercising arena. This internal training should be a regular part of work. Joint training goes hand in hand with integrated planning. It is usually conducted through exercises, many of which can be imaginative and inexpensive. There are several types of exercise from indoor table top through to full scale field training. Their cost is in direct proportion. It would, therefore, be usual to hold the larger scale exercises less frequently. For example a full-scale field exercise may be held only once every two years. What is important is that exercises of whatever scale are regularly held. In practice this is not often the case. Occasionally, there appears to be a reluctance on the part of some people to expose themselves to the risk of

being seen to make mistakes, during an exercise; this is to misunderstand the purpose of training compared to demonstrations. The lessons that stick most are those that have been learned through mistakes and all senior people should encourage this philosophy within their organisations. The highest levels should set the example. After all, the purpose of training is to improve the chances of getting it right when the real thing comes along, as surely it will, one day.

Part of training, in a broader sense, is public awareness. This is the seventh essential. Good levels of public awareness can have a significant impact on reducing losses, particularly in countries where the main risks have some warning associated with them, but not exclusively so. For example, knowing what to do, or perhaps more importantly what not to do, can save many lives in earthquakes. A key problem with public awareness is in retaining interest when a disaster has not occurred for some time. There is also the problem of overkill of awareness programmes resulting in saturated boredom in the public. Both of these problems can, to a large extent, be reduced by targeting children through school programmes. The children not only get the messages early, but they may also revitalise parental interest and responsibility. From a government perspective, there should be a clear idea of what the public already know and what more they need to know in order to help themselves. Often the best way to discover this is to ask them, using market survey techniques. However, to attempt to modify public attitudes and behaviour is a specialised business and so it pays to bring in professionals. Ask anyone whose business it is to sell a particular brand of washing powder.

The last of the list of eight essentials is cash. Whilst many of the activities listed above can be carried out at relatively low cost, there will always be a bill, or insurance premium to be met. Many aspects of disaster management do not readily lend themselves to standard business analysis techniques such as cost efficiency or cost effectiveness, though it is generally safer to use the latter on the grounds that what may be efficient may not actually be effective. Cost benefit analysis should be relatively straightforward in some projects, for example irrigation or flood control measures, but it can often be very difficult to quantify in others such as food for work or food for cash programmes. As with all insurance premiums, eventually a value judgement has to be made which takes into account the cost of doing nothing, a situation that has been known in the past to cause the removal of some governments. There has even been a whiff, thankfully rarely, when unnamed governments hinted that they did not need to spend money on this because, if they had a disaster, donors would pump in cash to resolve the problem and pay for future systems. That is, to say the least, a somewhat cynical approach to good governance. A more responsible approach followed in many countries is to create a disaster contingency fund.

The past years of this International Decade for Natural Disaster Reduction have seen significant increases in awareness, both in governments and amongst their peoples, but much remains to be done. It would be naive to imagine that disaster management will appear at the top of already crowded agendas, but, with the fair wind of IDNDR, it might just climb a few steps. The measures listed above can be achieved at relatively little cost. Mostly, they seek to make the best use of what is already there. They are a distillation of the experiences of many countries and of observations and studies and if anything in disaster management can come with a cast iron guarantee, they can. Let us hope that things have changed since the time of the rather depressing Churchillian quote at the start of this paper, and act before the jarring gong of self-preservation strikes.

THE CHINESE EXPERIENCE

A political commitment to disaster preparedness, mitigation and relief

Liu Yanhua, Ministry of Science and Technology, China



Photo: Associated Press

A six-year-old girl helps her father with a seeder for cotton in the Hebei province in April 1999. Low rainfall contributed to a drought in northern China

THE SEVERITY OF NATURAL DISASTERS is a prominent hindering factor for social and economic sustainable development in China. Disaster reduction capabilities have been strengthened in China, especially in the last ten years. The enhancement of disaster reduction capabilities has provided solid safeguard and foundation with economic development, and reduced economic and life losses. All of these have resulted from the Chinese Government's commitment to natural disaster preparedness, mitigation and reduction, and from active responses to IDNDR and international co-operation in disaster reduction.

China is affected by many different types of natural disaster, particularly earthquake, flood, drought and typhoon. They cover large numbers of people and vast areas of land and occur with

great frequency. For example, flooding happens every year, and in the most extreme cases can affect 400 million people in 368 cities. Other hazards experienced are hail, snow, sandstorm, landslide and fire.

The forming-conditions and inter-relationship of natural events frequently result in complex disaster chains. For example, there are strong reciprocal feedback relationships between floods and other hazards.

Collapse, landslide, and debris-flow, caused by flood, can intensify the water — and soil erosion processes in the upper reaches of a river, which usually results in the huge amount of mud and silt converging into rivers and lakes. As the mud and silt is accumulated in the riverbeds or lakebeds, it will block river courses, withdrawing lake-water areas and decrease the capability of the

river and lakes to store floodwater. This increases the severity of flood disasters.

In the last 50 years, 25–30% of the total population badly suffered from natural disasters, and economic losses caused by natural disasters account for 3–6% of the gross national product (GNP) each year. For example, the 1976 Tangshan earthquake killed 242,000 people.

The Chinese Government's main functions and tasks

The Chinese government has accumulated much experience of natural disaster management. Now, the governmental functions and tasks mainly include the following:

Decision-making: The government guides all kinds of disaster reduction works according to the development targets and aims of the nation and its regions. This includes overall preparedness, resistance and relief policies and guidelines, as well as the corresponding policies and guidelines for population, resources, environment and economic developments.

Lawmaking and implementation: In addition to making administrative laws and regulations, the governments at all levels have the power to lead and organise the corresponding departments to make and execute all kinds of disaster reduction technical standards, regulations, methods, and so on, during the disaster reduction process.

Programming and planning functions: Central and local governments have the right to enact and execute disaster reduction programmes and plans. Government at all levels also has responsibility to execute and supervise the implementation of the programme and plans adopted by society.

Establishment of disaster reduction organisation: The central and local governments can establish various disaster reduction organisations or institutions according to the needs of disaster reduction works. The government can also manage the business and market of disaster reduction, examine the quality of its corporations, and make the disaster reduction market standardised, and sound, in order to ensure quality.

Organisation and co-ordination functions: In the process of disaster preparedness, resistance, relief and post-disaster re-building, the central and local governments organise and co-ordinate different districts and governmental agencies to harmonise disaster reduction actions.

Disaster monitoring and prediction functions: Disaster monitoring and prediction is not only a complex scientific issue, but also a serious social work in China. The government has these responsibilities.

Preparation, distribution and utilisation of disaster relief funds and materials: In order to maximise efficient utilisation of the limited disaster relief funds and materials, the central and local governments should arrange and control the use of disaster relief funds and materials according to the needs of different regions and departments.

Disaster reduction education, learning and training: In order to improve disaster reduction awareness and capability, the government develops various activities, through, for example, media, schools, community organisations and research institutions.

Organisation and implementation of scientific research and development: Disaster reduction is a significant scientific issue relating to many disciplines and fields. The government has responsibilities to organise special programmes or projects to carry out disaster research works, to promote the scientific achievements to become practical and feasible, and to develop advanced and new technology so as to improve the disaster reduction capability of the whole nation.

International exchange and co-operation: Natural disaster reduction is important throughout the world and the Chinese Government has the organising and leading functions in international communication and co-operation for disaster reduction.

The achievements and experiences in disaster reduction in China

With years of exploration and effort, China has made noticeable progress in legislature and management concerning disaster prevention and reduction and disaster-reducing science and technology, hence improving the efficiency and capability concerning disaster preparedness and relief substantially.

The disaster management and action system, whose cores and central parts are government at all levels, has been established. During the emergency management of all severe hazards, this disaster reduction system not only played important roles in fighting disasters, but also provided reliable organisational insurance for the conventional disaster reduction actions.

The State Council issued a disaster reduction plan for the People's Republic of China in 1998. Other disaster reduction plans specifically coping with flood, agricultural disaster, forest disaster, geological disaster, and so on are also formulated and implemented by various governmental departments and agencies under the State Council. Many local governments, especially in the regions with heavy natural disaster possibilities, formulate synthetic or specific disaster prevention plans.

Construction of disaster mitigation and prevention works

By 1997, the country had built a total of 251,000 kilometres of dykes, 14,000 kilometres of damp-proof dykes, and 84,837 large- and medium-sized reservoirs with storage capacity of 458.3 billion cubic metres. More than 100 flood storage districts with storage capacity of about 120 billion cubic metres have been constructed. Many key engineering programmes with significant disaster reduction benefits are completed or being constructed. These works have played an important role in disaster mitigation and prevention.

Anti-seismic capabilities have been enhanced in newly built projects, and reinforcement activities have been conducted on those existing works lacking anti-seismic capabilities. On the basis of regional seismic safety evaluations, 230 million square metres of houses and some important facilities have been reinforced. Reinforcement has also been completed on 14 main railways in the major earthquake-sensitive areas, 90 major power plants, six major oil pipelines, 60 reservoirs, 20 large oil-refineries, more than 20 large iron and steel enterprises, and other large lifeline facilities.

Prospecting has been carried out on 46 projects for the resolution of geological problems, such as mudslides, surface subsidence, landslides, and fissures. Monitoring networks have been set up in the areas of frequent landslides and mudslides in the middle and upper reaches of the Yangtze River.

Currently, measures have been taken to control landslides in five places including the dangerous cliff sections of the Lianzi Cliff of the Three Gorges. Comprehensive measures have also been taken to control seawater intrusion in Laizhou Bay, Shandong province.

334 fire-proof stations, 28,000 kilometres of fire-proof roads, 41,000 kilometres of fire-proof telephone lines and 335,000 kilometres of fire separation zones have been finished in the major forest regions all over China. By the end of 1996, a biological control system had been set up at county and township levels,

including plant protection corporations, plant (crop) hospitals, and professional plant-disease prevention- and cure teams. In recent years, special efforts have been made for boll worm control in cotton-producing areas, and in the control of rice pests and locusts. Now, 4.2 million hectares of grassland are free of pests and rats (21% of the afflicted area).

There have been national shelter-forest and afforesting works, including 'Three Northern' (North eastern China, Northern China and North western China) shelter-forest systems, shelter-forest systems at upper and middle reaches of Yangtze River, seashore shelter-forest system and Taihang Mountain afforesting work with the total areas of 50 million hectares. 7.224 million hectares of water loss and soil erosion areas, 0.6 million hectares of desert and sandy areas and 0.561 million hectares of alkaline land areas have been harnessed.

Publicity and education on disaster reduction prevention and mitigation

The Chinese Government is making full use of existing media to produce popular films that are easy to understand and can spread disaster mitigation and prevention knowledge and to publish articles for improving the public skills and awareness of disaster reduction. This includes the publication of special books and proceedings on disaster mitigation and prevention, and academic exchanges between foreign and domestic specialists on disaster management.

Disaster mitigation and prevention courses are available in the earth sciences, architectural engineering, water conservation engineering and other specialties. Some universities and colleges have established faculties and offer MS and PhD Degrees in disaster studies. Disaster mitigation and prevention has been added to the geography and nature courses of primary and high schools. Public education on disaster reduction has been carried out, and disaster mitigation and prevention exercises have been conducted in some areas to enhance public consciousness.

Scientific R&D on disaster reduction

The Chinese Government pays great attention to the scientific research into the mitigation of natural disasters. Over 100 science and research institutions related to disaster reduction have been set and engaged in the study of disaster prevention and reduction techniques for a better understanding of the formation and occurrence of major natural disasters. There were major developments in digitised earthquake observation, medium-range weather prediction, severe marine environment, real time flood remote sensing transmission techniques, crops disease and pest control, comprehensive forest disaster control and geological disaster control, and a substantial improvement of techniques employed in natural disaster monitoring, prediction and assessment. The accuracy of medium-range earthquake prediction has risen from 25% in the past to around 40% at present. The accuracy of 24 and 48 hour forecast of regional rainstorms is 10–15% higher than before. The validity of period for typhoon forecast has extended to two to three days.

International co-operation and exchange

The China IDNDR Committee was set up in 1989 to strengthen the comprehensive co-ordination in disaster prevention and reduction. Extensive co-operation and exchanges have been carried out in the observation of earthquake occurrence, climate prediction and meteorology, forest diseases control and pests prevention, and storm surge, with substantial progress. China hosted many international disaster reduction meetings between 1990–99.

The benefits of disaster reduction efforts in China

Significant economic and social benefits resulted from the continued input in disaster reduction by the Chinese Government. The annual average death toll has been reduced from 8,681 to 6,389, collapsed houses from 4.72 to 3.06 million, the ratio between disaster-induced economic loss and GNP from 17.22% to 3.64%, and the ratio between disaster-induced economic loss and fiscal incomes from 59% to 27.5% in the 1990s compared with those in the 1950s. Almost one billion people and their property were protected during the heavy floods of the Yangtze River in 1991 and 1998.

Disaster reduction can provide good environment and the basis for social and economic development by protecting the safety of people's lives and wealth, and maintaining social stability.

The government must clearly understand that great emphasis should be paid to disaster reduction in the pursuit of economic and social development.

Future disaster reduction aims

Disaster events in China will remain severe, due to the continued increment of the population and accumulation of social wealth, an increasing frequency and severity of hazard and the need for improved disaster-reduction practices.

The Chinese authority will continue to promote disaster reduction and it aims to improve disaster management systems, organise and implement a series of disaster reduction projects, make full use of technology, to heighten public awareness, improve the legal system and reduce death and economic losses. In order to meet these aims, the Chinese authority must:

- Establish a socialised disaster reduction system and promote reform of the disaster management mechanism. Encourage participation and involvement of local governments, enterprises, social organisations and people into disaster reduction.
- Enhance formulation, implementation and enforcement of disaster reduction law and to improve the law-based management level of the whole society.
- Broaden fund sources and increase disaster reduction input. The government should increase financial input to ensure the growth rate of disaster control is greater than national economic growth. Develop insurance and mutual aid funds to improve the ability of self-salvation and social safeguard.
- Promote implementation of sustainable development strategy and enhance resource and environmental protection. Especially, there is a need to enhance the comprehensive harnessing of the large river basin areas, to plant trees, to turn the unreasonable cultivated land into forests, grassland or lakes, and to reserve and exploit reasonably the floodwater storage or detention areas involving deposit- or sludge-clearing and eliminating obstacles.
- Enhance scientific and technological research and development. This includes disaster formation mechanism and variation principles, risk assessment and zoning, statistics, disaster management information system, disaster monitoring, forecasting and warning, engineering technology, and law and regulation.
- Speed up the transformation of scientific and technological achievements, especially the utilisation of advanced technology in disaster management, and also to improve the quality of disaster reduction.
- Strengthen education, so as to further improve public awareness of disaster reduction through the society.
- Enhance international exchange and co-operation, actively participate in the post-IDNDR campaign, and establish more wide and sound international co-operation relationships.

DISASTER MANAGEMENT IN NEPAL

Problems and solutions*Dr Meen Poudyal Chhetri, Ministry of Home, Nepal*

NEPAL IS A SMALL and land-locked country in South Asia, situated between the two large and densely populated countries of Asia — China in the north and India in the south, east and west. Within the narrow breadth of the country, all varieties of climate and topography can be found ranging from the subtropical to the alpine. Nepal's climate is varied. The subtropical monsoon climate is found in the Tarai, temperate monsoon in the hills, and alpine in the mountainous region of Nepal. The average rainfall of the country in the whole year is about 1,900 millimetres. But the mean annual rainfall varies from less than 300 millimetres in the region near the Tibetan plateau to more than 3,700 millimetres in the Pokhara valley and the southern slopes.

The rugged and fragile geophysical structure, very high relief, high angle of slopes, complex geology, variable climatic conditions, active tectonic processes, unplanned settlement, dense and increasing population, poor economic condition and low literacy rate have made Nepal vulnerable to various types of natural disasters. Most part of the country is seismically active. Hence, the geomorphology is very fragile. The constant tectonic action of different degree along with varied intensity of weather has adverse effects on the stability of the earth surface and river course.

The physiography of the earth is changing slowly due to its own tectonic action and universal planetary action. Such activities are more pronounced in Asia, Oceania and South America. The Himalayan region and some pockets of Oceania are the most active. The Himalayan region of Nepal can be considered as one of the severest flood hazard zones in the world. Heavy precipitation, extreme wetness and steepness of watersheds and river channels all contribute to flood magnitudes. Thus, it is a great challenge to protect infrastructure and property from frequent landslide and floods.

The main natural hazards that occur in Nepal are earthquake, flood, landslide, debris flow, fire, epidemic, avalanche, glacier lake outburst flood, windstorm, lightning, hailstorm and drought. Each year, thousands of human lives and billions of rupees worth of physical property are destroyed. Since 1983, over 18,000 lives have been lost in Nepal as a result of natural disasters.

The Natural Disaster Relief Act (NDRA) of 1982 provided for a Central Natural Disaster Relief Committee (CNDRC) to be constituted under the chairmanship of the Home Minister. The purpose of this CNDRC is to formulate and implement the policies and programmes relating to the natural disaster relief work and to undertake other necessary related measures. It also prepares specific norms of relief assistance to be distributed to the disaster victims of the affected area in cash and/or in kind. There is also the provision of the Regional Natural Disaster Relief Committee, District Natural Disaster Relief Committee and Local Natural Disaster Relief Committee in order to undertake the natural disaster relief works immediately. Two sub-committees

also provide necessary advice and suggestions to the Central Committee, help to execute policies and directives and operate effectively the rescue, relief and rehabilitation work during very serious natural disasters. Army and police personnel can also be mobilised when necessary in rescue operations.

Provision of a Central Natural Disaster Aid Fund has been made under the control of the Central Natural Disaster Relief Committee. The fund consists of cash and kind provided by His Majesty's Government, funds received from the Prime Minister's Aid Fund, cash and kind assistance received from foreign countries, national and foreign agencies and individuals and from other sources. The Central Fund releases budget according to the need and justification for immediate relief assistance to the victims of natural disasters.

In Nepal, all pre- and post-disaster activities are carried out according to the provisions made in the Natural Disaster Relief Act, 1982. The Ministry of Home Affairs is the apex body in relation to disaster management in Nepal. Formulation of national policy and its implementation, preparedness and mitigation of disaster, immediate rescue and relief works, data collection and dissemination, mobilisation of funds and resources are the vital functions of the Ministry. It has its network throughout the country to cope with natural disasters. There are 75 administrative districts in the country and in each district there is a Chief District Officer who also acts as the crisis manager in the time of disaster. The Chief District Officer works in close co-ordination and co-operation with various governmental and non-governmental agencies and also mobilises military and police personnel to cope with natural disasters.

Problems

For a developing country like Nepal, managing the risk of natural hazards is a huge task. The suddenness and massive destruction of a hazard makes it very difficult to cope within a normal administrative framework with limited resources. The main challenges concern the compatibility of disaster management policies, roles, funds and resources, victim support, resource mobilisation, co-operation and co-ordination and public awareness.

The first step to address problems is their identification, and this has been done with the identification of 18 specific, yet separate, problems that hamper the nation's ability to manage the effects of natural hazards. These range from significant organisational problems, such as the absence of job descriptions in the Natural Disaster Relief Act, to problems of behaviour indifference, activity levels and co-operation of various agencies and government departments, to resource needs, such as the requirement for modern technology to assess risk and vulnerability and provide early warning.

In addition, only 39.6% of the total population are literate in Nepal. The majority of the people, particularly in remote rural areas,



Photo: Associated Press

A group of tourists dig their way through heavy snow in the Himalayan mountains in November 1995. Early snowfall triggered avalanches and landslides that killed 61 people and trapped thousands of trekkers for days

are illiterate, thus unaware of hazard management. This adds another obstacle to the ability to carry out awareness programmes and fulfil other educational needs. There is also a large number of people who accept natural disasters as an act of God and beyond the control of human beings. Facilities are ill-prepared to resist the forces of disaster, particularly earthquake, and the lack of roads and transportation systems adds communication difficulties.

Combining the above features with the unyielding geographical nature of Nepal, the set of challenges faced here with respect to disaster management are complex and difficult to overcome.

Solutions

Despite the problems and hard choices associated with disaster management in Nepal, the selection of proper strategies could help to provide solutions, which will simultaneously help to prevent and reduce disaster associated with the natural event. Therefore, the Home Ministry has also identified a series of specific measures which, if implemented gradually, could help to address and decrease the nation's vulnerability to hazards.

The need to amend the administrative framework is great. The role, functions, duties and responsibilities of all the agencies should be clearly specified and well-defined so that no agency could shift or ignore its responsibilities. Because of the absence of frequent dialogue and mutual understanding between the disaster management related agencies, duplication of work and delays have been experienced during and after disasters. For this reason, the agencies concerned should work in close contact and mutual understanding.

Collection and dissemination of data play a vital role in disaster management. Well trained and qualified manpower and necessary logistics should be made available for scientific data collection and analysis. This will also help in the development of hazard mapping, vulnerability assessment, risk analysis and early warning systems. Modern equipment and appliances would also be needed in this respect.

To achieve this, necessary funds and resources should be made available. There should always be a balance of at least 100 thousand rupees in each District Natural Disaster Aid Fund. All kinds

of external and internal assistance should be channelled through a single government entity. If such assistance is handled by several agencies, problems of duplication, over-expenditure or undue influence can arise.

In order to raise awareness, it is necessary to work at increasing the literacy rate. Moreover, knowledge of disaster management should be included in the school curriculum, which is not yet done. School teachers, selected students, social workers, women leaders and health workers could be trained to educate others in measures to prevent or mitigate the impact of natural hazards. For this, active people's participation is necessary. Such education may also encourage people to believe that the hazard need not, as an act of God, necessarily lead to disaster.

The urgent needs to improve road infrastructure, transportation and communication facilities exist and, in order to prevent inappropriate construction of buildings, the building code should be strictly implemented. People should be made aware that they are vulnerable and, for example, be advised to build earthquake-proof buildings in earthquake-prone areas.

Positive political thinking and commitment will contribute significantly to carry out the disaster management activities effectively and efficiently. For the effective implementation of preparedness, rescue and relief work, preventive measures, mitigation, rehabilitation and reconstruction programmes, it will be better to reflect the disaster management component in the development plan and the programmes of concerned agencies.

In view of the complexities and diversities of disaster management in Nepal, a concrete, effective and practicable policy is needed for which political commitment and a pragmatic policy formulation is very necessary. The first step in identifying the problems and proposing methods to solve these problems has been taken. It is hoped that by taking a step back and examining the problems, we may have also identified inefficiencies and duplication of efforts which, when overcome, may free up important resources. Such resources can be directed towards the proposed solutions in order to reduce the natural hazard risk faced by the people of Nepal.

PLANNING AND ADMINISTRATION

Frameworks and case studies

Professor Rae Zimmerman, New York University, USA



Photo: Rex Features

Devastation caused by the Oklahoma tornado, in the United States, May 1999

RISK ASSESSMENT AND NATURAL DISASTER management pursue parallel paths, yet have numerous points of intersection and have much to learn from each another. Both adopt systems perspectives to relate sources and outcomes of hazard, and in such a process, science and management go hand in hand. Risk management and natural hazard management differ in emphasis — the former emphasises human-initiated events and the latter, natural phenomenon. This paper identifies administration and planning functions for risk assessment in the United States. Then, a risk assessment and risk management framework are linked to natural disaster management in two cases in which natural hazards created risks to human life from built structures.

The function and location of risk assessment in the US Government

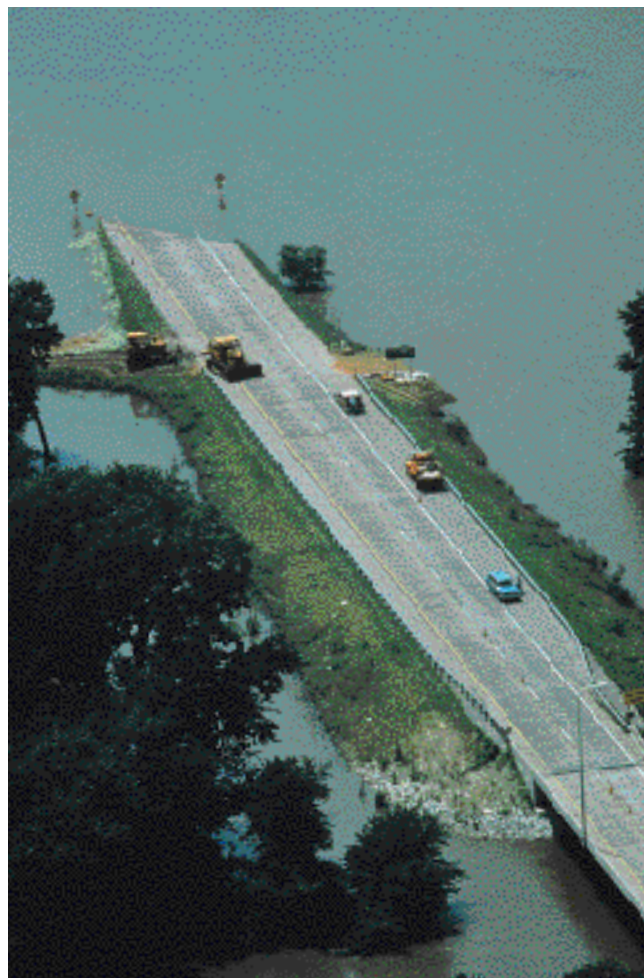
The role of risk assessment has increased dramatically within government. Although risk assessment existed in ancient times, more recently it emerged from nuclear engineering in the early 1970s for designing nuclear power plants. Since that time it has diffused throughout many government agencies engaged in health, safety and environment. It is now applied to impacts on people in many settings, eg. consumers and workers. For example, in the Federal government, risk assessment is used for testing and approving new drugs, developing food safety 'action' levels and inspecting food processing facilities (Food and Drug

Administration (FDA)); developing consumer product hazard standards, product bans (Consumer Product Safety Commission) and standards for worker health and safety (Occupational Safety and Health Administration (OSHA)); determining health-related aspects of abandoned waste sites (the Agency for Toxic Substances and Disease Registry (ATSDR)); registering and cancelling pesticides, and setting standards for drinking water, air quality, and other critical environmental resources (Environmental Protection Agency (EPA)).

The location of risk assessment administration and planning functions within the US Government reflects their importance relative to other functions. Risk assessment functions now occupy formal, usually centralised positions within many government agencies, reflecting the support for risk assessment from legislation. For example, in the Federal government the Department of Agriculture risk assessments for food safety are centralised in the Office of Risk Assessment and Cost-Benefit Analysis established in 1994. The Department of Health and Human Services' FDA undertakes risk assessments for food safety within its Bureau of Foods. The Department of Labour's OSHA conducts health-related assessments within one of its programme offices. Within the EPA, however, risk assessment is so pervasive, due to the many statutes that have risk assessment requirements and the support EPA lends to other agencies, that functions are diffused throughout many divisions. The focus, nevertheless, is the National Centre for



An airfield, completely underwater, during the Midwest Flood in 1993



Flooding is a common cause of bridge failure, USA, 1993

Photos: Rex Features

Environmental Assessment (NCEA), one of five centres within the Office of Research and Development as well as advisory boards such as the Science Advisory Board.

In order to understand the administration and planning functions for risk assessment, one needs to know the relationship between risk assessment and risk management, and its dramatic evolution over time since the National Research Council's Risk Assessment in the Federal Government—Managing the Process (1983). Initially, risk assessment and risk management were considered distinct, with management following assessment. During the 1990s, the integration of management and assessment as simultaneous, interactive processes has been emphasised in the National Academy of Science reports *Science and Judgment in Risk Assessment* (1994) and *Understanding Risk—Informing Risks in a Democratic Society* (1996), the Report of the Presidential/Congressional Commission on Risk Assessment and Risk Management (1996), and EPA's strategic plans (NRC, 1983). The need for the conceptual and administrative integration of risk assessment and management emerges from the inter-disciplinary thinking required first to link the steps in a risk assessment and second from the incorporation of interest-group perspectives.

First, a risk assessment consists of a series of steps across many disciplines, not unlike the assessments for natural hazard management. In risk assessments applied to chemicals, sources are linked to releases that are transported and transformed in the environment to points where people are likely to be exposed. Then the nature, magnitude, extent of exposure and toxic effects are

characterised. These steps comprise an exposure assessment. Independent of this sequence of steps, chemical hazards are identified and the relationship between doses and effects are quantified ('dose-response' assessment), usually in experimental settings. Both dose-response relationships and exposure assessments are central to risk assessment. The two are combined to produce the risk characterisation or magnitude of the risk, including its uncertainty. These steps are necessarily inter-disciplinary, requiring a systems orientation, and are applicable to natural disasters and physical structures as well as chemicals.

Second, integrated assessment arises when socioeconomic environments are recognised as key factors affecting human sensitivity to exposure and the degree to which people take defensive action that potentially affects whether exposure occurs and has an effect. Such risk averse action is related to risk communication and the values people place on risks. Incorporating these considerations into risk assessment necessitates an integrated framework. An example of such integration is where interest groups select exposure points and tailor exposure values to reflect individual and cultural preferences and traditions in food consumption and other behavioural patterns.

Cases have driven many legislative and administrative changes in risk assessment, such as the California oil spills prompting the National Environmental Policy Act, the West Virginia mine disaster and the Occupational Safety and Health Act, a New York waste site (Love Canal) and the Superfund Law, and a flood-related Hudson River Polychlorinated Biphenyl contamination and the Toxic Substances Control Act (Zimmerman, 1990). A case approach,

therefore, is useful to illustrate how risk assessment concepts can apply to natural hazard management.

Two cases: Lessons in risk assessment and risk management for disasters

Successful management of disaster-related risks usually involves a systems framework, where social and technological contexts are analysed in an integrated way. Two cases illustrate this—one involving a flood and the other an earthquake, in which a vital infrastructure facility and human lives dependent on the facility were affected. Both events occurred ten years ago, which allows an assessment of mitigating events that occurred subsequent to the disaster. The discussion of the cases artificially imposes risk assessment and management frameworks upon a natural disaster, that is, risk assessment and risk management were not actually used, but are superimposed after the fact to evaluate how post-disaster events helped to prevent similar disasters in the future.

Two cases illustrate the application of risk assessment concepts to natural hazard management. One is the Schoharie Bridge collapse in New York due to a flooding incident. Although events prior to the disaster represent a failure to apply risk assessment concepts to a socially and economically critical structure, it was a post-disaster success in leading to a major risk mitigation programme on bridge scour that is likely to prevent future events of this sort. The other is the collapse of the Nimitz Freeway in Oakland, California during the Loma Prieta earthquake in 1989, which also called attention to the manner in which risk assessment concepts could generate solutions for engineered structures.

Risk assessment and flooding events: The Schoharie Bridge collapse (Amsterdam, New York)

Flooding is a major natural disaster in the United States, ranking foremost among low-probability/high-consequence events. Its unintended consequences for infrastructure risks are often known, but usually not integrated into planning. For example, a major flooding disaster of the 20th Century, the 1993 Midwest Flood, caused at least 48 deaths and had the highest cost (US\$ 15.6 billion) of any flood on record. The losses and disruptions to transportation, water supply flood control, and environmental protection infrastructure were inestimable. For example, over three-quarters of the approximately 1,000 non-Corps of Engineer constructed levees built and a third of the Corps-constructed levees were damaged in the flood (Zimmerman, 1994).

Flooding is a common cause of bridge failures, though not usually resulting in human casualties. The National Transportation Safety Board (NTSB) investigates transportation accidents involving loss of life. Most bridge collapses investigated by the NTSB have not been caused by floods but by collisions of vehicles with bridges. One exception was the New York State Thruway (I-90) Bridge collapse spanning Schoharie Creek near Amsterdam, New York on 5 April 1987, killing ten people. The immediate cause was scouring around the bridge piers during a flooding event. However, the causes go far deeper than that, involving how risks are implicitly assessed and managed.

The Schoharie Bridge collapse involved water pressure build-up and scouring around bridge piers by floodwaters to an unexpected extent. Ultimately, design assumptions and construction practices that modified the initial design by altering pier spacing apparently increased the bridge's vulnerability to floodwaters, contributing to the collapse of the piers and bridge deck.

According to the NTSB report, uncertainty surrounded specifications for the bridge design and quality of supporting materials, creating initial conditions potentially enhancing exposure or

vulnerability. The bridge had a non-redundant design preventing little flexibility in the shifting of loads. Piers were weakened by cracks and structural problems even during its construction in the mid 1950s. Although the bridge had been designed for a 100-year flood (the April 1987 flood was only a 70-year flood) two factors allegedly made it vulnerable. Pier spacing was shortened during construction and population and land use estimates in bridge design may have been underestimated, resulting in unexpected increases in flood intensity. Analogous to a dose-response scenario in risk assessment, indisputable standards were not apparent for many of these factors as a basis for best engineering judgment. Mitigation in the form of inspections were not relevant at the time, since underwater inspections were not required that would have detected bridge scour and design deficiencies (*US Transportation Safety Board*, 1987; *Springfield*, 1988).

The stability and reliability of bridges in the face of natural disasters requires a sequence of steps from planning through operations in social and natural environmental contexts. Risk assessment organises these steps to produce an estimate of the likelihood and consequences of the risk of bridge failure.

Thus, in this case, risk assessment would have linked human risk directly to the materials and design assumptions, construction practices, and land use factors affecting floodwater speeds and impacts.

The case's positive outcome was the introduction of a programme on bridge scour that has received national attention, with associated bridge design, planning and inspection alterations.

Risk assessment and earthquake damage to infrastructure: The Nimitz Freeway collapse (California)

The Nimitz Freeway (IS 880) collapsed in Oakland, CA during the 1989 Loma Prieta earthquake, killing several dozen people. Risk assessment concepts were not explicitly used prior to the event, but risk mitigation measures were developed to avoid future problems.

Briefly, the freeway was designed as a double-decker (two-level) roadway with steel-reinforced concrete supports. According to a news analysis, different kinds of steel supports were used to reinforce the concrete pillars making them potentially vulnerable to uneven movement. Furthermore, the initial design used a standard for ground acceleration that was later upgraded, but at the time the earthquake struck, the structure had not yet been retrofitted to the newer standard (*Pollack, Bishop*, 1989).

Standards for reinforcement of steel supporting columns and tolerable ground acceleration based on cause and effect relationships, akin to the dose-response assessment, had considerable latitude. As in the Schoharie case, such latitude enabled political or bureaucratic procedure to prevail over conservative engineering considerations. Retrofit was deferred due to shifts in funding priorities. Nevertheless, standards and protocols did emerge in the form of increasing tolerance for ground acceleration and procedures for retrofitting raised structures. Many of these issues were recognised prior to the earthquake, and had been in place for implementation.

Conclusions

Both of these cases illustrate the need for decision-making institutions to explicitly use risk assessment in the planning, design, citing, operation and maintenance of infrastructure. The events that occurred in these cases illustrate that using risk assessment concepts or philosophy, lessons were learned and were likely to be incorporated into subsequent actions to mitigate future risks.

PUBLIC POLICY

Protecting people and property

Peet Stopforth, Department of Constitutional Affairs, South Africa

UNTIL THE EARLY 1990s, South Africa predominantly concentrated on planning effective responses to disasters. Very little was undertaken to develop strategies to mitigate and prevent catastrophes. This was not the most cost-effective policy and it required the rescheduling of available funds from development projects, to address the consequences of disasters. This created a vicious circle that contributed towards greater poverty, in particular amongst those who could least afford it.

As a result of international isolation and lack of exposure, South Africa failed to keep pace with global developments regarding disaster management, which further worsened the situation. The following major shortcomings also hampered the development of comprehensive disaster management policies.

Various government departments and other organisations were addressing the matter of disaster management independently in a very fragmented and unco-ordinated manner. This led to ineffective conduct and unnecessary duplication. Conflicting legislation was administered by different state departments. Specific facets of disaster management, such as pre-planning, were not sufficiently addressed, so the emphasis fell largely on reactive measures.

In June 1994, the national cabinet resolved that overall ability of government structures to deal with disasters should be assessed. A Management Committee was established comprising the Department of Constitutional Development, other state departments, the nine provinces, NGOs and all other relevant stakeholders. This committee has adopted a methodical approach to develop policies to protect people and property and to make it as transparent and inclusive as possible.

First, a draft Discussion Document was compiled and distributed to all the participants who had an interest in disaster management, for their comments. In addition, advertisements were placed in leading newspapers inviting interested parties to submit their written inputs regarding disaster and emergency management. The following year, a decision was taken by the cabinet committee to create a formal structure for the management of disasters in South Africa. The organisational structure would include a National Disaster Management Committee at national level, and similar related organisations at provincial and local government levels of responsibility. The Department of Constitutional Development was designated to be responsible for the overall co-ordination of disaster management functions in the country.

Notwithstanding this cabinet decision, in 1995 to establish an effective national disaster management structure, very limited progress was made to put a functional system in place at all levels of government. Subsequently, in March 1997, the cabinet decided that more explicit arrangements were necessary.

An Inter-Ministerial Committee for Disaster Management was created to include all key government ministries to direct a unified approach in formulating a comprehensive policy for disaster

management. A Disaster Management Centre would be established to give an institutional basis for confirmed attention to the subject. Most importantly, to demonstrate political commitment, the Minister for Provincial Affairs and Constitutional Development, in collaboration with the disaster management community, was tasked with producing a Green Paper on disaster management before the end of 1997 to clarify uncertainties and to facilitate public debate. Such a dialogue with the public was considered necessary if legislation was to be initiated the following year, in 1998.

Green Paper on disaster management

A Task Force was appointed which consisted of experts from all spheres of government and private institutions, with the express purpose of soliciting the views of all parties who have an involvement in disaster management. The process was an inclusive and transparent one ensuring input from all parties, namely state departments, provincial governments, local government, NGOs, community-based organisations and the private sector.

The main aim of the Green Paper was to analyse the problems with the current system and to consider how to proceed from the present reactive approach to a pro-active and preventive approach. In doing so, it would be necessary to determine the role and function of each level of government, the private sector and other parties in disaster management. The Green Paper was formally launched on 11 February 1998, with the explanation that it would lead to a White Paper, or a functional and workable policy document.

Upon completion, the Green Paper highlighted a number of key points. Disasters were increasingly viewed as an unexpected consequence of poor risk management rather than isolated random acts of nature. They were seen as an outcome of interconnected social and physical processes that increase risk and vulnerability to even modest threats.

Unsurprisingly, the Green Paper noted that it would be more cost-effective to prevent and mitigate disasters. In order to accomplish this though, disaster management should become an integral component of development planning, as disasters and development are so often interrelated. Offsetting these basic principles, the Green Paper also highlighted a number of prevailing weaknesses, which if allowed to continue, would jeopardise a viable disaster management programme.

First, there was the lack of a legislative framework, as well as limited support from either the national or provincial governments. Neither officials nor public volunteers were engaged in a meaningful endeavour and the overall lack of commitment was evident. Disaster management was not budgeted for and the few resources available were fragmented. The lack of overall knowledge or attention to the matter made it even more likely that officials with dual functions could set aside any disaster management functions. With such a lack of visibility, training or awareness-raising was improbable.

The response to the Green Paper proved to be extensive and detailed. It went a long way ensuring that the White Paper would be a policy that could be applied effectively and that it would have to be applied by all government institutions and other parties involved in the process.

White Paper on disaster management

The White Paper to define disaster management policy options for South Africa was launched on 19 January 1999. It sets out the process of implementing policy in four main categories:

- The establishment of a Disaster Management Centre
- How disaster management is to be funded
- The need for new legislation
- Training and community awareness.

The Disaster Management Centre would address the following key functions:

The Centre will serve as an information management and advice centre to all spheres of government, the private sector and the broader community on disaster management, including risk reduction. In order to enable the Centre to perform this critical function, it must have the authority to compel government and other role-players to make the required information available.

Crucially, the Centre should focus on preparing and compiling appropriate disaster management strategies, decreed policies and contingency plans. The compilation of disaster plans is seen as being essential for anticipating disasters, developing and implementing risk reduction strategies and co-ordinating disaster response among all parties.

The key to successfully reducing the effects of a disaster is to understand the nature of the potential disaster and the factors that contribute to it. Once this information is available, the ability to develop community mitigation, planning and advice is greatly increased. The principal outputs for the Centre are to enhance capability and assess vulnerability, determine levels of risk and ensure appropriate mitigation and effective disaster reduction.

The Centre should, in consultation with existing structures, audit the current capacity, structures, responsibilities and reporting mechanisms of all organs involved in disaster management and related activities. The auditing of current capacity in disaster management and the identification and delineation of clear lines of responsibility and functions will facilitate the integration of the information gathering role. The key strategy would be to dovetail the requirements and information needs of the Centre with national, provincial and local initiatives and programmes that are already functioning effectively.

Additionally, the Centre will serve as a focus for co-ordination and support during disaster and emergency situations. When an emergency or disaster situation arises, the Centre and other relevant disaster management structures should be able to expand their capacity and re-focus their activities to enable them to respond rapidly and effectively.

In order to fulfil all other functions it is essential that the Centre should facilitate disaster management training and promote community awareness of disasters and risk reduction.

The White Paper acknowledges the necessity of ensuring disaster management funding to maintain a comprehensive national programme. It specifically cites arrangements to encourage all levels of government to take measures to minimise the impact and reduce the likelihood of disaster. Where feasible, incentives should be provided for taking such measures. It requires that any programme clearly meet stated objectives of any disaster management strategy or plan in a timely and efficient manner that is

consistent with the financial policies of government. It also encourages that response to disasters be maintained at the most localised level of responsibility possible. National and provincial government should be approached for funding only when capacity and resources at local level have been exhausted or are absent.

The policies outlined in the White Paper are intended to guide the design and successful adoption of new disaster management legislation for the country. New national legislation needs to streamline and unify disaster management and promote a risk reduction approach, particularly at provincial and local levels. Fundamentally, the legislation should eliminate the confusion around disaster declarations and address current legislative gaps. The proposed legislation should include laws pertaining to:

- The issuance of disaster declarations by civil authorities
- The establishment of the National Disaster Management Centre
- The establishment of the provincial and local disaster management structures
- The preparation and compilation of disaster management plans
- Usage and insurance cover of volunteers at the time of need
- Punitive measures for non-compliance to disaster legislation.

In order to gain the fullest understanding among the public and to create a basis for sustained attention to disaster management, the White Paper outlines objectives to be achieved in the areas of training and community awareness programmes. Formal and informal training programmes should be developed and prioritised in accordance with the recommendations of training needs analyses, and existing training and community awareness initiatives should be strengthened.

To ensure quality and consistency throughout the country, minimum standards should be established for training material and training institutions. The training and community awareness programmes can remain valid and current only if research is undertaken on programmes that deal with disaster management and risk reduction.

In conclusion, it is important to note that the 1996 Constitution clearly states that everyone has the right to an environment that is not harmful to their health and well-being and to have the environment protected for the benefit of present and future generations that secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. In accordance with these rights, the paradigm shift and the transformation of disaster management was necessary to ensure that government meets its obligation in terms of the Constitution to improve the quality of life of all citizens, especially the very poor. By doing so it will bring South Africa in line with, and contributing to, the international trends.

Disaster management is not the exclusive preserve of government as the private sector and civil society also have crucial roles to play. The fostering of partnerships between government and the private sector is a prerequisite for sustainable and effective disaster management to take place. Similarly, the spirit of partnerships and co-operative governance between government agencies is equally important due to the crosscutting nature of disaster management.

With this process, South Africa envisages the accomplishment of not only an enabling environment for disaster management within the national, but also the creation of the right climate for regional and further co-operation. Disasters know no boundaries and successful prevention and mitigation strategies and programmes should also be actively promoted and shared to protect people and property by successfully addressing the identified causal factors of disasters.

CASE STUDY

Project Impact: Building a disaster resilient community

James Lee Witt, Federal Emergency Management Agency, USA



Photo: William R. Reckert

Director of FEMA, James Lee Witt, addresses a conference concerning Project Impact

STATISTICS CERTAINLY TELL PART of the story. In 1998, 32,000 people around the world were killed by natural disasters, and another 300 million were left homeless. The cost of the disasters in that one year alone topped US\$ 90 billion.

Pictures tell another part of the story. We see houses floating up to their roofs in polluted muck, business districts reduced to rubble by tornadoes, coastal areas smashed by a hurricane as if by a giant fist. Then there is the look in people's eyes as they see everything they've ever worked for destroyed. There is the terror in the children's faces as they see their schools demolished and their parents crying. And there are the fragile, priceless, irreplaceable pieces of a person's life — photographs, mementos, cherished heirlooms — torn into bits and lost forever.

And yet even this does not tell the full story. What is not readily evident is how preventable much of this destruction is. What we don't realise at first glance is that many of these towns have been down this road before, suffering

previously from the vagaries of nature, rebuilding without a plan for mitigating future losses, and then facing the same disaster again.

This is why the Federal Emergency Management Agency (FEMA) created Project Impact: Building a Disaster Resistant Community. FEMA, the US federal agency responsible for assisting states in preparing for, responding to and recovering from, disasters needed to change the way Americans dealt with disasters. It was imperative that we shift our focus to pro-active prevention and to act more aggressively to save lives and property before disaster strikes.

FEMA launched Project Impact: Building a Disaster Resistant Community in 1997. Seven pilot communities have since grown to 118 communities — at least two in every state, the District of Columbia, Puerto Rico and the US Virgin Islands. Under the Project Impact initiative, a community's officials, business leaders, school administrators, residents and others begin a comprehensive partnership to address the specific hazards they face and



Project Impact principles at work: Improved construction materials enable homes like this one on Dauphin Island, to withstand severe weather conditions

to plan on how to reduce the risk these hazards pose in the future. This is not another government grant programme. Project Impact is a way of leveraging private sector commitments alongside new public sector approaches. This combination of federal dollars and technical support with private sector, non-profit and state and local government partners is the best formula for success in reducing the effects of disasters.

In addition to the unique approach of using non-traditional community members beyond the customary emergency management community, Project Impact is also unusual in its approach to businesses as partners. FEMA has reached out to the business community—to businesses both large and small—as key assets in the fight against disasters. Businesses are key not only because they can bring resources to the table but because healthy businesses able to withstand disasters are vital to the long-term economic security of a community. More than 700 businesses are now official partners in Project Impact. For example, VISA Corporation has pledged donations to Project Impact for every flood insurance policy charged to its credit card, while low-cost loans for household mitigation has been made available by Fannie Mae, a shareholder-owned company and the nation's largest source of funds for home loans. In another example, home improvement store chains are offering classes on disaster mitigation to their customers. Thanks to these and other, similar partnerships, FEMA's initial investment of US\$ 5.8 million in the seven original pilot communities has been matched by

more than US\$ 26 million in contributions. And since it's estimated that for every US dollar spent in pre-disaster mitigation, FEMA saves two US dollars in future disaster relief costs, the true savings just from these initial pilot communities is already significant.

While Project Impact is less than two years old, we have already seen success. Just compare 1998's Hurricane George with 1995's Hurricane Marilyn. When Hurricane Marilyn smashed into the US Virgin Islands four years ago, the storm killed 11 people and cost FEMA US\$ 450 million in disaster aid. Insurance companies were hit with another US\$ 750 million in damage claims. Afterwards, community officials significantly strengthened building codes and strictly enforced compliance. The result? When Hurricane George hit the US Virgin Islands, there was minimal damage and no fatalities. Resorts and tourists attractions were closed for only a day or two and then were back in business. Less than US\$ 50 million in federal disaster aid was obligated and less than US\$ 5 million in insurance claims paid out.

Other communities have taken equally big steps in the direction of safeguarding themselves. Tulsa, Oklahoma, for example, raised money through city bonds and relocated hundreds of homes from an area repeatedly flooded over many years. Under Project Impact, such relocation projects have continued. Public support is high, community commitment is unwavering and the death toll and the damage-repair-damage cycle that had plagued Tulsa for years has ended.



Photo: William R. Rebert

A house in Baldwin County, being rebuilt on pilings (top) as a result of flooding from Hurricane Danny in 1998. A partial shot of the same house (bottom) with an almost fully submerged swing set

Hurricane straps and other roof reinforcements (top) as well as hurricane shutters (bottom) can reduce damage from strong winds and hurricanes

In Berkeley, California, another Project Impact community is setting a standard for a disaster-resistant university model, in partnership with the university of California. In this community, at risk for wildfires, earthquakes and mudslides, the community is pulling together to educate themselves on reducing their risk and making modifications to their homes and yards and to their government buildings.

And there are more successes, large and small. Deerfield Beach/Broward County, Florida, has initiated a Local Mitigation Strategy, a county-wide strategy that includes each participating municipality and focuses business impact analysis and hazard mitigation planning. As part of the strategy, 250 homes have been retrofitted with hurricane shutters and the first disaster-resistant marina in the United States was recently built by the city.

In Tucker and Randolph Counties, West Virginia, student volunteers collected data on floodprone structures using Global Positioning System equipment provided by FEMA. Allegany County, Maryland, has pulled its resources together and raised an estimated US\$ 8 million as part of Project Impact to retrofit homes and to buy out properties in disaster-prone areas. Pascagoula, Mississippi, is working with the US Department of Transportation to conduct a

risk assessment of its transportation infrastructure including railways, federal highways, bridges, waterways, Federal Aviation Administration facilities, and coastal structures. Making Project Impact work involves four basic steps:

- Creating a community partnership
- Identifying and evaluating disaster risks
- Prioritising mitigation actions to address these risks
- Building public and financial support for mitigation actions.

To help communities become disaster resistant, FEMA developed a technical guide book for Project Impact and has a large part of the agency's Web site devoted to Project Impact principles, successes and objectives.

At FEMA, we know two sure things. We know there will always be another disaster—hurricanes, tornadoes, droughts, earthquakes, fires and floods won't stop coming. And, we know that by working together before the next disaster strikes—communities, corporations, the media and fire and emergency management personnel—we can save lives, cut property and business losses, protect our environment and make our communities safer and stronger.

With Project Impact, we are changing the way America deals with disasters. We are working with individuals, businesses and communities to make our country disaster-resistant.

XIV

ACADEMIC, PROFESSIONAL & TECHNICAL INSTITUTION INVOLVEMENT

KEYNOTE PAPER

ACADEMIC, PROFESSIONAL AND TECHNICAL INSTITUTIONS

Professor Mustafa Erdik, Bogazici University, Turkey

RECENT NATURAL EVENTS and their impacts on physical infrastructure, economies, environment and health have provided evidence that human suffering and economic losses from natural disasters are unacceptably high. They demonstrate the urgent need to strengthen our capabilities for preparedness and mitigation.

Natural disaster mitigation is defined as a sustained action taken to reduce or eliminate the long-term risk to people and property from natural hazards and their effects. Preparedness, an important element of disaster mitigation, is a complex and highly inter-sectoral issue that should be a concern of every sector of the society. We should strive to develop a framework and linkages between the public and the academic, professional and technical institutions for mitigating the effects of natural disasters. Such linkages will open windows of opportunity to adopt policies and professional practices that will benefit their community.

A preparedness strategy involving government, academic, professional and technical institutions, the private sector, and individual citizens, should be developed with the initiatives of: hazard identification and risk assessment; applied research and technology transfer; public awareness, training, and education; incentives and resources; and leadership and co-ordination to further the goal of reducing risk to life and property from natural hazard events. Reliable and accessible scientific information about disaster risks is critical to making sound decisions on appropriate mitigation and response strategies. As such, the primary challenge for the academic and technical institutions is to expand the risk assessment efforts and to communicate the information on disaster risk and mitigation to diverse stakeholders in an easily understandable format.

The Seminar on the Role of Universities and Scientific Institutions in Natural Disaster Reduction, organised by IDNDR and University of Geneva, in Geneva in August, 1995 has identified that the universities and technical institutions con-

tribute to the preparedness and mitigation efforts for disasters in the following ways:

- Generation of knowledge (carrying out research)
- Transfer of knowledge (training, consultancy)
- Developing networks among universities and other institutions.

There is merit in studying the role of universities, professional and technical institutions in promoting the message of preparedness and ensuring a wider understanding of the dangers of natural hazards along these lines.

Generation of knowledge

Disaster preparedness and mitigation is inter-disciplinary and multi-sectoral and as such, research into these subjects is well suited to academic environments. Most of the academic research has been on the assessment of natural hazard. Although it is now increasing, the research on the determination of risk from these hazards and options for its mitigation has been somewhat limited. This research, in general, has not been problem-specific and did not serve social needs. In addition to their scientific and technical skills, the efficiency of the contribution of the academic circles on disaster management depends on their capacity to tackle the real and actual problems. The research in universities should deal with concrete programmes in disaster prevention in a problem-specific approach. It should be multi-disciplinary with mixes of engineering and socio-economic considerations, be linked to urban development and urban risk reduction and be focused on operational issues.

Among the most important tools of earthquake disaster mitigation are building codes. Implementation of modern building codes with standards designed to mitigate the effects of natural hazards is a key element in strategies to reduce damages from such events. Building codes are essentially based on empirical data from earthquakes and academic research on the earthquake performance, and earthquake-resistant design of buildings. Science and technology must also be employed to help reduce the vulnerability of cities and megacities to natural disaster, through research, development of data bases containing disaster information and appropriate hazard-specific warning systems.

Major research contributions from scientific institutions and universities can provide information on preventive mechanisms and mitigation techniques for natural disasters, inter-disciplinary approaches to mitigation, disaster vulnerabilities and, costs and benefits of preventive measures and response.

Transfer of knowledge

One of the key results of the IDNDR has been the willingness of member countries and other participants to build a 'culture of prevention'. Universities can and should spread this culture to young generations, policy and decision-makers and to the community at large. For any disaster management and preparedness programme, public awareness, information dissemination and the training of personnel, constitute the fundamental ingredient of success.

An effective education and training programme for disaster preparedness should: be participatory in design; be community specific; be based on a rational assessment of the information needed; be integrated with the existing response systems; include information on prevention; mitigation and recovery; be established as an on-going process; and include, as a priority, the most vulnerable section of the population. In this respect the academic institutions should build active bridges with communities and decision-makers and acquire feedback on needs for training and information dissemination. Furthermore they should capitalise on the awareness created by disasters to generate co-operation with other partners.

Knowledge alone makes no contribution to the reduction of disasters if it is unknown by those who would need it. A continuous transfer of information and technology to a wide variety of researchers, practitioners, and public officials at local, national, regional and international levels is needed by technical and professional institutions to reduce losses from natural disasters. The computer networks operated by universities and technical institutions have greatly improved the transfer of knowledge for the disaster preparedness and mitigation programmes and have supported the response and recovery functions.

Disaster preparedness, mitigation and rehabilitation, and disaster management in general, are essentially major concerns of public administration. Methods and procedures for effective disaster management have to be developed in line with the overall system, environment and society. Need exists to orient and refresh the skills of public officials with education and training programmes on a wide range of issues related to disaster management. In this respect, the universities have developed a variety of academic programmes on disaster management. It is believed that in the future more and more disaster managers in government business and industry will come to the job with a college education that includes exposure to disaster management.

Networking

Sound preparedness policies require strong partnerships. For miti-



Photo: Tony Stone Images

It is believed, that in the future, more and more disaster managers in government business and industry will come to the job with a college education that includes a degree in disaster management

gation to be truly effective, it must become connected with priorities of the community. Translating research into results requires a dialogue such that scientists can understand user community needs and how best to meet those needs. Similarly, scientists and professionals need to develop closer relationships with the news media before a disaster happens so they can provide more useful information during a disaster. An expanded base of support, from business, service sector, news media and the insurance industry will help in developing coalitions for successful mitigation.

Networks are means by which communities of interest are developed to facilitate pooling of information and exchange of ideas in natural disaster reduction. Through networking, university programmes can built upon the experience and knowledge of other universities. They can also facilitate inter-disciplinary interaction and assist in the formation of problem focused sub-groups. Today a multitude of internet sites exist to facilitate sharing of information among academicians, technicians, planners, managers and practitioners involved in disaster management issues and problems.

The inevitability of the occurrence of natural hazards makes it imperative that certain preparedness procedures should be conducted prior to a disaster. Universities and other technical institutions play a substantial role in the effectiveness of these preparedness procedures. It is strongly believed that, through expanded and enhanced co-ordination, communication, education, research, and public policy options, the academic, professional and technical institutions can have a direct and positive impact on the resiliency and the sustainability of the community with respect to natural hazards.

Disaster Education in the School Curriculum

Dr John Lidstone, Queensland University of Technology, Australia

IT HAS LONG been accepted that schools have a major part to play in the development of good citizens, and we were reminded by the International Ad Hoc Group of Experts at the start of the International Decade for Natural Disaster Reduction that 'Knowledgeable and involved people are critical to building a safe society' (Press, 1989). Indeed, the Rationale for the Decade (National Academy of Sciences, 1989) reminded us that the successful implementation of the Decade would require the involvement of all levels of the community, from worldwide down to the local level. Now, in 1999, as the Decade reaches its close, it is appropriate to reflect on the extent to which our approaches to encouraging this knowledgeable and involved populace at an international level have been successful and the extent to which this success may be projected into the future.

Research in education is always beset by difficulties of scale, context and alternative philosophies, and to make global statements about progress (or otherwise) in education would be extremely foolhardy. The comments on changes in disaster education worldwide that follow are therefore based on a series of snapshots, perceptions and small-scale studies and make no pretence to be all-embracing.

Knowing what to do in the face of hazard

If we start from the conventional approach to public education adopted by the hazard management community, we may assume that the prime objective is to reduce the potential for loss of life and property as a result of some hazardous event. The logical approach to achieving this aim is for hazard managers to determine those actions by the general populace that are most likely to mitigate the likelihood of a disaster and then to promote such actions through all means available to them. In various parts of the world, these means may include public drills, advertising and, most frequently, the pamphlets and posters distributed to as many people as possible, including school teachers and students who often write to hazard management authorities to request help with their lessons and projects. The importance of such basic advice should not be underestimated since, as Hewitt reminded us as long ago as 1983: 'Disasters are unmanaged phenomena. They are the unexpected, the unprecedented. They derive from natural processes or events that are highly uncertain. Unawareness and unreadiness are said to typify the condition of their human victims ...In the official-sounding euphemism for disasters in North America, they are "unscheduled events".' Given such levels of uncertainty, and in our daily lives with all their increasing complexity, we may count ourselves lucky if we can recall a few simple strategies to implement when disaster strikes.

A brief survey of such materials shows that they are reassuringly similar wherever their origins and regardless of the specific hazard event being addressed. Pamphlets informing people on appropriate behaviours in the event of earthquakes from California, New Zealand and Australia remind people to stay away from tall buildings if outside, if inside, not to run outside but to seek safety in bathrooms or beneath doorways and to avoid tall bookcases.

In addition to producing lists of instructions on appropriate behaviour in various situations, invariably described in terms of unique events that may occur, many civil defence and similar organisations have produced publications designed to increase public understanding of the physical processes that may become hazardous. The *Earthquake Awareness for Australians* pamphlet produced by the former Natural Disasters Organisation (now Emergency Management Australia) is a good example. Of the eight pages, six are devoted to information about earthquakes in general, earthquakes in Australia, the Newcastle experience and risk and epicentre maps of Australia. The remaining two gives the 'duck and cover' advice found elsewhere.

Only in the case of tsunamis is pamphlet emphasis usually placed more on background information than on any action that should be taken — although even here a series of bullet points is usually included. I particularly like the point made in a pamphlet published in Alaska that informs me that 'When you can see the wave, you are too close to escape'. Experience has shown that school students find such pamphlets to be both absorbing and helpful, and response to a Royal Geographical Society of Queensland competition in 1997 for school students to design a hazard mitigation pamphlet for their own home area was well supported.

Curriculum interventions for disaster mitigation from the hazard management community

While such public education campaigns of the past have had some success in persuading people to check their radio batteries and remove their hanging baskets when faced with a cyclone, they are unlikely to bring about the kinds of people needed to create the safe society envisaged by Press. It has become obvious that this fundamental aim of the Decade will only be achieved if the hazard management community and the educational community work together to promote an appropriate environmental ethic in our young people. With this in mind, specific materials have been designed by civil defence and other hazard management organisations in many parts of the world for use with school students and many of these have been highly successful. The comments which follow refer to just a few of these that have come to our attention.

In Costa Rica, a 100 page book, *Como Enfrentar Un Terremoto*, was produced for use in schools to be used in both teaching the underlying physical geography of earthquakes and appropriate behaviour for both children and adults. Although the intention of the authors is to promote the hazard mitigation message, the materials support the general academic curriculum aims of the education system. Similarly, the Fiji Red Cross produces a kit of lesson plans and student materials for teachers, on earthquakes and tsunamis, fire, cyclones and floods, while the Cyclones package prepared for schools in New Caledonia and French Polynesia consists of an 83-page booklet accompanying a set of 16 colour slides. While the text gives a conventional (academic) account of cyclones, the slides include satellite photographs of cyclones and pictures of high winds blowing palm trees, flooded



Photo: Tony Stone Images

roads and devastated houses. In all these cases, the materials have been initiated by the disaster management community and designed to support teachers and complement the schools' academic curricula.

The Weather Times, published in the United States, claims to be designed to 'give you essential information and motivate you to talk about it (the weather) in your home, school and workplace so that you'll be in a position to be more in control of the severe weather events in your life'. There are pages devoted to earthquakes, hurricanes, floods, winter storms, tornadoes and lightning, as well as quizzes for children and advice for parents on how to help their children overcome trauma. The overwhelming emphasis in all these publications, however, is still on what to do before or after an extreme natural event occurs.

There has been a range of other materials produced for schools, both as part of, and independent from, IDNDR initiatives. While hard data is difficult if not impossible to acquire, it appears that in each case, the success or otherwise of each project has depended on the level of integration with existing curricula. For this reason, a project to map the various geography curricula of the states and territories of Australia was supported by the Australian Committee for the Decade. A national conference to bring teachers and hazard managers together was funded and organised and the result was a publication entitled '*Learning to Live Safely in the Australian Environment*' (Lidstone and Wilson, 1993). This publication analysed the various curricula of Australia and New Zealand to identify both where teaching about hazards and disasters was mandatory and where it could be inserted electively. It then provided a series of examples of curriculum implementations to encourage and support teachers in their work. Partly as a result of this initiative, geography teachers' associations in a number of states organised state conferences and devoted issues of their journals to teaching

about hazards and disasters with a view to promoting disaster mitigation. More recently, the Australian IDNDR Committee has funded the development of a CD-ROM interactive multimedia programme for use in schools entitled *Hazards Happen* (Lidstone and Duncan, 1999).

Developing curricula for responsible citizenship

However, while it is important that initiatives that come from the hazard management community match the needs of the educational community if they are to be effective, it has also become obvious that there is a need for greater awareness amongst curriculum developers of the work of geographers, sociologists and others in enhancing our understanding of the nature of disasters. Although the Rationale for the International Decade for Natural Disaster Reduction (*National Academy of Sciences*, 1989) reminded us that a high level of environmental alteration often increases vulnerability to disasters and that this may only be mitigated by the socio-political will to direct development in a way that enhances collective security, the message that hazards are a natural part of our physical environment and that disasters occur when hazardous events impinge on vulnerable communities has yet to be adopted by many of our education systems.

School curricula in Australia, New Zealand, England and many other countries acknowledge that the school subject most appropriate for teaching about hazards is geography. Elsewhere, especially in the United States, both hazards and environmental education are part of the science curriculum. The existence of a subject in the curriculum does not, however, tell us very much about what is taught or why it is taught. The present writer conducted an analysis of the references to hazards and disasters in geography text books used in Australia and of the language used in those text books devoted specifically to hazards and disasters

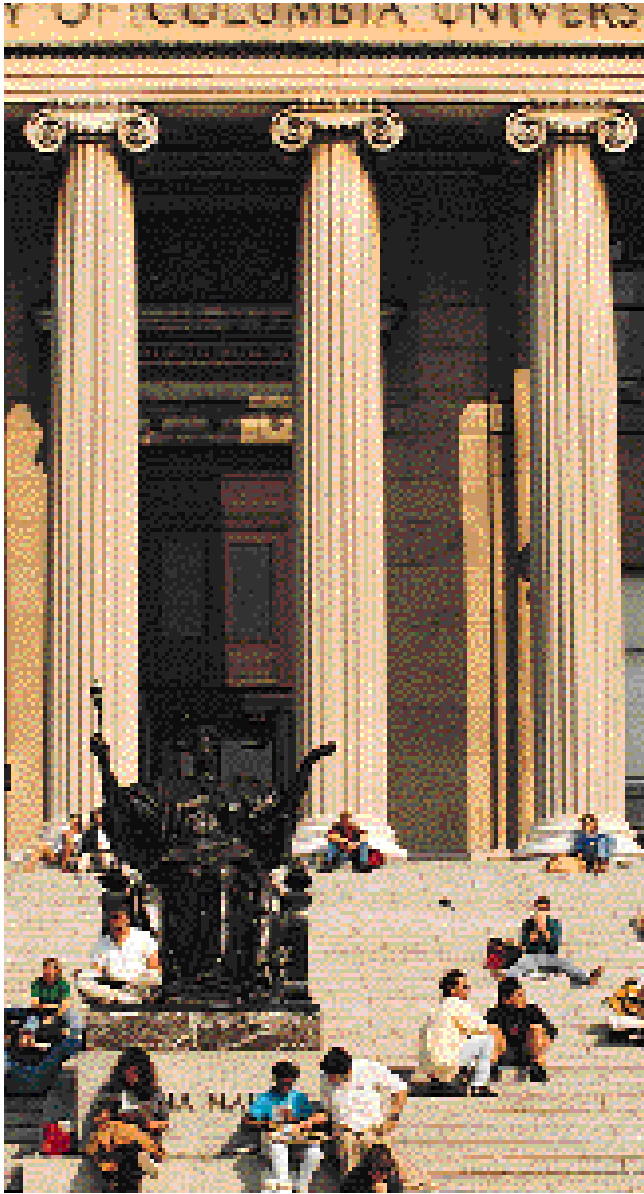


Photo: Rex Features

(Lidstone, 1995). The analysis suggested that geography text books as currently available to our students are based on six primary conceptions of natural hazards:

1. Natural hazards represent exciting forces of nature
2. Natural hazards represent impressive forces of nature that are inflicted against human beings
3. Natural hazards are one side of a battle for supremacy between human beings and nature
4. Natural hazards exist and while we (in the West) can counter them, those in the developing world are vulnerable
5. Natural hazards are a natural part of our environment and we should learn to live with them
6. Natural hazards lead to disasters due to poor human planning.

This analysis showed that school text books reinforce a number of the conceptions which underlie western media presentations on hazards and disasters. The single event-oriented focus with its emphasis on the magnitude of the event and immediate effects on human lives and property that is promoted by most media reports is echoed clearly in school text books. That two of the main sources of information available to teachers and students (textbooks and the media) include similar conceptions and

promote the development of similar schemata is emphasised by the heavy use made by many western text book writers of newspaper extracts about disasters.

After more than a decade of heavy international emphasis on environmental education as a solution to the perceived problems of the planet, much of which appears to have promoted a generation of young people who feel more like victims than ever before, perhaps it is now time to turn to an education that promotes feelings of power and control. It may be that the message of the Decade has become confused with the message of environmental educators and led to the situation described by Gigliotti (1990) who suggested that 'environmental education has produced ecologically concerned citizens who, armed with ecological myths, are willing to fight against the environmental misdeeds of others but lack the knowledge and conviction of their own role in the environmental problems'. If, as educators, we inadvertently support, and encourage the simplistic schemata of disasters that our students already possess as a result of their experiences with the media, then we are unlikely to promote the more complex schemata that are needed if citizens are to play their full role in disaster mitigation.

While it is important that students have a full appreciation of the physical events that can be hazardous to human beings and have confidence on the ingenuity of human beings to ameliorate the situation, it is equally important that we promote through our education systems a global perspective on disasters to ensure that the full complexity of the social influences on disaster, a morality of disasters, is explored rather than the more simplistic notions implied by the term 'natural disaster'. As Stoltman (1990) has declared — 'a key goal of citizenship education (and we may add, environmental education or disaster education) is to help students appreciate the complexity of social problems and the futility of simple solutions'.

It is for this reason that the Commission on Geographical Education of the International Geographical Union, together with the Committee on Capacity Building of the International Council of Scientific Unions, has developed a project entitled Education for Natural Disaster Reduction. This project brings together some of the foremost geoscientists, geographers with detailed regional knowledge of disasters and curriculum developers of the world to assist teachers to develop their understanding of disasters and their mitigation. While initially developed in English, the project has been eagerly seized by colleagues in Latin America for translation into Spanish, and both versions, with supporting workshops, should be available early in the year 2000. We hope that this project will illuminate a way forward into the post-Decade era and will be a worthy legacy to the work conducted during the Decade on Education for Disaster Mitigation.

We have come a long way in the last ten years, but if our educational aim to create a safe and sustainable society is to be achieved, much greater attention must be paid in the future to developing the concept of global citizenship. This entails encouraging people to develop knowledge and understanding that is appropriate for their individual groups while acknowledging our global society, encouraging appropriate levels of involvement for those who constitute our global society and redefining safety within a global context. So far we have assumed that the study of people-people and people-earth relationships will reveal all we need to know. We now need to consider the statement of the philosopher in Bertholt Brecht's 'The Messingkauf Dialogues': It is 'because people know so little about themselves that their knowledge of nature is so little use to them. [They] can cope with earthquakes, but not with their fellows' (Brecht, cited in Hewitt, 1983).

Training for Tomorrow

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EDUCATING, TRAINING, AND PREPARING men and women for positions and careers in crisis, disaster, and emergency management is rapidly becoming both more important and more difficult. Significant changes are affecting both the demand side and supply side of the training and education equation. The skills and knowledge required by future emergency managers will be strongly influenced by a number of trends.

The evolution of crisis, disaster, and emergency management and strong linkages between previously independent communities is producing a new profession. In the United States, the communities of first responders (fire and rescue), humanitarian response (Red Cross, Salvation Army), and government emergency management (FEMA) are linked together by formal plans and common threats. Government emergency response is no longer the exclusive province of retired military and civil defence officials. The American Red Cross and other non government agencies have standardised and professionalised their response operations. Private sector emergency managers work closely with their public sector counterparts in preparation, planning, mitigation, response and recovery.

There is now a growing recognition of the need for certifying emergency management professionals. The business community-oriented Disaster Recovery Institute has evolved its certification programme from the computer system-oriented Certified Disaster Recovery Planner to the organisational continuity focused Business Continuity Planner. The National Fire Protection Association, FEMA, the National Emergency Managers Association, and the International Association of Emergency Managers have produced a draft set of standards for public and private sector emergency managers (NFPA 1600).

The external threat is growing and is becoming more diverse and complex. The United States and most of the world's population centres are increasingly vulnerable to natural and technological disasters. Extensive development in areas prone to earthquakes, hurricanes, tornadoes and floods has increased the potential for catastrophic disasters. Technological hazards require first responders in all but the most remote jurisdictions to possess skills and equipment. The threat of domestic and international terrorism requires a plan and capability for dealing with weapons of mass destruction. Cyber-terrorism and Y2K have brought the task of critical infrastructure protection and restoration into the emergency management domain.

The functions of crisis, disaster and emergency management have expanded and merged. The public and private sector emergency manager is no longer just a co-ordinator of response operations. Disaster management and risk management have merged with the public sector focus on mitigation (eg. the IDNDR and FEMA's Project Impact) and the private sector's strategic focus on risk and safety management. Similarly the disaster recovery function typically associated with the public sector and the business continuity function performed by private sector managers have merged with each other and with the previously separate response and mitigation roles. Both sectors must be concerned with crisis management

and crisis communications. The professional emergency manager is not merely planning and preparing for response, he or she is managing a broad range of related roles and relationships.

Emergency management is changing from a low technology profession to a high technology profession. In the 1980s, then Senator Gore led a series of hearings and workshops intended to identify the need for applying information technology to emergency management. Less than twenty years later, a typical private or public sector Emergency Operations Centre (EOC) is a showcase for high technology. Information technology is embedded in all phases and aspects of emergency management. It is used for hazard assessment, risk modelling, drills and exercises, evacuation modelling, response decision support and management. Satellite surveillance and communication and the internet provide real time hazard and damage assessment capabilities. The typical emergency manager with a cell phone, lap top, compact disc player and fax modem, has more information and communication technology in his or her briefcase than the most sophisticated EOC did a decade ago. This technology provides access to information, models and expertise that will enhance the ability of a user that understands both the capabilities and limitations of this new power.

As a result of these changes, the demand for training and education is changing in three ways:

- The audience to be trained and educated is changing. As emergency management becomes a career, professionals and those desiring to enter the profession will demand career-oriented education and training. Training that supports organisational performance and learning, will increasingly be central to the profession since emergency management is an organisational and multi-organisational function. The educated professional will seek graduate education that will enhance both his or her current job performance and future career opportunities.
- The content demanded by this audience is changing. The skills and knowledge required by emergency managers will continue to become more complex and diverse. Management, leadership, and technological skills and knowledge are required in addition to the technical and functional skills and knowledge that have been the basis for traditional training curriculum.
- The delivery systems available to bring this content to the desired audience are changing. It is no longer necessary to bring instructors and students together for face-to-face, same place—same time instruction. The same technological revolution that has changed the role of emergency management has changed the way emergency managers will want to obtain training and education.

The response on the supply side has been in three areas—the development of professional education, the implementation of delivery technology, and the emergence of a new knowledge management paradigm.

Educational and training institutions are attempting to provide educational programmes that will support this emerging profession. Baccalaureate and graduate educational programmes that will enhance disaster, emergency, and risk management have



Photo: Tony Stone Images

The internet can be used to support automated training at a distance (one instructor to many students)

emerged at US, Canadian, European, and Australian universities. The George Washington University, for example, introduced an inter-disciplinary graduate programme in Crisis and Emergency Management in 1998 and the response has been very strong for both the masters and doctoral programmes.

Technology is used to support the hierarchy of learning experiences. Present internet technology, supported by better search engines, can support extensive information transfer and retrieval. Direct TV and the internet can be used to support automated training at a distance (one instructor to many students). Individual facilitated interactive on-line learning (synchronous or asynchronous) can provide in-depth, one-on-one, education and training, at both a time and place convenient to the learner. Finally, the certification and evaluation of professionals could move from the face-to-face standardised testing to a distributed, interactive environment, which could include simulations, drills, and exercises.

The domains of training, education and information storage are merging into a new knowledge management role. In the US, education has been the domain of degree-granting institutions. Training programmes have been designed to produce specific skills and have been targeted to specific audiences. Training and education have existed in parallel universes. Information management has been the function of libraries, clearing houses,

professional associations, and organisational data managers. Technology has now made it possible for the merging of the roles of collecting, managing, and distributing information.

In order to meet the challenge, the new educator/trainer/knowledge manager will have to develop new capabilities. Existing educational and training materials will have to be re-purposed — re-cast into products that make sense to a wide audience and that take advantage of the delivery mechanism available. Educators and trainers will have to be re-trained and re-tooled. The skills that make a professor a good lecturer or seminar leader and the abilities that make a trainer a good platform instructor are not the same skills required to prepare and present an asynchronous internet based course.

Users of training and education and suppliers of education will have to find new ways of establishing inter-personal and communication linkages that work. The face to face dialogue that takes place in a classroom (and often during class breaks) will be replaced by email, voice mail, video conferencing and other technologies. Educational and training organisations will meet this challenge. However, they and the emergency management community must be willing to forge the necessary partnerships and be able to make the investment required to effectively use today's resources and technology to train the emergency management leadership of tomorrow.

Natural disaster reduction research under the umbrella of the ICSU

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RESEARCH ON THE EXTREME natural events that, in populated areas, may have disastrous effects on society, including death, uprooted population, capital losses and impeded socio-economic development, is evidently an essential element of disaster mitigation. This has been recognised from the very beginning of the International Decade for Natural Disaster Reduction. Research on the vulnerability of the affected populations, their perceptions and coping strategies and their responses to emergency situations is, however, of equal importance for assessing the risk incurred and for taking appropriate prevention measures.

The great diversity and the complexity of all types of natural hazards require a fully inter-disciplinary scope of all scientific investigations aiming at disaster mitigation. The dynamics of the earth's interior, terrain configuration and earth surface processes, atmospheric circulation and oceanic impacts are interacting factors that impose concerted efforts of natural scientists of diverse specialisation. Because all research for disaster mitigation is focused on the effects of extreme events on society, social scientists obviously have an essential part to play in disaster mitigation research. The inter-disciplinary approaches should therefore incorporate natural scientists as well as social scientists. Above all, however, co-operation—from the beginning to the end—of scientists and engineers on the one hand and authorities, decision-makers and disaster managers on the other, is an absolute necessity for the adequate implementation of scientific research and recommendations, and thus for optimising all disaster prevention and mitigation measures.

International transfer of knowledge on extreme natural events and related disasters, training of scientists, capacity building in less-equipped countries, and awareness-raising among authorities and affected populations are other science-related issues to be addressed by the global scientific community. International research teams, workshops and roving seminars are among the most important vehicles for achieving optimal use of existing knowledge throughout the world.

The ICSU and the IDNDR

Convinced of the important part that science and technology can play in natural disaster mitigation, the International Council for Science (ICSU) established an ad-hoc committee for the IDNDR immediately after the adoption by the UN General Assembly of the second UN resolution that made the 1990s the 'International Decade for Natural Disaster Reduction'. This ad hoc committee met in Rabat, February 1989, and formulated a provisional ICSU-IDNDR research programme. The meeting, initiated by Julia Marton-Lefèvre, ICSU Secretariat, and hosted by Dr Dris BenSari, was chaired by Professor Vladimir Keilis-Borok and attended by the author, representing the International Geographical Union, and several other invited scientists. The ICSU General Assembly,

at its meeting in Sofia, October 1990, subsequently decided that ICSU should be involved during the entire Decade in disaster reduction research and established a Special Committee (SC/IDNDR). The late Sir James Lighthill became the first Chairman and was succeeded by the author in July 1995.

Hazard zoning and related investigations, monitoring leading up to forecasting and early warning systems, vulnerability and risk assessment are major elements of the research programme, while international exchange of knowledge, disaster education and providing guidelines/recommendations to decision-makers are other main foci. Because the furthering of disaster resistant structures, the formulation of building codes and other engineering contributions are an essential element in disaster mitigation, representatives of the World Federation of Engineering Organisations (WFEO) and the Union des Associations Techniques Internationales (UATI) were invited to membership of ICSU-SC/IDNDR. They have launched various research projects and education programmes in this particular area of disaster mitigation. All research carried out is an integrated issue, involving natural scientists for susceptibility aspects and social scientists for vulnerability components. The programme has a decentralised structure—every project is co-ordinated by one of the international scientific unions adhering to ICSU while other unions contribute as appropriate. Not all projects necessarily cover the full range of integration. However, all those engaged in the scientific and technological investigations are confronted with the risks and needs for protection of society, that differ widely in the south and in the north.

The ICSU-SC/IDNDR research programme comprises a number of International Demonstration Projects, as specified by the IDNDR Secretariat in Geneva, and numerous other projects that gradually materialised during the Decade and became of comparable importance.

The first category comprises:

- The Drought Assessment and Famine Disasters Project (Co-ordinated by the International Geographical Union, IGU)
- The Reducing Volcanic Disasters Project (Co-ordinated by the International Association of Volcanology and Chemistry of the Earth's Interior, IAVCEI)
- The Global Seismic Hazard Assessment Project, GSHAP, (Co-ordinated by the International Association of Seismology and Physics of the Earth's Interior, IASPEI, and the International Lithosphere Programme, ILP, jointly)
- The Tropical Cyclones Disasters Project (Co-ordinated jointly by the International Union of Theoretical and Applied Mechanics, IUTAM, and the World Meteorological Organization, WMO)
- The Engineering for Disaster Reduction Projects (Co-ordinated by the engineering organisations WFEO and UATI). These comprise a variety of projects such as the UATI Roving Seminar,

Lake Nyos Disaster Project, and Bangladesh Case Study, and the WFEO Structures to Withstand Disasters and Megacities Projects. The second category comprises other important ICSU-SC/IDNDR research projects such as:

- The Intermediate Term Prediction of Earthquakes Project (Co-ordinated by the International Union of Geodesy and Geophysics, IUGG)
- The Flood Hazard Reduction Project in Bangladesh (Co-ordinated by the International Geographical Union, IGU)
- The Mountain Hazards Project, DOMODIS, (Co-ordinated by the International Association of Geomorphologists, IAG)
- The Education for Natural Disaster Reduction Project (Co-ordinated by the International Geographical Union, IGU)
- The Earthquakes in Megacities Project (Co-ordinated by ILP and IGU jointly).

Rationale of the research activities and results obtained

The research carried out under the umbrella of ICSU-SC/IDNDR is aimed at supporting the specific goals of the IDNDR:

- To improve the capacities of all countries, but especially developing countries, to mitigate the effects of natural disasters
- To disseminate existing and new information related to natural disasters through international knowledge exchange
- To stimulate scientific and technological advancements regarding critical gaps in our knowledge that limit our capacity to reduce natural disasters
- To foster demonstration projects etc for the assessment, prediction/reduction of natural disasters.

More specifically the tasks of the scientific and technological communities include:

- Advancing fundamental understanding of natural phenomena causing disasters
- Analysing anthropogenic factors, socio-economic dimensions and human perceptions of natural disasters
- Fostering adequate building codes, land use practices and physical planning in disaster-prone areas
- Promoting disaster mitigation and preparedness projects in co-operation with governments and other authorities
- Introducing and improving hazard zoning, early warning and other hazard protective techniques included their efficient use by appropriate awareness-raising procedures
- Conveying scientific and technical knowledge in a way that makes it understandable for non-scientific users.

The ICSU-SC/IDNDR projects address, without exception, all specific IDNDR goals. They vary in orientation, however, where the specific scientific tasks are concerned. The Drought/Famine Project, for instance, focuses on households and populations of developing dryland countries, notably in Africa. Specific themes are: risk mapping, analysing vulnerable food systems, drought prediction, driving forces of vulnerability and education/training. The research of the Volcanic Disasters Project is concentrated on sixteen Decade Volcanoes where international teams ensure an optimal exchange of knowledge related to fundamental understanding of hazardous volcanic phenomena, volcanic hazard zoning and early warning.

The Global Seismic Hazard Assessment Programme amounts to a worldwide inventory of seismicity and seismic risk and is divided into a number of smaller and larger regional projects, tailor-made to regional needs. Its successor programme, the Earthquakes in Megacities (EMI) Project, has a different orientation and incorporates environmental site analysis, engineering aspects and urban

vulnerability and planning in densely populated high-risk conurbations. The Tropical Cyclone Disasters Project aims at improving the prediction of cyclone/hurricane/typhoon tracks for purposes of early warning. ICSU's contribution is concentrated on oceanographic and sea-air interaction aspects and complements the expertise of WMO on meteorological and hydrographic aspects and on the effective delivery of forecasts and warnings.

The Intermediate Term Earthquake Prediction Project has tested three prediction algorithms by predicting severe earthquakes (Richter eight and up) with a statistical significance of 96–99%. New research methods, including the analysis of satellite data, have been developed. The Flood Hazard Reduction Project focuses on river flooding in Bangladesh but it has also developed activities in the areas of coastal and urban flooding. Flood data acquisition from satellites, GIS and the use of GPS in field surveys are major aspects, while vulnerability studies are also included. Transfer of knowledge, in the field and through workshops and training abroad, is another focus. Scientists from four countries take part in the work, and a Disaster Research, Training and Management Centre has been established in Dhaka.

The Engineering for Disaster Reduction Projects have resulted in important WFEO publications on Disasters in Megacities and on Structures to Withstand Disasters, and in a massive effort in knowledge transfer and education by way of Roving Seminars (UATI), first at several locations in the Caribbean area and subsequently in Asia and the Mediterranean zone. A number of other projects were also implemented. The main task of the Education for Natural Disaster Project has been the compilation of a Handbook for Teachers, in English and Spanish.

Other activities of ICSU-SC/IDNDR include a seminar on river floods in Koblenz, Germany, participation in the Early Warning Conference in Potsdam, etc.

The ICSU-SC/IDNDR Research Programme is funded by ICSU, UNESCO and the US National Academy of Sciences. Most of the projects have also raised substantial funds from other sources.

Progress in disaster mitigation and post-Decade research

The initiative for launching the IDNDR has been triggered by the occurrence of a number of dramatic flood, volcanic, seismic and other disasters in the late 1980s. The magnitude of the issue in terms of loss of human life and property damage called for concerted global action. The achievements in science and technology during the Decade are also remarkable. Nevertheless, the impacts of natural disasters on society are still ever-increasing as a result of factors such as rapid urbanisation, degradation of rural areas and increased vulnerability of, particularly, marginal groups. It is evident that the research and other activities should be continued when the Decade has come to an end. Three major fields of future research emerge from experience gained over the past years:

- The risks incurred in large urban/industrial areas, where more than half of the world's population is concentrated and where enormous property damage by natural and technological disasters can be expected
- The effects of changing land use and population patterns on disaster vulnerability. Increased emphasis on vulnerability research in disaster studies is necessary
- The disasters related to decadal climatic fluctuations, such as 'El Niño', the Southern Oscillation and the North Atlantic Oscillation. Droughts, river floods and mountain hazards are strongly affected by these and disasters, social distress, food shortage and economic losses will be the result.

A continued concerted effort of scientists and engineers in the area of disaster reduction is needed in the next century.

VOLCANIC HAZARD MANAGEMENT

Promoting integration and communication

D. Johnston, D. Paton and B. Houghton, Institute of Geological & Nuclear Sciences, New Zealand

THE RESPONSE TO THE 1995–96 eruptions at Ruapehu volcano, New Zealand involved some 42 organisations and provided an opportunity to review certain operational aspects of response and their implications for the integrated emergency management (IEM) of volcanic hazards. Co-ordination is central to effective IEM, and structural and procedural mechanisms must be established to facilitate integrated operations. These, however, represent only part of this process. Comprehensive networking and communication is essential, as is information management and decision making capability. The latter issues have, at an operational level, been less extensively canvassed.

Co-ordination and communication

When responding to volcanic hazards, the unpredictable, rapidly changing, diverse and geographically-dispersed nature of their consequences creates a management environment characterised by uncertainty and which transcends the expertise and/or jurisdiction of any one agency. The unprecedented and complex nature of the organisational response environment (Figure 1), and limited prior networking between these agencies resulted in a lack of co-ordination being a prominent response problem (Paton, Johnston & Houghton, 1998).

While structural response models were being developed, several operational issues had received less attention. A crucial operational factor is the management of diversity. This issue is particularly salient when agencies only operate collectively during a volcanic crisis and conflicts emanating from the accrued diversity in skill, professional knowledge and philosophy, and personalities, can undermine the effective implementation of structural response models. While such diversity represents a strength of the IEM philosophy, its constructive use requires negotiation, the management of team diversity, training involving all prospective partners and sound inter-agency communication.

Effective communication is essential for sustaining an integrated response. While some communication problems emanate from hazard effects (eg. ashfall affecting communication systems), inadequate crisis information management systems can generate additional problems.

Emergency managers require knowledge (of the specific physical impact of an event) and understanding (of the type of mitigation measures required) whereas scientists can take data (eg. raw seismic data) and turn it into information (an eruption of size x at location y). Most time is spent in acquiring the data but the value lies in the quality of the understanding (Figure 2).

A first step in developing understanding involves networking with information providers to discuss information and decision needs. The central role of the key scientific agency, the Institute of Geological and Nuclear Sciences (GNS), is evident in Figure 1. The information they obtained from monitoring and measuring eruption effects was crucial to the response activities of several

agencies. However, response agencies often presume that these sources will go beyond scientific advice to provide for their information and decision needs. This is likely to be the exception rather than the rule for several reasons.

The information-knowledge transition (Figure 2) often falls between the spheres of science and management. Bridging this gap is a key communication issue, yet it is often difficult to convince funding agencies that this is both an urgent and, ultimately, a profitable activity. Scientific agencies must concentrate on their core business of science activities. The rarity of eruptions makes it imperative that their resources are used for developing understanding of the hazard phenomena to be managed rather than for translating data for diverse agencies with wide-ranging information needs.

Because it is obtained within an environment characterised by uncertainty, scientific information cannot be viewed as prescriptive. Recipients of this information must recognise this uncertainty, develop their interpretative capability accordingly, and accept that judgement will be required for decision-making and determining appropriate actions.

For instance, several agencies require data on ash thickness and composition. But, for example, conservation (effects on rare plants, tourist movements), utility (effect on power/water supply), agriculture (effect on crops, livestock), civil aviation (effect on aircraft movement) and transit (effect on road/rail networks) agencies must interpret this data to meet their specialised information and decision needs. Geographical (eg. ash thickness will change with distance from source and interact differently with soils or water) and temporal factors (eg. ash threat may change over time depending on wind patterns) also signal a need for response agencies to develop their interpretative capability. Agencies must have sufficient understanding of scientific data, and their inherent limitations, to make appropriate and effective decisions. Further, decisions may require the collation and processing of information from several scientific sources (eg. responding to requests from the agricultural community about volcanic threat to livestock or crops requires input from volcanologists, biologists, meteorologists, and veterinarians). Emergency managers should be trained to specify their information needs, develop networks with information providers accordingly, manage any uncertainty inherent in the data, interpret it appropriately and, if required, adapt it for different functions and end users, including the public, the media and policy makers.

Decision-making will be affected by information quality and availability. Decision procedures may have to be adapted to manage uncertainty and to suit the changing circumstances of volcanic crisis response. The scale of hazard impact, its multi-jurisdictional implications, and the geographical dispersion of decision makers, signals a need for distributed decision-making and the development of a shared decision environment. Decision

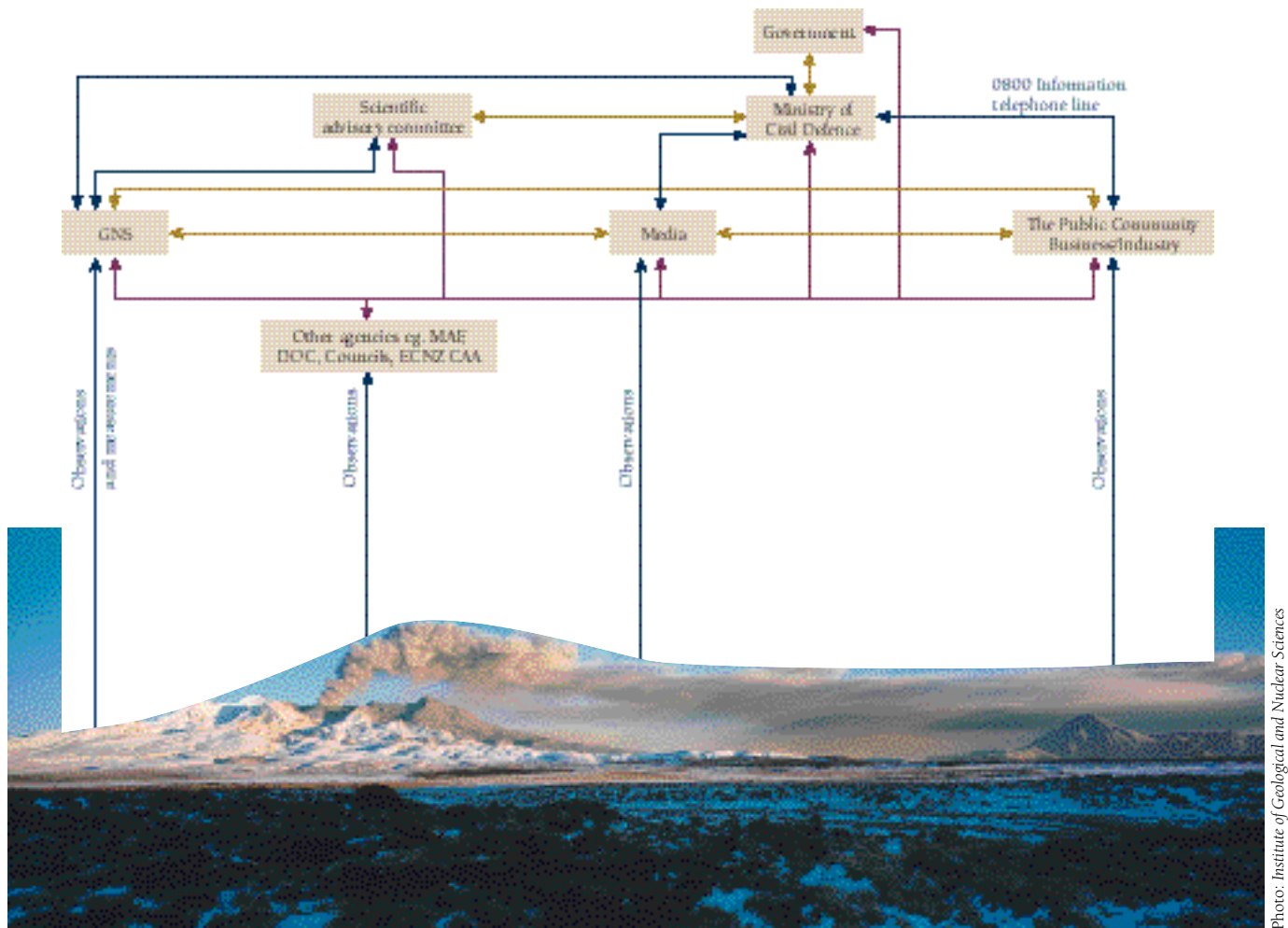


Figure 1 (top): The flow of information during the 1995–96 Ruapehu eruptions.

Figure 4 (bottom): The 17 June 1996 eruption of Ruapehu. The 1995 and 1996 eruptions dispersed ash over much of the North Island of New Zealand, closing airports and creating a nuisance to other sectors

style will also change periodically. Between eruption episodes response plans can be carefully evaluated and compared, making analytical decision making appropriate. During eruption episodes rapid decisions must be made within a short time frame, making an intuitive or naturalistic style more appropriate (Paton, Flin & Violanti, 1999). Attention must be directed to understanding the naturalistic decision making of experts and how it can be modelled in simulations to develop this contingent capability in emergency managers.

Management systems

Response management can be constrained by several factors, including underestimating risk, overestimating response capability and ambiguity of responsibility. The last point was particularly evident following the 1995 eruption. A potentially more serious issue concerned discrepancies between assumptions about future response capability and the observed incidence of actual response problems (Paton *et al.*, 1998). Hazard perceptions are influenced by, for example, training or new mitigation practices. While intended to reduce risk these can, ironically, have the opposite effect. 'Risk homeostasis' describes how a perceived increase in safety can reduce the risk attributed to a hazard and encourage unsafe behaviour. Consequently, evaluation of risk reduction interventions (eg. training, mitigation strategies) must consider whether they introduce any bias into the meaning attributed to hazards

and influence perceived vulnerability and response capability in a manner counter to that intended. Perceptions of risk and capability are also influenced by the manner in which experience is interpreted.

While disaster planning encourages thinking in terms of scenarios that represent a serious test of their capabilities, organisations are more likely to encounter events that do not constitute a major test of their systems (eg. the 1995–96 Ruapehu eruptions). Following such events, the psychological mechanisms (eg. optimistic bias) that guide interpretation of performance can encourage overestimation of future response capability (Johnston *et al.*, 1999; Paton *et al.*, 1998). Accordingly, objective, critical and comprehensive evaluation should follow response to any event. In addition, the management systems themselves deserve close scrutiny.

Prior to a disaster, organisational structure and systems function to manage routine operations rather than crisis demands. System effectiveness is influenced by organisational characteristics (eg. management style, decision procedures) and bureaucratic flexibility. Rigid bureaucracies can — by persistent use of established procedures, internal conflicts regarding responsibility, and a desire to protect the agency from criticism — complicate the response management process and hinder the development and/or implementation of integrated arrangements.

Adopting a more responsive structure involves planning, exercises and the development of devolved management systems to

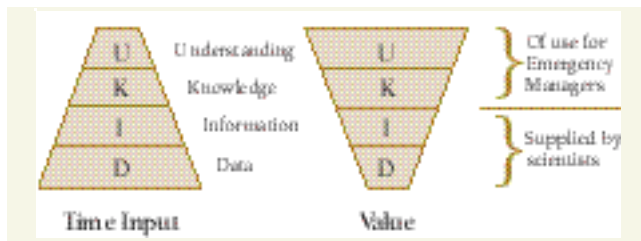


Figure 2: The information-knowledge transition showing the relationship between time input required and the value of each stage

cover, for example—networking, information management; delegation (including to external agencies); and contingent decision making (Paton, *et al* 1998). When responding to volcanic hazards, these systems may be required over a period of several months. Attention must also be directed to developing procedures to manage the transition back into routine operational activities.

Training

Training is crucial to response-effectiveness and should utilise an all-hazards approach to facilitate technical (eg. information analysis, decision making, managing uncertainty) and psychological preparedness and the development of an adaptable response capability. Training should also provide opportunities to develop realistic expectations about the disaster operating context and its implications for performance (Paton *et al*, 1999). Managing these issues requires that training needs analysis is conducted explicitly to identify the demands, competencies and contextual constraints that characterise disaster operating contexts. It must also accommodate multi-agency operations. The outputs of this process can then be modelled in simulations.

Simulations afford opportunities for emergency managers to develop technical and management skills, practice their use under realistic circumstances, receive feedback on their performance, increase awareness of stress reactions, and facilitate rehearsal of strategies to minimise negative reactions (Paton *et al*, 1999). Critical and comprehensive process, content and performance evaluation should follow all simulations and training exercises.

The media and the public

The media and the public are prominent recipients of information. Both will experience the hazard directly and receive information from several sources (Figure 1). Consistency of information is important, and facilitating this capability should be integral to the IEM process.

Developing an effective media response involves, for example, anticipating information needs within set deadlines, identification of expert sources for referral and establishing a media liaison function to control information flow. The manner in which the uncertainty implicit in much of the information available for public dissemination is handled is an important issue in this context.

Objective measures of risk and community perceptions of risk need not coincide. During the 1995–96 eruptions, inaccurate media reporting of volcanic hazards resulted in the ‘social amplification’ of perceived community risk and heightened anticipatory anxiety in surrounding communities (Johnston & Paton, 1998). By understanding the social amplification process, steps can be taken to improve communication and mitigate some of its undesirable outcomes. Attending to this issue may also underpin the public credibility of scientific and administrative agencies and

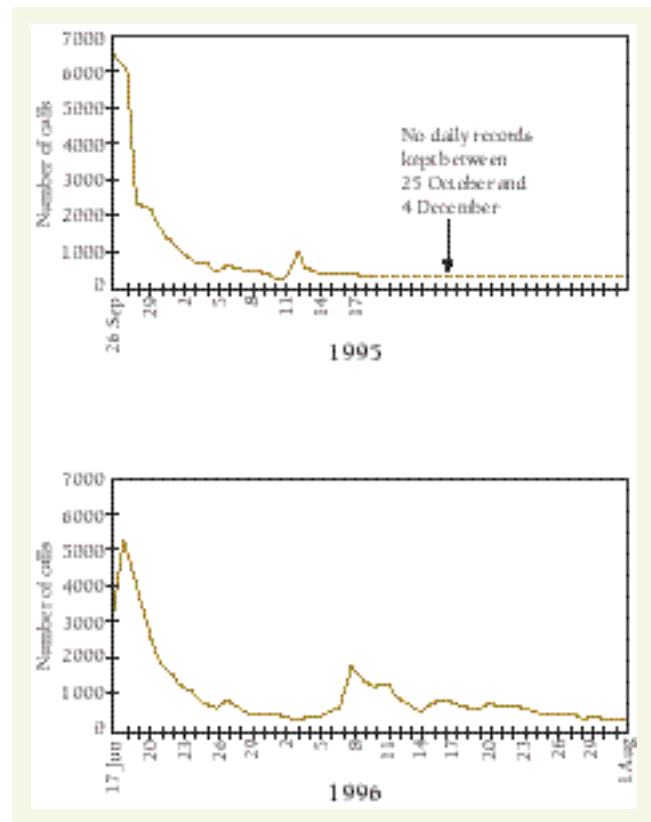


Figure 3: The number of calls received per day on the Ministry of Civil Defence 0800 information line during the 1995–96 Ruapehu eruptions. The free information phone line was operational from 26 September to 4 December 1995 and 17 June to 6 August 1996. Unfortunately some of the daily call records were deleted, notably between 25 October and 4 December 1995 although the total number of calls received in 1995 is known (34,893)

increase the likelihood that future warnings or information is utilised in the manner intended.

The public demand for information was substantial (Figure 3) and peaked immediately following the eruptions. This makes it imperative that response agencies have the resources and information to meet these demands and attend to other response activities. Community information needs during and after disasters differ radically from those prevailing within a non-disaster environment. Common problems for agencies providing information to the public include making inaccurate assumptions of community needs, failure to consider differences in needs and risk status within communities, and failure to consider how community needs change over time. A detailed analysis of how hazard consequences interact with community vulnerability and functions over time is required to determine information needs, sources, and dissemination mechanisms.

Conclusion

In addition to developing emergency structures and procedures, the integrated management of volcanic hazards requires that the operational issues characteristic of transitory, multi-agency contexts are defined and addressed. Prominent issues include team management, training and simulation, contingent decision-making and the development of crisis management systems. Ensuring that comprehensive and critical evaluations are conducted and a capability to meet public and media needs, represent other areas where further attention will prove beneficial.

CASE STUDY

Seismic reinforcement of existing adobe housing in the Andean countries

Alberto Giesecke, Ceresis, Peru

THE ANDEAN countries of South America — Argentina, Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela — have a combined population of about 140 million. Approximately 25% (35 million people) live in 'adobe' housing which is structurally vulnerable to earthquakes. Many millions of people throughout the developing world are in the same condition.

The Andean region is one of the most active seismic regions of the world; it accounts for about 15% of the total seismic energy generated worldwide. In this century, at least 450 earthquakes of magnitude 6.5 or greater have occurred in this region. The distribution of Maximum Intensities on the Mercalli Modified (MM) scale, as observed during this period, is shown in Figure 1 (see page 247). Note that strong earthquake induced ground shaking with Intensities varying from VII MM to X MM, shown by different shades of red, has been experienced throughout the entire Andean area. Damage to adobe construction ranges from serious — Intensity VII MM, to total destruction — Intensity X MM.

A significant portion of the low income sector of the population live in vulnerable adobe housing in earthquake-prone regions of the world; they, in particular, are in a high seismic risk situation. This is the kind of situation that the International Decade for the Reduction of Natural Disasters could not ignore.

The earthquake, if sufficiently close and strong enough, will not only destroy an adobe house in a few seconds but it is also likely to kill or bury the people inside the house when it collapses. We often learn of hundreds or even thousands of people killed by an earthquake, in the Middle East, North Africa, China or Latin America, when a severe earthquake hits an adobe community — for example, 1944 — San Juan, Argentina, 10,000 victims; 1976 — Guatemala, 22,545 victims; 1970 — Ancash, Peru, 67,000 victims; 1997 — Iran, 1,567 victims.

BACKGROUND

Ceresis: The Regional Centre for Seismology for South America — is an international organisation created and supported by the governments of the South American countries, under a Multinational Agreement, ratified by law in each country. The purpose of Ceresis is to further the

knowledge of seismology and related disciplines and to apply such knowledge to build up the region's capacity to cope with earthquake and volcanic hazards.

The critical shortage of housing throughout South America is a priority problem on the agenda of the governments in the region. On-going programmes, with varying degrees of success, provide better homes to a relatively small number of families that can afford to pay the respective loan. There are no programmes designed to solve the urgent dilemma of the millions threatened by an earthquake that can occur at any time, any day, whose adobe homes are particularly vulnerable to seismic excitation and whose income is at the poverty level.

The very important problem of reducing the seismic risk faced by 35,000,000 million people living in vulnerable adobe houses in earthquake-prone regions of South America is a challenge that Ceresis has to address.

The international IDNDR Scientific and Technical Committee (STC), appointed by the UN Secretary-General, held its First Session in Bonn, Germany, in March 1991. The Committee decided at that time that a certain number of projects should be executed as international demonstration projects for the IDNDR.

The STCs Second Session was held in Guatemala City, Guatemala, in September 1991. Proposals for IDNDR demonstration projects having high potential for disaster mitigation were duly examined. In the area of Earthquake Hazards — Risk Assessment and Preventive Actions — a proposal presented by Ceresis to carry out such a project in the Andean region was approved. The project, designed to reduce earthquake effects, specifically to reduce the number of victims, proposed the reinforcement of adobe houses throughout the earthquake-prone areas.

Reinforcement of an adobe house so that it will react to seismic excitation as well as a well-built brick and concrete house and not collapse, is complicated and very expensive. The cost would exceed the funding capacity of housing programmes and of individual owners, and probably even the cost of building a new house. With this in mind, Ceresis proposed developing a simple technology designed to retard the collapse of the house and not necessarily to save the house. Adobe houses, unless exceptionally well built, are apt to collapse in a very few seconds when severely shaken.

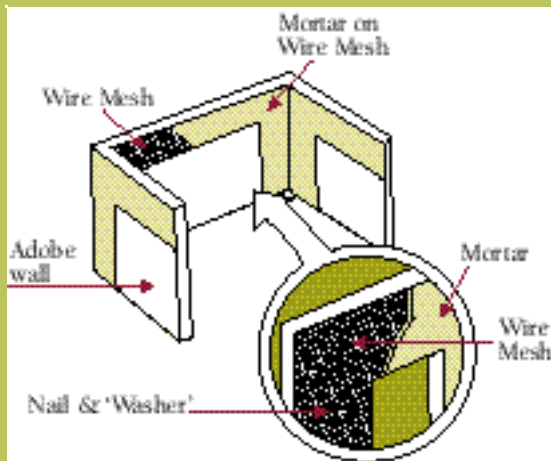


Figure 3: Sketch of reinforcement

If the earthquake occurs when people are indoors, a situation that is worsened if they are sleeping, they simply do not have enough time to escape outdoors to safety. Even though most adobe houses are rather small, offer escape routes to the front and to the rear of the house and are usually one-story high, there can still be insufficient time for their occupants to get out. When the house collapses, quite often those inside are badly injured or crushed to death by the crumbling walls, heavy beams and clay tile roofs. Additional time, even a few seconds more with the house still standing, enables the dweller to escape alive and watch the house from the outdoors as it collapses, rather than being trapped inside, badly injured or dead.

The Ceresis proposal was brought to the attention of funding agencies by the IDNDR Secretariat as an IDNDR demonstration project. A few weeks after Guatemala, the German IDNDR National Committee informed Ceresis that the German Government was interested in the project. This was followed by prolonged negotiations leading to a formal Agreement signed by Ceresis and the German Co-operation for Development programme, duly represented by GTZ, for the transfer of DM 590,000,—the amount required by Ceresis to execute the proposed demonstration project during a four-year period.

THE DEMONSTRATION PROJECT

The objective of the project was to produce a well tested solution based on simple reinforcement technology which makes use of low-cost readily available materials. For many, many years, empirical techniques to reinforce adobe housing have been applied by people for various reasons and with varying degrees of success. Some houses and schools have been reinforced to correct specific problems due to ground subsidence, uplift, wind erosion, rain or defective construction. The idea of reinforcing well-preserved adobe houses

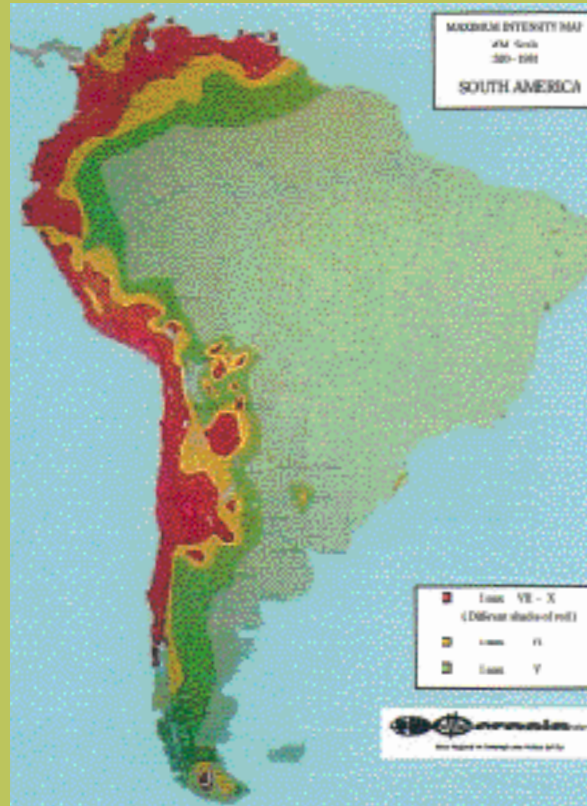


Figure 1: Distribution of maximum intensities (MM Scale) observed during a 460 year period (1520–1981). Reds correspond to intensity 7 and higher

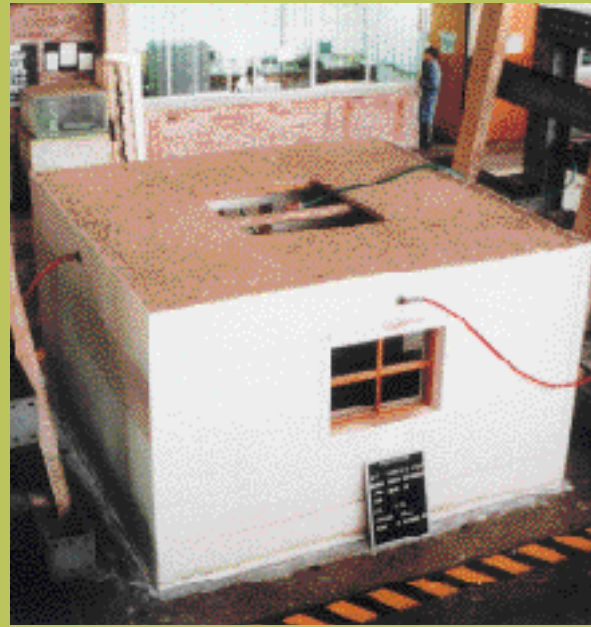
as a preventive measure against eventual earthquakes has never been formally adopted, as far as we know, or incorporated in national, regional or local civil defence plans.

The Ceresis project included laboratory tests of known techniques and of new ideas that would meet the requirements—low-cost, simple do-it-yourself technology, making use of available materials. Also considerable field work was undertaken to document potential difficulties arising from the broad spectrum of the quality of existing adobe houses. The final phases addressed the difficulty of ‘marketing’ the product, ie. spreading the message, gaining the confidence of the people and also having in place mechanisms to evaluate the behaviour of reinforced houses whenever a strong earthquake should occur.

A three-year laboratory research and testing programme was carried out with the large shaking table, 20 square metres, and other equipment installed and available at the Structures Laboratory of the Catholic University of Peru. The Laboratory is able to test fairly large scale models. Faculty members of the University’s Department of Civil Engineering, with many years of experience with adobe construction, under a formal agreement with Ceresis, accepted the responsibility of executing the laboratory programme and selecting the technology that best met all of the requirements for a good solution to the problem. It might not be the very best technical solution, the cheapest, or the



Figure 2: Collapse of unreinforced module...



...Minor fissures in a similar module reinforcement externally with wire mesh. Both modules were exposed to the same earthquake on the shaking table

easiest to apply, but as a whole it had to be a viable and attractive option.

The movements of the shaking table simulate ground shaking under seismic excitation; the table is controlled by a computer that reproduces seismic waves as recorded by strong motion instruments. The acceleration can be regulated to produce moderate to severe shaking. On this table, successive modules were built and shaken with varying degrees of acceleration, both unreinforced modules and modules reinforced with rope, wooden planks, corner braces, ordinary chicken-wire, electro-welded wire mesh or a combination of these. Knowing the behaviour of unreinforced adobe modules is of the utmost importance to identify critical zones that need to be reinforced. Past earthquakes in Peru, even some of moderate size, have confirmed the poor behaviour of adobe; some houses have collapsed very quickly with fatal consequences (Figure 2).

The fragile behaviour of adobe is due to the lack of a structural element that controls the size of the cracks. The cracks, in turn, cause sudden loss of lateral rigidity and convert the construction to a very flexible system with a large mass. This then generates the collapse as the seismic forces are greatly enhanced.

Basically, the reinforcement technique consists of nailing electrowelded wire mesh along the insides and outsides of adobe walls, connecting the two sheets of mesh using wire and then spreading cement mortar over them.

The mesh is placed in horizontal and vertical strips (simulating beams and columns, respectively) in the critical parts of the building. Their purpose is, together with the applied mortar, to prevent the abrupt loss of lateral rigidity that occurs when cracks form in non-reinforced buildings (Figure 3).

Pilot projects have been executed in six localities throughout Peru; similar pilot projects are being carried out in Bolivia, Colombia, Chile, Ecuador and Venezuela. Strong motion seismic equipment is being installed in the localities where the projects have been carried out in Peru. The demonstration consists of reinforcing three or more buildings in each locality with materials provided by Ceresis. At the same time, local masons and the population in general are trained. Experience has shown that they quickly and correctly learn the technique; one has to remember that in general adobe houses are non-engineered and people build their own homes. So they themselves have the basic ability to apply the reinforcement, when properly instructed.

The technology has been adopted by the National Civil Defence Authority in Peru. Their local representatives will be asked to distribute flyers and manuals urging the people to make use of the available technology to 'vaccinate your home and save you and your family's lives'.

Although the cost of the materials is quite modest, the lack of financial resources is in many cases a major obstacle to the application of the reinforcement. At this stage, consideration is being given to government support possibly through a Materials Bank that will supply the two most expensive items—cement and wire mesh, at a low price and on a long-term credit basis. The loan required is estimated to be less than US\$ 400 per house.

To conclude, the simple method of reinforcement Ceresis offers is suited for delaying the collapse of adobe dwellings in the Andean region when earthquakes occur. This gives the occupants enough time to get to a safer place, thus contributing to one of the major goals of IDNDR—to reduce the number of victims of natural disasters.

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WALL ST

XV

FINANCIAL INVESTMENT
& CORPORATE ENTERPRISE

KEYNOTE PAPER

IDNDR: THE DAY AFTER

Alcira Kreimer, The World Bank, USA

VERY SOON WE WILL ARRIVE AT THE end of the IDNDR. This is a good time to reflect on its achievements and to explore what is next. At the beginning of the Decade, Frank Press, then President of the US National Academy of Sciences, defined natural disaster reduction as a ‘moral imperative’. The IDNDR played a major role in raising awareness about disaster risks and about the need to prevent or mitigate losses.

On the other side of the equation is the issue that the IDNDR will be over soon. The international community faces a major challenge in the next millennium as natural disasters have an increasingly devastating impact on development. A report by Worldwatch Institute indicates that insurance companies have paid out US\$ 91.8 billion in losses from weather-related natural disasters in the 1990s so far, close to four times the weather-related claims handed out during the entire decade of the 1980s. In fact, the magnitude of the destruction and the severity of the impact on social and economic systems in the last two years provided an advance warning of what we can expect in the decades ahead. The explosion of disasters caused by El Niño in 1998 (Argentina, Bolivia, Brazil, Ecuador, Kenya, Mexico, Papua New Guinea, and Peru among other countries), in addition to the severe disasters in Bangladesh, the Caribbean, Central America, China, Colombia, Indonesia, and Mexico, indicate that we will need to be on our toes in the years ahead.

Changes in temperature rates and sea-level rise in the next century will occur in a context of important human activities such as changes in ecosystems and land cover, that are rapidly modifying the adaptive capacity of natural systems. The scenarios of what is to come due to climate change and sea-level rise in vulnerable countries like Bangladesh provide important warning signs. As it is, given its topography, location and poverty, Bangladesh is one of the most vulnerable countries in the world. And the climate change scenarios developed for the next 50 years indicate that Bangladesh may expect even more extreme events, as it may experience up to one-third of a metre rise in sea level, an increase in

temperature, and an increase in precipitation of about 30%. Other countries face similar risks. Of particular concern are small island states in the Caribbean, and in the Indian and Pacific oceans that may be significantly reduced in size or completely wiped out due to sea level rise. Climate change is also an issue of special concern for the insurance industry, which sees that an additional risk factor needs to be included in its calculations.

It is clear that human activities are important contributing factors in the recent devastation we have witnessed. For example, in Central America after Hurricane Mitch, an assessment of damage conducted by the United Nations Development Programme concluded that the effects of the natural disaster were aggravated by manmade factors. Population pressures that resulted in large-scale deforestation and the cultivation of marginal lands without proper soil conservation left communities vulnerable to the destruction that resulted from the floods and mudslides. Mountainous areas also suffered due to erosion and deforestation, and it is now evident that deforestation contributed to the massive mud slides that engulfed entire towns and helped increase the water level of rivers which washed away people and homes.

The 1997 forest fires in Indonesia are also an important warning concerning what may lie ahead. The transboundary haze resulting from the fires affected several neighbouring countries for a period of about four months. It had significant impacts on health, daily life, transportation and air traffic. Due to the fires, there were a number of direct, indirect and secondary economic impacts. For example, there was an increase in hospital admissions for

treatment of 'haze-related ailments', workdays lost, and impacts on rural and urban activities such as limited crop yields resulting from reduced sunlight. In neighbouring countries, there was foregone income from reduced fishing activities, limited tourist arrivals and airport closure due to poor visibility. Indonesia experienced major fires in 1982–83. However, the experts agree that very limited progress was made after that disaster to develop effective policies, institutions and procedures to manage fires.

It is clear then that not only have disasters been very significant recently, but also that the vulnerability of many areas has increased exponentially. The forest fires in many parts of the world illustrate deficiencies in forest management as well as in regulations and legislation to control the techniques used in agriculture to clear forest land. The growth of cities and human settlements in areas that are disaster-prone, the location of industry and infrastructure in vulnerable locations, and the utilisation of inadequate agricultural practices in areas that are exposed to either floods or droughts have contributed to an increase in the losses. In analysing what is next, we need to do so in the context of the 'moral imperative' highlighted at the beginning of the Decade.

What are we doing?

In 1998 the World Bank created a Disaster Management Facility (DMF) to improve the management of vulnerability in risk-prone areas of member countries. The DMF is working to promote sustainable projects and initiatives that incorporate effective prevention and mitigation measures. The creation of the DMF responds to a need to be more pro-active concerning the inclusion of prevention and mitigation in the Bank's portfolio. In the last two decades, the World Bank financed projects related to disasters amounting to over US\$ 14 billion. A number of those projects addressed the ex-post needs after major extreme events and a pro-active attitude has emerged now. There are two issues which have surfaced as key for the DMF. The first is how natural disaster vulnerability impacts social development and economic performance. The second is whether mitigation and loss financing activities can be instituted to improve social and economic development. Those two issues frame the focus of the DMF, which includes mitigation measures on the one hand, and risk transfer on the other. On mitigation mechanisms, the DMF has been actively working to include sound environmental practices, land use management, building codes, retrofitting of existing structures and disaster planning in Bank-financed projects. On risk transfer tools, the DMF has been exploring issues such as insurance, reinsurance, private risk pools, government risk pools and catastrophe options. In view of the losses from disasters and the reallocation of funds, ex-ante measures provide significant comparative advantage over existing ex-post financing measures to deal with the costs of catastrophes.

At the DMF we are currently implementing a project called 'Market Incentives for Mitigation Investment' (MIMI) which explores possibilities of innovations and partnerships between public policy and private sector practice to improve and expand alternatives for mitigation and for risk transfer. The goal of the initiative is to identify the best incentives for appropriate disaster mitigation investments and the most efficient mechanisms to transfer risk. Partnerships are key to the MIMI initiative. As the manager of the MIMI initiative, the DMF has mobilised team members from the financial, infrastructure, insurance/reinsurance sectors, and the research community. Country case studies are the linchpin of the MIMI initiative, which examine the potential role of insurance and reinsurance in transferring risk and in helping to reduce losses. The studies, with the assistance of local



Photo: Courtesy of Dr Goldammer

Fleeing from smoke caused by fires in Indonesia

officials and experts, document current disaster exposure, existing insurance coverage, use of mitigation practices and the potential for positive development in insurance and financial markets to mobilise mitigation investment. We are conducting studies of ex-ante alternatives in several regions and countries, including Argentina, Bangladesh, the Caribbean, Central America, Indonesia, and Mexico.

The case studies are resulting in recommendations to promote a better process of risk identification, cost-effective measures for disaster mitigation, identification of the main strengths and bottlenecks in the local insurance sector and better design for government-backed disaster funds. Importantly, the cases, and the discussion they generate in public meetings, are opening a dialogue between the public and the private sectors. The cases stress the importance of continued funding for high quality research of natural hazard identification and vulnerability reduction. They also highlight the importance of changing the perceptions and behaviour of all members of society to abandon a fatalistic approach to disaster and to place a high priority on safety in all physical planning and development. The cases emphasise the importance of information and education in raising people's awareness of risk and the importance of investing in mitigation measures.

What is next? A safer millennium

The challenges that lie ahead are complex. It is clear that we need to improve our strategies, to move from a paradigm based on relief and reconstruction to one based on prevention, mitigation and risk transfer whenever feasible. We need to embrace and promote a culture of prevention. We certainly need to do everything within our reach to build a safer world in the next century. And to make operational the 'moral imperative' of prevention and mitigation.

A Reinsurance Perspective of Risk Assessment

Dörte Aller, Partner Reinsurance Company, Switzerland

MOST OF THE ECONOMIC LOSSES from natural catastrophes larger than US\$ 10 billion have occurred in the last ten years. The insurance and reinsurance industry is in the business of pre-financing, and sometimes post-financing, such losses and to compensate those who are affected when nature strikes. Hence, insurers and reinsurers should have an idea of what size future losses may be and how often such catastrophes can happen. Natural science, actuarial science and other sciences are methodologies to provide the tools to successfully tackle the issues.

Insurance and reinsurance functions on the principle of risk sharing. In the chain of risk takers, the reinsurer is the one who sells insurance to an insurance company that wants to reduce the impact of a major catastrophe on its business. In other words, the reinsurer is the insurer of the insurance company. This paper gives some insight into how this business works, which procedures are normally applied and what contributions are expected from a research team.

Insurance and reinsurance

Insurers are usually able to cope with losses when they result from a moderate event (high-frequency/low-severity). This is because the damaged structures are likely to represent only a relatively small number of insured values within a large portfolio of risks. However, the portfolio can be hit by a severe event (low-frequency/high-severity) simultaneously affecting a considerable number of risks. This is when the insurance companies may have to rely on reinsurance to take a main part of the loss amount.

Insurance companies play an important role in reducing the impact of natural catastrophes, even before they occur. They can provide important information on hazards, vulnerability and loss prevention to their clients, the policy-holders. In order to manage their book of business, insurance companies should know exactly which specific risks (eg. single objects) they insure, what premium must be charged to cover such risks, how the risks may be best protected and what kind of reinsurance needs to be purchased. The problem for insurers is that insurance premiums in catastrophe prone areas need to be substantial, although technically justified. In fact, if looked at in isolation, exposed regions may find it difficult to buy insurance where it is most needed.

Reinsurers know which risks they cover and they use risk assessment methods and pricing models to assess the reinsurance premium to be charged to the insurance company. Scientists provide such tools.

In most countries, natural catastrophes are considered insurable. Whether extended coverage is available — ie. a fire policy providing coverage against natural perils as well — largely depends on the amount of capacity the insurance and reinsurance markets are willing to offer. Another aspect is that capacity may be inadequate for some risk situations or prices are too high from the buyers' point of view. For example, PartnerRe doubts whether more than US\$ 8 billion of flood capacity is available at a fair price for any specific region likely to be inundated (*PartnerRe*, 1997). In order to cope with the potential lack of traditional reinsurance capacity,

other markets with different products may step in and be added to the catastrophe reinsurance programme. The current industry buzzword is 'ART' which stands for Alternative Risk Transfer; ART includes risk transfer by means of securitisation, but also catastrophe index futures and options based on catastrophe indexes.

Reinsurance tasks

There are three core technical functions which reinsurers must perform. Reinsurers must assess the probable maximum loss, determine the price for capacity, a function of the loss potential and the loss frequency relation, and evaluate whether the up-front insurance pricing is in line with actual needs.

Probable Maximum Loss (PML) evaluation

The reinsurer wants to know the worst case scenario for the risks he shares, be it a number of risks or a whole book of risks. The estimate of a maximal loss amount of a catastrophe, assuming that loss controls systems operate, is called a PML. Reinsurers may suggest that the largest possible event occurring in a given period is what they refer to as their PML. Typically a reinsurer would talk about an event that occurs with a return period between 100 and 250 years.

Establishing capital needs

An alternative means of measuring worst probable loss scenarios is judging on whether a company, either insurance or reinsurance, is adequately capitalised. The challenge is to optimise capital allocation. Reinsurers are experts in doing this. An insurance company may work with its own capital or prefer to depend largely on the capital of its reinsurers. There is a choice, and one solution may be more economical than the other, depending on the situation. Many reinsurer's products and solutions are based on real-time multi-variate modelling of the grand total of business risks assumed. The method is called 'Dynamic Financial Analysis'. DFA techniques combine management, underwriting and asset risk evaluation.

Insurance and reinsurance price calculations

Experience pricing for natural hazards is highly dependent on having an understanding of the history in a given hazard region. Confidence in 'what we know' is not always high because the retrospective records, combined with the details of the hazard environment and the insurance conditions prevailing are often inadequate. However, underwriters are held responsible for their professional assessment of coverage and pricing. The challenge researchers must meet is to make a forward-looking evaluation of risk through exposure analysis. By using computer modelling techniques, much improved underwriting tools have been created in recent years and consequently, the margin of error has narrowed. Additionally, the credibility gap continues to close rapidly. Today, it is fair to say that insurers and reinsurers alike have a much better understanding of the risks kept on their books or newly written.

When calculating a price, the reinsurer considers the loss experience of the past, referred to as experience pricing. Typically, this information is available for the low-severity/high-frequency losses. For the high-severity/low-frequency losses the price is primarily determined by the losses to be expected based on scientific knowledge. The latter is referred to as exposure pricing.

Experience pricing, where an insurer can make use of historical information available, provides an instant insight into the relative success (or failure) of an insurer's underwriting capabilities.

On the other hand, pure exposure-based pricing is the most difficult, yet the most rewarding. At best, it allows the reinsurance underwriter to fully evaluate the potential impact of all possible loss events.

PartnerRe's risk assessment method for exposure pricing

Catastrophe reinsurance provides protection against the impact of financial losses caused by natural catastrophes for an insurer's property book of business. One standard reinsurance product is called 'Excess of Loss Treaty'. This contract allows an insurance company to recover if and when a certain retention, the deductible, is exceeded. Pricing should be fair, but in today's market, competitive as well. Four main pillars form the general framework of PartnerRe's risk assessment methodology. These are:

- Hazard
- Geographical distribution of values
- Vulnerability
- Insurance conditions.

It is a demanding job to assess all four parameters correctly. The findings are then merged and condensed into a 'loss frequency distribution'. The loss frequency distribution is the backbone of what is used by the underwriters to measure price and it shows the annual frequency of a catastrophe exceeding a certain loss level.

Hazard, geographical spread, vulnerability and insurance conditions

Hazard deals with the intensity, frequency and location of the natural phenomenon that causes damage. The geographical spread of insured values is submitted by the insurer, and the information is broken down into various business types such as automobile, dwelling risks, household, commercial and industrial.

The vulnerability section quantifies how insured properties are likely to respond to given hazard intensities

Policy conditions, such as deductibles, must be considered since they have a large influence on the overall loss amount per event and premium rates. It is also crucial to know the extent of coverage provided by the original policy. For example, some policies cover buildings only, others include contents too or even consequential losses. The loss to the reinsurer greatly depends on the scope of the underlying covers.

PartnerRe's tropical cyclone model

Many of the existing model methodologies currently used by reinsurers are based solely on historical land-falling data. This more traditional approach can not adequately weigh the impact of storms that make multiple landfalls. In response, PartnerRe established a new modelling methodology in 1997. Our improved methodology allows for analysis of multiple land-falling cyclones. The new approach simulates the entire life cycle of a tropical cyclone, including its development and subsequent movements. This enables PartnerRe to use much more data, ie. data for all tropical cyclones, and not only of those that hit land. The more



Photo: Rex Features

Severe avalanches in the Alps, in 1999, led to many insurance claims...

data used, the better the prediction. In addition, The method allows inclusion of more sophisticated features, such as climate change scenarios and El Niño effects.

Moreover, the models generate windfields for both historical and synthetic storms, which are then translated into insured loss amounts. PartnerRe's model takes into account the roughness of the terrain profile, the duration of the storm and different vulnerability functions of the insured objects. For major historic storms, wind and damage maps are available and, based on those, 'synthetic model storms' are validated against reality. It may be added that, based on PartnerRe's hurricane model, an insured market loss for the US East Coast runs at US\$ 42 billion with a return period of 100 years.

PartnerRe has analysed many hazards including tropical and extratropical storms, floods, hailstorms and earthquakes in a number of countries. The main advantages of developing in-house experience are flexibility and responsiveness. Requirements of management and needs of underwriters can be both fully addressed. Moreover, new scientific knowledge can be built into a model update easily. The uncertainties of a model have to be taken into account too, and in-house modelling makes sure that users know the models hands-on, understand what the model can deliver and also what its limitations are.

Conclusion

Wherever there are risks — there is (or should be) insurance and reinsurance. Today, much-improved risk assessment enables insurance and reinsurance companies to help countries and people to better cope with natural catastrophes. The basic questions insurers and reinsurers have to answer are — Where can it happen? What is the impact? and, How often should we expect it? In order to answer these questions, a significant concerted effort is required. The scientific community, governments and the insurance and reinsurance industry must all join forces with a common goal. PartnerRe strongly feels that the IDNDR plays an important role in achieving this by facilitating much improved communication. This is why we trust that natural catastrophes in the future will be managed more efficiently and more effectively.

NATURAL HAZARDS RISK ANALYSIS

Mitigating property and business losses

Dr J. Schneider, G. Rao, S. Daneshvaran and J. Perez, Impact Forecasting LLC, USA

NATURAL HAZARDS RISK ANALYSIS methods can be used to rigorously quantify the costs and benefits of a wide array of mitigation strategies. The key is in incorporating science, and engineering-based parameters into advanced risk models that capture the physical processes associated with the hazard impact. This paper first discusses the essential components of an advanced natural hazards risk model, with a focus on property and business risk from hurricanes and earthquakes. With this model as a backbone, we then develop a strategy to evaluate the impacts of various aspects of risk mitigation, and apply it to three case studies:

- Low-cost measures for mitigating residential property losses due to hurricane wind damage in Florida
- Building and contents upgrades and emergency planning to mitigate property and business interruption losses to earthquakes at a major research and development firm in northern California
- Building upgrades and emergency planning to mitigate post-earthquake recovery time to a major manufacturer in southern California.

We conclude this paper with a discussion of how one can use the results of these types of studies to make informed decisions about mitigation strategies.

Assessing the risk

The assessment of risk to natural hazards is a relatively new field of analysis, especially for business application. It is rapidly evolving and heavily relied upon by insurers, business analysts, real estate owners and managers, and financial/lending institutions to assess the potential losses that may occur in major natural disasters. Analytical tools are becoming more sophisticated as scientists, structural and software engineers, mathematicians, economists and others model the physical processes associated with causing damage, along with their economic consequences. In addition, insurance companies and businesses are gaining more experience through recent catastrophic events. The data resulting from these events is also being used to calibrate, validate and improve available models.

Four essential components or modules, characterise a typical model for natural-hazard loss estimation — Natural Hazard, Physical Damage, Restoration Cost and Probability of Loss. The level of analysis of each of these modules depends on the accuracy and detail that is required. In turn, the achievable accuracy is driven by the availability and cost of the data needed to reduce the uncertainty in the results. A broad-based or ‘generic’ analysis is the common approach when risks are accumulated over many assets, such as for a portfolio of insured properties. A detailed or ‘site-specific’ analysis is often more appropriate for high-valued or critical assets. In this case, the additional analysis is warranted by the confidence gained towards making informed decisions about the risk.

Natural hazard

The Natural Hazard Module utilises scientific data or models regarding the future locations, sizes and rates of occurrence of hazard events. Moreover, the module must be able to evaluate the properties or parameters of the event that contribute to damage at any given site. For hurricanes and earthquakes, wind speed and ground shaking amplitude respectively are the hazard parameters that contribute most to potential damage. Hazard intensities can be strongly influenced by local conditions at a given property, such as local soil conditions in an earthquake and effects of rough terrain or topography in a hurricane. It is also important to capture collateral effects, especially landslides, soil liquefaction and fires from earthquakes, and storm surge and flying debris from hurricanes.

Physical damage

In the Damage Module, descriptions of the building and its contents, as well as the building function (or social class) are used to estimate the building vulnerability in terms of the extent of damage to be expected for a given hazard intensity. In a site-specific evaluation, a detailed analysis is conducted of buildings and contents to determine how specific factors will likely modify the vulnerability. In a generic evaluation, each building is assigned to a building class (eg. unreinforced masonry or steel frame) for which a general relationship has been established between each hazard intensity and the expected damage to the building. In addition, classes of contents have been developed that represent typical types and configurations of building contents.

Restoration cost

In the Restoration Cost Module, the physical damages to buildings and contents are converted to the costs and time to repair or replace them. In its simplest form, this analysis of the restoration process provides an estimate of the direct costs to restore or replace a building and its contents, plus direct business interruption caused by loss of function of the facility for an extended period of time. In a generic application, the estimation of physical damage and the restoration process are commonly combined to provide damage/cost functions that directly express the restoration cost (or time) as a function of the hazard intensity.

For any hazard event affecting a wide geographic area, there will be indirect or contingent costs that should be factored in. For instance, repair costs are often subject to hyperinflation because of the high demand for labour and materials after a damaging event. The availability of fire protection, water, electricity or gas may also be compromised.

For business interruption, other contingent factors would include the locations and vulnerabilities of critical suppliers and the availability of transportation systems.



Photo: Rex Features

Boats badly damaged by Hurricane Hugo

Probability of loss

In the Probability of Loss Module, the probabilities of occurrence and cumulative effects of hazard intensities, physical damage and restoration cost are combined to develop estimates of potential loss. This combination or aggregation process also includes the impacts (and associated probabilities) of all possible hazard events (eg. different magnitudes and locations for earthquakes) at all locations (and for all assets) of interest. Estimates are commonly reported in terms of the probable maximum loss (PML), which is the loss expected to be exceeded at least once in a given time period, such as 50 or 100 years. For insurance purposes, losses may be expressed in terms of insured losses, with appropriate deductibles and limits for each coverage type (eg. building, contents, and business interruption).

Figure 1 shows a typical PML curve, in which the probability of meeting or exceeding a given level of loss (in a given year) is plotted against the loss incurred. Note that the annual probability is equivalent to one over the average return period or recurrence time. Also of general interest are estimates of the average loss in any given year, which represents the cumulative loss expected over all years, divided by years. Losses can also be estimated for specific event scenarios (eg. a Category five hurricane sweeping through Miami, Florida) or for specific hazard source zones, such as an earthquake fault of interest. Further, an important component of more advanced models is the estimation of uncertainty in the loss estimates. This uncertainty (eg. 90 or 95% confidence bound) is an important indicator of how well we think we understand the range of loss values that might actually occur.

Mitigation analysis

Mitigation strategies can be developed using the risk modelling tools and framework discussed above. The process incorporates both generic (or global) and site-specific characteristics of the buildings, contents and business operation into a risk model for making probabilistic estimates of the potential losses. In this case, the effects of building and contents upgrades should be incorporated into the same methodology used to generate the unmitigated building and contents vulnerability curves. Our approach utilises a restoration-process model (Rao *et al*, 1998) to simulate the facility repair/reconstruction process in order to capture the mitigating effects of upgrades on the restoration time

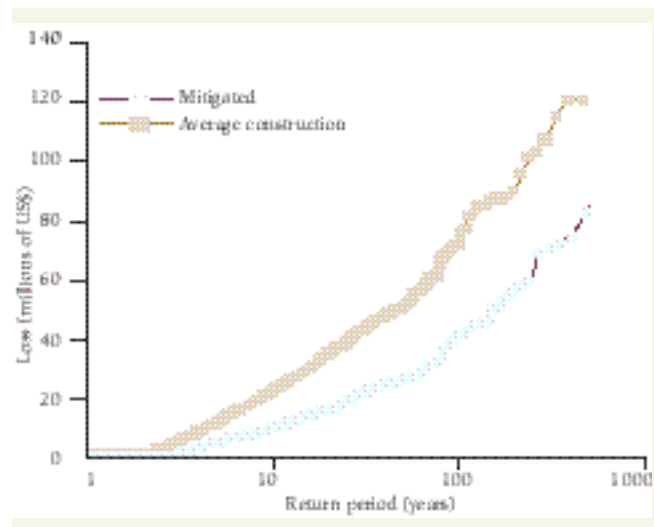


Figure 1: A typical PML curve, in which the probability of meeting or exceeding a given level of loss (in a given year) is plotted against the loss incurred

and potential business interruption. In addition, the business recovery plan should address a wide array of issues, from emergency responses to mitigate loss of property (eg. fire protection) and life (eg. evacuation), to contracts with alternative suppliers or redundant operations to mitigate recovery time.

We present here three examples of risk assessment studies that we have recently performed to assist in mitigating potential losses from future hurricanes and earthquakes. Additional applications of natural hazards risk analysis techniques to mitigation can be found in the professional literature (eg. EERI, 1989; FEMA, 1997, Eidenger and Goettel, 1998).

Example 1: Residential property damage from hurricanes.

The first example is an evaluation of hurricane risk with respect to construction practices in Florida. The objective of the study was to evaluate the effectiveness of various low-cost improvements to single family homes. Our reliability-based damage model simulates a large number of failure scenarios for the buildings using the ultimate capacities of the components. The failure scenarios were then used as input to a restoration process simulator, which

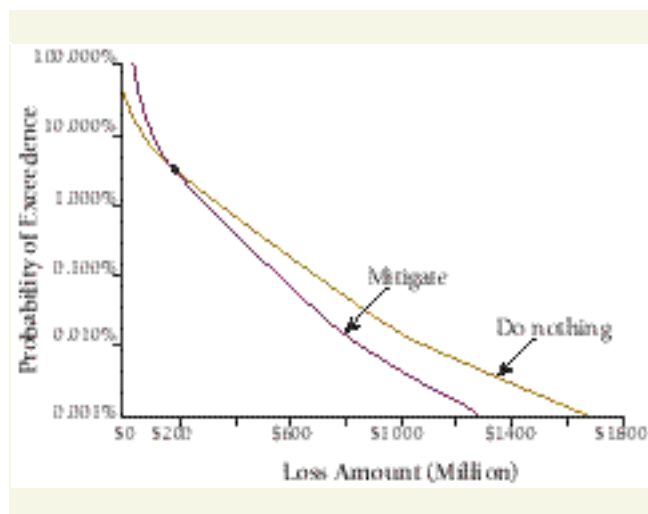


Figure 2: Mitigation decision using loss exceedance curves

translates physical damage into restoration cost as a function of the hazard intensity (Rao *et al*, 1998). Two levels of construction were considered: 'average' and 'mitigated'.

In order to evaluate the merits of these mitigation measures, we applied the two damage models to a set of 10,000 randomly-located homes in Dade, Broward, and Palmbeach counties in southern Florida. The results, indicated that overall (direct) losses can be reduced by approximately a factor of two by implementing simple measures to improve construction practice. Results also show that for the 100-year hurricane event, the loss difference would be, on average, about US\$ 4,000 per residence. These construction standards are probably cost-effective for any new construction and for upgrading homes in locations that are more exposed to hurricane damage.

Example 2: Property and business interruption losses from earthquakes. A research and development firm in northern California, producing patented instruments and products, sought to establish the efficacy of its risk management programme. The firm's risk managers had performed earthquake upgrades of buildings and equipment and established a comprehensive emergency response plan. We were asked to quantify the benefits of these initiatives and to propose additional mitigation strategies, if necessary. Using natural hazard risk analysis as a tool, we analysed all of the facilities on the R&D campus.

The probable maximum losses for the unmitigated scenario (ie. ignoring the upgrades and emergency response plan) is 17.9, 6.2 and 9% of the building, contents and business interruption values, respectively. In the next step of the analysis, building and equipment upgrades were incorporated into the building and content vulnerability curves; and the business interruption model was modified to give credit for the emergency response plan. These changes reduced the probable maximum losses to 9.2, 4.1 and 2.2% of the building, contents and business interruption values, respectively. Reduction in business interruption was and is the key goal of the risk managers. This analysis allowed them to quantify the costs and benefits of their programme and help them to identify areas for further reducing the risks, such as by segregating exposures on their campus or moving some operations off-site.

Example 3: Business recovery time from earthquakes. A large manufacturing company in southern California was interested in estimating the benefits of a business recovery strategy on its business interruption exposures due to earthquakes. Due

to the confidential nature of the financial data, we were asked to assess the benefits in terms of timesaving only. This was accomplished by simulating the building restoration process, with and without the elements of a response strategy, to generate a relationship between building damage percentage and time to full restoration. Factors such as in-house engineering capabilities, availability of resources to employ multiple repair crews in multiple shifts, etc were incorporated in the mitigated process model.

The results clearly demonstrate the significant savings from the response plan in place. Of interest is the reduction in restoration time from 260 days to 180 days in the event of severe damage to the facility. This, according to the manufacturer, translates to several million dollars of income, far exceeding the cost of preparing, maintaining and implementing the business recovery plan.

Decision making

The final step of the process is to cast the results of risk mitigation studies in a manner that facilitates decision making. The process is illustrated schematically in Figure 2. Presented here are probability exceedence curves for a hypothetical facility at risk to damage and loss from hazards. First, the probability of exceeding a range of loss values (ie. loss curve) is estimated for the facility as it exists today (heavy dashed line). Next, based on input from a risk mitigation study, a second loss curve (heavy solid line) shows the reduction in potential loss. This curve includes the cost of carrying out the mitigation plan, which provides the initial offset of the curve. Thereafter, the losses decrease relative to the 'do nothing' plan, eventually crossing at approximately three per cent probability, where the mitigation plan becomes cost-effective. In other words, there is a 97% chance in a given year that the implementation of the mitigation plan and any additional losses from the occurrence of events (in a given year) will cost more than the unmitigated losses.

At first blush, it would appear that the mitigation effort is unwarranted. However, it may be more appropriate to look at the savings accrued over a more significant period of time, such as the life of the facility. In this case, the three per cent probability per year translates into an occurrence rate of once every 33 years. Further, included in the 3% annual chance of savings due to mitigation are potential losses (without mitigation) that may be substantially greater than one can afford. These factors need to be considered in the context of the risk reduction gained by mitigation against a variety of risk transfer mechanisms. The most commonly available one is insurance, where the cost of an annual premium and the associated coverage can be evaluated against the mitigation costs and benefits generated by the risk model. In this case, the decision to mitigate may lie in a comparison of the annual savings in the insurance premium accrued over time against the cost (and future value) of the mitigation. Finally, even better information for making an informed decision can be gained by including realistic estimates of the uncertainty in the estimates of loss.

Conclusions

In this paper, we have demonstrated that natural hazards risk analysis methods can be used to rigorously quantify the costs and benefits of a wide array of mitigation strategies. This is demonstrated first by incorporating science- and engineering-based parameters into advanced risk models and mitigation strategies, and second by presenting examples of several case studies.

The results show that the optimal solution is often highly dependent upon the level of risk that one is willing to accept and/or the available mechanisms for transfer of risk to others (eg. via insurance).

CASE STUDY

Corporate Preparedness

Stan Quintana, AT&T, USA

IN ADDRESSING AND implementing a disaster preparedness programme, there are certain key elements required to ensure success. These elements are many times obvious out of context and difficult to understand and implement in context. What are some of these obvious components? They include sponsorship at the highest level of management, comprehensive integrated end-to-end operational components, a systemic process and organisation to programme manage, and last but not least the value added rational for disaster preparedness.

Implementing a disaster preparedness programme with the focus of ensuring continuity of business and 'due diligence' to shareholders and customers is one of the key challenges management faces. Many times this success factor only becomes evident when a corporation's livelihood is interrupted by a natural disaster. Understanding this critical success factor and finding the correct formula that best fits your corporation is fundamental to gaining sponsorship at the highest level of management.

Service interruptions during the early 1990s helped us better understand the value in having a disaster preparedness programme in place. These 1990 events solidified sponsorship at the senior level of management.

This senior level of management in many cases should include the Board of Directors. The Board of Directors of any public company must delegate to senior management team the responsibility to protect the assets of the company from loss or compromise due to any act or event. With any corporation, senior managers may individually become personally liable for losses that could have reasonably been avoided. The term 'reasonably' is incorporated in a notion called due diligence which all senior leaders individually and as a team must exercise in carrying out their responsibility to the Board. Due diligence is established by a set of preventive and remedial measures which are put into place by senior management based on factors which include risk, cost, prevailing industry practices, brand image, and others.

At AT&T, the Continuity Services organisation is responsible for oversight of the Business Continuity and Disaster Recovery (BC/DR) programme throughout, in order to ensure operability, reliability, and recoverability of critical business processes. The Continuity Services organisation programme manages the work programmes to assure the recoverability of critical business process components (Applications, Work Centres, Data, Networks, and Platforms) in accordance with the Disaster Recovery Planning and

Certification & Assurance Standards. The role of Continuity Services in this effort is to create and programme-manage the disaster recovery programme at the corporate level, create and maintain the Disaster Recovery Planning and Certification & Assurance Standards, obtain from the business partners their identified critical components to maintain a current inventory supporting the business, create or identify environments for exercising recoverability capabilities and use in the case of a declared disaster, programme-manage the exercising of BC/DR plans through the business partners co-ordinators, certify according to corporate standards, and track and report to management.

The role of partnerships overall is to propose and implement such senior management approved measures that are fully funded in order to protect company assets and the processes they support. These measures focus on the response, recovery, restoration and relief capabilities that must be put into place to respond to any catastrophic event affecting company operations. The partners are jointly responsible to achieve this objective in as much as the respective senior leaders are equally accountable to the Board to achieve an appropriate level of due diligence as quickly and economically as possible.

Incident Management (IM) Planning is a critical function that is necessary to ensure the timely co-ordination, management, activation, and execution of various business continuity plans in the event of a devastating business interruption or failure.

Incident Management provides the infrastructure and communication processes needed to manage response to a potential or actual threat and co-ordinates the activities and interfaces among Response, Recovery, Relief, and Restoration should a disaster take place. Incident Management provides multiple levels of co-ordination, from site-specific to corporate-wide, depending on the nature and impact of the incident. This process provides for structured, systematic, co-ordinated, and effective Incident Management.

TWO-TIER INCIDENT COMMAND SYSTEM

Tier I: A Site Incident Management Team (SMT), is responsible for IM co-ordination and communications at the affected site/community from which they operate and is the only team that can make the disaster declaration decision.

Tier II: A Corporate Support Team (CST) is responsible for providing overall direction, policy, and support to site teams.

The two IM tiers are supported by the Incident Management Operations Centre (IMOC), which is the central point of contact for incident co-ordination and tracking. Information concerning each affected site is maintained in the IMOC. The status of incidents will be provided via the corporate web, electronic mail, and other methods as warranted. Co-ordination during an incident is provided by the Continuity Services Incident Manager who facilitates the status calls, escalates within various corporate entities, and provides status to management. Coverage is provided by Incident Support Managers who assist in the notification of incidents to the appropriate personnel, maintain an incident log, take minutes, track storms, etc. Together, these managers develop and provide Situation Reports to all necessary stakeholders.

IM planning enables a business process/function to sustain a major interruption while continuing to satisfy customers, maintain revenue, minimise expenses, preserve market share and alleviate the concerns of stakeholders.

While IM is site-specific, plans should address the co-ordination of the physical site; the tasks or work functions performed, and the workbench, communications and data.

Each Business Process Owner must have representation on the SIMT which develops the IM Plan, documenting the co-ordination of activities for each of these components supporting the business process/function at a specific site. The SIMT also provides assistance to the associates and their family who are affected by the disaster. Accounting for associates and family members and providing for life essentials are a few of the additional functions the SIMT provides.

Business continuity includes all the functions necessary to ensure the continuous operation of the critical business of the corporation. It includes the identification of the critical business processes, assessment of the risks that could interrupt those processes, the steps needed to reduce the risks, planning for potential disruptive events, and execution of those plans if an event does occur. The business continuity process is divided into three major phases—Assessment, Planning/Preparation, and Event Management.

The assessment phase begins with the identification/classification of the business processes critical to the continued health of the corporation and an evaluation of the relative impact of an interruption of those processes. These steps are usually accomplished through the execution of a Business Impact Analysis (BIA).

A risk assessment of the areas which pose a potential threat to the continued operation of the critical processes is the next step in this phase. The final step is risk mitigation, which defines actions needed to mitigate or reduce the chance of the threat occurring and/or the resulting impact. This phase also includes the definition of the business requirements for both survival (recovery) of the process and its eventual restoration to full functionality in the event that a disruption does occur. Risk assessment, mitigation, and disaster recovery requirement definitions are performed both at a full process level and at a site-specific level, since each site is subject to different threats.

The planning/preparation phase encompasses the creation, maintenance and exercising of strategies and plans to cope with a disruptive event to one or more critical processes at any applicable site. Based on the information and requirements identified in the assessment phase, alternative strategies which meet those requirements are developed, documented and included in a business case. Once approved, plans to prepare for and manage an event are documented and put in place. The plans are kept current and viable via regular updates and maintenance, coupled with exercises designed to simulate anticipated events.

Event management is the phase in which the plans and strategies are put to the ultimate test—an actual disruptive event occurs and critical business processes are in jeopardy. The plans developed in the earlier phase, and executed in this phase, address the following functions:

Incident Management: functions in managing the activation and execution of the various business continuity plans. IM provides the infrastructure and communication processes needed to manage the corporation's response to a threat, and co-ordinates the activities and interfaces among Response, Recovery, Relief, and Restoration activities in the event that a disaster does, in fact, take place. IM can provide multiple levels of co-ordination, from site-specific to corporate-wide.

Response

The activities which will be executed once an event occurs and continue until a recommendation is made to either declare or not declare a disaster. Response includes an initial assessment of the damage caused by the event at the affected site.

If the event results in a disaster declaration, the following plans are executed:

Relief

Relief provides for activities required at the site of the disaster to reduce and relieve the impact of the disaster on the employees, their families and the community.

Recovery

Recovery provides for the continued execution of the critical business functions in a site(s) other than the site of the disaster. The business functions are recovered at the alternate site(s) in a predetermined time frame and at a predetermined level of service that provides for survival of the corporation.

Restoration

Restoration addresses the activities required to fully restore the business function to normal (pre-disaster) capability. This plan could provide for the rebuilding of the failed site, movement to a new site or absorption of the business function into existing facilities.

Over the past decade, AT&T continues its dedication to the community by volunteering its resources to various humanitarian, local, state and federal programmes.



XVI

PARTNERSHIP AND PROGRESS

KEYNOTE PAPER

LAYING THE GROUNDWORK

Harvey Ryland, Institute for Business and Home Safety, USA

HURRICANE HUGO CAUSED ALMOST US\$ 9 billion in damage when it hit the Carolina coast of the United States and the Virgin Islands in 1989. A tropical cyclone hit Bangladesh in 1970, claiming over 300,000 lives. And the 1972 Managua earthquake caused damage equal to Nicaragua's GNP for the entire year.

Based on the realisation that losses such as these, both in terms of economic losses as well as the human toll, were fundamentally unacceptable, the International Decade for Natural Disaster Reduction shifted from the traditional response-and-recovery approach to natural disaster management to an emphasis on mitigation. This new course of action has led to a much improved understanding of how to stem disaster losses, more advanced building techniques, a better understanding of risk and increased co-operation along with information-sharing both intranationally and internationally.

Yet losses continue to rise. Since 1989, the United States alone has suffered at least US\$ 90 billion in insured damage (not including disaster payments from government or the costs property owners must absorb themselves), and has seen more than 23,000 people injured and at least 2,000 more killed. Even more disturbing, worldwide natural disaster losses for a single year in 1998 exceeded US\$ 90 billion in losses. And they were accompanied by 50,000 deaths (*The Daily Telegraph*, 1998). Obviously, we still have a long way to go.

This is especially true in a world where experts predict that multi-billion dollar mega-disasters are looming on the horizon. According to the US Insurance Information Institute, if an earthquake with an 8.3 magnitude hit San Francisco, as it did in 1906, losses could reach US\$ 225 billion. The 1923 Tokyo earthquake occurring today could wreak US\$ 4.3 trillion in damage. And the state of Florida represents more than US\$ 900 billion at risk (*Insurance Information Institute*, 1999). The insurance industry, government, business and, most importantly, the people they serve, simply will be unable to manage and rebound from events that take an enormous toll.

Given all that we have learned during the Decade, how do we move from understanding to action, especially now, when an increasing number of people and property are in harm's way?

Every nation, region and community is at risk from natural disasters. It is unreasonable to assume that government entities or scientific organisations in and of themselves can find the answers to our compromised safety. Such a monumental task cannot be undertaken alone. Partnerships that cross traditional lines of communication and action are critical to stemming future losses. Clearly, the best decision-making comes not from a top-down approach but rather a collective one. Only when stakeholders work together to devise technology and land-use plans and, more importantly, to decide how to apply mitigation principles, can we hope to have a truly integrated approach to reducing the deaths, injuries, property damage, economic losses and human suffering that natural disasters cause.

Indeed, we have learned a lot about partnerships during the Decade. We have seen several success stories, and we're on the brink of many more. Japan and the United States strode toward a global approach to mitigation, expanding on their common agenda for co-operation on global issues to include natural disaster reduction. As a first order of business, both countries pledged to strengthen international networks for exchanging early warning data. The Decade Secretariat itself has facilitated a number of efforts internationally, creating region-specific programmes in Europe, the South Pacific, Latin American and the Caribbean, to name a few. The forums gave regional partners the opportunity to share experiences and exchange information on the problems unique to their geographic areas.

Furthermore, the National Committees have made strides within their own borders. One initiative that has served as the cornerstone of American efforts is the Public Private Partnership 2000 (PPP 2000). At times, public and private efforts to reduce natural disaster losses have gone in different directions. The US Sub-committee on Natural Disaster Reduction, part of the White House Office of Science and Technology Policy, has worked with



Photo: Rex Features

Flooding caused by Hurricane Hugo, USA, 1989

the Institute for Business & Home Safety (IBHS), to co-ordinate a series of high level policy forums to develop an agenda for the future of loss reduction. These forums have seen a welcome consensus among the country's leading experts on disaster assessment and reduction to identify most of the critical issues and how to resolve them. Certainly, exporting this model on an international scale can lead to even further advances in the post-Decade years.

But again, the most dramatic changes are not going to take place in a conference room in Washington DC, Geneva, Sao Paulo or New Delhi. The real work must be done at the grassroots level—wherever people live and work. The Showcase Community/State effort, borrowing from IBHS experience once more, is one example of what can be accomplished when natural disaster preparedness is brought to the forefront of a community and/or state agenda as governments, citizens and businesses work to make their environments safer. Stakeholders, including consortia of businesses, drive the process and organise themselves around a set of loss reduction criteria that touch on the total mitigation package. Everyone has a voice and an opportunity to become involved. Going even further, every person has the responsibility to take action and make changes.

The intent of the Showcase concept is threefold—to help communities/states within the US help themselves; to generate a 'me too' attitude among other entities; and to learn what and what does not work in the battle to reduce the devastation caused

by natural disasters. With community action and leadership, state and regional assistance and IBHS' guiding hand, these pilot programmes have started the ball rolling and will serve as examples to spur similar, concerted action by others.

These experiences are but a few in the long list of partnership success stories. The Decade planted the seeds for leadership, with many organisations taking up the banner of natural disaster preparedness. But while we are meeting the challenge in terms of research and technological accomplishments, the critical challenge remains—making the appropriate information and technology available to every stakeholder, making mitigation a public value, and empowering and impelling citizens to act. This is an enormous undertaking, especially since we live in a world in different stages of development, with different national agendas and with different priorities identified for resources. And this condition is why co-operation, consensus and the sharing of resources are all the more important.

With the growing interdependency between nations, no one can feel safe or removed from the threat of natural disasters until mitigation practices are applied worldwide. Even if one feels his or her own borders are relatively secure from any natural hazards facing them. What affects one will, in some manner, affect everyone. And so, we continue the work we have only just begun. Until the citizens of the world, and those who represent them, recognise that not only is risk unacceptable it is unnecessary and their decisions and actions mirror this understanding.

Understanding urban seismic risk around the world

Cynthia Cardona, Rachel Davidson and Carlos Villacis, GeoHazards International, USA

NATURAL DISASTER RISK is a global challenge. Hazards of different types and levels of severity exist worldwide. Moreover, the impact of a single natural disaster event may ripple far beyond the region that is physically affected, and mitigation and relief efforts directed toward one area may originate in regions worldwide. As the previous United Nations Secretary-General Boutros Boutros-Ghali declared at the May 1994 World Conference on Natural Disaster Reduction in Yokohama, Japan, 'science, politics, economics and the vagaries of nature are linked in a way that requires us to address disaster reduction from an international perspective' (Duguay, 1994).

In particular, a consistent, systematic description of the magnitude, causes and ways to manage natural disaster risk, as they are distributed worldwide, could improve understanding of the risk from natural disaster. It will help identify the natural disaster risk problems common to different urban areas, and support the management decisions of several particular groups. International development organisations could use global risk assessment to more efficiently help allocate their limited mitigation and relief resources among regions worldwide. Multinational companies could use it to help them incorporate natural disaster risk into facility siting and risk management decisions. Insurance and reinsurance companies could use global risk assessment to help allocate their underwriting capacity among regions worldwide, local governments could use it to raise awareness in their communities and prompt actions to mitigate risk.

Despite the potential benefits of worldwide risk assessment, natural disaster risk is not usually considered in a comprehensive, global way. While researchers have made great progress in understanding natural hazards and their effects, most projects to date have concentrated on either a specific region or a specific aspect of the risk (eg. vulnerability of steel structures). Few previous studies address the overall risk from a global perspective, and because of the differences in objectives and data availability, global natural disaster risk assessment presents a unique set of challenges and requires different methods to regional risk assessment. Global risk assessment does not necessarily have to be performed with high resolution, but it should be a consistent across regions and rely only on information that is available in compatible form worldwide. Because global natural disaster risk assessment is still in the embryonic phase, no consensus exists yet about many key issues, eg. what model is appropriate to measure global risk, what data is available in a consistent form worldwide to support the model, who the real users will be and how they will use it, and what form the results should take.

Understanding urban seismic risk around the world project

To begin exploring the possibilities of developing and using global natural disaster risk assessment, the Secretariat of the IDNDR and

GeoHazards International (GHI), a non-profit organisation dedicated to reducing earthquake risk in the world's most vulnerable communities, launched the Understanding Urban Seismic Risk Around the World (UUSRAW) project. The UUSRAW project is being implemented as part of the Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters (RADIUS) initiative. The UUSRAW study, which addresses only earthquake risk, will last from April 1998 to October 1999. Representatives from 73 cities worldwide are participating in the study.

Objectives

The objectives of the UUSRAW project are:

- To improve understanding of the magnitude, causes, and ways to manage urban earthquake risk worldwide
- To help participating cities identify which cities around the world are facing similar earthquake risk challenges, learn what those other cities are doing to address their challenges, and develop partnerships with them
- To provide a forum in which cities can share their earthquakes and earthquake risk management experiences using a consistent, systematic framework for discussion.

The project has the following specific aims:

City profiles: For each of the participating cities, publish a profile of the city's earthquake risk, its causes, and efforts that have been undertaken to reduce it. A profile includes a comparative analysis that describes the city's earthquake risk in relation to other cities worldwide, a discussion of some of the city's most important earthquake risk concerns, along with references for more in-depth information.

Summary report: Publish a summary report that includes: a discussion of the similarities and differences in the magnitude and causes of earthquake risk in participating cities; a compilation of risk management efforts that have been undertaken in cities around the world; and a summary of the city representatives' discussion.

Worldwide network of earthquake professionals: Establish partnerships among city representatives. Every city has much to gain if they all share their knowledge and experiences. The benefits of such partnerships should outlast this project. Once established, this network of earthquake professionals will be able to support continued work in global earthquake risk assessment and future international risk management initiatives.

Background

The Earthquake Disaster Risk Index (EDRI) provides a framework for the UUSRAW project's comparative study of urban earthquake risk. Introduced in 1997, the EDRI is a composite index that compares metropolitan areas according to the magnitude and nature of their earthquake disaster risk (Davidson, 1997). The

index aims to allow direct comparison of the relative earthquake disaster risk of different cities, and to describe the relative contributions of various factors (eg. hazard, exposure, vulnerability) to that risk. The EDRI is analogous to the Human Development Index and the Consumer Price Index, but instead of rating relative levels of development in various countries or relative price levels in different years, it rates relative levels of earthquake disaster risk in various metropolitan areas. It may demonstrate, for example, that the earthquake disaster risk in Mexico City is about the same as the risk in Jakarta, but significantly less than the risk in Tokyo. Examining the components of the EDRI could indicate that while the risk in one city is mostly the result of the vulnerability of the infrastructure and insufficient emergency response and recovery capability, the risk in a second city is due primarily to the high frequency of earthquakes, and the risk in a third city is driven by the number of people and structures exposed.

In the UUSRAW project, the EDRI methodology offers a helpful structure with which to conduct a systematic, accessible discussion of earthquake risk that includes issues related to all disciplines, to academicians and practitioners, to all regions of the world.

Project design

In implementing the UUSRAW project, a network of more than 70 seismically active cities in almost 50 countries worldwide was established. In each, a representative, usually at the municipal level, was designated to provide information on the city. A group of project co-ordinators is in charge of preparing worksheets to gather information from the participating cities, collecting and compiling the requested information, moderating an internet forum for the city representatives, and keeping participants informed of the project's status. Several international advisers were also invited to participate in the project.

The project co-ordinators created worksheets requesting:

- The earthquake risk information necessary to determine the cities' EDRI values
- Information about earthquake risk management efforts that have been undertaken in each city
- Feedback on the experience of gathering the requested data, the form and usefulness of the EDRI, and the project design and management.

The worksheets were distributed to the city representatives, who then completed and returned them. At the time of this text being written, the project co-ordinators are compiling the requested information into a computer database that will be distributed to city representatives for their research and professional use. The project co-ordinators are also analysing the data gathered, and using it to develop the summary report and the compilation of city profiles that describe the key elements of each city's risk and risk management efforts in a consistent, systematic way.

The project centres on local participation for several reasons. The integral involvement of local professionals improves the quality of the final global risk assessment because local professionals have access to information that is unavailable to outside researchers, a valuable intuitive understanding of their own cities, and insight into the ways in which a global natural disaster risk assessment can be used to reduce future losses in their cities. Moreover, local participation improves the chances that the assessment will lead to real risk management

activities, and benefits the participants in several ways. Through their participation, city representatives gain a better understanding of their city's risk and how it compares to the risk in other cities. In fact, for many representatives, this study offers their first opportunity to be involved in a comprehensive study of earthquake risk. Through the project's internet forum, local representatives are able to voice their ideas and concerns, and learn from the comments of others. They establish valuable connections with other earthquake professionals worldwide, and are able to participate in the analysis of the information collected.

The study relies heavily on the internet as a vehicle for implementation. Worksheets were distributed and collected as email attachments. Email has facilitated administrative communication between the project co-ordinators and participants. Most importantly, an internet forum (ie. email discussion group) lasting the duration of the project is providing a way for all participants to discuss the project methodology and how to develop and present the earthquake risk information so that it is most understandable and useful to the public, government officials and other stakeholders. Using the internet has reduced project costs significantly by virtually eliminating the need for travel, and has enabled implementation of a truly global project that includes participants from around the world. While the experience has highlighted a few logistical difficulties associated with co-ordinating a large group of geographically-dispersed participants (eg. inter-regional differences in computer capabilities and language), the success of the project suggests that the internet is a valuable tool for enabling future global endeavours.

Future plans

A one-day meeting of UUSRAW project participants will be held as part of the October 1999 symposium marking the end of the RADIUS initiative. The meeting offers an opportunity for UUSRAW project participants to review the project results, to try to reach consensus on some of the issues that have been raised in the internet forum, and to develop a plan for how to proceed once the project has been completed. The in-person meeting will complement the internet forum by allowing an intensity of discussion that is difficult to achieve via email. Another in-person meeting may take place in January 2000. A proposal has been submitted to hold a Special Theme Session about the UUSRAW study at the Twelfth World Conference on Earthquake Engineering (12WCEE) in Auckland, New Zealand.

While the UUSRAW project represents a significant step towards the goal of developing a technically-sound, well-accepted global risk assessment, it is only a first step. The challenge remains to improve, expand, and apply this work. Future efforts to improve the project's methodology should include more thorough validation, incorporation of the local input gathered in the UUSRAW project, and more comprehensive review by the worldwide community of natural disaster risk experts. The UUSRAW study should be expanded to include coverage of more regions worldwide and more hazards (eg. tropical cyclone, flood). Finally, efforts must be undertaken to apply global natural disaster risk assessments, ie. to actually use them to try to raise public awareness, motivate mitigation efforts among government officials, and help international development organisations improve the efficiency of their strategic planning and resource allocation.

Converging approaches to disaster management

John Newton, John Newton Associates, Canada

HURRICANES, EARTHQUAKES, and ice storms do not discriminate in selecting who will be severely affected. Community services, business operations, and individual citizens all feel the impact of a disaster and each responds in its own way, based on its inherent capabilities and the plans that have been made. All too frequently, the collective response is disjointed, not co-ordinated, and lacks an appreciation of each other's needs and capabilities. Unknowingly, and with all good intentions, we have developed 'silos of response', often highly effective in a narrow application, yet unconnected to the society of which they are an integral and essential part.

Reality is that in a disaster situation the roles and responsibilities of government and business response teams diverge as they seek to achieve a similar condition from differing perspectives. Whether it is labelled 'continuity' or 'sustainability', business and bureaucratic leaders wish to ensure a reasonably stable business or societal condition, over the long term. And when disasters cause disruptions, a swift return to 'normal' conditions is desired by all. Citizens expect it and investors demand it. During the 1990s these two similar, but differing, approaches to disaster management have begun to collide in an uncontrolled fashion. What will be the outcome? Can they work co-operatively? And will it be economics or sound management practice that bring them together to address future natural disasters? As we enter the new millennium, these questions reverberate with a chilling intensity and frustration.

The lack of linkage

Forty-eight centimetres of snow fell on Toronto, Canada over two days in early January 1999. For northern cities this is not usually a significant event. This event was different. While businesses, small and large, were struggling to cope, the Mayor unilaterally announced the city was 'closed' and people should stay home. Confusion ensued as employees were unsure what to do—stay home or go to work. The result—many businesses were open with a skeleton staff ready to serve customers who thought companies were closed. Why did this happen? Could it have been avoided? These are the questions that need to be asked, and answered, if our communities are to cope effectively with the diversity of emergencies they will experience. To achieve a broad-based capacity for coping will require more than improved inter-organisational communication. It will require the convergence of governmental and private sector emergency response thinking.

Today, such linkages are tenuous and undeveloped, often informal and without the dependability essential for effectiveness in the heat of a disaster. One might reasonably ask—'Why is this so?'—especially in light of the exponential growth in major catastrophic events and rapidly escalating losses during the 1990s.¹ The tragedies that befell countless communities have caused much reflection, and some consternation at the lack of concerted

efforts to seek improved mitigation, preparedness, response, and recovery strategies. Governmental organisations tend first to address their legislated mandates and have often acted from political self-interest rather than looking beyond their traditional processes for solutions. I will argue briefly that this situation can be modified through commitment, co-operation, and imagination. Before we move in this direction, however, it is prudent that the evolution and context of disaster management efforts by governments and private organisations be explored.

Government thinking on disasters

Governmental organisations have long recognised their responsibility for the life and safety of citizens in times of crisis. Out of a readiness for military action has evolved, in most jurisdictions, a civil response capacity. In the 1980s another conceptual framework emerged from international forums to challenge the narrow perspective of disasters as unique events. At a global level the sustainability of human settlements came under intense scrutiny by a few,² driven by renewed interest in the utility of ecological and environmental concepts. Emergence at this time of widespread concern was indicative of a critical mass of latent concern for the fragility of the human condition, not acknowledgment of the extensive body of literature on human-environment interaction. While not readily acknowledged, or widely recognised, the genesis of thinking that led to the emergence of the 'sustainability ethic' can be traced back to Gifford Pinchot and the Conservation Movement at the beginning of this century, and earlier still to the ideas of visionaries such as George Perkins Marsh, Henry Thoreau, Aldo Leopold, and more recently the bold leadership of Rachel Carson and James Lovelock.

The search for sustainability, whether at a micro, meso, or macro level—and scale is a crucial factor—is on-going though not as prominent as in the heydays of the environmental movement. This is due in a large part to the economic upheaval of the late 1990s and the difficulty of progress in areas of high interconnectivity. Nonetheless, governments seek to understand human-environment interaction and discover the elusive formula that will lead to a sustainable existence. The effort, while significant, is founded on the illusion that sustainability, based on what we conceive of as 'desirable', is attainable over a long period of time.

This belief contradicts the laws of nature that govern our existence and simultaneously underscores the necessity of ongoing efforts to manage our relationship within a rapidly and constantly changing political and social context. In dealing with calamities, governments are not only addressing life and safety issues, but indirectly contributing to the desire for sustainability with its wider ramifications. Nowhere is this more evident than in institutional efforts, however small and dispersed, to mitigate losses due to natural hazards.



Photo: Shutterstock

Moving toward continuous business operation

During the last century, the business community has been more complacent, or has placed faith in Adam Smith's 'invisible hand' of market forces, for its emergency response roots are shallow and immature by comparison to governmental efforts to secure the safety of citizens. Nonetheless, during the past two decades significant progress has been made, partly due to the vision of a few, and more poignantly by a series of severe disasters³ such as earthquakes and bombings, that have disabled businesses and destroyed communities.

The primary focus of corporate efforts has been the preservation of financial stability and protection of corporate reputations. Out of early data recovery and information protection activities has grown a global disaster recovery capacity that is now metamorphosing into a drive toward continuous business functionality. In a global economy, many businesses never close and the recent advent of e-commerce is creating a 7x24 on-line business environment. Protecting the viability of these operations has become paramount and yet all is not in the control of corporate continuity planners. Municipal infrastructure, electrical systems, and telecommunications lie, at least for the moment, outside the control of the corporations that purchase these services. The trend, however, toward corporate mega-campuses with dedicated infrastructure and communications systems may, for a few, isolate them from these dependencies, but not the vulnerabilities their customers and employees face.

Similar objectives — different focuses

Compare the tracks taken by government and business. They are similar in objective — sustainability or continuity of operation — but fundamentally different in application and ironically interdependent. Convergence is beginning to occur, albeit in an uncontrolled and irregular manner that leads to inefficiencies and random failures. This condition is concerning to many and unacceptable to a few, who see the necessity of convergence, but lack the resources and political will to take more than small steps. Efforts tend to be regional, and in a few cases national in scope, and distributed globally — a positive note for a dispersed bottom-up groundswell will be required to achieve convergence. In democratic societies, political action in disaster management will follow, not lead, public desire for change, making many highly dispersed local initiatives⁴ the driving force toward convergence.

Linking communities, businesses, and governments took a bold step forward in the United States when James Lee Witt, Director

of FEMA announced Project Impact, now active in over one hundred US communities. In Canada, government and business are evolving a National Mitigation Strategy that will only move forward if a formula for joint activity can be found. To date this has been elusive. In Australia, emergency management authorities have developed educational materials to heighten community awareness and encourage mitigation and continuity plans throughout the commonwealth of states. On the business side, recent efforts such as IBM's initiative in motivating a Leadership Coalition for Global Business Protection, the Public and Private Businesses Inc that spun off the Disaster Recovery Journal, and the Major Industrial Accident Council of Canada, show evidence of interest in bridging the public-private gap.

That interest has yet to reach the level of national agendas, except perhaps in the United States, making progress slow and uncertain. The lack of movement is due, in part, to the complexity of disasters, the myriad of linkages needed for a co-ordinated response, and the lack of ability to generate momentum in a fast-paced, rapidly-changing business environment. Indeed, the task seems beyond the capacity of one organisation or government, similar in magnitude to global environmental issues such as climate change, or achieving peace in traditionally warring regions. Too much hope rests in the idea of 'partnerships', which will be necessary but not sufficient to achieve the synergy needed for strong, lasting linkages and more closely aligned visions.

Seeking convergence

The evolution of disaster management will be slow and largely technological without convergence. To move in this direction requires acknowledgment of a shared responsibility in which governments recognise the increasing importance of the continuity of businesses to their communities, especially those devastated by disasters, and the business community awakens to the reality that through their employees, customers and suppliers they depend on the sustainability of the communities they serve. These dependencies are not new, but have not been fully recognised and developed as part of a shared vision and co-operative approach toward effective disaster management. The challenge for the business community will be to address this need from their community-based roots at a time when the global information environment is driving them to focus on e-commerce, an initiative characterised by impersonality and the elimination of sense of place. The vision of sustainable communities and globally continuous business functionality are not inconsistent, as at their core they are interdependent parts of the evolving fabric of life in the 21st Century.

Natural disasters have been, and will continue to be a part of our societies we cannot avoid, only learn to live with in greater harmony through acceptance, knowing what to do, and working together despite our differences. To achieve this will require moving forward together, not through will or due to vision, but by necessity, and in the end recognising that the degree to which corporations remain profitable and government services are functional will be our measure of survival. Independent paths are not an option, each needs the other whether they like it or not, to cope with the disasters that threaten them both.

Footnotes

1. See annual reports by Munich Re in their publication Topics.
2. ICUN, Brundtland, Lester Brown, Arne Naess, Worldwatch Institute, etc.
3. Northridge & Kobe earthquakes, First Interstate Bank fire, World Trade Centre bombing, Oklahoma City bombing.
4. The International Council for Local Environmental Initiatives (ICLEI) is a good example of the type of effort that will be needed.

An international disaster recovery business alliance

Mary Carrido, MLC & Associates Incorporated, USA



Photo: Earthquake in Colombia, Associated Press

WE LIVE IN A GLOBAL economy in which disasters do not know regional boundaries. Business preparedness, mitigation, and recovery programmes must start at the grass roots level and are needed in every community. Responsible public and private leaders understand that if businesses do not survive a disaster, the community will not survive. Furthermore, disasters can also have far-reaching economic effects. In fact, large-scale disasters can result in economic disruptions of a global scale. Mitigation programmes are therefore needed to reduce the financial impact of disasters. Public agencies gain by reducing the amount of financial aid necessary to assist communities to recover from a disaster. The business community gains by reducing the amount of downtime and losses due to business disruptions. Insurance companies gain by reducing claims on business interruption insurance. Finally, the entire community gains by maintaining the existing business base.

The Disaster Recovery Business Alliance (DRBA) objective

Public sector emergency authorities, utility service providers, emergency medical teams and other first responders have well developed emergency response procedures, and they generally co-ordinate well with disaster relief organisations. However, the recovery of essential commerce and trade is traditionally left to chance, market forces, or ad hoc liaisons created in the chaotic aftermath of the event.

Quick and co-ordinated recovery of basic commercial networks — electric and other utilities, food and water distribution, telecommunications, financial services, transportation and fuels,

and broadcast media — is the key to timely recovery of other businesses, the viability of neighbourhoods, and the continuity of government. The reason is clear. If businesses do not survive a disaster, people are out of work, a community's revenue stream is severely disrupted, and the impact prolongs the recovery process. While many organisations have performed 'internal' planning and mitigation, an increasing number of communities is examining the feasibility of establishing a 'business recovery alliance' to promote 'external' planning and mitigation. The objective is to bring together the leadership and expertise of businesses, emergency preparedness organisations, the engineering and scientific community and, others to develop a public/private partnership approach to reducing the vulnerability of businesses and communities to all hazards.

The Disaster Recovery Business Alliance planning model

A Disaster Recovery Business Alliance offers a tested model to assist local leaders in forming and facilitating a lifeline-based planning organisation to serve a local community. The purposes of a DRBA include:

- Before emergencies, to provide a forum within which local leaders and planning experts can identify and mitigate risks to essential channels of commerce serving the community and surrounding counties
- Before, during and following emergencies, to provide members with access to proven and emerging technologies in support of loss mitigation, disaster monitoring, geographic information applications, and sustainable energy and communications.

- During and following emergencies, to accelerate socio-economic recovery through co-ordinated exchange of status and resource information between business members, public sector emergency authorities, and volunteer organisations active in disasters.

Basic components

The basic components of a DRBA are:

Public and private lifeline industries: A DRBA is often financially supported by the lifeline industries within the community. Lifelines can be described as those businesses, whether from the public or private sector, which provide essential services to the community to support and maintain basic human needs. Lifeline industries maintain the health, safety, and welfare of the community and include such agencies as the police, fire, emergency medical services, public utilities, hospitals, transportation companies, waste removal services, communication companies, fuel suppliers and financial institutions. Because of their importance to a community, protecting these lifelines is essential.

Business & industry: Business is the lifeblood of the community. When businesses fail, a community loses its people and the tax base that a community needs to provide Lifeline Services. Loss of small businesses as well as major employers can have an effect on the economy of the community. It is essential every business protect its survivability with Internal Contingency Planning.

Community organisations: Community preparedness is driven by the organisations and individuals that live and have a stake in the economic sustainability of the community. These organisations include non-profit agencies, religious groups, neighbourhood groups and volunteer organisations. It is essential that these community-based organisations work with businesses to develop external contingency plans that enhance the economic sustainability of the community.

Local and regional public agencies: Local and regional public agencies provide services that ensure public safety through regulations that monitor building practices, health concerns, environmental and safety requirements, etc. They enhance the quality of life within the community by supplying public education, library facilities, mass transportation, housing assistance, and recreational facilities. These agencies must be included in the external contingency plans to protect the citizens and the culture of the community.

The following points are intended to help clarify the importance of implementing the DRBASM concepts and to show how a DRBA serves to bolster these broader-scoped initiatives into successful, long-lasting, economically sustainable initiatives.

What is a Disaster Recovery Business Alliance (DRBA)?

A DRBA is defined as a vehicle for building a partnership between business and government that will lead to significant improvements in the ability of businesses to recover from disasters. DRBA is an organisation, a process and an end product. This in itself creates some confusion as to what DRBA is.

The end product of the DRBA process is the establishment of a successful and sustainable business alliance between the businesses within a community or region and the local, state, and federal governments that support them. It is important that this alliance be driven and managed by the business community in order for it to be effective. Ownership by businesses is the best way to assure participation and acceptance by the private sector. This operation, known as the local or regional DRBASM, serves many purposes for alliance members. Not only does it continue to focus on initiatives to reduce the vulnerability of businesses in disasters, but it also serves as a

basis to promote improvements in the day-to-day economic wellbeing of the community.

A DRBA is not intended to be a comprehensive programme for helping a community to be disaster resilient. It is only an element of such programmes. Public sector initiatives being driven by the local, state and federal governments tend to be focused on response and mitigation for the public at large. A DRBA tends to focus on economic recovery and businesses within the community. This role is supportive and complementary to public sector initiatives. DRBA is not a government driven programme, although it requires government participation and support. A DRBA is an alliance between local businesses and local governments and is to be initiated and managed by local businesses. It needs to be driven by local businesses to have sustainability and business support. DRBA is not intended to be a moneymaking organisation. DRBA is intended to be funded by its alliance partners to maintain staffing and operations to achieve its objectives. The intent is for funding to come primarily from the business members participating in the alliance.

DRBA as a methodology or process

For the last several years large businesses have applied enough resources for contingency planning to lessen the financial impact to their own internal operations by developing internal contingency plans. What has often been overlooked is the survivability of the community in which they operate. Smart business leaders are starting to realise that there needs to be mutual involvement with the public sector in their local communities to build economic strength and enhance the quality of life. Today, partnerships are being formed to ensure economic sustainability and to protect lives. A business alliance can help a community, region and nation to forge alliances, form private-public partnerships, secure funding and conduct joint training and testing exercises. Local governments, community development agencies and business organisations realise their full potential for reducing the loss from natural and technological disasters through cross-cultural bridge-building involving business, non-profit organisations and elected or appointed officials.

The DRBA process is driven by community awareness and recognition of the need for disaster mitigation planning. Business sponsors are solicited and form the community steering group. A community operation is then established which collects and analyses area-specific data, resulting in a Regional Business Impact Analysis (RBIA). Programmes are then developed based on the results from the RBIA. Eventually, a self-sustaining community programme is established that continues the process of disaster preparation, mitigation, response, recovery, and resumption. The plans that are developed from these programmes focus on the external aspects of the community, rather than the internal operations of a particular business. External plans that involve all the business that interact within the community are a necessity to ensure community continuity.

DRBA as an end product

Both the DRBA organisation and the DRBA process exist to establish DRBA the product. The end result of the process is the establishment of a local operation that is supported and managed by the local business community to provide an alliance with the local public sector operations in preparedness, response, recovery and resumption of businesses in the event of a disaster within the community. The local DRBA staff will be involved in leading the business community in disaster mitigation initiatives and co-ordinating the exchange of information between public sector

emergency operation centres and the business community. With pre-planning, the DRBA operation will assist in the recovery and resumption of normal business operations.

The structure, location and financial support of the local DRBA operation is dependent on the environment in which it is established. The same reasons for customising the DRBA process apply to the customisation of the DRBA product, or local operations. It is important to recognise that DRBA exists to bridge the communications gap between the public and private sectors. These two elements of the community tend to have different cultures. The local DRBA operation serves as a cross-cultural manager or liaison in leading the two groups to success in all aspects of disaster recovery activities.

Implementation of a DRBA

Determine the need for, and feasibility of, establishing a business alliance: In this organisational/start-up phase, an important first step is to articulate the benefits of establishing a business alliance to the leadership of the business community. The objective of group orientation and one-on-one meetings with major employers is to recruit participants for the alliance, including the formation of an executive committee. The executive committee elects a chairperson who takes the lead in organising the business alliance. This person also co-ordinates with external organisations, including volunteer organisations that respond in a disaster, and the local, state and federal government agencies.

Initiation of a pilot project to develop a vulnerability assessment for natural, technological, and manmade hazards for the area: The assessment would have quantitative estimates of losses, functionality losses of critical facilities and transportation systems and extent of hazards analysis. The objective is to enable the major businesses in the community to develop a business resumption and recovery programme that takes into account any hazard that might impact a community. The vulnerability assessment is used to support the conducting of a DRBA workshop to help establish priorities for recovery planning. The vulnerability assessment also establishes agreement on the hazards and geographical scope of the alliance area. The conclusions of the workshop help to establish a baseline to use in setting goals and measuring progress.

Develop a two-year work plan: The categories of the plan may include:

- Business risk assessment and vulnerability reduction: a seminar series provides the business alliance founders with a firm technical foundation on how to develop a comprehensive business risk assessment and vulnerability reduction programme
- Hazard and risk assessment enables the major businesses in the community to develop a business resumption and recovery programme that takes into account the regional impact of disasters. The vulnerability assessment is used to establish a baseline for setting goals and measuring progress
- The business alliance may establish incentive programmes that can be used to promote adoption of loss reduction measures. (eg building permit fee incentives, utility rate incentives, or insurance rate incentives)
- Loss reduction demonstration projects serve as 'integrating tools' bringing key groups together in project design and implementation. They help focus community and business attention on the value of mitigation and preparedness
- Education and Awareness/Web Site Development: The web site is designed to capitalise on the research and materials that are available, as well as utilising the internet and other tools, which promote hazard awareness and education at home, and at the

workplace. It also promotes the business alliance and its role in the community.

Identify and plan for the application of mitigation technologies to be used by alliance members: Alliance members work closely with state, federal, and local agencies and private organisations to implement cost-effective technologies to reduce recovery time.

Hire a business alliance full- or part-time executive director and establish a self-sustaining programme: This is based upon a co-ordinated recovery plan including notification procedures and documentation. This includes the initiation of an emergency operations centre's communication and recovery plan, as well as procedures and agreements.

International DRBA

As with the existing DRBA communities in the United States, there will be a need to customise the alliances to fit the community's culture in which they will reside. Each alliance will be tailored to fit the needs of its alliance members and its community. It will be the bridge between the public and private sectors, allowing for the communication, co-operation and collaboration between business and local, regional and national governments. The alliance will not seek to supplant agencies and programmes that are already working to promote community recovery but will instead strive to commingle and work with these agencies to ensure the survival of the community in the face of a disaster.

DRBA can offer an organised approach to the unified recovery of businesses within the community. It strives to create common terminology, allowing everyone anywhere in the world to understand the vocabulary of disaster preparedness. It can co-ordinate a community's disaster recovery management by helping to develop community-wide mitigation and contingency plans and disaster response and recovery plans. The alliance can design a plan for a rapid assessment of the needs of the business community immediately following a disaster. With this organised approach, each community will ensure its economic sustainability by protecting the businesses that operate within its boundaries.

Conclusion

We live in an increasingly small world. What happens to the businesses in one nation affects the economy of many. We must all be sensitive to this economic fact and take steps to protect our local communities, thereby ensuring the continuation of all communities. DRBA can be the vehicle for building partnerships between the public and private sectors. Because it is adaptable, it can be customised to work in different environments whether they are local, regional, or national. DRBA is an organisation, a process and a product that is designed to provide an improvement in a community's ability to deal with disaster recovery by the formation of an effective alliance between the private and public sectors of a community. Because of the cultural differences and the typical perspective businesses have toward public agencies, the DRBA approach suggests that leadership and management of the local DRBA programme should originate from the private sector, with the support and co-operation from the local public sector operations.

DRBA exists to support communities in their efforts to improve their ability to recover from any disaster that threatens the well-being of the local community. Its broader objective is to ensure that healthy local business communities ensure healthy regions and nations and ultimately a healthy and economically sustainable world.

Partnerships in Disaster Management

David Sanderson, UK

PARTNERSHIP CAN be defined as: 'A sharing of power, resources, information, and experience based on equitable arrangements regarding trust, accountability and exchanges' (*Partnership Africa-Canada*, 1989).

Within international development, the encouragement of partnerships between different stakeholders is increasingly seen as a desired and vital activity. Jim Wolfensohn, President of the World Bank has described 'the challenge of inclusion' as now the major focus for development (*World Bank*, 1997), whilst Kofi Annan, Secretary General of the United Nations, has spoken of partnership at the heart of UN objectives (*Davos*, 1998). Equally the British Government's Department for International Development (DFID) sees the forming of partnerships between the state and civil society as crucial in contributing to its goal of eliminating world poverty (*DFID*, 1999–2002). The concept of partnership within the voluntary sector, from which the above definition of partnership emerged, has also been keenly debated for many years in relation to the often contentious relationships (*Harare Declaration*, 1998) between northern and southern non-governmental organisations (NGOs).

The purpose of forming partnership for the latter two is to improve approaches to reduce poverty. Poverty is inextricably linked to natural disaster—in most developing countries it is almost always the poor, ie. those who lack sufficient capital or assets to withstand disasters, that are themselves the most vulnerable to disaster. Within the context of international development therefore, partnership is also as important for more effective natural disaster management. Yet there are as equally complex debates relating to issues of equity, power sharing, leadership and accountability as exist within the private or voluntary sector.

When rapid-onset natural disasters strike, eg. flood, earthquake, hurricane, those involved have complementary and overlapping roles to play. Key actors and their roles/relationship to disaster management are detailed in Table 1.

Disaster management is concerned with the implementation of both good relief measures post-disaster, and effecting sustainable mitigation and preparedness measures to reduce risk, before a disaster. Each of these broad sets of actors usually only interact during or after a disaster event, eg. in government or NGO provision of relief, emergency services putting out a fire. In such cases the relationship between the affected community and the outside is one of service provision. Partnerships however seek something more—a close collaboration between different groups seeking the same goal. These collaborations however can cost; for municipalities this may mean devolving some decision-making, or for emergency services spending time with vulnerable community volunteers to share skills.

Forming partnerships of course is not always the most desired relationship. Emergency services do not need to share decision making in putting out a fire. Partnership relationships may best be served during mitigation and preparedness planning where the purpose is to reduce risk to lives and livelihoods of the most vulnerable through sharing knowledge, skills and power. In most

circumstances the most vulnerable are those in poverty, eg. slum dwellers living in poorly constructed housing liable to collapse in earthquake, or urban squatter residents living in flood prone areas made of easily combustible materials. Almost by definition these groups are disempowered. Conversely those with power (government, emergency services and to some extent NGOs) are called upon, in developing partnerships, to share some of their power, as well as knowledge and resources. This may not be an easy relationship to achieve—clearly one party has to give up something. What then does the group with the greater power have to gain?

Partnerships with vulnerable communities for reducing risk

If the reduction of risk of disaster in vulnerable communities is the aim of disaster management, then it is with these (and their representatives) that those with power should seek to build partnerships. Key reasons for this are:

To develop sustainable risk reduction measures: Mitigation and preparedness measures are more sustainable if they involve those who are likely to be affected by disaster. A preparedness plan that involves vulnerable communities in its design will be more likely to be respected and adhered to.

To build up social capital: Social capital, ie. established networks of contacts or strong relationships of trust (*Carney*, 1998), is important for two primary activities—to meet basic needs (thus reducing poverty) and, as capital is built up, to reduce vulnerability to household level shocks, which includes natural disasters. For example if a fire is in a local market, market traders who know and trust the local fire services are more likely to ring for assistance to prevent further destruction than if suspicion and distrust pervades (this real example is described later).

'Owning the problem' to reduce dependency: Those most vulnerable to disaster need to be in the lead of developing effective risk reduction measures. This depends on the recognition that vulnerable communities themselves, often those in poverty and therefore where resources are already limited, are primarily responsible for resolving their own problems

Addressing different scales of disaster: Outside emergency services are usually only called in for large scale disasters. However, smaller everyday events, for example floods to which services may not respond, can perpetuate poverty through destroying livelihoods.

Improving response in the event of disaster: Developing skills and abilities among vulnerable communities can lead to improved actions in the event of a disaster, eg. the development of community response teams in an earthquake prone area.

Maximising resources: If those most vulnerable are those with fewest assets, it is because resources are limited. To these ends, unlocking the support, skills and abilities of vulnerable communities seeks to maximise resources for reducing risk. This may also lead to new, unexpected directions as the confidence of those involved grows.

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NATURAL DISASTER MANAGEMENT

Actor	Description	Role
Vulnerable communities	Those most affected by disaster, ie. usually those in poverty	• First line of defence in withstanding disasters • Present throughout all stages of disaster management (from relief to mitigation and preparedness) • May need assistance depending on scale of disaster
Civil society organisations (CSOs)	Non governmental organisations (NGOs) and representative community-based organisations (CBOs, traders and community associations, etc)	• Providing support to communities and lobbying governmental bodies • Channelling resources and knowledge • Can represent/comprise vulnerable communities • Specialist relief NGOs exist, eg. for search and rescue
Government/authorities	Municipalities, central government Civil Defence organisations Emergency services Specialist support inputs, eg. consultants, scientists	• Policy decision making • Channelling of funds and support • Responsible for disaster management • Usually focused on post disaster relief and rehabilitation • Specific objectives of saving lives and property • Fire and ambulance services for 'everyday' response; military for larger scale disaster, eg. earthquake • Called in for specific input, eg. forecasting of hurricane, volcano

Table 1: Key actors and their roles/relationship to disaster management

Building partnerships

Each of the above involves the sharing of power and decision making of organisations in control, eg. government, civil defence, municipality, NGO. Work by Warner (1999) describes ten activities for consensus building which are applicable for reducing risk. They are :

1. Accommodate cultural differences
2. Acknowledge perceptions
3. Ensure good communications
4. Creating a level playing field for negotiations
5. Building and maintaining rapport
6. Focus on satisfying underlying motivations
7. Widen options
8. Clarify motivations and options
9. Achieve mutual gains
10. Test agreement for feasibility.

Some of these principles may be difficult for many centrally-organised, hierarchical institutions expected to relate to civil society organisations. Yet if sustainable risk reduction is an aim then partnership building activities ought to be attempted, with the comparative advantages of entering into such relationships clear to all. The following case study from Peru summarises a project which sought to implement these techniques, which led to a variety of fire risk reduction activities based on the partnership formed between market traders and the local fire services.

Reducing urban risk, Lima, Peru case study

In 1996 a workshop was held to identify and subsequently develop sustainable risk reduction measures for Caqueta, a particularly low income area of Peru's capital city, Lima, vulnerable to landslide, earthquake and fire. The strategy was to build consensus amongst stakeholders in affordable actions to be taken to reduce risk. Over 30 representatives attended the workshop from local municipalities, congress, traders and residents associations, local NGOs, the fire services (bomberos), and international NGOs. Small working groups formed around commonly agreed themes; each explored uncovering common approaches that could be adopted to reduce risk, how different actors had a key role to play, and what skills and knowledge each group brought. Plans of action were then developed with time frames and responsibilities identified.

One of the working groups addressed the problem of the frequency of fires in poorly maintained markets, leading to the

loss of livelihoods by market traders through destruction of their property. Often the fire services were not called because they were perceived as being ineffective. For the fire fighters' part, they were frustrated at the market traders' lack of interest in their support; their equipment was also old and local recruitment into the service was low. A joint partnership initiative was developed by market traders with the bomberos and aimed to promote risk awareness and education for communities and bomberos. The project comprised the following elements.

Community risk-awareness-raising workshops with community traders and bomberos. Four workshops were held with a total of 96 participants attending. Three workshops were two-day residential action planning events focusing on developing specific fire risk reduction activities within markets, whilst a fourth workshop was held over two nights for 'brigadistas' — market volunteers charged with ensuring fire requirements were met within markets

Joint training workshops for bomberos and brigadistas in risk reduction. A key component of this was the formulation of an action group with equal representation from both communities and bomberos for implementing decisions made regarding risk reduction as agreed throughout the life of the project.

Regarding developing partnerships, an independent evaluation of the project found that:

'An improvement in the relation between the two groups (bomberos and market traders) was noted. Market-holders felt that the fire-fighters were 'more accessible, friendlier and more communicative' (workshop participants). Fire-fighters mentioned that the market-traders were 'more aware, more helpful, more friendly' (fire volunteers, Station 65). The Association representatives of San Martin (fire station) explained that the fire-fighters had previously been viewed as more or less part of the municipal authority, ie. as part of authority and, given the tensions between the local authority and the markets, seen as hostile to the traders. The project had helped to break down that image and the fire-fighters were seen to be 'on our side' and supportive of the traders position vis-à-vis their possible eviction (Richmond, 1997).

The success of the fire project led to other activities, including the provision of several fire fighting and ambulance vehicles donated by the British fire services; training programmes; and the development of a fire reduction manual. There has also been a noticeable increase in local pride in the fire station, which has been subsequently renovated by the bomberos with donations from the market traders.

CASE STUDY

A working example of a public-private partnership

D. Malmquist and R. Murnane, Bermuda Biological Station for Research, Bermuda

UN RESOLUTION 44/236, adopted by the General Assembly in 1989, describes the objective, goals, and policies of the International Decade for Natural Disaster Reduction (IDNDR) (1990–2000). The overall objective of the IDNDR is to ‘reduce through concerted international action, especially in developing countries, the loss of life, property damage, and social and economic disruption’ caused by natural perils such as tropical cyclones and earthquakes.

Recognising that insurance can be an effective market-based mechanism for helping societies to meet the IDNDR objective, the Resolution identifies several goals and policy measures that relate to the insurance and financial industries. The Risk Prediction Initiative (RPI) provides a working example of a public-private partnership whose activities embody the insurance-related goals of the IDNDR resolution. The RPI is a research and educational program of the Bermuda Biological Station for Research (BBSR), a US 501(c)(3) non-profit oceanographic research facility on the mid-Atlantic island of Bermuda. The goal of the RPI is to facilitate a working relationship between climate scientists and businesses such as insurance that can benefit from climate-related information and predictions.

The RPIs inception was catalysed by the shock of Hurricane Andrew in 1992 and the consequent rapid growth of Bermuda’s catastrophe reinsurance sector. Reinsurance refers to the purchase of insurance by an insurance company. In a reinsurance transaction, a primary insurer pays a reinsurer a premium to assume a portion of its risk (Figure 1). The catastrophe reinsurers established in Bermuda and elsewhere after Hurricane Andrew specialise in the analysis of risk via the use of computerised catastrophe risk models.

The RPI was conceived in 1993 during conversations between BBSR director Tony Knap and Michael Butt, CEO of Mid Ocean Reinsurance Company Limited, a leading catastrophe reinsurer. Mr Butt showed interest in BBSR as a Bermuda charity, but wondered further whether a research institution such as BBSR could create a programme that would benefit the property-catastrophe insurance industry through a link to climate science. Acting on this suggestion, and after lengthy consultation with many different insurers, Dr Knap teamed with BBSR

scientist Tony Michaels and Dr Mark Johnson to start the RPI in 1994.

Table 1 shows the original and current RPI sponsors. Many of these companies are headquartered in Bermuda, to take advantage of its unique regulatory structure, which does not tax income from the investment of insurance capital. All of the companies conduct their business on a global scale, and focus primarily on the provision of property-catastrophe insurance and reinsurance.

This article describes the activities of the RPI as they relate to the objectives and policy measures of the 1989 IDNDR Resolution. These activities fall within three broad categories:

1. The identification and funding of insurance-relevant research efforts
2. The application of research results to the insurance industry
3. The dissemination of the methodologies employed and knowledge created during the first five years of the RPI programme.

FOSTERING SCIENCE AND ENGINEERING EFFORTS

The focus of RPI activities is determined through a continuing series of workshops (Table 2) in which insurers and invited scientists identify new directions for insurance-relevant climate research. The RPI uses funds contributed by its industry partners to support research on topics identified at the workshops. The RPI subsequently creates communication tools that translate the research results into a format that insurers can use.

The nature of the research projects that have been identified and funded during this process (Table 3) illustrates the types of scientific and engineering knowledge that RPI insurance participants find relevant and valuable to their business. The companies that have participated in the RPI constitute a diverse group of primary insurers, reinsurers, brokers, risk modellers, and technical-service providers that conduct business on a global basis. The nature of the RPI research priorities thus provides a realistic and relatively comprehensive view of where the global property-catastrophe (re)insurance industry perceives value in the creation and application of scientific and engineering knowledge.

Original Sponsors	Current Sponsors
Mid Ocean Re	XL Mid Ocean Reinsurance Company, Limited*
EXEL Limited	
Cat Limited	ACE USA Inc.**
ACE Limited	
Centre Reinsurance Corp	Zurich Group/Centre Solutions (Bermuda) Limited
The Chubb Group	
General Reinsurance Corp	General Reinsurance Corp
Renaissance Reinsurance Ltd	Renaissance Reinsurance Ltd
American International Grp	American International Grp/IPC Re
AON Corporation	
Employers Reinsurance Corp	Employers Reinsurance Corp
Terra Nova Insurance Company Limited	
Tillinghast-Towers Perrin	American Reinsurance Company

Table 1: Original and current sponsors of the RPI. The roster of RPI sponsors continually changes due to mergers, acquisitions, and a greater or lesser emphasis on catastrophe coverage among (re)insurance companies. *Mid Ocean Re merged with EXEL Limited in 1998 **Cat Limited merged with ACE Limited in 1998

1999	Hedging with Weather Derivatives European Windstorms and the North Atlantic Oscillation
1998	Transition of Tropical Cyclones to High Latitude Storms RPI Funded Research 98 Update Workshop
1997	1998 Atlantic Tropical Cyclone Forecast Workshop Theory and Prediction of Large Crises, and Hedging of Large Risks Recent Developments in Modeling and Predicting Storm Surges Windspeed Probability Workshop Windfield Dynamics of Landfalling Tropical Cyclones RPI Funded Research Update
1996	1997 Atlantic Tropical Cyclone Forecasts ENSO Forecasting, Rare Storms, and RPI Funded Research Climate Variability and Tropical Cyclone Prediction Assessing Earthquake Hazards Novel Approaches to Return Periods of Severe Hurricanes
1995	Hurricane Forecast Update Climate Prediction and Insurance Risk The Science of Complexity Statistical Forecasts of Hurricane Frequency ENSO Prediction Meeting

Table 2: Risk Prediction Initiative workshops, 1995–99

It should be noted that this perception continually changes, as the global reinsurance industry is a continually evolving enterprise. The changing roster of RPI sponsors reflects this dynamism and is illustrated in Table 1.

The workshops and research projects listed in Tables 2 and 3 show that the insurance industry currently perceives the greatest potential value in scientific research that is focused on the tropical cyclone peril. This focus reflects two separate facts. The first is the significant impact of tropical cyclones on the global reinsurance industry. Tropical cyclones are the primary cause of insured losses due to natural disasters. In the United States, tropical cyclones caused annual average damages of US\$ 1.6 billion between 1950–89, and of US\$ 6.2 billion between 1989–95 (Hebert, Jarrell, Mayfield, 1997). Hurricane Andrew, which struck south Florida and Louisiana in 1992, is the costliest storm to date, with US\$ 30 billion in total losses and US\$ 16 billion in insured losses. Other countries that experience significant tropical cyclone damages include Japan, China, Australia, Bangladesh, and numerous states in Central America and the Caribbean. Worldwide, tropical cyclone damage is about US\$ 10 billion per year, with estimates of potential losses from a single storm ranging up to US\$ 100 billion (Sheets, 1994). Levels of insured loss in these countries of course depend on the percentage of property owners that choose to purchase insurance.

Also apparent in Tables 2 and 3 is the emphasis on tropical cyclone research in the Atlantic basin. This reflects the

concentration of 35% of the world’s property-catastrophe premium volume in North America (*The Fact Book*, 1996), and the high concentration of insured property along the hurricane-prone eastern and Gulf coasts of the United States. The current focus on the Atlantic is tempered by insurers’ growing interest in the emerging insurance markets of Australia and Asia. The RPI has funded several projects whose geographic focus lies in China or the western North Pacific, or whose results are applicable across all tropical cyclone basins. The RPI has also recently begun to expand its focus to European windstorms. Between 1990–98, storms caused insurance losses of US\$ 1.2 billion per year. They rank as the second highest cause of insured catastrophe loss during this period, after US hurricanes.

The second reason that insurers have focused on funding tropical cyclone research is the disproportionate amount of US government funding already applied towards earthquake research. Even though the property damage costs of tropical cyclones equal or exceed those of earthquakes and every other type of natural catastrophe, the level of federal funding and attention applied to tropical cyclone research falls short of that put toward earthquake research. The uneven response to these comparable perils in the US reflects both the differing nature of the phenomena and the distinctive features of the respective policy communities (Birkland, 1997). Given this funding disparity, insurers generally perceive the support of tropical cyclone research as a more cost-effective use of their resources. For similar

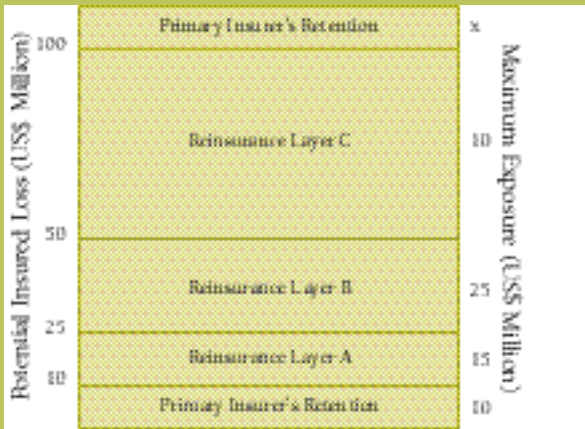


Figure 1: A typical reinsurance package acquired by a primary insurer may include multiple layers purchased from different reinsurance companies. Coverage in the higher layers (eg. Layer C) may be divided among several different reinsurers. Catastrophe reinsurance transactions typically involve a substantial deductible and a limit on total losses

reasons, most tropical cyclone work funded by the RPI represents basic scientific research, as opposed to applied engineering studies. This reflects the perception among many insurers that engineers understand how a structure responds to wind stress (and what mitigation measures will improve its response) better than climate scientists understand the structure, behaviour, and climatology of the underlying tropical cyclone peril.

APPLYING SCIENTIFIC AND
TECHNICAL KNOWLEDGE

A fundamental challenge facing the RPI is determining how to apply the results of basic scientific research to society via the insurance decision-making process. This challenge is exacerbated by the increasing dependence of the insurance industry on commercial risk-analysis models (Figure 2).

Insurers increasingly use these models for such activities as analysing portfolios, setting premiums, and allocating capital. Rating agencies have also begun to use model output to help rate a company's financial strength. Risk-analysis models have become so integral to the operation of many insurance companies that basic scientific knowledge stands little chance of being applied to the insurance decision-making process unless it can be incorporated into a model. Moreover, insurers' use of models largely dictates the type of scientific research that they find most valuable and relevant to their business.

Table 3 shows the foci of current RPI-funded research. This research focuses on projects that:

- 1. Use proxy signals to extend the documentary record of hurricane landfall
- 2. Improve hurricane landfall forecasts
- 3. Elucidate the link between tropical cyclones and climate variability
- 4. Promote development of a public risk model.

These research foci represent areas in which insurers consider that science can provide information to facilitate model usage. Close examination of one of these areas of proxy studies helps illustrate how risk models drive insurers' interest in these particular aspects of tropical cyclone research.

PROXY STUDIES

Landfall-probability estimates for rare, intense hurricanes commonly disagree among commercial risk models, sometimes by an order of magnitude. This is perhaps not surprising given the small sample size on which these estimates are based (Malmquist, 1997). For example, just two Category 5 hurricanes (with wind speeds greater than 155 miles per hour) have made landfall in the US during the approximately 100-year-long historical period.

Yet it is intense hurricane landfalls that cause the brunt of wind-generated losses to the property/catastrophe insurance industry. Between 1925–95, only 21% of all land-falling US hurricanes have been intense (with wind speeds greater than 111 miles per hour), but these storms account for more than 80% of all hurricane-generated damages (Pielke, Landsea, 1925–95).

Disagreements in intense landfall probability among different commercial risk models can significantly confound an insurance company's business decisions. Insurers who collect too little in premium or who have too little capital will fail when an event of unexpected magnitude generates losses that exceed their calculated probable maximum loss. This failure ultimately shifts the financial burden of a natural disaster to individuals or governments (Michaels, Malmquist, Knap, Close, 1997).

It is in this model-based context that proxy techniques to extend the record of intense, landfalling tropical cyclones acquire significant value. Reinsurers, in particular, perceive value in proxy studies because they conduct most of their business in the tail of the risk distribution curve (Figure 1), the realm of rare events. The RPI has thus devoted significant resources to funding research projects that use proxy evidence to extend records of intense tropical cyclone land-fall. Proxy studies are the only means of verifying risk-model predictions of the probability of these events.

Most RPI-funded proxy projects involve the study of over-wash deposits. These form when a hurricane's high waves and storm surge erode sand from a barrier island and deposit it as a layer atop the muddy floor of a normally placid coastal lake. When the storm wanes and the background rain of mud resumes, the sandy layer may be left behind as a proxy record of the passage of the tropical cyclone.

Researchers have now studied cores from numerous lakes along the US Gulf and East coasts in order to construct millennial-scale records of intense hurricane landfall (Boose, 1997 p307; Collins, submitted p365; Liu, 1993 p42; Liu, 1997 p309; Liu, 1998 p562; Liu, in press p561). Insurers can potentially use this type of data to help judge model-based landfall probabilities.

Principal Investigator	Research Institute	Title
Proxy studies of landfall probabilities		
C. Barton	US Geological Survey	Scaling laws and probabilistic forecasting of hurricanes in the Atlantic basin and at landfall locations in Florida, USA
D. Foster	Harvard University	New England historical hurricane reconstruction/pollen
K-b. Liu	Louisiana State University	Reconstructing the recurrence intervals of catastrophic hurricanes: lake and marsh sedimentary records from the Gulf Coast
K-b. Liu	Louisiana State University	Reconstructing a 1,000-year typhoon record from Chinese documentary evidence
D. Scott	Dalhousie University	Trend analysis of hurricane landfalls in the northwest Atlantic Ocean
T. Webb	Brown University	Paleoecological research on the history of hurricanes in southern New England
Tropical cyclone forecasts		
J. Elsner	Florida State University	Multi-year hurricane landfall forecasts
W. Gray	Colorado State University	Methods for multi-season predictions of U.S. hurricane landfall probability
J. Chan	City Univ. of Hong Kong	Prediction of annual tropical cyclone activity over the western North Pacific
Tropical cyclones/climate variability		
C. Landsea	NOAA-HRD	Effects of El Niño-Southern Oscillation on global tropical cyclone activity
I. Ginis	University of Rhode Island	Understanding and predicting the effects of large-scale climate variability on tropical cyclones: a numerical modelling programme
T. Barnett	Scripps Inst of Oceanography	Hurricane — ENSO relations in the tropical Pacific and Atlantic oceans
L. Druyan	Columbia University	The impact of climate change on tropical storm climatology
K. Emanuel	MIT	Hurricane climatological potential intensity maps and tables
T.N. Krishnamurti	Florida State University	Hurricane general circulation model validation
C. Penland	University of Colorado	A study of Atlantic variability using stochastic and dynamical modelling
Wind-field dynamics		
M. DeMaria	National Hurricane Centre	Development of a ten-year Atlantic basin tropical cyclone wind structure climatology
B. Harper	Systems Engineering Australia	Scoping study for a public wind-field model

Table 3: Selected research projects funded by the Risk Prediction Initiative between 1996–99

DISSEMINATING SCIENTIFIC AND
TECHNICAL KNOWLEDGE

The RPI strives to build links between insurers and climate researchers concerning scientific topics that have value to insurers. However, the RPI is not an attempt to create a consulting programme. Instead, the RPI identifies areas in which public, academic research can benefit industry, and then sponsors such research with funds donated by insurers. The public nature of the RPI has been critical to the programmes success, as it allows RPI-funded researchers to fulfil their academic responsibility to publish, and also guarantees high quality work via scientific peer-review. RPI insurance sponsors benefit from public research through their ability to help determine research directions, and their access to preliminary results during the course of the research projects.

CONCLUSION

Participation in the RPI provides climate scientists with funding and intellectual support for their work, and helps clarify how they can maximise the utility of their research to a business audience and to society. Insurers enhance their business via access to more accurate predictions of future hazards and catastrophes, and by gaining a better understanding of the science behind the predictions. Society benefits via access to more accurate and relevant data on risk probability, and better informed response and

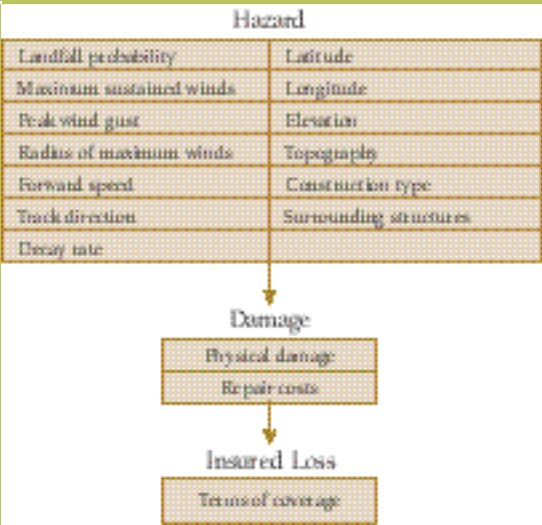
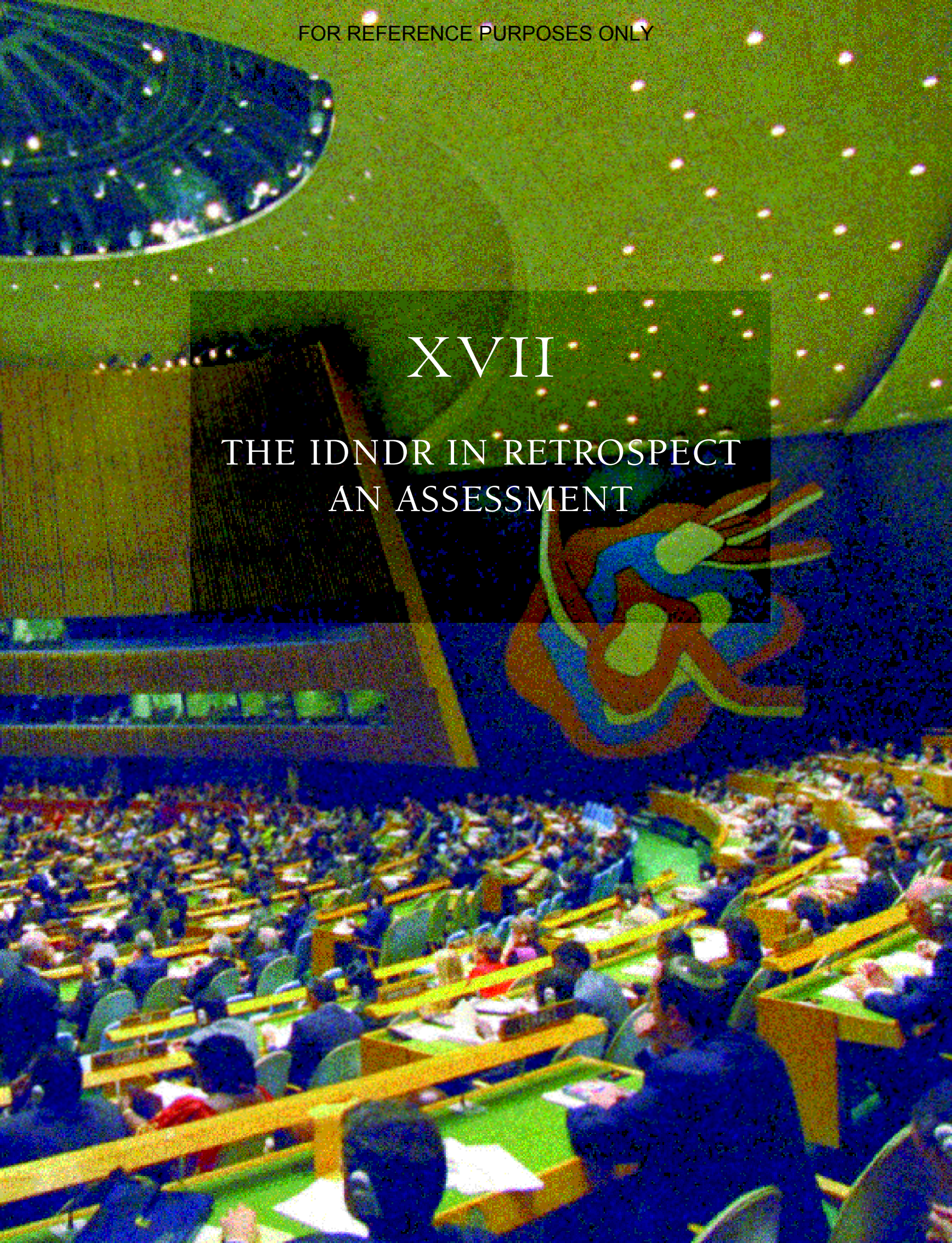


Figure 2: Risk-analysis models typically comprise three components. In a wind model, the hazard component estimates the probability that a storm of a given intensity will strike a specified area. The damage component translates the wind speed at the structure into an estimate of physical damage. The insured-loss component applies specific coverage terms to the damage estimate

recovery efforts. By providing a means to foster, apply, and disseminate scientific knowledge related to natural disaster assessment and mitigation, the RPI affords a heuristic example of a public-private partnership that continues to address the goals of the IDNDR charter.

XVII

THE IDNDR IN RETROSPECT AN ASSESSMENT



KEYNOTE PAPER

THE IDNDR IN PERSPECTIVE

Walter Hays, United States Geological Survey, USA

WHERE WERE WE TEN YEARS AGO? I believe that the IDNDR was a good idea that was an appropriate initiative for the 1990s. In hindsight, however, few nations had policy makers and stakeholders ten years ago who knew how to change their natural disaster reduction culture and make natural disaster reduction a national and worldwide public value, the goal envisioned by those who developed the concept of the IDNDR prior to 1990¹.

Ten years ago, the implementation process for the IDNDR was just getting underway in over one hundred nations as a result of the unprecedented United Nations resolution adopted unanimously in December 1989 by delegates of one hundred fifty-five nations to the forty-fourth General Assembly. National organisations, or designated national entities, were being formed of stakeholders, encompassing insurers, reinsurers, business, industrial organisations, utility companies, academic organisations, health care organisations, volunteer organisations, architectural and engineering firms, and public and private-sector professionals. Their mandate was to create an innovative national programme and to seek ways to devise and implement cost-effective changes in existing public policies that would cut the trend of increasing economic losses, mortality and morbidity from natural hazards and make natural disaster reduction a public value. Programme objectives were being framed in terms of two broad questions integrating research and public policy considerations. They are:

‘What are Planet Earth’s impacts on us?’

‘What can we do to reduce Planet Earth’s impacts?’

The United Nations resolution provided every nation with two choices for coping with natural hazards having atmospheric, geologic, hydrologic, and biological origins. The first choice — to participate in the IDNDR — was an explicit commitment of the participating nation to change its natural disaster reduction culture. The kinds of changes that were envisioned included:

- Changing from mostly basic research to a mix of basic and applied research

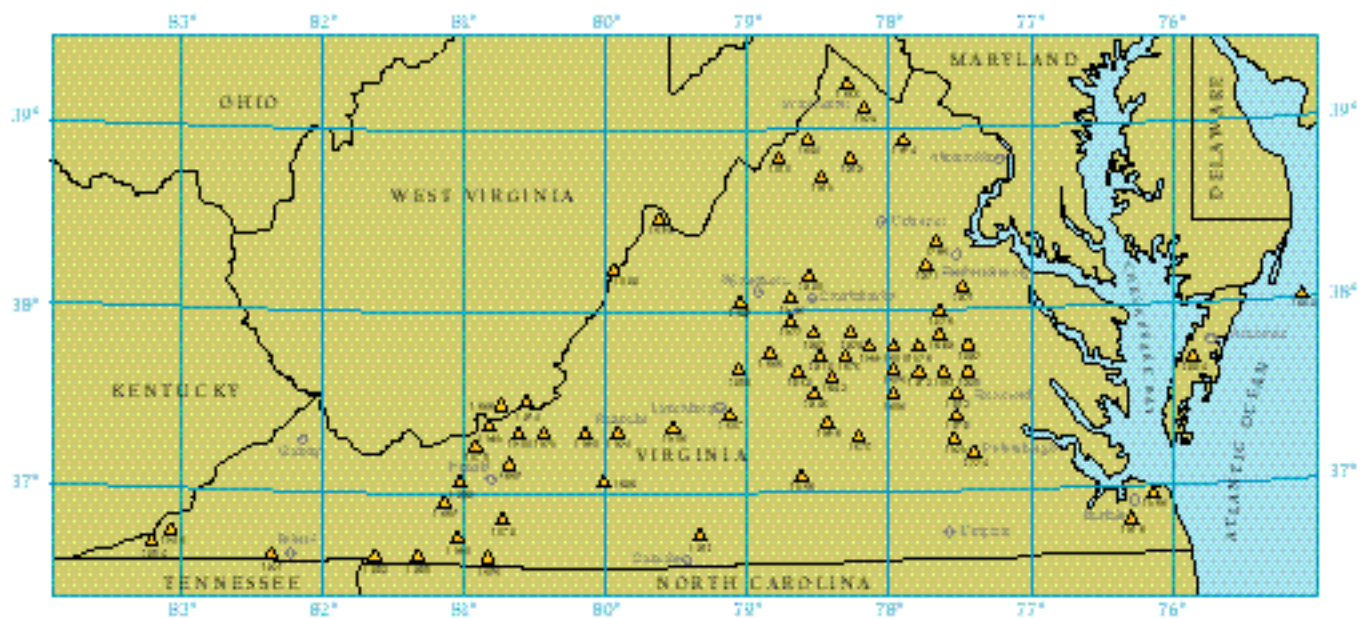
- Using the existing body of science, technology, and traditional knowledge to form and underpin public policy initiatives
- Changing from fragmented programmes on single natural hazards to integrated programmes on all natural hazards
- Changing from individual efforts to partnerships
- Changing from random or ad hoc planning to strategic planning
- Changing from reaction (ie. response and recovery) to anticipation (ie. mitigation and preparedness).

The IDNDR Secretariat’s Scientific and Technical Committee served as a catalyst for change when it established the following goal for all participating nations: ‘By the year 2000, every nation should conduct a national risk assessment, initiate a national mitigation strategy, and develop improved capability for monitoring, forecasting, and warning’.

The second choice — to maintain the status quo on natural disaster reduction — was also a commitment, but in this case to a default public policy that would allow well-known flaws in planning, site selection, design, construction, and use of the built environment in every community of every nation to continue unabated into the 21st Century (*IDNDR*, 1997). These flaws in the built environment were present in every nation and represented policy failures. They were, and still are, the root causes of urban and social vulnerability, and undoubtedly contributed to the unprecedented number of natural disasters throughout the world in the 1990s.

Barriers to achieving the goal of the IDNDR

Although the IDNDR was right for the 1990s, the process of effecting major changes in each nation’s disaster reduction culture



Map: Department of the Interior, United States Geological Survey

and forging bilateral and multilateral international co-operation, especially with developing nations, created difficulties that had not been envisioned by the framers of the United Nations resolution. Policy makers and stakeholders of all nations found:

- No legal or societal mandate from the citizens and stakeholders to evaluate existing research and research applications programmes, plans, and public policies and to make major changes in the natural disaster reduction culture
- A lack of overall understanding of the complex inter-relationships between the hazard, built, and policy environments of their nation
- A lack of technical capacity to conduct a national risk assessment (Figure 1, page 278)
- A lack of technical capacity to develop improved monitoring, forecasting, and warning systems
- A lack of political will to initiate a national mitigation strategy
- Existing science, technology, and traditional knowledge were not enough to effect these kinds of major changes in their natural disaster reduction culture.

The process of enacting, adopting, and implementing cost-effective public policy for natural disaster reduction requires a long-term effort to balance the nation's social, technical, administrative, political, legal, and economic factors (ie. the STAPLE factors, Figure 2, page 278), and each of these interrelated factors is difficult to evaluate, quantify, and change (Petak, 1984).

Where are we now

The IDNDR is ending, but the urgent worldwide need to make natural disaster reduction a public value remains as a challenge for the 21st Century. I believe that many nations were able to make significant changes in their natural disaster reduction culture during the 1990s and to initiate a number of important works in progress. Table 1 (page 279) lists some of these works in progress as examples of what can be done. The unprecedented number of natural disasters throughout the world and the difficulties experienced by each nation in changing their disaster reduction culture indicate that no nation was able to accomplish

their goal completely. These difficulties were directly related to the inability of policy makers and stakeholders to change their STAPLE factors (Petak, 1984). Each of these dynamic factors change with circumstances, place, time and control each nation's (and each community's) natural disaster reduction culture.

As the nations of the world stand on the threshold of the 21st Century, the bad news is that natural disaster reduction and global change (Houghton et al, 1995) are urgent challenges. The first challenge was also the main challenge for the 1990s that still urgently needs attention in the 21st Century, and the second is the emerging challenge for the next century and beyond. The goal for every nation during the 21st Century is to make natural disaster reduction and reduction of greenhouse gases, the primary cause of global change, public values.

Natural disaster reduction and reduction of greenhouse gases are urgent national and international goals in the 21st Century for two primary reasons: The world's population is growing rapidly and projected to grow from six billion in 2000 to approximately eight billion by 2025 (IDNDR, 1997). This high rate of growth is exacerbating the risk associated with natural hazards and greenhouse gases.

Cities are expanding and developing rapidly in locations that are well known to be susceptible to natural disasters:

- Close to the water's edge
- On unstable slopes
- In the flood plain of rivers
- In or adjacent to an active fault zone
- On soft and/or unstable soil
- On the flanks of an active volcano
- Near an urban-wilderness interface.

Land-use patterns are being altered as forests are cleared and burned in order to make more land available for agriculture to feed the populace.

Simultaneously with the rapid growth of cities, greenhouse gases (eg. water vapour, carbon dioxide, methane, nitrous oxide, and ozone), now recognised as the primary cause of global change, are increasing. Emitted from energy consumption and

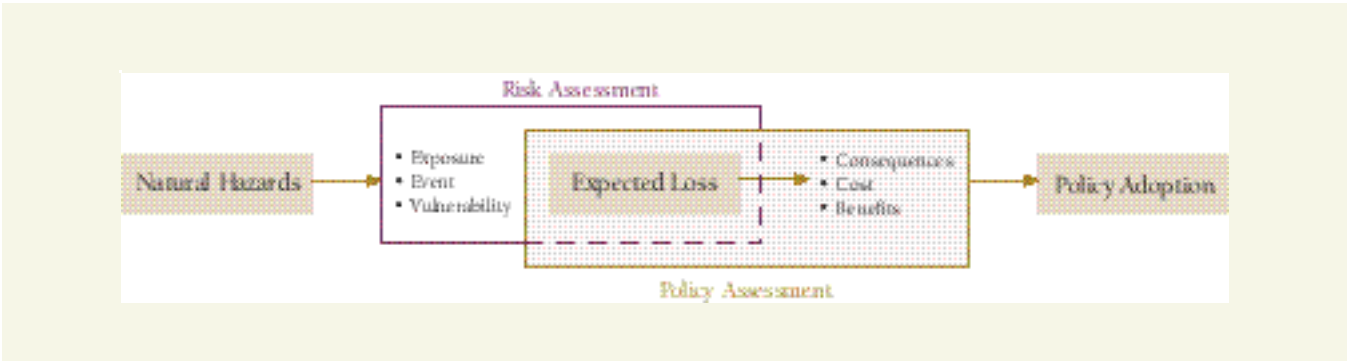


Figure 1: Schematic illustration of the science, technology, and fundamental knowledge needed for a risk assessment

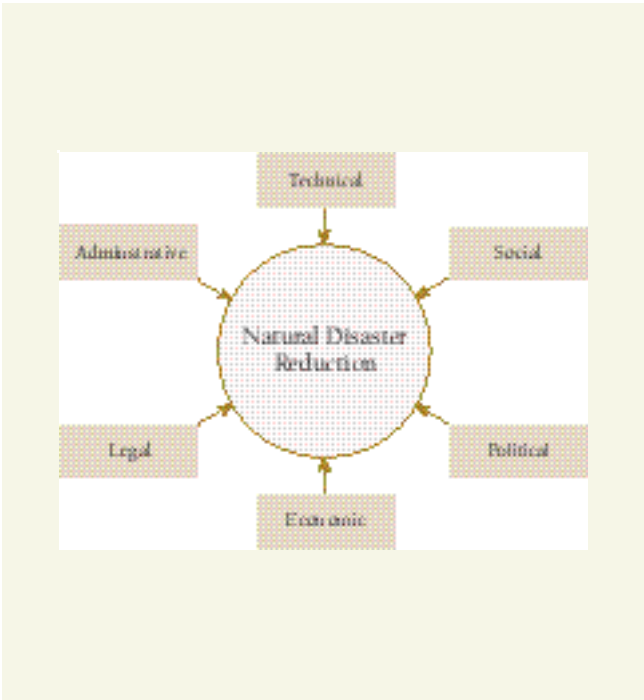


Figure 2: Schematic illustration of the dynamic STAPLE factors that control the natural disaster culture in every nation and community

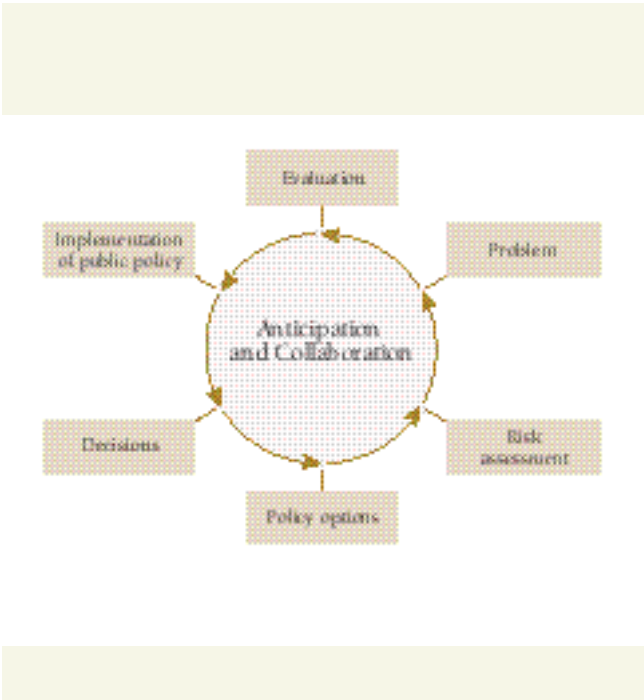


Figure 3: Schematic illustration of a long-term process that policy makers and stakeholders of every nation can follow in the 21st Century to deal with the challenges of natural disaster reduction and global change

other activities in each nation, greenhouse gases are being carried around the world within a few weeks by atmospheric winds, trapping heat near the Earth’s surface, changing the heat patterns of the Earth, and contributing significantly to global change.

Because natural disaster reduction and global change are inter-related; policy makers and stakeholders of every nation can accelerate the process of framing their national, bilateral, and multilateral international programmes by identifying the national and community STAPLE factors that need to be changed. The following two linked questions frame the challenge:

‘What are Planet Earth’s impacts on us?’ and
‘What can we do to reduce these escalating impacts?’
and
‘What are we doing to Planet Earth?’ and
‘What can we do to reduce our impacts on Planet Earth?’

A long-term process (Figure 3) is needed to achieve this urgent and ambitious goal. Because of the experience gained during the

IDNDR, each nation can benefit from the lessons learned during the 1990s as it deals with the barriers that still must be overcome. Policy makers and stakeholders in each nation need to start framing a long-term, holistic programme and strategic plan to deal with these two urgent problems now. The overwhelming balance of evidence and scientific opinion is that:

- The cost and societal impacts of natural disasters are on the increase
- Global change is underway, but the costs and societal impacts are unknown
- Human activity is exacerbating natural disasters and global change, and influencing some of the natural disaster agents such as the severity, intensity, and extremes of precipitation, and the spatial and temporal nature and distribution of ambient stresses, increasing the potential for hydrologic and geological hazards.

The dilemma for scientists and policy makers is that forecasts of future natural disasters and global change are both imperfect,

Important new works in progress

1. Improved strategic planning	7. Improved capacity for risk assessment
2. Assessment of natural hazards research in the past 20 years	8. Improved capacity to reduce vulnerability of cities/megacities
3. Improved use of existing science, technology, and traditional knowledge	9. Creation of public-private partnerships
4. Improved mitigation and preparedness strategies	10. Improved capacity for international co-operation on research and policy
5. Improved post-disaster studies	11. Creation of a global disaster information network
6. Improved hazard maps	12. Better international capacity for linking risk assessment and management

Table 1: Examples of important new works in progress initiated during the IDNDR

General status

What was planet earth doing to us before 1990?

Economic losses, mortality, and morbidity from floods, severe storms, earthquakes, landslides, volcanic eruptions, wildfires, droughts, and tsunamis were increasing with time in almost every nation. The principal causes were rapidly increasing populations concentrated in cities and megacities having vulnerable buildings and infrastructure that were being sited, designed, and constructed in hazard-prone areas without a comprehensive consideration of the risk.

What were we doing to reduce these effects before 1990?

1. Strategic planning was rare, and implementation of plans varied widely.
2. The concept of Public-private partnerships existed, but individual efforts dominated.
3. Research was fragmented and focused on single natural hazards, seldom on all natural hazards or on implementation of research.
4. The existing body of science, technology, and traditional knowledge was not widely used to form and underpin public policy. Research applications lagged behind research.
5. International programmes existed, but most were short term, bilateral activities.
6. Public policy for risk management focused mainly on reaction strategies (ie. emergency response), not on anticipation strategies (ie. mitigation and preparedness).

General status of plans, programmes, and public policies ten years ago

causing a wide range of scientific opinion on precisely what the potential impacts are, what they can be, and how to anticipate, prevent, mitigate, and prepare for them. The dilemma for policy makers and stakeholders in each nation will remain the same next century as during the IDNDR; namely how to motivate all sectors of their public to support policies that require investment of immediate resources that each nation needs for a range of other high priority social problems. Continued rapid urbanisation, without consideration of the adverse impacts of natural hazards, and increasing greenhouse gases, without consideration of the potential impact of climate change and the environment, are problems that have long-term policy implications. They are also so controversial in political and scientific circles that neither scientists nor policy makers are likely to know for certain if they are on the right track for decades or possibly a century.

To add to the dilemma, there is now a growing sense of urgency that at some point in time, it may be too late for some nations to reverse the adverse trends in human behaviour and human

activity now thought to be exacerbating natural disasters and global change.

I believe that policy makers and stakeholders of the over one hundred nations that participated in the IDNDR are much better prepared because of their experiences and the networks of co-operating organisations they formed than those nations that did not participate in the IDNDR. The verdict is still out on the success or failure of the IDNDR because of the inherent difficulty in measuring the benefit/cost of works in progress such as those shown in Table 1. It may be impossible, in fact, to change the natural disaster reduction culture of a nation in ways that are meaningful, or even to quantify the impacts of any changes actually made.

Footnote

1. Three papers were particularly important in the development of the IDNDR concept — National Research Council (1987), Housner (1989) and United Nations (1989).

Progress and challenges in reducing losses from natural disasters

William Hooke, National Science and Technology Council, USA

THE CONCLUSION of the United Nations' International Decade for Natural Disaster Reduction (IDNDR) provides an important opportunity for agencies of the United States federal government to take stock. Where does the nation stand with respect to this important challenge? What have been the major accomplishments of the Decade? What are prospects for the future? What work remains to be done? The National Science and Technology Council's Committee on the Environment and Natural Resources/Subcommittee for Natural Disaster Reduction (SNDR) brings together nineteen federal agencies to address these and related questions.

The entire premise of the Decade is that so-called natural disasters are primarily social in origin. Earthquakes, storms, floods, drought, and other geophysical extremes are inevitable. Furthermore, many of these extremes confer benefits as well as pose a hazard. For example, many ecosystems have adapted to occasional wildfire, favoured by drought; pyrophytic species in these ecosystems actually require fire for proper germination. Riverine habitats and ecosystems are often dependent upon annual floods, to such an extent that the US Department of the Interior has begun to reintroduce such flooding into the environment downstream of the Glen Canyon Dam.

By contrast, disasters — disruptions of entire communities, persisting after the hazard has come and gone, and exceeding the communities' ability to recover unaided — reflect the ways societies do business. They result from decisions and policies with respect to land use, engineering practice, ecosystem management, and social institutions and frameworks.

As a result, disasters are evolving rapidly in response to major changes in our society — mutating in response to population increase, economic growth, the globalisation of commerce, technology advance, and other trends now underway worldwide. The multi-disciplinary suite of activities known collectively as 'natural disaster reduction' are barely keeping pace. The 1990s have seen a shift in US national policy on natural disasters — a move away from primary reliance on emergency response and reconstruction after an event and toward greater emphasis on pre-event mitigation measures. Over time, the consequences of this change in approach could prove profound.

Economic losses continue to rise for several reasons, each of which is likely to continue in the near term:

- A simple rise in value of assets in harm's way, as a result of population increase and economic growth
- Increasing use of hazardous lands (coastal zones, fault zones, flood plains, unstable slopes, fire vulnerability, etc) in response to both population pressure and demographic preferences
- A continuing failure to use best seismic, wind, fire and flood mitigation and engineering practice. Nations and private enterprise are beginning to take steps to reduce vulnerability, especially in new construction. However, a huge amount of existing

construction has taken place in an unsafe manner, in dangerous locations, and has yet to prove it can withstand a major hazard

- A growing shift in the economic losses from property damage *per se* to associated business disruption. This occurs as both developed and developing societies become increasingly dependent on critical infrastructure that is introducing new vulnerabilities to hazards. Today, the direct costs of repairing road damage, restoring power to regional electrical grids and reinstating disrupted water supplies are often small compared with the losses due to business stoppages while these repairs are being made. The problem is often aggravated because these systems are interdependent and because our society works unceasingly to reduce inventories in favour of 'just-in-time' practices. These problems are particularly acute in the world's megacities, where rapid population influx combines with fragile infrastructure and a lack of the supportive, co-ordinated social systems that characterise more stable nation states to produce unprecedented vulnerabilities. These realities virtually guarantee increasing human and economic losses for decades to come.

IDNDR Targets

Early on, the IDNDR Scientific and Technical Committee responsible for co-ordinating international efforts established three targets. They challenged each nation, in the context of its plans for sustainable development, to:

- Identify hazards and assess risk
- To develop and implement mitigation plans
- Implement regional warning and dissemination systems.

Over the past decade, the United States has made substantial progress with respect to each of these three targets. Not all of the effort has stemmed directly from the Decade *per se*. Much was the culmination of actions already underway. In fact, it might be argued that the role of a Decade should not be so much the redirection of energy away from previously existing efforts but rather the acceleration or increased emphasis on actions and policies that already make sense, independently of any named 'decade'.

The Federal Emergency Management Agency (FEMA) has made hazard identification and risk assessment the starting point for the National Mitigation Strategy. FEMA has worked with the National Institute for Building Sciences to develop HAZards US (HAZUS), a GIS-based computer programme to estimate earthquake losses. HAZUS methodology is already being used in the San Francisco Bay and greater New York City areas. Several communities from the Central US Earthquake Consortium (CUSEC) have created HAZUS user groups that bring together state emergency managers and GIS experts. FEMA is currently generalising the software to incorporate hydrometeorological hazards. Training in the use of HAZUS is available for state and local officials. The US Department of Agriculture (USDA) and the



Photo: Superstock

The San Francisco earthquake in California in 1906 caused widespread devastation

Department of the Interior (DOI) are together building corresponding risk assessment capabilities with respect to fire.

During the 1990s, a number of private-sector firms have developed proprietary software for hazard identification and risk assessment. Some of the models are quite detailed, involving quite specific characterisation of the geophysical event and high resolution models of building construction and type. These have been used to provide vulnerability assessments for specific events in specific locations such as, for example, a repeat of the San Francisco earthquake of 1906 (above) or an earthquake along the Hayward Fault, a repeat of worst-case Los Angeles or New Madrid earthquakes, or worst-case hurricane events in New Orleans, Miami, or New York City. Several scenarios imply losses in the US\$ 100 billion range for individual events, in some cases approaching US\$ 250 billion. The insurance and re-insurance industries have been major customers for the information because the models are proprietary and are increasingly sophisticated, test and evaluation have become a serious and contentious issue.

During the Decade, more than 100 experts from many institutions and disciplines, under the leadership of the Natural Hazard Research and Applications Information Center (NHRAIC) at the University of Colorado, have worked for more than five years to conduct a Second Research Assessment. (This updates the First Research Assessment, carried out more than two decades ago). The assessment attempts to pull together, in one summary document, what is known about the evolving nature and causes of natural disasters. The overall assessment is that by and large, most of the roots of natural disasters are not geophysical or even engineering, but rather societal in origin. Furthermore, decisions

with respect to natural disaster reduction cannot be made in isolation but must be made in a larger context of sustainable development and other societal goals. As the assessment's title, *Disaster by Design: A Re-assessment of Natural Hazards in the United States*, suggests, the authors conclude that disasters cannot be so much avoided as simply shaped, a kind of 'choose your poison' option that helps us understand why many past mitigation policies (eg. fire suppression, dam and levee-building) have not eliminated hazard or vulnerability but rather simply exchanged a profile of many small disasters for fewer, more costly ones.

During the IDNDR, the United States has begun a shift in policy emphasis from primary reliance on emergency response and reconstruction to increasing pre-event efforts to mitigate the impacts of hazards. Early in the Clinton Administration, FEMA conducted a series of 'town meetings' in each of its regions and developed in co-operation with state and local emergency management officials and others a National Mitigation Strategy as part of the IDNDR to cover:

- Hazard identification and risk assessment
- Research application and technology transfer
- Information and data access
- Resources and incentives
- Leadership and co-ordination.

As its instrument for working with state and local governments as well as private enterprise to achieve the ends of the National Mitigation Strategy, FEMA conceived and implemented Project Impact, which is explained further in Chapter 13. Other communities are beginning to take corresponding actions, even without



Photo: Tony Stone Images

Firefighters watching a forest fire in Yellowstone National Park, Wyoming, USA

federal funding. Similarly, USDA and DoI are working changes in national policy with respect to forest fire and fuels management.

Throughout the 1990s, the United States has taken steps that provide an extraordinary improvement in its ability to forecast and warn of coming hazards. The National Weather Service has undergone modernisation and associated restructuring, resulting in improved weather warnings and forecasts on time scales ranging from tornado forecasts of a few minutes to hurricane land-falls of a day or so to severe winter storm forecasts out to a week or more. In addition, the United States has worked with other nations to deploy and operate a global network of buoys to monitor the ocean changes responsible for triggering El Niño, La Niña, and related seasonal to inter-annual changes in the patterns of severe weather worldwide. As a result, the world enjoys its earliest and best warnings to date of such events.

The United States has worked with other nations to provide new insights into changes in conditions that can be reasonably expected over periods of decades to a century. Through the Global Disaster Information Network initiative, led by Vice President Gore, the United States is beginning to integrate national technical

means with other satellite and information processing assets to provide wholly new capabilities for damage assessment and emergency response. US agencies (FAA, NASA, NOAA and USGS) have also instituted an operational capability for alerting aircraft to the presence of volcanic ash plumes.

The federal government has made great strides during the decade to improve its ability to partner with the private sector. By far the most important example has been Project Impact. Additionally, the SNDR has worked in conjunction with the property and casualty insurers and reinsurers through the Institute for Business and Home Safety (IBHS) to establish the Public Private Partnership 2000.

The United States has also worked bilaterally and multilaterally with other governments to reduce natural disasters. Following the Kobe earthquake, under the Common Agenda for Co-operation in Global Perspective, the United States and Japan have initiated a series of Earthquake Policy Symposia and Forums. These meetings enable participants to share and develop common insights into earthquake research, disaster prevention, emergency response, and long-term recovery and reconstruction.

The United States and China conducted a bilateral natural disaster reduction workshop in November 1997 and initiated a number of follow-up measures. The US and China continued their successful research collaboration under the US/PRC Protocol for Scientific and Co-operative Research on Earthquake Studies, Earthquake Engineering and Hazard Mitigation. The United States and Indonesia co-operate with respect to forest fire management and related research. These are but a few examples in an extensive list. Success is challenging, but nonetheless likely, with respect to:

Warning and emergency response: Thanks to the great investments being made by the United States and other nations, improvements in forecasting the hydrometeorological events are likely to continue over the next few decades. Furthermore, because of the investments in information infrastructure, the emergency response environment is likely to be transformed from one that is currently information-poor to one that will be increasingly information-rich.

Insurance and other mechanisms for spreading risk/loss: Alarm over the likely size and scope of impending natural disasters has prompted insurers to take action on a broad range of fronts. They are actively creating new mechanisms such as catastrophe bonds for securitising risk. They are seeking Congressional relief from taxation of contingency reserves, and seeking to formalise government's role as a reinsurer of last resort. The Administration is considering whether and how to provide for federal intervention in reinsurance markets for natural disasters, while adhering to common-sense principles that any such intrusions should not displace private initiative or impose a cost on taxpayers.

Information access: Not only on mitigation measures in general but also in regard to best practice. Taken together, Project Impact and investments in information infrastructure promise greater future availability of information on pre-event disaster mitigation best practice at the local community and free enterprise level where it is most needed.

Success is possible, but more problematic with respect to:

Public awareness: There is no question that media attention of the past few years has heightened public interest in and awareness of natural disasters. The question is whether and how this enhanced media coverage will translate into greater public support for pre-event mitigation measures in the face of competing demands for attention and for resources.

Sustained, meaningful implementation: of pre-event mitigation measures and their concomitant financing. Again, a broad range of pre-event mitigation measures are demonstrably effective, but the financing of such measures, and steps by government and industry (eg. the financial sector) to provide incentives, may prove more difficult to implement in practice.

With respect to continued international co-operation: The fall 1998 Atlantic hurricane season, and Hurricanes George and Mitch in particular, drove home the point that current international efforts to mitigate natural disasters, and to incorporate disaster risk in international investment, remain far below what is desirable. In this case, for example, dramatic decreases in loss of life for US hurricanes reflects improved forecasting capability plus communications plus planning. This same level of attention and support is needed internationally.

Success is unlikely without new national and international emphasis with respect to:

Newly emerging hazards: These include but are not limited to the technological hazards resulting from otherwise natural extreme events, and other, closely related hazards such as terror-

ism, particularly with respect to the use of chemical, biological, and nuclear agents of mass destruction.

The vulnerabilities of critical infrastructure: to natural hazards, especially at the systems performance level. Not enough is known about the performance of particular structures such as buildings, bridges, power generating plants, water treatment plants, and the like with respect to a variety of natural threats. Far less is known, however, about the performance of these infrastructures as a whole with respect to natural extremes. For example, no individual roadway was directly lost to the Florida forest fires of this past year, but it was necessary to shut down Interstate 95 with a resulting disruption of Florida commerce and tourism. Many homes were lost, but many more could not be occupied because of the disruption in access and critical support services. The effects of the January 1998 ice storm on the electrical networks of the Northeast were largely unanticipated. New vulnerabilities associated with cyber infrastructure, and particularly with regard to the increasing control of other infrastructures such as communications, electricity, gas, water, sewage, and transportation by cyber infrastructure, remain uncharted and potentially threatening to an unprecedented degree. If nothing else, such technological change transforms the nature of economic loss from actual property damage to economic disruption.

The emergence of megacities: Simply put, megacities can be viewed as 'job shops' competing for global business and work. Like all job shops, they must attempt to keep wages and overheads low. At the urban level, this implies inattention to environmental protection, overcrowding, fewer resources and more responsibilities, greater fragility of infrastructure, even in the absence of hazards, and greater recovery problems following disasters.

Equity issues: To the extent that most natural disasters are indeed social in origin, it also follows, as experts agree, that their burden falls disproportionately on those already most economically disadvantaged, both on an international level, where LDCs face greater risk than their developed counterparts, and domestically. The poor within each society are forced to live in sub-standard structures on more dangerous land, and have fewer resources to lessen their own risk and vulnerability. Just as these issues remain at the heart of the overall sustainable development challenge, they find themselves at the root of efforts to reduce natural disasters.

Because natural disasters have their roots in societal causes, and today's rates of population increase, economic growth, and technological advance are rapid and unprecedented, disasters are evolving rapidly in response. Scientific understanding and engineering practice may not be keeping up; furthermore, the application of scientific knowledge and best practice engineering and ecosystem management are lagging. Specific problems may occur in the science of loss estimation, social analysis, and the resolute unpredictability of geophysical hazards, the pace of engineering advance and its implementation in practice, the interaction of wild and managed ecosystems with extreme events, the performance and vulnerability of critical infrastructures and the interaction of these threats with technological hazards and with willful threats such as terrorism.

All these realities speak to the importance of continued, multi-disciplinary scientific and engineering attention to natural disaster reduction in the decades ahead. Improved science must be accompanied by other efforts to make natural disaster reduction an public value, for sustained, committed emphasis on mitigation planning and implementation and expanded partnerships between the public and private sector.

A Decade of Missed Opportunities?

Professor Gilbert White, University of Colorado, USA

A LONG WITH the main programmes and accomplishments of the Decade, attention should be directed to what was not done and, therefore, to what should be considered for the future. It is important that lost opportunities be recognised and that inadequacies in both planning and execution be noted in thinking of next steps to lessen social losses due to disasters. This analysis focuses not on administration of approved programmes but on opportunities missed. The general conclusions are that there is not yet a solid basis for assessment of what happened as a result of Decade activities, and that there was little attention to several promising lines of action.

An effort as ambitious and complex as the IDNDR is difficult to appraise until all of its facets and products have been reported thoroughly, but on the basis of information readily available to this observer early in its final year there appear to be at least four highly promising opportunities that the Decade largely missed. These are: specifying the relevant lessons from preceding international decades and programmes; measuring the benefits from its major efforts at changing vulnerability of specific areas to disasters; estimating the benefits from other possible efforts with similar aims; and setting up a consistent international system for estimating the costs and benefits from extreme natural events worldwide. Other observers might well suggest other opportunities that were neglected.

Appraisal of previous decades

It would have been useful to all participants in the IDNDR if they could have been provided early in their efforts with a description and accompanying appraisal of how previous international decades under the United Nations' auspices had operated and what tangible results those efforts had yielded. The Development Decade and the Decade for Water Supply and Sanitation could have served as examples of what had been done. Neither of those had been conspicuously fruitful. There had been other similar efforts to foster global collaboration on widespread problems. It would have been challenging to IDNDR collaborators to have summaries of what appeared for those ventures to be causes of their success or of their failure to achieve higher influence on worldwide activities.

Estimating benefits from programme efforts to change vulnerability

It would have been useful from the beginning to establish procedures for careful appraisal of samples of the actual results of the various Decade programmes. The Decade has yielded details on committees organised, research initiated, reports published and events sponsored. It has not provided careful assessments of precisely what were the effects of those activities in hazardous areas. In what ways and to what extent was the property, activity and population liable to disaster altered? If there was no significant effect from a mapping programme, for example, why not? What were fruitful results from a combination of early research and information programmes? Did information programmes make

a significant difference? Did land use in typical areas change significantly? Why? If not, why not? How was the quality of life altered in both rural and urban areas?

While there is an abundance of information about programmes, such as that in reports from the Scientific and Technical Committee or from national committees, there is very little about observable consequences on the ground.

This should be no surprise. We know that although an administrator, such as the head of a development programme, may issue instructions regarding a new policy with respect to hazard mitigation, there rarely is any public report on the practical results of such directives. There is careful description of what was planned and what it cost in money and time, but not of the consequences in the hazard area. For example, when the United States government considered a 1966 report recommending the first national programme for insurance against losses from floods it accepted the proposal in 1968 and began expending large sums for mapping and indemnity, but it never acted on the recommendation that the efforts be assessed in sample areas after a few years to see whether or not they had been counter-productive. Yet only now is the government exploring such comprehensive appraisals.

Possibly one negative effect of the Decade effort is that its emphasis may have led key public officials to feel that in promoting the agreed co-operative scientific and technical programmes, they were making genuine progress in dealing with hazards. Thereby, they may have neglected other more positive prevention and mitigation measures. Lacking thoughtful assessment of representative programmes, it has been difficult to know if the net effects have been positive or negative.

It would not have been necessary to delay such audits until the end of the Decade—they could have been undertaken promptly on samples of programmes already under way in some place or they could have been initiated on pilot new programmes in suitable areas. Thus, there could have been early evaluation of the likely impacts of major approved efforts.

Estimating benefits from other proposed programmes

Before and during the Decade there could have been judicious testing of samples of programmes that had been proposed but not adopted, thus promoting further flexibility. The strong inclination to pursue only activities that had been mentioned positively in the early Decade planning fostered caution in later innovation and made it difficult for new staff members, however innovative, and newly participating agencies to contribute beneficial ideas after the programmes were first launched.

A conspicuous example of neglect of possible opportunities was offered by a task force appointed in 1986 by a branch of the US National Research Council to draft a possible programme for the proposed Decade. It suggested that a promising approach might be to try to involve every community school on the globe in canvassing a) natural disasters to which it might be susceptible, and b) possible mitigating measures the community might



Photo: Tony Stone Images

Abandoned farm vehicles in the Mid-West, USA

adopt, drawing upon the best scientific evidence and technical advice that could be provided by local and national agencies in its area. The aim was to be to involve responsible local citizens and groups in thinking about and organising constructive action in their community. The emphasis was to be on appraising ways of meeting local demand rather than initially organising the supply of national skills. It was to be demand-driven, not supply-driven, and was to focus initially on the needs of local groups. This proposal was not approved. It led to the task force and its staff member being dismissed, and to the appointment of a new group that later recommended a programme similar to that initially adopted by the Decade.

After that new group proposed its programme, there was some criticism by observers such as Mitchell (1988) who argued that the emphasis was unduly on physical science and engineering contributions and tended to ignore the problems raised by economic development and population growth. The alternate approach was never subjected to trial, and although a few activities, such as experimentation with design of school buildings in parts of Latin America, showed promise they did not become the basis for wider application.

Likewise, the argument by some experts that programmes suited to regions with extreme natural events such as Europe were not suited to regions, such as parts of Africa with more disperse, longer-lasting events like droughts, was not considered. The significance of such differences could have been examined in sample areas without initially trying to alter the global programmes.

The Yokohama mid-Decade Conference offered an opportunity to examine problems of this nature, however it led to few major

alterations in the previously accepted programme. Many national and regional agencies continued their established activities that were then labelled as contributing to the general goals of the Decade.

The lack of an adequate measure of disaster effects

In considering the aims and scope of activities undertaken during the Decade, it is important to recognise that an essential aspect is the concrete effect of those measures on the actual risk from natural hazards as measured by the number of people and areas affected, either local or regional. There is little gain to the world's population if the stated purpose and activities do not lead to basic improvements on the ground. One major device for judging those effects is the estimation of the full social, economic, and environmental costs and benefits of so-called natural disasters.

When a United States scientific committee enthusiastically predicted in 1987 that the proposed Decade measures would reduce losses from natural disasters by at least one half by the year 2000, it was patently optimistic. However, the sad fact is that by the end of the Decade there still were no adequate, agreed criteria and methodology in place for calculating losses and benefits in all areas. Thus, while Munich Reinsurance had mutually consistent criteria for calculating losses, those criteria were not applied uniformly by all insurance companies or public relief and engineering agencies in all countries. While a few thoughtful attempts were made to improve criteria, they were not adopted widely. The published data on property and indirect economic losses are at best only partial. Estimates of loss of life were considered relatively accurate and comparable in some quarters but were viewed with major doubt by some observers.

By the end of the Decade there is no generally-accepted set of criteria for calculating the losses resulting from extreme natural events. Nor is there an agreed system for estimating the social and environmental benefits from such events. It would be desirable if relatively uniform criteria and methods were to be used around the world. These still are lacking. As a result, when time series or regional comparisons are presented, there remains serious doubt as to how much they reflect differing criteria over time and space.

A number of other possible activities might have been considered and have been described in such sources as geography text books on national hazards. This paper, in suggesting a few major opportunities, does not attempt to list all that have been identified.

Summary

Had the opportunities noted above been grasped early in its life, the Decade results might have been significantly different. As a minimum, there would have been knowledge of lessons from earlier decades and of what the Decade had accomplished in changing vulnerability to natural hazards in selected areas. There also might have been a more solid basis for dismissing some proposed projects or for trying others. A continuing system for estimating the social and environmental effects of extreme events on a solid, consistent basis might have been established.

Just as it still is difficult to measure the actual achievements of the Decade, it is even more troublesome to estimate with any accuracy what it might have accomplished. Both efforts involve a high degree of speculation. In any event, it is important to recognise that an accurate description of committees convened, resolutions passed, reports published and research completed is no substitute for hard evidence as to how the world's vulnerability to extreme natural events actually changed or began to change during the Decade.

CASE STUDY

A review of the Australian achievements

Alan Hodges, Emergency Management Australia, Australia

Australia is not renowned for large loss of life as a result of national disasters. However, we do suffer significant damage to property and environment from forest fires, flooding, severe storms, tropical cyclones and earthquakes. On average, the cost to the Australian community is US\$ 1 billion per year. Therefore, we have a significant rationale for pursuing a culture of prevention.

On 21 April 1989, the Prime Minister of Australia announced our participation in the International Decade for Natural Disaster Reduction and the formation of an Australian IDNDR Co-ordination Committee. A Committee Secretariat of two people was established within the Natural Disasters Organisation (subsequently Emergency Management Australia), the federal agency responsible for reducing the loss of life, property and the environment in conjunction with Australian States and Territories. Annual funding of approximately US\$ 230,000 was provided for sponsorship of projects.

The first meeting of the Australian IDNDR Co-ordination Committee was held here in November 1989. The Committee consisted primarily of representatives of various federal government departments and agencies, and from research, NGO and academic areas. At its inaugural meeting the Committee recognised that there must be selectivity in allocating project funding. Accordingly, it was decided to adhere to guidelines provided by the United Nations IDNDR Scientific and Technical Committee.

The IDNDR targets which were used as a guide in assessing projects were:

- Comprehensive national assessments of risks from natural hazards, with these assessments being taken into account in development plans
- Mitigation plans at national and/or local levels, involving long-term prevention and preparedness and community awareness
- Ready access to global, regional, national and local warning systems and broad dissemination of warnings.

The allocation of project funding allowed for a dedicated programme of both national and international relevance. Projects in Australia were specifically directed towards meeting the needs of the communities for mitigation of the natural hazards which affect the nation.

Internationally, projects were undertaken with our neighbouring South Pacific Island nations on issues specifically needed by their people.

During 1993 and 1994, a Senate Committee of the Federal Government undertook a review of: 'The capacity of public sector authorities to plan for, forecast and respond to major disasters and large-scale emergencies, fully respecting and utilising the skills and capabilities of the volunteer organisations involved'.

In the first chapter of the Committee's report, significant emphasis was given to the Decade. The Committee stated that it believed that IDNDR needed to have a much higher profile and also noted that Australia's strategy for natural disaster reduction needed to be looking into the next century.

The Committee went on to say that State and Territory Governments should be developing a range of activities that would enhance the ability of our communities to prevent, or be prepared for the impact of, disasters.

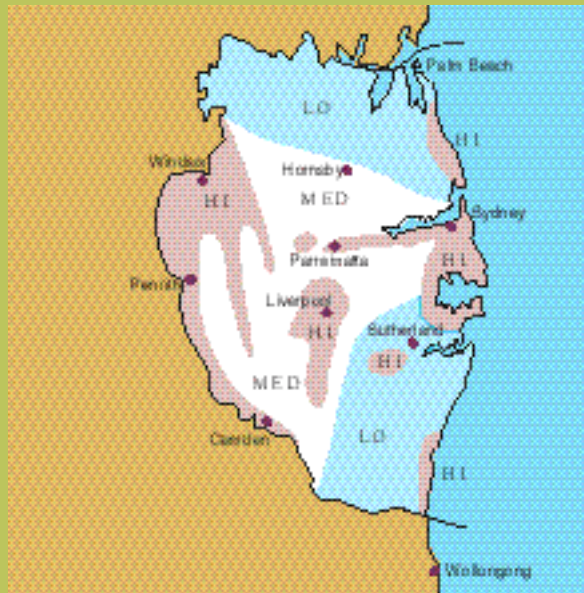
As a result of the Senate Committee study, the size of our IDNDR Co-ordination Committee was increased. Representatives from the peak Emergency Management Councils of each of the six Australian States and two Territories were included. This change was very significant in spreading awareness of the importance of the International Decade and in promoting a national approach to the programme.

The Yokohama IDNDR World Conference held in 1994 provided further stimulus for achieving the objectives of the Decade. The early years of the Decade in Australia had seen development of some twenty very useful projects covering the three target areas. However, the Australian IDNDR Co-ordination Committee felt that an evaluation was needed of the national approach.

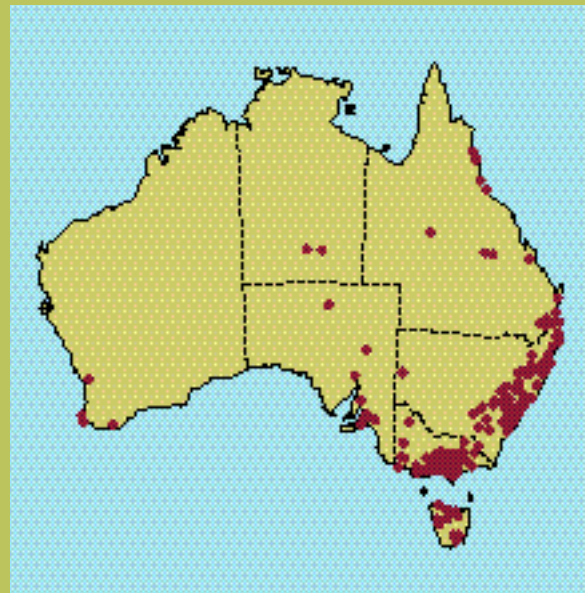
MID-TERM EVALUATION

In 1995 the Australian IDNDR Co-ordination Committee invited Professor Russell Blong, Director of the Natural Hazards Research Centre, Macquarie University Sydney, to undertake an evaluation of the national programme. The Terms of Reference for the review focused on five tasks:

- Assess the overall impact of the Australian IDNDR programme
- Assess the effectiveness of the use of IDNDR funding
- Examine the Committee structure and membership and thereby identify strengths and weaknesses
- Recommend changes to the current approach
- Recommend options for new approaches which can be



Earthquake zonation map of Sydney and environs



Locations of landslides in the Australian Landslide database

implemented without increases to current staffing levels or funding.

In August 1995 Professor Blong delivered his report. He noted that: 'More than 70 people were approached for their views and considerable effort was made to read documents produced by other countries. A comparison of efforts during the first five years of the Decade indicates that Australia has gained international respect for its approach, undertaking one of the most active programmes in terms of in-country projects and supporting programmes in neighbouring developing countries. Moreover, it is recognised in Australia, the Pacific and more widely, that Australian IDNDR efforts are managed by competent, efficient and enthusiastic staff.'

The report contained 19 recommendations which were used as a basis for further development of the Australian approach. The key recommendation, to which all others were subsidiary, was: 'That a Strategic Plan, which identifies the clients of Australian efforts in the IDNDR, charts the course of the remaining five years, determines the required outcomes and the measures of success, be prepared as a matter of urgency.'

STRATEGIC PLAN

Towards the end of 1995, a three-day workshop was convened to examine in detail the recommendations of the Mid-term Evaluation and to develop an IDNDR Strategic Plan. The workshop was attended by 39 delegates comprising the IDNDR Co-ordination Committee, representatives of the wider Australian emergency management community, two overseas nations and the United Nations.

The workshop participants agreed to an Australian IDNDR Mission: 'To reduce, especially in Australia and the South West Pacific region, loss of life, property damage and economic disruption caused by natural disasters, in accor-

dance with the spirit of the International Decade of Natural Disaster Reduction as formulated by the United National General Assembly.'

In fulfilment of this Mission, five key goals were identified: Improve community awareness of risk, preparedness and response; develop and implement programmes to assist community understanding of vulnerability to hazards; foster partnerships within communities to pursue the IDNDR vision; ensure IDNDR activities are adequately resourced; and develop a framework that will generate quality programmes, based on IDNDR principles, that will continue beyond the year 2000.

To complement the goals, 15 specific strategies were developed as well as two key themes for special attention: *Lifelines 2000* — to support the reduction of the vulnerability of community lifelines to natural and technological hazards; and *Education 2000* — to include information in school curricula on prevention strategies for, and the effects of natural hazards on, communities.

NATIONAL APPROACH

The Strategic Plan provided further guidance for the selection and commissioning of projects during the second half of the Decade. In all, 120 projects were undertaken during the Decade. Some examples will give an indication of the range of areas covered:

- Report on Major Conflagrations in Australia and preparation of a 'A National Bushfire (Wildfire) Preparedness Strategy'
- Evaluation of South Australian school-based Project Fireguard — Fire, Burn and Scald Safety Resources
- Earthquake Zonation Studies in (Sydney, southeast-Queensland, Melbourne, Newcastle, Adelaide and also Canberra)

- Production and distribution of Landslide Awareness and All-Hazards Emergency pamphlets
- Development of a Marine Safety Training Video on Severe Weather and Tropical Cyclone Education
- Study of disaster reduction roles and responsibilities of the community and local government in Remote Aboriginal Communities of Northern Australia
- Development/publication of guidelines for cost-benefit analysis, 'Economic Benefits of Disaster Mitigation'
- Production of nationally-broadcast television series of six 15-minute shows on Personal Emergency Management Skills for different hazards.

A particular focus was on projects for the South Pacific. Perhaps the most far-reaching programme was the provision of funding to assist the holding of annual meetings of disaster managers within the region. These meetings have been crucial in raising awareness of the need for disaster prevention in the small island nations to Australia's north-east. As the Decade progressed, the meetings gave particular attention to the need for an integrated programme for disaster reduction. At the 1997 meeting, delegates agreed to a regional disaster-management framework, to be implemented over a five-year period.

Some of the projects funded for the Pacific included:

- Landslide hazard education booklet 'Living with Landslides' for Papua New Guinea
- Study of the social impact of 1994 volcanic eruptions in Rabaul, East New Britain, Papua New Guinea
- Provision of computer system, radio, and backup power supply for Niue Meteorological Office
- Provision of Australian Tropical Cyclone Workstations
- Acquisition and installation of Weather Satellite Receiving Station for Solomon Islands Meteorological Service
- Support for Fiji cyclone preparedness and awareness training through Awareness Community Theatre Guidelines for Disaster Preparedness of Water and Sanitation Systems in Pacific Island Developing States
- Re-evaluation of the volcanic history and hazards of the Tofua Volcanic Arc, Tonga.

There were two key factors which considerably assisted the IDNDR programme in Australia. The first was to place responsibility for the national secretariat and for programme management within Emergency Management Australia, the organisation at federal level responsible for all aspects of emergency management. Associated with this placement was the appointment of the head of the organisation as the Chair of the Australian IDNDR Co-ordination Committee. These responsibilities ensured that the concepts of IDNDR and the day-to-day developments and correspondence which came from the UN IDNDR Secretariat were highly influential in guiding the direction of Australian emergency management policies and programmes.

The second factor was the allocation of annual funding for sponsorship of projects. Most of the project proposals resulted from bids following annual press advertising and dissemination of information by a variety of other means.

Invariably, bids greatly exceeded the available funding and difficult choices had to be made between worthy projects with approval going to those which most closely supported the IDNDR targets and the Australian Goals and Strategies.

The identification in the Strategic Plan of the two key themes of *Lifelines 2000* and *Education 2000* was of particular benefit. These enabled the IDNDR Co-ordination Committee to focus specifically on needs in these areas by commissioning a number of projects.

In looking back over the ten-year period, it is interesting to see the change in emphasis. Projects in the first half of the Decade were characterised by a focus on the hard sciences. The second half saw a welcome inclusion of a number of important projects dealing with somewhat difficult issues associated with the social sciences.

CONCLUSION

In October 1998, the Australian IDNDR Co-ordination Committee was presented with a Certificate of Distinction under the United Nations Sasakawa Disaster Prevention Award. This was in recognition of the Committee's 'distinguished contribution to disaster prevention, mitigation and preparedness and furthering the goals of the International Decade for Natural Disaster Reduction'.

Given this award and the many achievements of the Decade, it would be easy to conclude that IDNDR has gained major public recognition in Australia. Certainly, nearly all the projects achieved their aims and a number were the stimulus for significant additional funding which would not have been forthcoming without IDNDR seed money. However, while Australians respond magnificently during disasters, it is difficult to capture the imagination of individuals and communities for such a long period when a theme may not appear of immediate relevance. Accordingly, as the Decade progressed we decided not to spend a great deal of effort in actively promoting the concept of an 'International Decade'. Rather, the approach was to undertake a variety of activities focusing on disaster-prevention outcomes, but nevertheless with IDNDR as an important focus. There will now be a natural evolution into disaster mitigation and avoidance of the feeling that disaster prevention ends with the conclusion of the Decade.

There are continuing pressures to maintain disaster response capabilities and it is right that these capabilities should be retained. However, the need for a higher priority to be given to prevention and mitigation activities is less obvious and it is much more difficult to attract political support. Although there is still much work to be done in this area in Australia, there is now a significant national focus on disaster prevention as part of a total risk-management approach — an approach which is in accordance with the fifth goal of the Australian Strategic Plan:

To generate quality programs, based on IDNDR principles, to continue beyond the year 2000. This is the real legacy of IDNDR in Australia — a Decade of achievement and a foundation for the future.

XVIII

THE CHALLENGE FOR A SAFER 21ST CENTURY



KEYNOTE PAPER

THE CHALLENGE FOR A SAFER 21ST CENTURY

Dennis Mileti, University of Colorado, USA

EVENTS DURING the past quarter-century have shown that natural disasters are not problems that can be solved in isolation. Rather, they are symptoms of broader and more basic problems. Losses from hazards—and the fact that we cannot seem to reduce them—result from shortsighted and narrow conceptions of the human relationship to the natural environment.

To redress those shortcomings, a shift is needed in the 21st Century to a policy of ‘sustainable hazard mitigation’. This concept links wise management of natural resources with local economic and social resiliency, viewing hazard mitigation as an integral part of a much larger context.

The problem

Many disaster losses—rather than stemming from unexpected events—are the predictable results of interactions among: the physical environment, which includes hazardous events; the social and demographic characteristics of the communities that experience them; and the buildings, roads, bridges, and other components of the local constructed environment. Growing losses result from the fact that all these systems—and their interactions—are becoming more complex with each passing year.

Three main influences are at work. First, the earth’s physical systems are constantly changing—witness the current warming of the global climate. Second, recent and projected changes in the demographic composition and distributions of the population mean greater exposure to many hazards. The number of people residing in hazardous areas is growing rapidly; and worsening inequality of wealth also makes many people more vulnerable to hazards and less able to recover from them. Third, the built environment—public utilities, transportation systems, communications, and homes and office buildings—is growing in density, making the potential losses from natural forces larger.

Settlement of hazardous areas has also destroyed local ecosystems that could have provided protection from natural perils.

For example, the draining of swamps and the bulldozing of steep hillsides for homes have disrupted natural run-off patterns and magnified flood hazards. And many mitigation efforts themselves degrade the environment and thus contribute to the next disaster. For example, levees built to provide flood protection can destroy riparian habitat and heighten downstream floods.

Another major problem has become clear: some efforts to head off damages from natural hazards only postpone them. For example, communities below dams or behind levees may avoid losses from the floods that those structures were designed to prevent. But such communities often have more property to lose when those structures fail because additional development occurred that counted on protection. Similarly, by providing advance warnings of severe storms, we may well have encouraged more people to build in fragile coastal areas. Such development, in turn, makes the areas more vulnerable by destroying dunes and other protective natural features.

A new approach is needed

Researchers and practitioners need to shift their strategy to cope with the complex factors that contribute to disasters in today’s—and especially tomorrow’s—world. A global perspective is needed. Rather than resulting from surprise environmental events, disasters arise from the interactions among the earth’s physical systems, its human systems, and its built infrastructure. A broad view that encompasses all of these dynamic systems and interactions among them can enable professionals to find better solutions. People and society need to accept responsibility for



Photo: Tony Stone Images

Technicians working in a satellite network data processing centre

hazards and disasters. Human beings—not nature—are the cause of disaster losses, which stem from choices about where and how human development will proceed. Nor is there a final solution to natural hazards, since technology cannot make the world safe from all the forces of nature.

We must anticipate ambiguity and change. The view that hazards are relatively static has led to the false conclusion that any mitigation effort is desirable, and will—in some vague way—reduce the grand total of future losses. In reality, change can occur quickly and non-linearly. Human adaptation to hazards must become as dynamic as the problems presented by the hazards themselves. Short-term thinking should be rejected and replaced with long-term views. Mitigation as frequently conceived is too short-sighted. In general, people have a cultural and also an economic predisposition to think primarily in the short term. Sustainable mitigation will require a longer-term view that takes into account the overall effect of mitigation efforts both on this and future generations.

Societal factors, such as how people view both hazards and mitigation efforts or how the free market operates, play a critical role in determining which steps are actually taken, which are overlooked, and thus the extent of future disaster losses. Because such social forces are now known to be much more powerful than disaster specialists previously thought, growing understanding of physical systems and improved technology cannot suffice. To effectively address natural hazards, mitigation must become a basic social value. Finally, we must embrace sustainable development principles. Disasters are more likely where unsustainable development occurs, and the converse is also true: disasters hinder movement toward sustainability because, for example, they degrade the environment and undercut the quality of life. Sustainable mitigation activities should strengthen a community's social, economic, and environmental resiliency, and vice versa.

Mitigation that fosters local sustainability

Sustainability means that a locality can tolerate—and overcome—damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assis-

tance. To achieve sustainability, communities must take responsibility for choosing where and how development proceeds. Toward that end, each locality evaluates its environmental resources and hazards, chooses future losses that it is willing to bear, and ensures that development and other community actions and policies adhere to those goals.

Multiple objectives must simultaneously be reached to mitigate hazards in a sustainable way and stop the trend toward increasing catastrophic losses from natural disasters. For example, sustainable hazards mitigation would comprise human activities to mitigate hazards that should not reduce the carrying capacity of the ecosystem, for doing so increases losses from hazards in the longer term. Mitigations must also enhance people's quality of life. A population's quality of life includes, among other factors, access to income, education, health care, housing, and employment, as well as protection from disaster. To become sustainable, local communities must consciously define the quality of life they want and select only those mitigation strategies that do not detract from any aspect of that vision. Additionally, communities should take mitigation actions that foster a strong local economy rather than detract from one. Moreover, a sustainable community selects mitigation activities that reduce hazards across all ethnic, racial, and income groups, and between genders equally, now and in the future. The costs of today's advances are not shifted onto later generations or less powerful groups.

Finally, a sustainable community selects mitigation strategies that evolve from full participation among all public and private stakeholders. The participatory process itself may be as important as the outcome.

A long term, comprehensive plan for averting disaster losses and encouraging sustainability offers a locality the opportunity to co-ordinate its goals and policies. A community can best forge such a plan by tapping businesses and residents as well as experts and government officials. And while actual planning and follow-through must occur at the local level, a great deal of impetus must come from above. Nothing short of strong leadership from national governments will ensure that planning for sustainable hazard mitigation and development occurs.

Needed actions

The shift to a sustainable approach to hazard mitigation will require extraordinary actions. Here are several essential steps; note that many initial efforts are already under way in some nations.

Sustainable mitigation networks: Today hazard specialists, emergency planners, resource managers, community planners, and other local stakeholders seek to solve problems on their own. An approach is needed to forge local consensus on disaster resiliency and nurture it through the complex challenges of planning and implementation. One potential approach is a 'sustainable hazard mitigation network' in communities that would engage in collaborative problem solving. Each network would produce an integrated, comprehensive plan linking land-use, environmental, social, and economic goals. An effective plan would also identify hazards, estimate potential losses, and assess the region's environmental carrying capacity. The stakeholder network especially needs to determine the amount and kind of damage that those who experience disasters can bear. These plans would enable policy-makers, businesses, and residents to understand the limitations of their region and work together to address them. Full consensus may never be reached, but the process is key because it can generate ideas and foster the sense of community required to mitigate hazards.

This kind of holistic approach will also situate mitigation in the context of other community goals that, historically, have worked against action to reduce hazards. Finally, the process will advance the idea that each locality controls the character of its disasters, forcing stakeholders to take responsibility for natural hazards and resources and realise that the decisions they make today will determine future losses. National and state government agencies could provide leadership in this process by sponsoring — through technical and financial support — a few prototype networks such as model communities or regional projects.

Establish a holistic government framework: To facilitate sustainable mitigation, all policies and programmes related to hazards and sustainability should be integrated and consistent. One possible approach toward this goal is a conference or series of conferences that enable national, local and other government officials to re-examine the statutory and regulatory foundations of hazard mitigation and preparedness, in light of the principles of sustainable mitigation. Potential changes include limiting the subsidisation of risk, making better use of incentives, setting a federal policy for guiding land use and fostering collaborations among agencies, non-governmental organisations, and the private sector.

Conduct hazard and risk assessments: Not enough is known about the changes in or interactions among the physical, social and constructed systems that are reshaping our hazardous future. National risk assessments should incorporate information from those three systems so hazards can be estimated interactively and comprehensively, to support local efforts on sustainable mitigation.

Local planning will require multi-hazard, community-scale risk assessment maps that incorporate information ranging from global physical processes to local resources and buildings. This information is not now available, and will require investment in research on risk-analysis tools and dissemination to local governments.

Build national databases: We must collect, analyse and store standardised data on losses from past and current disasters, thereby establishing a baseline for comparison with future losses. These databases should include information on the types of losses, their locations, their specific causes and the actual dollar amounts, taking into account problems of double-counting,

comparisons with gross domestic product and the distinction between regional and national impacts. A second database is needed to collate information on mitigation efforts — what they are, where they occur, and how much they cost — to provide a baseline for local cost-benefit analysis. These archives are fundamental to informed decision making and should be accessible to the public.

Provide comprehensive education and training: Today hazard managers are being called upon to tackle problems they have never before confronted, such as understanding complex physical and social systems, conducting sophisticated cost-benefit analyses and offering long-term solutions. Education in hazard mitigation and preparedness should therefore expand to include interdisciplinary and holistic degree programmes. Members of the higher education community will have to invent university-based programmes that move away from traditional disciplines toward interdisciplinary education that solves the real-world problems entailed in linking hazards and sustainability. This will require not only new degree programmes but also changes in the way institutions of higher education reward faculty, who now are encouraged to do theoretical work.

Measure progress: Baselines for measuring sustainability should be established now so nations can gauge future progress. Interim goals for mitigation and other aspects of managing hazards should be set and progress in reaching those goals regularly evaluated.

This effort will require determining how to apply criteria such as disaster resiliency, environmental quality, intra- and inter-generational equity, quality of life and economic vitality to the plans and programmes of local communities.

Evaluating hazard-mitigation efforts already in place is also important before taking further steps in the same direction. For example, the National Flood Insurance Programme in the United States, which combines insurance incentives and land-use and building standards, has existed for 30 years, yet its effectiveness has never been thoroughly appraised.

Each disaster yields new knowledge relevant to hazard mitigation and disaster response to recovery, yet no entity collects this information systematically, synthesises it into a coherent body of knowledge and evaluates progress in putting knowledge into practice. Systematic post-disaster audits are needed.

Sharing knowledge internationally: Nations must share knowledge and technology related to sustainable hazard mitigation with other nations and be willing to learn from those nations as well. Disaster experts also need to collaborate with development experts to address the root causes of vulnerability to hazards, including overgrazing, deforestation, poverty and unplanned development. Disaster reduction should be an inherent part of everyday development processes and international development projects must consider vulnerability to disaster.

Moving forward

To support sustainable mitigation, researchers and practitioners need to ask new questions as well as continue to investigate traditional topics. Important efforts will include interdisciplinary research and education and the development of local hazard assessments, computer-generated decision-making aids and holistic government policies.

Future work must also focus on techniques for enlisting public and governmental support for making sustainable hazard mitigation a fundamental social value. Members of the hazards community will play a critical role in initiating the urgently needed nationwide conversation on attaining that goal.

PREPARING FOR 21ST CENTURY CATASTROPHES

Essential conceptual shifts and policy perspectives

Randolph Kent, UK

ON THE CONFERENCE table in the office of the United Nations Resident Co-ordinator in Ethiopia lay several brochures announcing the newly launched International Decade for Natural Disaster Reduction. The year was 1989, and the UN system and a host of other bilateral and non-governmental organisations were in the process of concluding another international effort to help fend off famine in war-torn Ethiopia.

For those few people who had noticed the IDNDR brochures, it was difficult to understand why so much attention was being given to so-called natural disasters. A sizeable percentage of peoples in Eritrea and the Sudan as well as Ethiopia lived on the brink of malnutrition and starvation for reasons that were directly attributable to 'manmade', or human-induced, events. The rationale for embarking upon an international campaign that ostensibly perpetuated a division between natural and human-induced disasters seemed perplexing...at best.

It would be wrong to leave the impression that IDNDR did not have its own dragons to slay. The Decade's message from the outset was that disasters were not acts of some divine force, but rather were the results of human intervention with the natural environment. In the final analysis, the critical factors explaining disasters were the ways that human-beings structured their societies and the ways that they allocated their resources. Human activities create the vulnerabilities that turn hazards into potential disasters.

IDNDR was also committed to prevention, or mitigating the worst effects of hazards in order to prevent disasters. In that regard, disaster relief at least conceptually reflected absent prevention policies. Underlying the assumption was that if one understood those factors that led to disasters—from arcane building techniques to poverty-driven deforestation—one could take action that would significantly reduce the impact of hazards upon vulnerable populations.

And yet for reasons that were partially political, partially due to the particular visions of its founders and partially because of certain assumptions about vulnerabilities on a global scale, IDNDR remained focused on natural disasters and how they could be reduced in frequency and effects. In so doing, a false dichotomy between natural and human-induced emergencies was perhaps unintentionally perpetuated.

Only a year into the Decade arose the phenomenon of 'complex emergencies'. The term, 'complex emergency', was in part a deception and in part a cry of despair. The former reflected the reticence of an international community that—for political and diplomatic reasons—was reluctant to point to the basic failure of the state as the source of mass human misery. The latter, that cry of despair, was a reflection of an equally basic fact, namely,

that there was neither the international will nor available resources to deal with the scale of misery or the root causes that created so-called 'complex emergencies'.

From the Gulf War to the disintegration of Somalia, from the implosion of Yugoslavia to the genocide of Rwanda, it was becoming increasingly evident that disaster response in the early 1990s was also about dealing with the consequences of societal and state collapse. There had indeed been similarly large-scale and complex emergencies before the spate of the 1990s. The East Pakistan cyclone in November 1970 was one example. It led to the death of an estimated 250,000 people in one day and the central government's seemingly inadequate response proved to be a prime factor in the civil war that resulted in an independent Bangladesh the following year.

Similarly, the Ethiopian government's insensitivity to the nation's famine of 1973–75 had direct bearing upon subsequent social and political upheaval that cost tens of thousands of lives and a change of government. Yet, Bangladesh and Ethiopia took place during an era when the international community still assumed that governments around the world had the will and capacity to pay some attention to the needs of their populations before and, if need be, during and after disasters.

The 1990s revealed a new spectre. While the numbers involved in a growing number of complex emergencies were in, and of themselves chilling, what was becoming ever more evident was the fact that these emergencies revealed that all too often the state structures themselves were the root cause of these so-called complex emergencies.

Few, if any, in the international community were willing to commit resources to address the societal and structural issues that were generating such emergencies. However, a growing number of donor governments, multilateral and non-governmental organisations were willing to try and deal with the consequences of such crises. Hence, complex emergencies—with their numbing numbers of affected peoples, camps for refugees and internally displaced people and provisions for 'recovery'—transformed the disaster industry from a million dollar to a multi-billion dollar industry.

Nevertheless, the two—natural disasters and complex emergencies—evolved in the consciousness of the international political community separately but in parallel. Rarely, if ever, were the two perceived as inherently interactive.

The reality is very much to the contrary. The two have common antecedents and more often than not interrelate. They both reflect ways that societies structure themselves and allocate their resources. Both concern the ways that humanbeings live their normal lives, and both in one way or another are part of an

inter-active process that creates vulnerabilities. The catastrophes of the 21st Century will demonstrate not only the falseness of maintaining a division between natural and human-induced disasters, but also the dangers of perpetuating that divide.

Characteristics of 21st Century catastrophes

There can be little doubt that over the next quarter of a century, technological innovation, communications and economic globalisation will dramatically change the dynamics and indeed the very essence of existence for many people. The general consensus of today's analysts is that the spectre of the next few decades is a bright one for a considerable majority of the Earth's burgeoning population.

This relatively optimistic view has to be offset by several negative factors. The world's projected population in 2025 will be eight billion, with all that that might suggest in terms of additional needs for habitable land, water and other resources as well as the consequences to the environment. Of that population, an estimated 23% will be trapped in impermeable poverty, mainly in large conurbations. The nation-state system will continue to be in the throes of profound adjustments that, in turn, will affect the ways that states will be able to reconcile contending interests within most societies.

This period of adjustment will witness deterioration in public welfare and infrastructure and the inability of states to develop effective regime management over such issues as the environment, technology transfers and illicit trade. In many instances, even the very benefits of economic growth may rebound upon supposed beneficiaries as, for example, various consumer desires take their ecological and environmental toll. Disaffection and alienation will intensify insecurity at regional, transnational and state levels, supported in no small part by easy access to weapons and materials of mass destruction.

Based upon such trends, the numbers, inter-active nature and geographical reach of future catastrophes could well increase. Large numbers of stranded minorities, economic migrants, ghetto people and victims of conflict may be central though unwelcome concerns for a future international community. So, too, may pandemic surges, technological emergencies, mutating diseases and violence-induced crises such as mass trauma and ethnic cleansing be core catastrophe concerns.

Increasingly, human intervention will intensify vulnerability. As in the past, but even more so in the future, poverty will be a major factor in linking the effects of natural and human-induced hazards. However, equally as significant will be the hazards that will emerge from an imperfect understanding of the impact of technological innovations upon social and economic structures as well as from increasing links between technological (eg. Chernobyl radionuclides) and natural hazards. Here, again the assumption that one can separate natural from other forms of human-induced hazards will be severely challenged.

Preparing for 21st Century catastrophes

Preparing for such 21st Century catastrophes has to begin by changing the focus of dealing with prevention and preparedness. Too often, disasters, complex emergencies and catastrophes have been seen as the purview of a particular community—the humanitarian community—whose activities are supported by a loose if not random network of actors, including bilateral donors and multilateral institutions. The challenge for preparing for 21st Century catastrophes is to bring global trends, potential causes of catastrophes and prevention and preparedness directly into the domain of broad public policy.



Photo: Associated Press

Thick haze still chokes the city of Pontianak, Indonesia, as a result of the forest fires in September 1997

The extent to which a broad public policy approach can be developed to anticipate and mitigate the effects of major catastrophes and respond to them will depend upon three factors. The first concerns the degree to which global trends and their implications are actually understood by those involved in the political and policy process. The second factor reflects the extent to which the inter-relationship between global trends and their implications can be articulated clearly and can lead to practical and politically acceptable decisions and solutions. Finally, the degree to which relevant information can be integrated coherently into the decision-formulation and implementation process will be an essential factor for effectively linking public policy to catastrophe prevention and preparedness.

Each of these factors may be profoundly influenced by any or all of the following four policy perspectives.

Information and the policy-making process: The difficulties that scientists and politicians have in 'talking to each other' are not new themes. In most developed countries, mechanisms have been created to bridge the conceptual and practical gulfs between the two. Yet, in a world driven by increasingly complex science, with technologies that are often divorced from the day-to-day experiences of most people, the gulf too often remains and indeed widens.

At the same time that the differences between the realms of science and politics need to be narrowed, a third element, the corporate sector, has to be added to the public policy equation. The problem for each is that they individually work from different assumptions about knowledge and, perhaps more importantly, different uses of knowledge. The politician looks for certainty, for public policy clearly cannot be overtly ambiguous. The scientist on the other hand knows that—scientifically speaking—there are no certainties. The corporate executive relies upon the wisdom of 'market forces' to determine what in the final analysis he or she needs to know.

Reconciling these three contending uses of knowledge is difficult, often impossible. Yet, without some mutually acceptable framework about utilisation and interpretation, information that is incomplete or irreconcilable will inevitably result in public policy decisions that are disjointed, incremental and below a reasonable standard of potential achievement.

Complexity and unanticipated consequences: Whether barriers to policy coherence can be lowered depends, to some extent, upon the capacity to deal with complexity and unanticipated consequences and the constraints of present-day organisational dynamics.

Perhaps few could have foreseen the full panoply of consequences arising from Indonesian plantation owners' efforts to expand their palm-oil crops. More land was needed to plant more palms and that land would come from burning hitherto untouched forests. By 24 September 1997, however, the World Health Organization warned of a major increase in respiratory and heart ailments along a wide swathe of South East Asia due to the smog created by the plantation owners' slash and burn techniques. Soon after, two ships in the Straits of Malacca collided, an incident directly attributed to that smog.

This incident is a microcosm of a far more fundamental problem: the very complexity of social structures, inventions and resultant technologies and economic systems have made the calculation of impacts and consequences ever more difficult and unpredictable. It is more than the assumption that change has become discontinuous (ie. no longer a projection of past trends into the future (*Handy*, 1996a); it is unpredictability that mirrors Prigogine's view of change in the physical sciences, ie. chaos theory: all systems contain sub-systems, which are continually 'fluctuating'. At times, a single fluctuation or a combination of them may become so powerful, as a result of positive feedback, that it shatters the pre-existing organisation. At this revolutionary moment — it is impossible to determine in advance which direction it will take (*Prigogine*, 1984).

On one level this issue cannot be rectified by technology; it is not about an infinite number of computers reaching into an infinite universe of possibilities to plot correlations and lay out a full spectrum of possible causation. And yet, on another level it is about practical ways to limit the numbers of unpredictable events. This in turn depends upon the degree to which analysis, planning and eventually decision-making can be based upon a multidisciplinary perspective and on organisational methods which eschew conventional organisational dynamics.

Organisational dynamics: Organisations are driven by three fundamental dynamics:

1. Standard operating procedures and repertoires
2. Specialisations and institutional perspectives
3. Institutional survival, including a seemingly constant search for resources.

No matter how experimental management efforts may be nor how secure and positive the workforce, these basic dynamics are always at play.

The persistence of these dynamics is not surprising. Organisations are designed to deal with complex systems, and the most effective way to date to deal with complexity over time is to reduce complexity to its constituent elements. As a result of decomposing complex matters into relatively simple sub-components, patterned responses can be developed that ensure consistent performance and output.

Organisational dynamics, perhaps one of the most single controlling factors in the 20th Century, do however pose severe

constraints on effective adaptation to change. Organisations tend to 'screen out' information to which they are not attuned, are prone to ignore inputs that do not correspond to their standard operating procedures and repertoires and ultimately assess the value and importance of change in terms of their own institutional perspectives and survival.

Such maladaptive tendencies do not necessarily apply to all organisations on all issues over time. Yet, they are sufficiently prevalent to warrant greater attention to the inter-relationship between change and organisational behaviour. More emphasis will have to be placed upon transitional organisations, ad hococracy and non-institutionalised methods of analysis and planning. Within conventional organisations, greater attention will have to be paid to what one expert has called 'the discipline of mental models' (*Senge*, 1994).

Living through change: A leading professor in business management arrived towards the end of his career at what he regarded as a great revelation about controlling change: 'the world is not an unsolved puzzle waiting for the occasional genius to unlock its secrets. The world or most of it is an empty space waiting to be filled' (*Handy*, 1996b). What might have been a liberating revelation to the former professor is for most people a source of 'discomfort, anxiety, inconstancy, bloodletting, and psychological distress: whatever terms you choose, there has never been, nor will there ever be, a change initiative that leaves unscathed the people it purported to benefit' (*Robbins*, 1996).

Most human beings are reluctant to venture too far away from worlds that they know and feel they understand. Change in both individual and societal context is not normally a welcome phenomenon. To the extent that change is confronted, it is normally done incrementally, that is to say, a kind of reverse Gestalt — where the parts loom far larger than the whole.

In the realm of public policy, factors affecting change are generally analysed incrementally: priorities are randomly determined by perceived urgency rather than integrated analysis (*Steinbruner*, 1974). There are many reasons for this, including sheer overwhelming management workloads. Uncertainties on personal as well as professional levels regarding the consequences of change, the potential embarrassment that arises from not understanding the issues entirely, the conflict that change may also generate within and across organisations, all are part-and-parcel of living through change.

The first steps as the last statement

The relationship between natural and human-induced disasters has always been close and intellectually apparent. That the divide between the two has been perpetuated to date is both a convenience and a luxury that the world's burgeoning population and the international community at large can ill afford. So intimately related to this concern is the need to have public policy reflect the fact that disasters and more complex emergencies are not the result of aberrant phenomena but are the result of the ways human beings live their 'normal lives'.

There is still time to throw off such comfortable but dangerous divides, and integrate 'prevention' into the very ways that we deal with social, economic and security policies. However, to bring true disaster and emergency prevention into the main arena of public policy will demand new ways of understanding diverse and seemingly disparate information combined with new ways of dealing with the constraints of organisational dynamics and the unpredictability of inherent chaos and finally a renewed appreciation that change is a puzzle to be solved and not necessarily a threat.

GLOBAL NATURAL CATASTROPHES

Prospects for the next millennium

Professor Bill McGuire, Benfield Grieg Hazard Research Centre, UK

GEOLOGICALLY speaking, modern society has developed during remarkably quiet times. The Earth's 4.6 billion-year history has been punctuated by catastrophic events capable of global impact, but none during the last two millennia. Despite the millions of people affected annually by natural hazards, we still await the first natural megadisaster; a global natural catastrophe taking in excess of a million lives and causing serious disruption to the social and economic fabric of our civilisation. Although such high magnitude events have long return periods, there is no question that they will continue to occur and it is time now to start planning for such an eventuality. Three events have the capability to cause major destruction that can affect the entire planet or a substantial part thereof. Two of these are terrestrial, a volcanic supereruption and a giant tsunami formed by the collapse of an oceanic island and the third, an asteroid or comet impact, has its origin beyond our planet's atmosphere. The impact threat is now attracting increasing interest from both scientists and national governments, but the comparable threats from giant tsunami and volcanic supereruption have yet to capture a share of the attention. Presented here is a synthesis of current thinking on the risk and affect of these geophysical megahazards and briefly addresses the issue of preparedness.

The tsunami threat

The devastation and loss of life in the Sissano area on the north coast of the island of New Guinea during the Summer of 1996 provides testimony to the destructive power of even relatively small tsunami. Here an offshore earthquake, possibly triggering a submarine landslide, displaced sufficient seawater to generate a number of waves up to seventeen metres high. Due to the proximity of the quake these smashed into villages along the coast only minutes after the quake, taking at least three thousand lives. Such seismogenic tsunami are common, particularly around the Pacific Rim, and over four hundred tsunami here have taken fifty thousand lives during the last century alone. In common with gigantic volcanic eruptions and impact events, tsunami have the capability to cause destruction and loss of life thousands of kilometres away from their source. For example, the great Chilean earthquake of 1960 — by far the greatest this century — produced tsunami that killed over two thousand people along the coastline of South America, but also took over sixty lives in Hawaii and a further hundred and eighty in Japan — over sixteen thousand kilometres from the earthquake epicentre. Furthermore, not only do tsunami have the capability to cause remote destruction, but they can travel with astonishing speed. In deep water, these seawaves can travel at velocities in excess of eight hundred kilometres an hour. Here they will be barely detectable as a slight swell. As they enter shallower water, however, they can build to

heights of several tens of metres before they crash into a coastline with the energy of an atomic bomb. Tsunami are not generated merely by earthquakes however and two of the most lethal have been associated with volcanoes. In 1792, part of the Unzen volcano on the Japanese island of Kyushu collapsed into the sea producing a series of tsunami that killed nearly fifteen thousand in the many fishing villages along the coast. Almost a hundred years later in 1883, the huge volcanic explosion of Krakatoa generated waves that devastated the coastlines of the neighbouring Java and Sumatra, taking over thirty-six thousand lives.

Looking further back in time, it becomes apparent that volcanoes are responsible for some of the biggest tsunami ever seen. Around about a hundred thousand years ago on the Big Island of Hawaii, a gigantic landslide with a volume in excess of a thousand cubic kilometres collapsed into the Pacific Ocean forming a wave that rode up the neighbouring island of Lanai — over a hundred kilometres distant — to a height of nearly four hundred metres. So huge were the tsunami generated by the collapse that they were still fifteen metres high when they crashed into the coast of Australia's New South Wales — seven thousand kilometres away. Such an event today could be expected to devastate the entire Pacific Rim, taking millions of lives and causing trillions of US dollars worth of damage. As far as we can tell, the frequency of giant landslides from the Hawaiian volcanoes ranges between 20,000 to 100,000 years, and we have no evidence at the moment of when the last such event occurred. Rather worryingly however, the next major collapse of a volcanic island may take place in the Atlantic Basin. During an eruption in 1949, around two hundred cubic kilometres of the west flank of the Cumbre Vieja volcano, on the Canary Island of La Palma, dropped seawards by four metres and then stopped. This huge mass of rock remains critically unstable and could be triggered to slide during the next eruption, although it may be thousands of years before it eventually collapses. In geological terms, however, this will occur soon, and when it does the consequences for the eastern seaboard of the United States and the Caribbean, in particular, will be catastrophic.

The super-eruption threat

The sizes of volcanic eruptions are described using a logarithmic scale known as the Volcano Explosivity Index or VEI. This open-ended index runs from 0, for the quietest effusions of lava, to 8 for the most cataclysmic of explosive eruptions. In recent decades, the 1980 eruption of Mount St. Helens (Washington State, USA) merited a five on the scale, while the 1991 Pinatubo (Philippine) eruption scored a six. We have to go back to Tambora (Indonesia) in 1815 to find the last VEI 7, and to the start of the last Ice Age seventy three thousand years ago for the last VEI 8. This gigantic blast also occurred in Indonesia, at a place called Toba in



Photo: Rex Features

Future threat: Possible asteroid collision with earth

Sumatra, and appears to have had a catastrophic effect on the global climate. Because the scale is logarithmic, the Toba blast was ten times more powerful than that at Tambora which, in turn was ten times greater than the Pinatubo eruption. The Toba event then was a thousand times more powerful than the spectacular eruption of Mount St. Helens.

Volcanic blasts on the scale of Toba are increasingly referred to as supereruptions, and they are now recognised as offering a threat to our civilisation that may be on a par with the impact of a 0.5–1 kilometre asteroid or comet impact. The enormous destructive power of a supereruption is graphically demonstrated by considering the effects of such an event that occurred at Yellowstone (Wyoming, USA) some two million years ago. This cataclysmic blast ejected over two thousand cubic kilometres of debris, which fell to Earth over sixteen states. Ash fell in Los Angeles (California), Des Moines (Iowa), and El Paso (Texas), and was a quarter of a metre deep fifteen hundred kilometres from the eruption site. The Toba supereruption provides even more impressive statistics. Not far short of three thousand cubic kilometres of ash was blasted into the stratosphere, along with up to five thousand million tonnes of sulphuric acid droplets. As this material rapidly enveloped the entire planet it blocked out solar radiation to such an extent that temperatures fell in places by as much as fifteen degrees celsius, and the northern hemisphere experienced an average cooling of up to five degrees celsius. As the planet was already experiencing a fall in temperatures, the eruption may have been the final trigger that plunged the Earth into full ice age conditions from which it only emerged ten thousand years ago. Today such a blast would mean the loss of at least one and possibly more, growing seasons. Mass starvation would probably take hundreds of millions of lives, and the impact on the socio-economic fabric of our global civilisation is likely to be severe. Since the Yellowstone eruption, there have—on average—been two super-eruptions every hundred millenia. With Toba occurring over seventy thousand years ago, it is perhaps time to start worrying about the next great volcanic blast and its potential effects.

The impact threat

Since July 1994, when the fragments of Comet Shoemaker-Levy hammered into Jupiter, there has been considerably heightened interest in the threat to our civilisation arising from asteroid and comet impacts. This is evidenced by two major films and a plethora of books on the subject. More importantly, however, the threat is also being taken more seriously by both scientists and national governments, as increasing evidence is obtained for past impacts on Earth during historic and prehistoric times and the devastating ramifications of the impact that wiped out the dinosaurs are better understood. As the Earth travels around the Sun its orbit intersects the orbits of perhaps a billion rock fragments in excess of ten metres and maybe a million with diameters of a hundred metres or more. Objects in the 40–50 metres size range collided with the Earth in Siberia (1908 and 1947), Brazil in 1931 and Greenland in 1997—each capable of wiping out a major city or a small country had they not impacted in remote parts of the planet. Of much greater concern are objects a kilometre or more across that have the capability of wiping out a quarter of the Earth's population and which are estimated to strike our planet about once every hundred millenia.

There are perhaps four thousand asteroids of kilometre or greater size, the orbits of which, cross that of our own planet. Of these, however, we have only observed a few hundred and the remainder constitute an unknown and considerably worrying threat to the survival of modern society. In an attempt to learn more about these objects, the organisation Spacewatch was established in 1989. This international group of astronomers is dedicated to locating all Earth-crossing objects in the one kilometre or more size range and mapping their orbits. Despite notional support from the UK, US and other national governments, however, funding for the Spacewatch survey remains insufficient.

Currently, only five per cent of such objects have been identified and at the present rate of progress it could be the end of the next millennium before all are located and their orbits mapped. This may be too late.

Like giant tsunamis and supereruptions, the effects of the collision between a one kilometre asteroid or comet will not be confined to the immediate vicinity of the impact site. If the object impacts in the ocean, the resulting tsunami will dwarf those caused by the collapse of oceanic volcanoes, causing basin-wide destruction and loss of life. The enormous volumes of debris ejected into the stratosphere will trigger a Cosmic Winter from which it could take years to emerge and it is perfectly feasible that our global civilisation might not survive.

What can we do?

Because modern society has yet to experience a global natural catastrophe, a failure of the imagination becomes apparent when discussing the implications with government officials, disaster managers and others involved in the 'disaster business'. The message must be got across, however, that it is not a question of if but when a natural catastrophe of global dimensions next occurs. If we can make the point that such events are certain in the future of our race, then we have already made a start on the long road towards coping with their effects. During the Cold War, civil defence in many countries was strongly tailored towards coping with the terrifying results of an all-out nuclear exchange. Perhaps now similar attention and effort can be paid to ensuring that appropriate measures are firmly in place to minimise, as much as is feasible, the effects of a Volcanic or Cosmic Winter, as opposed to a Nuclear one.

The RADIUS Initiative

Kenji Okazaki, IDNDR Secretariat, Switzerland



The six-story Mitsubishi Bank stands in ruins after the earthquake hit Kobe in January 1995

THE WORLD is rapidly being urbanised with almost half of its population living in cities. Cities where population and all kinds of human activities are concentrated are more and more vulnerable to disasters, particularly to earthquakes. Once an earthquake takes place in a big city, the damage would be tremendous both in human and economic terms. Even an intermediate earthquake can cause a destructive damage to a city, as in the case of the 1995 Kobe Earthquake in Japan.

However, there is a tendency to look at disasters only from a humanitarian angle, bringing us into the position of giving priority to the response to disasters. There is also an unfounded tendency to consider that the investment to strengthen the existing infrastructure before disasters will cost much more than the cost of response after the disasters. It is actually just the reverse. It is clear that from the economical view point, preparedness pays off in the long term. Besides, the response activities never save human lives which have already been lost. In order to reduce the impact of the disasters, it is therefore essential to concentrate our efforts on prevention and preparedness.

The IDNDR Secretariat therefore launched the RADIUS (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters) initiative in 1996 with assistance of the Government of Japan to reduce seismic disasters in urban areas, particularly in

developing countries. In collaboration with nine selected cities around the world, the initiative will develop common tools for seismic risk assessment and management in the urban areas.

Objectives: The major objectives of the RADIUS initiative are four fold:

1. Develop seismic damage scenarios and risk management plans for the nine case study cities selected worldwide
2. Develop practical tools for seismic damage assessment and management which could be applied to any earthquake prone city in the world
3. Conduct a comparative study to understand urban seismic risk around the world
4. Promote information exchange for the seismic risk mitigation at city level.

Case studies: The objectives of the case studies are two fold:

1. Develop an earthquake damage scenario which describes the consequence of a possible earthquake
2. Prepare a risk management plan and propose an action plan for earthquake disaster mitigation.

An earthquake damage scenario will describe physical damage to buildings and infrastructure (roads, water supply, electric power

Nine case study cities

Addis Ababa (Ethiopia), Antofagasta (Chile), Bandung (Indonesia), Guayaquil (Ecuador), Izmir (Turkey), Skopje (TFYR Macedonia), Tashkent (Uzbekistan), Tijuana (Mexico), Zigong (China)

Three international institutes

Asia (Bandung, Tashkent, Zigong) Center for Disaster-Mitigation Engineering (INCEDE) and OYO Group, Japan
Europe, Middle East and Africa (Addis Ababa, Izmir, Skopje) Bureau de Recherches Géologiques et Minières (BRGM),
France Latin America (Antofagasta, Guayaquil, Tijuana) GeoHazards International (GHI), USA

Regional Advisory Committee Members (in alphabetical order, as of 1998)

Asia: Dr Anand S. Arya (India), Dr Jack Rynn (Australia), Dr Tsunehisa Tsugawa (Japan)

Europe, Middle East and Africa: Dr Mohamed Belazougui (Algeria), Dr Victor Davidovici (France),
Professor Dr Rainer Flesch (Austria)

Latin America: Dr Andrew Maskrey (Peru), Ms Shirley Mattingly (USA), Professor Carlos E. Ventura (Canada)

Figure 1: Raising public awareness of seismic risk

supply, etc) and human losses as well as the effects to the urban functions and activities during and after a probable earthquake. The result may be shown in visual forms by a Geographical Information System (GIS).

A risk management plan will be prepared, based on the earthquake damage scenario. It may contain the following aspects.

- Urban development plan to mitigate seismic disasters
- Improvement plan for the existing urban structures such as reinforcement of vulnerable buildings and infrastructures, securing of open spaces and emergency roads and designation of areas for evacuation
- Emergency activities such as life saving, fire fighting, emergency transportation, and assistance to the suffering people
- Individual counter measures for important facilities
- Dissemination of information to and training of the public and private sectors.

Finally, a practical 'Action Plan' will be proposed. It will prioritise the necessary actions so that they can be implemented soon after the project. The scenario and action plan will be disseminated to relevant organisations and the public.

The goals of the case studies are:

1. To raise the awareness of decision makers and the public for seismic risk, involving mass media
2. To transfer appropriate technologies to the cities from the advanced world as well as the scientific world
3. To set up a local infrastructure for a sustainable plan for earthquake disaster mitigation
4. To promote multidisciplinary collaboration among the local government, scientists and the public
5. To promote worldwide interaction with other earthquake-prone cities.

Nine cities were selected from 58 (Table 1), which had applied for the case studies, under consultation with the STC (Scientific and Technical Committee for IDNDR) subcommittee for RADIUS (Members are Doctor Tsuneo Katayama (Chair), Mr Robert Hamilton, Professor Mustafa Erdik). The case studies were carried out from February 1998 until July 1999 with financial assistance

from the IDNDR Secretariat (US\$ 50,000 to a full case study city) and technical assistance from internationally renowned institutes.

Three international institutes offer technical assistance to these cities in each region while three regional advisory committees visit the cities to provide technical advice and to raise public awareness of the seismic risk there together with the international institutes (Figure 1).

Two training seminars were held mainly for the RADIUS case study cities in 1998. The JICA (Japan International Co-operation Agency) Seminar on 'Seismology and Earthquake Engineering,' was held for the technical experts with assistance of IISEE, BRI and the Japanese Ministry of Construction in support of the RADIUS initiative in Tsukuba, Japan, from 11 May to 19 June 1998. The seminar was attended by 17 scientific/technical experts from the nine RADIUS case study cities and other cities pre-selected for the RADIUS case studies. The RADIUS training seminar for city government officials was held from 22 to 30 June, 1998, in Tokyo and Fukui, Japan, with 18 participants from 13 cities, including the RADIUS case study cities. It was co-organised by UNU (United Nations University, UNCRD (UN Centre for Regional Development), and the IDNDR Secretariat.

All the case study cities have held the Earthquake Scenario Workshop from October 1998 to March 1999 at the end of the first stage of the case study. The common objectives of the workshop are:

- To present the damage estimates to the city and ask for feedback from the participants
- To estimate the impact of the estimated damage on the city activities
- To produce ideas of actions that could reduce the impact of an earthquake on the city
- To discuss the conditions needed to institutionalise the risk management activities.

The workshops were attended by representatives of various sectors of the communities as well as the regional advisors and experts from the international institutes. The second workshop for Action Plan was held in each city from April to June 1999, at the final stage of the case study.

Development of tools

A technical manual for the urban seismic risk assessment will be developed, based on the analysis of the case studies. The scenario will show how the damage to buildings and infrastructure and human loss by zone in a city would change as time passes after a probable earthquake. However, it should be noted that the indicative result will be and must be only the first step for seismic risk assessment of the city.

In order to facilitate any earthquake prone city to conduct a RADIUS type project, guidelines will be also developed, based on the experiences of the nine case studies. The emphasis will be made on:

- How to involve decision makers, relevant organisations/institutions, communities, private sectors, mass media, and scientists in a multidisciplinary way
- How to transfer the scientific data into decision making information in a practical way
- How to disseminate information and educate the people, particularly through the mass media
- How to prepare risk management and action plans
- The next step

The tools will be useful to decision makers and government officials who are responsible for disaster prevention and disaster preparedness in the cities:

- To decide the priorities for urban planning to mitigate seismic disasters
- To prepare an improvement plan for the existing urban structures such as reinforcement of vulnerable buildings and infrastructures, securing of open spaces and emergency roads and designation of areas for evacuation
- To prepare for emergency activities such as life saving, fire fighting, emergency transportation and assistance to the suffering people

The tools will be useful to communities, NGOs, and citizens:

- To understand the vulnerability of the area where they live
- To understand how to behave according in case of an earthquake disaster
- To participate in preparing a plan for disaster prevention

They will be also useful to semi-public and private companies, particularly to those who maintain urban infrastructure such as electricity and communication, to understand the necessity of prevention and preparedness so that they could minimise the damage on their business.

Comparative study on 'understanding urban seismic risk around the world'

More than 70 cities are participating as 'Member Cities' in the comparative study on 'Understanding urban Seismic Risk Around the World,' which started in June 1998. The study aims at developing a better understanding of the various aspects contributing to the seismic risk of a city, underlining the common earthquake risk problems in different urban areas of the world and identifying solutions and risk management practices that have been successful and can be duplicated. GeoHazards International (GHI) is responsible for this study.

There are several benefits by joining the study. First, the participating cities can gain a better understanding of the characteristics of their seismic risk as well as the factors that contribute to this risk, such as the city's vulnerability, economic exposure, emer-

gency response and recovery capabilities. This information could then be used by the city to generate public awareness and support the city's risk management efforts. Second, the study helps the cities recognise and prioritise projects they could use for their disaster management. Third, the study also offers the opportunity for the cities to establish partnerships with other cities facing similar problems.

Information exchange

Associate cities: More than 30 cities which have carried out a seismic risk assessment, or are in the process of doing so with independent resources, joined RADIUS as 'Associate Cities' for information exchange and international co-operation. The Associate Cities are expected to offer their valuable experience to other cities, mainly through the RADIUS home page, while they can also obtain useful information from the other cities.

RADIUS Homepage

The IDNDR Secretariat launched the RADIUS website, providing a clear, user-friendly and up-to-date access to all the information available concerning the RADIUS Initiative. It provides a fully interactive medium to exchange information on the experience of RADIUS. The midterm reports from the nine case study cities, the three international institutes, and the associate cities are presented in the home page. The results of RADIUS, including the developed tools, will be also presented there (*Okazaki, 1999*).

RADIUS Symposium in October 1999

The RADIUS Symposium will be held in October 1999 at one of the RADIUS case study cities, to present and discuss the results of RADIUS, such as reports of the nine case studies, the developed manual, the comparative study on the urban seismic risk, and reports of similar efforts in many other cities.

Cost

The total cost is estimated to be approximately US\$ 2.5 million. The Japanese Government has contributed US\$ 1.6 million so far while several international organisations such as UNU and UNCRD have co-operated to hold a training seminar. It is expected that any cities/countries or organisations will assist specific cities technically or financially so that they can conduct a similar project for seismic risk assessment or follow up RADIUS activities.

Closing remarks

The main goal of RADIUS to raise the public awareness, particularly at city level. The RADIUS case studies, with assistance from the United Nations, have already involved decision makers, communities and mass media in the cities. Its activities have been broadly covered by newspapers, television, radio etc.

It has also created active partnership between scientists and local people. The local scientists are closely co-operating with the local governments to transfer scientific data into decision-making information. Thus, the RADIUS case studies have already achieved some success.

RADIUS does not draw a closed circle but draws an open circle. While all the results will be open to anybody interested, any information and contributions are welcome. It is expected that further actions will be taken to reduce the impact of probable earthquakes in as many cities as necessary, following RADIUS by learning its experiences and by utilising the practical tools to be developed by the end of IDNDR.



Destruction to property caused by the Kobe earthquake in Japan

Table 1

Cities concerned: 58 cities applied for RADIUS case studies

Asia (27 cities)

Almaty (Kazakhstan), Amman (Jordan), Ashgabat (Turkmenistan), Bandung (Indonesia), Baoji (China), Bishkek (Kyrgyzstan), Calcutta (India), Damascus (Syria), Daqing (China), Dushanbe (Tajikistan), Hefei (China), Istanbul (Turkey), Izmir (Turkey), Kathmandu (Nepal), Mandalay (Myanmar), Metropolitan Manila (Philippines), Mumbai (India), Shiraz (Iran), Tabriz (Iran), Tangshan (China), Tashkent (Uzbekistan), Tbilisi (Georgia), Tehran (Iran), Urumqi (China), Yangon (Myanmar), Yerevan (Armenia), Zigong (China)

Europe and Africa (12 cities)

Accra (Ghana), Addis Ababa (Ethiopia), Algiers (Algeria), Belgrade (Yugoslavia), Bucharest (Romania), Conakry (Guinea), Dodoma (Tanzania), Giza (Egypt), Petropavlovsk-Kamchatsky (Russian Federation), Skopje (TFYR Macedonia), Sofia (Bulgaria), Tirana (Albania),

Latin America (19 cities)

Ambato (Ecuador), Antofagasta (Chile), Cali (Colombia), Cumana (Venezuela), Guayaquil (Ecuador), Kingston (Jamaica), La Paz (Bolivia), Lima (Peru), Manizales (Colombia), Medellin (Colombia), Pasto (Colombia), Pereira (Colombia), Popayan (Colombia), Quito (Ecuador), San Juan (Argentina), Santiago (Chile), Santo Domingo (Dominican Rep.), Tijuana (Mexico), Toluca (Mexico)

73 Member Cities

Accra (Ghana), Addis Ababa (Ethiopia), Algiers (Algeria), Almaty (Kazakhstan), Ambato (Ecuador), Antofagasta (Chile),Athens (Greece), Bandung (Indonesia), Baoji (China), Beijing (China), Bogota (Colombia), Bucharest (Romania), Cairns (Australia), Caracas (Venezuela), Colima (Mexico), Delhi (India), Dhaka (Bangladesh), Gilgit (Pakistan), Giza (Egypt), Guadalajara (Mexico), Guatemala City (Guatemala), Guayaquil (Ecuador), Gyumri (Armenia), Huaraz (Peru), Irkutsk (Russia), Izmir (Turkey), Jakarta (Indonesia), Kampala (Uganda), Kathmandu (Nepal), Khartoum (Sudan), Kingston (Jamaica), La Paz (Bolivia), Lima (Peru), Lisbon (Portugal), Manizales (Colombia), Metro Manila (Philippines), Mumbai (India), Newcastle (Australia), Pasto (Colombia), Pereira (Colombia), Pimpri (India), Popayan (Colombia), Potenza (Italy), Quito (Ecuador), Rome (Italy), St. George's (Grenada), San Jose (Cost Rica), San Juan (Argentina), San Salvador (El Salvador), Santiago (Chile), Santiago (Dominican Republic), Santo Domingo (Dominican Republic), Seattle (USA), Seoul (Republic of Korea), Shiraz (Iran), Skopje (TFYR of Macedonia), Sochi (Russia), Sofia (Bulgaria), Spitak (Armenia), Tabriz (Iran), Tai'an (China), Tashkent (Uzbekistan), Tbilisi (Georgia), Tehran (Iran), Tijuana (Mexico), Tirana (Albania), Tokyo (Japan), Tuscan Region (Italy), Ulaanbaatar (Mongolia), Urumqi (China), Vladivankaz (Russia), Yerevan (Armenia), Zigong (China)

35 Associate Cities

Algiers (Algeria), Baoji (China), Beijing(China), Bogota (Colombia), Cairns (Australia), Calcutta (India), Dalian (China), Damascus (Syria), Gyumri (Armenia), Hefei (China), Istanbul (Turkey), Jabalpur (India), Kathmandu (Nepal), Khartoum (Sudan), Lima (Peru), Manizales (Colombia), Mumbai (India), Newcastle (Australia), Pereira (Colombia), Pimpri (India), Quito (Ecuador), St. George's (Grenada), San Juan (Argentina), Shiraz (Iran), Sochi (Russia), Spitak (Armenia), Suva (Fiji), Tai'an (China), Tangshan (China), Tehran (Iran), Tianjin (China), Tuscan Region (Italy), Ulaanbaatar (Mongolia), Urumqi (China), Yerevan (Armenia)

THE MID-DECADE SHIFT

Integrating natural disaster management in sustainable development

Bernaditas Muller, Department of Foreign Affairs, Philippines

THE INTERNATIONAL DECADE for Natural Disaster Reduction (IDNDR), from its inception, has recognised the close inter-relationship between natural disaster reduction and national development planning. The crucial role of early warning in reducing damage and saving lives and the importance of integrating natural disaster risk assessment in developing infrastructure underlie much of the work programme of the IDNDR.

In 1993, however, during the preparatory conferences for the United Nations World Conference of Natural Disaster Reduction in Yokohama, Japan, the inter-linkages of natural disaster management and development took on a new dimension. Coming as it did in the wake of the global mobilisation for sustainable development, following the historic 1992 UN Conference on Environment and Development (UNCED), it was inevitable that the Yokohama Conference agenda take on board sustainable development objectives of States.

Natural phenomena as they occur impact directly on the environment. Disasters resulting from these natural occurrences inflict serious damage to human settlements and infrastructure, basic to economic and social development. The shift to the continuum of disaster preparedness, prevention and mitigation, to emergency relief and the subsequent rehabilitation and reconstruction, rapidly took its proper context within the sustainable development agenda.

While all these seem self-evident today, this was not the case at mid-decade. Even now, the integration of environmental management within development planning still presents a challenge for many countries. Faced with the constraints of financial and technological shortcomings, countries vulnerable to natural disasters have to cope with yet another impediment on the road to sustainable development. The need to make natural disaster management a central theme of sustainable development planning became imperative.

Institutional adjustments

Among the first steps to be taken was to mainstream the Yokohama Strategy and its Plan of Action into the co-ordinated approach to the follow-up of the major UN conferences and summit meetings on the principal issues of the decade.

For this purpose and to take advantage of the momentum gained during the Yokohama Conference, open-ended informal core and contact groups of interested countries, representing the main regional groups of the UN system, were set up with the assistance of the IDNDR Secretariat in Geneva, immediately after the Conference. The core group of countries was represented through their respective Permanent Missions in Geneva. Their representatives met regularly, informed their respective regional

groups of the developments and reported on IDNDR activities to a plenary meeting. The core group was joined by representatives of the UN system and countries in New York, at a later stage, to improve co-ordination of natural disaster management activities within the UN headquarters, both in New York and in Geneva.

Concerned international organisations and specialised agencies of the UN system participated in the deliberations of the core group. These included the World Meteorological Organization, the World Health Organization, the UN Center for Human Settlements (UNCHS), UNICEF and UNOPS. The group discussed ways and means through which natural disaster reduction issues can be reflected in the work of these organisations and agencies. It was also deemed essential that countries ensure the consistency of their activities on natural disaster management within the UN system, so that these may be mutually supportive.

The core group and the contact groups likewise provided the channel through which national committees and national focal points on natural disaster management are consulted on activities that will be undertaken at the regional or global levels. The merits of the bottom-up approach to natural disaster management policy-making apply not only to implementation of the programme of action but also to the conceptualisation of the integration of disaster management to sustainable development agenda at the international level.

The Scientific and Technical Committee

The very important role of the Scientific and Technical Committee (STC) of the IDNDR was recognised as part of the comprehensive effort to integrate natural disaster management into sustainable development plans. The core group recognised early on that the work of the STC should be made 'accessible' to policy-makers, in order to provide the necessary scientific basis for policy decisions. The STC in turn readily incorporated the shift to sustainable development in their work programme.

In its Declaration in 1997, the STC reaffirmed 'the need for governments all around the world to integrate disaster reduction and risk management as essential elements of their development planning and sustainable development policies'. The STC put its weight behind the campaign to bring disaster management issues to the highest level of intergovernmental deliberations within the UN system, and to have a meaningful end-of-the decade event, which will ensure a continued co-ordinated approach to disaster management into the 21st Century.

The IDNDR Secretariat

Without the initiatives and constant support provided by the IDNDR Secretariat in Geneva, nothing much would have been

accomplished. The Secretariat gave the impetus for action, organised the core and contact groups' meetings, prepared the documentation and undertook the necessary consultations to stimulate the necessary national, regional and global steps to be taken for the implementation of the Yokohama Plan of Action.

Like the other agencies in the UN system, the IDNDR Secretariat had to cope with financial difficulties all throughout these last years. Here too, the focus on sustainable development objectives helped in mobilising donor support. Prevention and preparedness made for less damage in case of natural disasters, paved the way for better emergency relief delivery and rendered the work of rehabilitation and reconstruction more effective and long-lasting. For countries providing assistance at the international level, it is the most cost-effective means of dealing with disaster management. Along these lines, the emphasis on early warning, espoused in particular by Germany, gained particular momentum. Early warning means saving lives, minimising damage, facilitating emergency relief and rationalising reconstruction work.

International co-operation on disaster management did not take on the North/South divide that marks other sustainable development issues. Natural disasters occur in any country, whether developed or developing. International assistance is extended upon request of governments. Particular vulnerabilities of least-developed countries and small island developing States are fully taken into account in international action. The IDNDR remains guided by these basic principles of international co-operation in disaster management.

IDNDR within the UN system

The international co-ordinated promotion of natural disaster reduction activities within the UN system are institutionally located within the Office for the Co-ordination of Humanitarian Affairs (OCHA). The IDNDR Secretariat has had its headquarters at the UN Office in Geneva, where other humanitarian agencies are located.

Within the context of the ongoing restructuring of the United Nations, the IDNDR sought to find a place that would not detract from its humanitarian mandate, but at the same time firmly entrench it into the sustainable development agenda of the UN system. An Inter-Agency Steering Committee provides a future possibility for strategic planning with UN partners on disaster management policies and activities within the system.

One of the initial tasks of the core group was to reflect disaster management in the sustainable development agenda item of the UN General Assembly, moving it from the humanitarian agenda item. It therefore meant shifting the discussions on disaster management from the 3rd to the 2nd Committee of the UN in New York. Developing countries pooled their efforts to sponsor decisions, through the Economic and Social Council, for adoption by the UN General Assembly that would make the shift possible. Proper documentation was primordial in these efforts and the IDNDR Secretariat worked tirelessly to produce the necessary papers, subject to review by the interested countries. With the co-operation of all countries, the shift was accomplished without much difficulty.

Work also started early on the manner in which the IDNDR would conclude the decade. After a series of successful regional and key thematic conferences pertaining to the future of disaster prevention, the dominant feeling among many UN members has been one of consolidation of efforts, rather than a continuation of global, high-level conferences. The option of another world conference to end the decade was therefore put aside in favour of

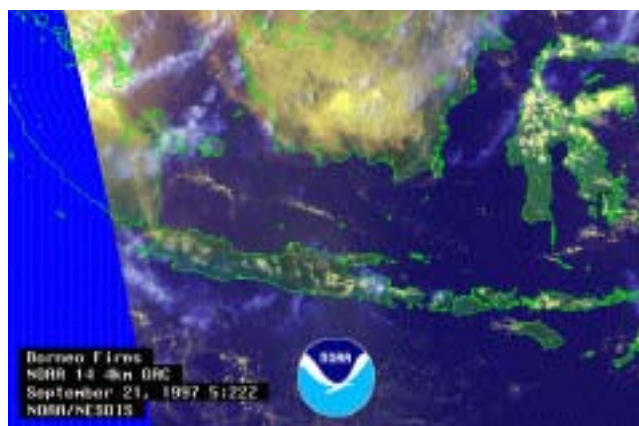


Photo: Satellite picture, NOAA

a 'closing event' which would emphasise achievements made so far, problems faced in implementation of the Plan of Action, evaluate solutions proposed and most importantly, pave the way for action on disaster management for the 21st Century. Such a Programme Forum is being held in Geneva in July 1999 which will also address the problem of a central focal point for action on disaster management at the international level.

Information dissemination and awareness-raising

Disaster prevention, preparedness and mitigation are built upon information dissemination and raising awareness among the local population, all stakeholders, the policy-makers and the media. For disaster management to be fully taken into the political agenda of States, the necessary information must be provided to all interested national sectors. Policy-makers must fully realise that action must be taken not only when disaster strikes, but, more importantly, before it occurs. This realisation promotes understanding of the need to incorporate disaster management into sustainable development planning. As is practiced in many countries, national committees on disaster management form part of inter-agency committees on sustainable development planning.

Another essential aspect of disaster management that puts it in line with sustainable development activities is the involvement of all sectors of the civil society. Effective implementation of disaster management policies can only be accomplished within the context of multistakeholder participation. A unique feature of the UN Conference on Environment and Development (UNCED) is the full and active participation of members of major groups, in particular non-governmental organisations, the private sector, and local authorities. The tie that binds them together is essentially composed of information sharing for consultations leading to policy-making and awareness-raising for effective implementation of these policies.

The way forward

As the decade comes to an end, it seems safe to assume that disaster management is fully accepted within the context of sustainable development. Achievements made along these lines should be consolidated at the highest policy forum at the international level. Agreement must be reached on the next steps to be undertaken to ensure that gains made are continued into the 21st Century. This should include the establishment of a permanent focal point within the UN system to undertake co-ordination of disaster management activities at national, regional and international levels. Natural disasters will continue to occur. The IDNDR has shown the way forward. We now all have the task of continuing along this path.

Natural disaster reduction in the 21st Century

Robert Hamilton, National Academy of Sciences, USA



Photo: Associated Press

As ash from the Mount Pinatubo volcano blocks the midday sun, Filipino tribesmen in Tarlac, north of Manila, cover their faces and flee villages at the base of the volcano in June 1991

IN 1999, HURRICANE MITCH devastated Honduras and Nicaragua and erased many years, if not decades, of economic development. This major disaster during the final year of the IDNDR not only vividly portrays the continuing threat posed by natural hazards, but also demonstrates the importance of implementing the various strategies for mitigating natural disaster impacts. Beyond the Decade, disaster managers and other decision-makers should move ahead aggressively to reduce future natural disaster losses. Drawing on the final report of the IDNDR Scientific and Technical Committee, the 25-member group of experts that guided overall programmes for the Decade, this article briefly reviews salient advances in mitigation methodology and identifies major challenges for the years ahead.

In evaluating the IDNDR, one must appreciate the concept of a United Nations 'Decade' or 'Year', of which there have been many. Such a designation highlights a specific issue and provides an opportunity for stakeholders to promote an enlightened approach for dealing with it. Decades or Years are rarely supported

with new funds, typically being designated as 'extra-budgetary' and depend on the willingness of organisations to focus resources on the issue and the enthusiasm of champions to put forth extra effort. The IDNDR followed this pattern and may well have been one of the better Decades. Many organisations in the UN System, as well as non-government, professional and national organisations contributed considerable effort. The questions at hand concern whether these efforts have achieved significant progress and are headed in the right direction.

Reducing natural disaster losses

There are three basic approaches for reducing the impact of natural hazards: avoid them, withstand their effects and share their impacts. Avoiding them requires information about where they are likely to occur, so structures can be placed elsewhere or people can move out of harm's way. Withstanding the effects of hazards requires building new structures, or strengthening existing ones to accommodate stresses caused by shaking from

earthquakes or pressure from wind, for example. Sharing the impacts involves spreading the burden of losses through mechanisms such as insurance or government assistance.

Effective implementation of these strategies depends on advanced scientific and engineering knowledge and effective implementation systems. Locating structures in safe areas is guided in some communities by a land-use plan that should be based on a hazard assessment, that is, an analysis of the location, frequency of occurrence, and likely effects of the possible hazards. Evacuating people requires a monitoring system to detect hazardous conditions, such as rising water or an approaching storm, plus a communications system for informing people about the appropriate actions they should take. Appropriate construction methods are usually embodied in building codes or in industry standards or practices. A sound insurance system requires an actuarial basis for setting appropriate rates to protect the financial integrity of companies, which increasingly utilise methodologies for estimating probable maximum loss.

Although strategies for mitigating natural disaster impacts are fairly well developed, they cannot be effective unless they are adopted and implemented. Officials in the government and private sectors must be convinced that a mitigation action is in the best interest of their organisations and can be justified on a basis such as cost effectiveness, public safety, or liability.

Assessment of progress

This assessment is based on the experience and observations of the author during the course of the Decade and addresses only a few selected topics. The intention is to identify the general state of mitigation practice as a prelude to defining future challenges.

Hazard assessment: The causes of natural hazards are sufficiently well understood to provide a basis for undertaking actions to mitigate their effects. Nevertheless, research should continue to advance the understanding of natural hazards in order to improve estimates of threats and to provide a sound basis for utilising limited resources for mitigation and preparedness actions. The regions of the world that are prone to natural hazards are generally well delineated and this knowledge provides the foundation for identifying the most threatened areas within countries. In some countries the threat can be characterised with sufficient detail to be useful in regional land-use plans; however, relatively few areas have a sufficient hazard assessment for local land-use planning and much more effort is needed for this purpose. A major problem is that regional, or local-scale hazard assessments that are adequate, are often not utilised in overall planning efforts.

Warnings: Capabilities for predicting the occurrence of natural hazards on a time scale useful for moving people out of harm's way — hours to months — vary from non-existent to fairly reliable. With respect to geologic hazards, earthquakes cannot be predicted with any useful degree of reliability, but indications of impending volcanic eruptions are often detectable and some predictions have saved many lives and reduced property damage, as was achieved for the Mount Pinatubo eruption in the Philippines during 1991. Tropical cyclones are tracked globally and their landfall is often predicted accurately. The successful prediction of the El Niño phenomenon during 1997–98 indicates an improving capability for predicting inter-annual variations in weather and related heavy-rainfall or drought conditions.

Predictions are not useful, however, unless they are translated into a warning and action plan the public can understand and unless the information reaches the public in a timely manner. The information provided can take a variety of forms depending on the nature of the hazard and the time frame involved, but the

information disseminated must be tailored for each specific situation and must be based on a well-conceived system for observation and analysis.

Over the last decade, the availability of information about natural hazards and disasters has increased enormously. This has occurred through new studies of these phenomena, an explosive expansion of global channels of communication and, perhaps most significantly, through the widespread availability of the internet in most parts of the world. Efforts are now needed to improve the quality of the data and to develop tools for merging and analysing data.

The ability for individuals and computer systems to communicate has also been transformed in recent years, and even greater opportunities appear in the near future. The improvement in telephone systems, their availability and data rates, coupled with satellite-based transmission systems is markedly changing the way information is exchanged.

Vulnerability and risk assessment: Hazard assessments are combined with inventories of structures and other facilities, plus demographic data, to produce risk assessments. A risk assessment identifies the most vulnerable areas or populations and can be used for allocating resources. Risk-assessment methodology is well established and is becoming more widely employed, for example, in the insurance and financial sectors for loss estimation. Common obstacles to its use are inadequate inventories and unreliable fragility data, that is, estimates of the degree of damage to various classes of structures for specified stresses or loads.

The factors affecting vulnerability vary considerably among populations, with the poor having the fewest options and limited resources to cope. They often occupy marginal or unstable lands, or inhabit sub-standard structures. Also, hospitals and schools often suffer disproportionate damage from natural disasters despite their fundamental importance to the well being of a society.

The increasing concentration of population in large cities poses a degree of vulnerability that can threaten the economic viability of a country or region. These megacities serve as hubs and centres for transportation, communications, financial and commercial activity, as well as government. The severe impairment of their functions can disable a country.

Sharing losses: Hazard insurance provides a means for spreading risks, but is not widely utilised for a variety of reasons. A major problem is the difficulty of assessing risk because many natural hazards occur infrequently, but with large losses; therefore, it is difficult to establish an actuarial basis for rates and to build financial reserves. A single natural disaster could ruin an insurance company, so most of them would prefer to engage in other lines of coverage. Substantial insured losses in the US caused by Hurricane Andrew in Florida during 1992 and the Northridge earthquake in California during 1994 prompted insurance companies to curtail coverage in those States. The availability of insurance can also have the effect of encouraging development in hazardous areas, for example, the barrier islands along the US Atlantic coast.

Whether hazard insurance could include incentives to encourage mitigation has been the subject of numerous discussions, but the premium reductions that could be realised by themselves may not be sufficient to motivate property owners. Linkage with favourable loan terms and exposure to liability for dangerous conditions may provide additional incentives.

Implementation: Unless the most senior government officials commit to implementing mitigation practices, as an investment in protecting assets and conserving resources, disaster reduction will be of low priority. History shows that without such leader-

ship, short-term crises will overshadow the long-term considerations and absorb the resources needed for effective loss-reduction measures.

Governments cannot sustain mitigation measures without broad public support. Many measures may appear expensive, at least in the short run, or add costs to construction projects. In other cases, landowners will not readily accept a decision to develop land in a manner that yields less than the optimum profit. In the face of these pressures, public understanding of hazards and an awareness of relative risks are essential considerations in choosing government officials who will implement sound policies that can protect community assets and resources.

As substantial financial resources in most countries are linked to economic development, it is important that natural disaster mitigation become an integral part of the development process. Officials must come to recognise that failure to consider natural hazards can jeopardise economic development itself.

Challenges for the 21st Century

As we move beyond the Decade into the 21st Century, efforts will continue to reduce natural disaster losses. The IDNDR Scientific and Technical Committee selected the following challenges to draw attention to major areas that require attention.

Integrated risk management and vulnerability reduction:

Communities and development organisations can reduce potential natural disaster losses by integrating mitigation measures into a comprehensive disaster prevention programme. Land-use plans and building standards are two of the major requirements for reducing vulnerability. Preparedness plans and warning systems are also essential elements. Mitigation can be effective only if it is accorded high priority and integrated into an overall planning and development process with organisations and government.

The reduction of potential losses depends on the commitment of both public and private leaders at all levels. It can be sustained by an understanding embedded within the community based upon public awareness. Consequently, the highest priority should be accorded to the development of public awareness to bolster commitment to natural disaster mitigation at the highest levels of all organisations.

Population concentrations and urban hazards: The global population is projected to exceed ten billion people by the middle of the 21st Century. This growth will be accompanied by an even greater rate of increase in material goods and facilities to support this population. Thus, exposure to natural hazards will steadily rise. Unless sustained actions are taken to reduce vulnerability, losses will continue to accelerate as has happened during the past thirty years.

The world population is concentrating in urban areas, which depend on complex infrastructures. Seventeen of the twenty largest urban areas are located in developing countries. Many of these megacities have difficulty coping with day-to-day problems and are poorly prepared to face the additional disruption and losses that a natural disaster brings. Furthermore, as population migrates into coastal areas and other previously unsettled hazard-prone areas, the exposure to natural hazards is compounded in many countries.

The infrastructure of megacities, including roads, pipelines, power grids, telecommunications networks, and similarly linked systems, are particularly vulnerable to natural hazards because a single break in the system can render the entire system useless. Barring specific capabilities for routing around disruptions, such as can be utilised in electrical grids, a system failure can trigger numerous other cascading effects in other linked systems.

Increasingly, communities will be faced with massive failure of essential systems.

The potential for disasters caused by natural hazards on a scale not previously seen is a possibility that governments must confront. The earthquakes at Tangshan, China in 1976, with about 250,000 fatalities, and Kobe, Japan in 1995 with losses in excess of 120 billion US dollars, are harbingers of the extraordinary loss and destruction that natural disasters can cause in a modern urban environment. Even greater losses are a real prospect, due to a sequence or combination of hazardous events, or the direct impact of an unusually severe hazard, such as Hurricane Mitch demonstrated. Governments need to devote serious attention to the risks such events pose and begin to implement long-term, sustained mitigation strategies in order to lessen their impact.

Environmental and resource vulnerability: Much past attention focused on the threat that natural and human-induced hazards pose to people and structures. However, their threat to habitat and various ecosystems demands a similar priority, especially as ecosystems are often the basis for various forms of economic livelihood. The production of food and various natural resources can depend on preventing ecosystem degradation.

The 1997–98 El-Niño phenomenon demonstrated how weather variability can cause natural hazards and stimulate human behaviour resulting in substantial impact on the environment and essential resources of land, forest, water and even air quality. The extensive and persistent effects of floods and drought around the world come immediately to mind, but landslides, wildfires with associated smoke and haze and other hazards, such as severe and adverse temperature variation, are also important in this respect.

Disaster prevention capabilities of developing countries:

Advancing the practice of disaster prevention depends on recognising the threat posed by natural hazards, evaluating options for addressing the threat, and assigning a priority for implementing appropriate measures. Experience shows that progress in this endeavour depends on a continuing dialogue between authorities in each risk-prone country or region and experts on the various aspects of hazard assessment and risk management. Therefore, every vulnerable country needs a national or regional expert capability for disaster prevention and mitigation.

It is equally important to recognise that foreign consultants cannot usually meet this need because they often are not able to articulate the issues and advocate appropriate actions as part of the national decision-making process. Therefore, high priority should be accorded to assisting developing countries in establishing these capabilities.

Assistance to developing countries for natural disasters is mostly for recovery in the aftermath of a calamitous event. Relatively small amounts of assistance are provided for avoiding disasters in the first place. Moreover, disaster mitigation assistance often takes the form of short-term technical studies and training, or equipment, which usually does not, in the end, actually increase the permanence of the developing capability because the people quickly move on and the equipment breaks down. A better way to build capabilities is through partnerships between institutions in developing countries and similar, counterpart organisations in industrialised countries.

A partnership needs to be a long-term relationship involving exchange of personnel and joint development of programmes and maintenance of instruments.

Co-ordination and implementation: By undertaking the IDNDR, the UN Member States cast a spotlight on the increas-



Photo: Tony Stone Images

The Kobe earthquake in Japan in 1995 caused widespread damage to property affecting the entire infrastructure

ing threat to modern societies of natural hazards. The Decade has provided a global opportunity to increase public awareness, to motivate official and professional bodies, to engage scientists and technical interests, and to stimulate commercial endeavours in the promotion of new programmes. This focus provided by the UN has, together with a series of some very costly and devastating natural disasters during the Decade, succeeded in increasing awareness of approaches to natural disaster reduction. Increased attention is being given to the matter by many international, regional and national organisations. As the end of the Decade approaches, the need for future responsibility and leadership in this area must be addressed.

Many organisations in the UN system have devoted substantial attention and resources to furthering the goals of the Decade. Although the effort was, at times, overshadowed by other crises, such as large migrations of populations during complex emergencies, the UN maintained a sustaining vigilance on the IDNDR. There is no substitute for continued attention to natural disaster mitigation activities by the UN system after the Decade. The programme areas of greatest priority are:

1. Advancing the frontiers of science and education
2. Implementing scientific and technical programmes to monitor hazards phenomena
3. Promoting and implementing mitigation as an integral part of economic development
4. Implementing preventive measures to promote public health.

The co-ordination function should be placed at a level to assure oversight of all organisations in the UN system during this phase of implementing and institutionalising natural disaster reduction. A multi-disciplinary and a multi-sectoral perspective are required. Various options could be effective, including establishment of an intergovernmental panel, a task force or a commission, combined with an appropriate level of staff support. Whichever form of co-ordination is chosen, the essential result must be that the relevant parties are brought together to implement strategies for reducing disaster losses in a co-ordinated, sustained approach.

Concluding observation

In launching the IDNDR, the United Nations drew attention to the importance of mitigation in reducing losses from natural hazards and disaster prevention. Numerous organisations have seized this opportunity, assisted by a series of disasters during the Decade that have vividly demonstrated the growing threats faced by modern societies. Mitigation concepts are being applied more widely than ever before, aided by a much-increased exchange of global experience spanning many different areas of professional endeavour. In many countries and organisations, mitigation and prevention practices are now achieving a priority approaching that previously reserved for emergency response and recovery. The time is ripe, as we move beyond the IDNDR, for increased implementation of loss reduction methodologies with the goal of disaster-resilient communities.

CASE STUDY

The future of disaster management in Central America

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NATURAL DISASTERS are consequences of phenomena produced by the dynamics of the Earth and its ever changing and evolving processes. From the viewpoint of society and the psychology of human beings, they are a serious disruption of the functioning of society that causes widespread human, material and environmental damage. These losses often surpass the ability of the affected society to cope unaided and with its own resources and for many countries they may considerably reverse their development efforts.

Natural disasters can be characterised by the probability of their occurrence and the past record of similar events, by the unavoidable amount of damage produced, by their cost to society and by the confusion and crisis they bring about in almost all activities of a region or country.

The type of preventive measures and preparation required to mitigate the impact of a natural disaster depend on the multidisciplinary analysis of the above characteristics. Special consideration must be given to fundamental aspects such as a) Anticipated planning and risk evaluation; b) Preventive and preparedness actions; and c) Crisis management techniques required for an effective performance during an emergency.

The organisation of a system of civilian protection and response to natural disasters and major accidents caused by human actions, requires clearly defined policies and guidelines, both for the institutional level and for conducting community organised participation.

On the basis of these policies proper planning, programming and implementation processes can be developed and structured. In this article, those elements and factors that emphasise the concepts of foresight, prevision, prevention and efficient performance in managing a crisis are addressed.

A natural disaster creates a typical crisis situation that follows this sequence of factors:

1. The occurrence of a natural phenomenon or event of certain magnitude and characteristics
2. The destructive effects on the physical infrastructure and the impact on the environment
3. The damaging consequences and disruption of the everyday activities of the people, including health problems and the loss of life

4. The negative economic effect, the set back of the long-range, developing economic policies of a country and the direct short-range damage to individual activities.

CENTRAL AMERICAN SCENARIOS OF RISK AND VULNERABILITY

Central America is prone to the occurrence of frequent natural disasters. The region is exposed to the ravages of climatic, tectonic and severe land degradation phenomena that create highly vulnerable areas. The region's geographical condition as a tropical isthmus, its geological structure, the fragility of its environmental and ecological systems, together with the patterns of distribution and location of the population and its productive activities, delineate vulnerable areas where natural disasters can produce extensive damage and high social cost.

As a result of the interaction between a complex weather activity and geomorphology, Central America experiences very frequent torrential rains and damaging strong winds provoked mostly by the Caribbean hurricanes. The major effect of meteorological activity is the recurrent flooding of the lowlands and the occurrence of dangerous flash floods in the mountain rivers.

Information and data records show that from 1959 to 1999, Central America has suffered the impact of 56 important hurricanes. The most damaging have been Hazel in 1954, Katie in 1955, Martha in 1969, Irene in 1971, Fifi in 1974 and Cesar in 1996. Gilbert in 1988 and Mitch in 1998, both classified as grade five, have produced a high number of victims and enormous socioeconomic and development damage.

Mitch affected the region by producing enormous quantities of rainfall that created a real catastrophe for Nicaragua and Honduras, and severe damage to Guatemala, El Salvador and Costa Rica. The flooding and large amount of landslides resulted in close to 10,000 deaths, and more than half a million people affected.

Costa Rica has experienced in the last five years serious, indirect effects from six of these hurricanes with close to one hundred deaths. Damages in infrastructure, housing and production systems are estimated to have cost nearly US\$ 550 million.

Central America is crossed by thousands of active and inactive faulting geological structures, some of them identified and some begging further study. These conditions determine the constant seismological activity and the frequent eruptions of the numerous active volcanoes in the isthmus region.

From 1970 to date, the area has experienced approximately twelve major earthquakes with magnitudes larger than 5.5. The most destructive ones have been in the cities of Guatemala, San Salvador and Managua causing at least twenty thousand deaths.

The natural resource base of Central America is, by nature, fragile and subject to the action of climatic and geological forces. This condition is aggravated by the problems created by human action, notably making inefficient and frequently irresponsible uses of the land. The concentration of people in the major towns, the poor practices of agricultural production and, especially, the high degree of deforestation in combination with the above-mentioned forces of nature, create a dismal panorama of vulnerability and physically insecure conditions for the development of a stable society.

POLICY AND LEGISLATION

The basic element for a reliable emergency management organisation respected and trusted by the people, is a good performance record. This requires solid policies and legislation; competent direction and co-ordination; qualified field leadership and strong community involvement and response. In order to attain these desirable goals, the first step is to have in place an effective and clearly articulated national policy statement to guide and provide the required enabling authority for the implementation of the aims and objectives of a prevention-oriented all-risk disaster management programme. This policy must include the notion of inserting concerns of risk management and vulnerability reduction into the social and economic strategies. It should recognise that disaster reduction is an ongoing process and not a single-event driven activity. It must also recognise that the approach to disaster reduction must be multi-sectoral and multidisciplinary.

In the process of developing policies and legislation for natural and manmade disaster prevention, there should be a special emphasis on incorporating in their innermost structure a holistic and thorough understanding of the following elements:

- Reduction of natural disasters is a strategic concept that aims at decreasing the loss of life and property and the socioeconomic disruption resulting from natural disasters
- The natural conditions that trigger the natural hazards such as hurricanes, prolonged rainy periods, droughts earthquakes and volcanic activity, among others
- The origin and implications of the man-made conditions like poor land management, inadequate agricultural production techniques, disorderly urban and commercial development of fragile areas, aggravated by massive defor-

estation, that lead to problems such as extensive floods and increased erosion

- The functions of policy and guidance generation on prevention and preparedness to mitigate the risks and effects of natural and anthropogenic disasters fall under the responsibility of governments and the corresponding technical authorities in charge of policy implementation and execution
- The responsibility and contribution of civil society as a whole
- The notion that a large portion of the effects, damages and costs of a natural disaster should be attributed to the high degree of improvisation and lack of planning and early warning before the occurrence of any of these events.

The most important elements of this policy should consider:

- Ways and means for the development of a specialised organisation providing criteria for assessing risk and probability of occurrence of natural or man-made disasters
 - Inducing and promoting the establishment of proper planning processes and criteria for analysis and establishment of preventive and responsive measures and also procedures
 - Developing technical and resource capability to be prepared to respond rapidly and efficiently to the impact of a crisis and to act diligently in the restoration of normal conditions
 - Co-ordination of institutions responsible for the tasks and functions corresponding to each one of the four phases or stages of an emergency
 - A proficient organisation system structuring the levels of authority and functional responsibility should be firmly established
 - Integration of regional efforts with neighbouring countries and close relations with international agencies dedicated to capacity-building and to providing assistance and support in disaster situations
7. Promotion and advice for the developing, revision, and updating of the necessary legislation to assure a proper framework for dealing with emergencies.

ORGANISATION AND IMPLEMENTATION

The havoc brought about by Hurricane Mitch has made very clear that the Central America region is not properly equipped to deal effectively with a major natural disaster, its impact and its consequences. For 1999, several important storms are being predicted that probably will affect the Central American Isthmus and the Yucatan peninsula. A special effort should be made to accelerate preventive and preparedness measures and instruments to face these probable events. The Costa Rican Emergency System, which has been evolving since the early sixties, separates the operations for a crisis situation in four groups or phases:

1. Preparedness activities
2. Response to the impact

3. Assistance and relief

4. Reconstruction and return of normal conditions.

In the first aspect, the effort should concentrate in preparedness as the key element to implement the policies for protecting the population and the infrastructure and productive systems. This is the basis for applying preventive and risk reducing measures. The second and third phases — Impact Response and Assistance and Relief — fall in the professional fields of established emergency, health and welfare institutions. These usually perform proficiently in their respective functions. The emergency agency should provide co-ordination and information for their tasks. The utility and transportation services, as well as the Red Cross and volunteer NGOs should be part of this effort.

The functions of an emergency agency should terminate at this point and the process of reconstructing and returning to normality should be absorbed by the regular sectorial institution such as the ones in charge of housing, infrastructure, agriculture, commerce, etc. Specific and clearly stated legislation is required to make the transfer of responsibility a mandatory task.

PLANNING AND PROGRAMME

An emergency agency should be essentially a strong co-ordinating centre in charge of marshalling, without attempting to duplicate the specialised functions of other institutions. It should be a relatively small and respected technical and managerial group, qualified to structure and direct a participatory system in which all the institutional resources of a country should take part, striving for efficient and economic utilisation of the national potential. Its work should be oriented to create formal agreements with all other governmental departments, with a clear understanding that the emergency agency does not intend to impose its authority over the rest of the institutions.

One of the best ways to attend a high level of participation is by establishing a planning and programming scheme with concrete and well defined tasks whose results can be evaluated, accounted for and incorporated, with the proper recognition, in the overall effort. Five groups of programmes are suggested:

1. A managerial and organising sector centred on policy implementation and oriented to the processes of preparedness, civil protection and preventive actions
2. A technical group of studies and investigations in the geographic, geological and hydrological areas, to identify risks and vulnerability conditions and advise on ways to reduce and mitigate them
3. A combined group of land management, agricultural, environmental and social sciences experts assigned to analyse the interrelations between man and nature. This

type of programmes should put special emphasis on the criteria of sustainable land use, resource management and population deployment and location

4. A group of programmes and projects oriented to organise, train and drill the personnel that should incorporate into their functions the different levels of direction and execution during an emergency

5. Another important programme must be oriented to cover the technological and communication areas, including the operation of a geographic information network and applications of telemedicine to emergency situations

CONCLUSIONS

One of the most difficult tasks is to convince the politicians, the decision-makers and the people in general that the areas in which they live are prone to natural disasters. There is the strong notion, because of the randomness and unpredictability of some of the natural hazards, that emergency relief and humanitarian assistance are the only measures at hand, serving the objective of helping victims to survive and recover and providing aid to the rehabilitation and reconstruction process. Advocacy and awareness raising effort must be oriented to all levels of society to insert, in the same manner as environmental awareness has successfully been incorporated into the Costa Rican society, the concepts which led to a natural disaster reduction strategy.

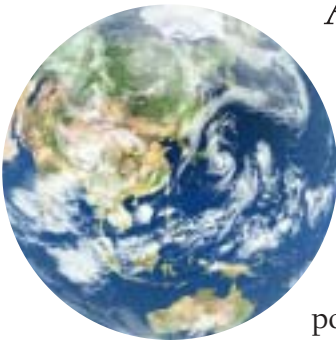
It is necessary to motivate, prepare and educate government officials, public service groups and the general population to realise that the one of the most important tasks of a society is to be aware that natural disasters do occur repeatedly, setting back the economic and social development efforts. It must be understood that natural disasters are a product of the interaction of a natural phenomenon and the socioeconomic environment. While natural phenomena cannot be prevented from occurring, human behaviour can certainly be influenced and in this manner vulnerability is reduced. This requires a clear set of policy statements with proper legal and co-ordination mechanisms for effective implementation, emphasising the need for preparedness and preventive measures as the only rational way to confront the reality of living in a natural disaster prone region. Thus, the need to move from a reactive to a pro-active approach towards natural disaster reduction is essential. This pro-active approach must incorporate the concepts of early warnings, risk management and reduction of vulnerability into the national and regional sustainable development strategies, so that disaster reduction becomes an integral part of the development process thereby ensuring the sustainability of the socioeconomic investment efforts.

ALL ABOUT

The European Space Agency

How it works, What it does, All its programmes

The idea of creating an independent space power in Europe goes back to the early 1960s — in July 1973, a ministers conference met in Brussels and laid down the principle of creating the European Space Agency (ESA) from the two European organisations already in existence, ELDO and ESRO.



SINCE THEN, THE ESA has acquired a total of 14 Member States (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom) and these countries are working together and pooling their resources to open up new pathways in space exploration and the development of advanced technologies for the nations of Europe.

Co-operation agreements have also been signed to allow Canada to participate in certain ESA programmes and sit on the ESA Council.

What ESA does

‘...to provide for and to promote, for exclusively peaceful purposes, co-operation among European states in space research and technology and their space applications, with a view to their being used for scientific purposes and operational space applications systems’.

ESA’s convention lays out the task of defining and putting into effect a long term European space policy that allows Europe to become and remain competitive in the field of space technology. ESA also endorses a policy of co-operation with various partners on the basis that pooling resources and sharing work will boost the effectiveness of its programmes.

ESA’s European space plan spans the fields of science, Earth observation, telecommunications, space segment technologies (including in-orbit stations and platforms), ground infrastructure and space transport systems, as well as microgravity research. Its role also takes in co-ordinating the Agency’s own work with the national programmes of its members, so that they can be progressively integrated within pan-European programmes.

ESA, which is basically a research and development organisation, also has an industrial policy that encourages competition and ensures that each member country will, for the investment it makes, enjoy a fair financial return and a fair share of the technological spin-offs.



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CHAPTER VI

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3. The Philippines has 220 volcanoes, twenty-one of which are active. Mayon Volcano is one of the most active volcanoes of the Philippines.
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The RADIUS initiative

The Radius homepage is: <http://www.geohaz.org/radius>

A decade of missed opportunities?

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Yokohama Message

States Members of the United Nations and other States



WE, THE STATES MEMBERS of the United Nations and other States, having met at the World Conference on Natural Disaster Reduction, in the city of Yokohama, Japan, from 23 May to 27 May 1994, in partnership with non-governmental organisations, and with the participation of international organisations, the scientific community, business, industry and the media, deliberating within the framework of the International Decade for Natural Disaster Reduction, expressing our deep concern for the continuing human suffering and disruption of development caused by natural disasters, and inspired by the Yokohama Strategy and Plan of Action for a Safer World,

Affirm that:

The impact of natural disasters in terms of both human and economic losses has risen in recent years, and society in general has become more vulnerable to natural disasters. Those usually most affected by natural and other disasters are the poor and socially disadvantaged groups in developing countries as they are least equipped to cope with them.

Disaster prevention, mitigation, preparedness and relief are four elements which contribute to and gain from the implementation of sustainable development policies. These elements, along with environmental protection and sustainable development, are closely interrelated. Therefore, nations should incorporate them in their development plans and ensure efficient follow-up measures at the community, national, subregional, regional and international levels.

Disaster prevention, mitigation and preparedness are better than disaster response in achieving the goals and objectives of the Decade. Disaster response alone is not sufficient, as it yields only temporary results at a very high cost. We have followed this limited approach for too long. This has been further demonstrated by the recent focus on response to complex emergencies which, although compelling, should not divert from pursuing a comprehensive approach. Prevention contributes to lasting improvement in safety and is essential to integrated disaster management.

The world is increasingly interdependent. All countries shall act in a new spirit of partnership to build a safer world based on common interests and shared responsibility to save human lives, since natural disasters do not respect borders. Regional and international cooperation will significantly enhance our ability to achieve real progress in mitigating disasters through the transfer of technology and the sharing of information and joint disaster prevention and mitigation activities. Bilateral and multilateral assistance and financial resources should be mobilized to support these efforts.

The information, knowledge and some of the technology necessary to reduce the effects of natural disasters can be available in many cases at low cost and should be applied. Appropriate technology and data, with the corresponding training, should be made available to all freely and in a timely manner, particularly to developing countries.

Community involvement and their active participation should be encouraged in order to gain greater insight into the individual and collective perception of development and risk, and to have a clear understanding of the cultural and organisational characteristics of each society as well as of its behaviour and interactions with the physical and natural environment. This knowledge is of the utmost importance to determine those things which favour and hinder prevention and mitigation and encourage or limit the preservation of the environment for the development of future generations, and in order to find effective and efficient means to reduce the impact of disasters.

The adopted Yokohama Strategy and related Plan of Action for the rest of the Decade and beyond:

- Will note that each country has the sovereign responsibility to protect its citizens from natural disasters.
- Will give priority attention to the developing countries, in particular the least developed, land-locked countries and the small island developing States.
- Will develop and strengthen national capacities and capabilities and, where appropriate, national legislation for natural and other disaster prevention, mitigation and preparedness, including the mobilisation of non-governmental organisations and participation of local communities.
- Will promote and strengthen subregional, regional and international cooperation in activities to prevent, reduce and mitigate natural and other disasters, with particular emphasis on:

Human and institutional capacity-building and strengthening

Technology sharing, the collection, the dissemination and the utilisation of information

Mobilisation of resources.

The framework of action of the International Decade for Natural Disaster Reduction provides all vulnerable countries, in particular the developing countries, with the opportunity to achieve a safer world by the end of this century and beyond. In this regard, the international community and the United Nations system in particular must provide adequate support to the International Decade for Natural Disaster Reduction, and its mechanisms, especially the secretariat of the Decade to enable them to carry out their mandate.

The Yokohama Conference is now at a crossroad in human progress. In one direction lies the meagre results of an extraordinary opportunity given to the United Nations and its Member States. In the other direction, the United Nations and the world community can change the course of events by reducing the suffering from natural disasters. Action is urgently needed.

Nations should view the Yokohama Strategy for a Safer World as a call to action, individually and in concert with other nations, to implement policies and goals reaffirmed in Yokohama, and to use the International Decade for Natural Disaster Reduction as a catalyst for change.