5

The distribution of environmental costs and benefits: Acid rain

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5.1 Introduction

This chapter discusses the issue of acid rain or, to use the more appropriate term, *acidic atmospheric depositions*, in Europe. Acid rain has become a recurring problem in many European countries over the past couple of decades. It not only causes environmental damage, but also leaves a huge cost in its wake.

The majority of depositions in most European countries come from neighbouring countries. At the same time, most European countries also emit acidic compounds themselves. Consequently, they may be regarded as both the victims and the culprits. Although this may seem to imply an equal sharing of the burden, this is far from the truth. The costs incurred by importing acidifying substances (through deposition) and the benefits reaped from exporting them are unevenly distributed across European countries: some end up as net sufferers, others as net beneficiaries. Solving the acid rain problem therefore demands international co-operation, as no country can solve its acid rain problems without the help of the adjacent producing countries. However, international co-operation is very difficult to pull off, as the interests of the countries involved may well conflict with each other. The present chapter seeks to describe and analyse the negotiation process from a political point of view. Particular attention will be given to the role economic costs and benefits play in this process.

Section 5.2 gives a description of the scientific and historical background of the acid rain problem. After a discussion of the recent history of the problem in various countries, consideration is given to the emissions, the sectors involved and the countries suffering from acid rain. This leads to an analysis of the problem posed by acid rain in political terms. A crucial feature of the analysis is the conception of air as a common property resource. Section 5.3 includes a description of the barriers that hinder the solution of the acid rain problem, placing particular emphasis on European strategies. Attention is also paid to the role of scientific uncertainty and traditional economic theories in the negotiating process. In Section 5.4, the fairly broad analysis as performed thus far is applied to the situation in a specific country, namely The Netherlands. Policies, actual measures taken and their effectiveness are all discussed. The chapter closes with a number of conclusions (section 5.5).

5.2 Atmospheric deposition

What is atmospheric deposition?

The main sources of atmospheric deposition include emissions of *oxidised sulphur compounds* (SO and SO_2, referred to collectively as SO_x), *oxidised nitrogen compounds* (NO and NO_2, referred to collectively as NO_x) and *reduced nitrogen compounds* (NH_3 or ammonia and NH_4^+ or ammonium, referred to collectively as NH_x).

Sulphur compounds are emitted when oil and coal containing sulphur (as they almost invariably do) are used as fuel. In other words, both oil refineries and coal-fired and oil-fired power plants emit sulphur oxides, with the amounts emitted depending on the amount of sulphur present in the fuel. Nitrogen compounds are emitted in various situations, especially when high temperatures are reached in power plants, oil refineries and engines (of motor vehicles in particular). Both these oxidised compounds may result in *acidic atmospheric depositions* (see Box 1) as a result of various chemical conversions. Finally, reduced nitrogen compounds such as ammonia are emitted when

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Why not speak of 'acid rain'?

When it became clear, at the beginning of the 1980s, that forests in Western Germany were dying off on a large scale, it was recognised that the acidity of the rain was to blame. It was then that the term 'acid rain' was coined. The term is, however, unfortunate. Firstly, it covers only a limited set of deposition types, whereas scientists soon discovered forms of deposition other than rain. Some acidic substances are precipitated (*wet deposition*), whilst others come down incessantly in the form of particles (*dry deposition*). Wet deposition includes rain, snow, hail and mist. The majority of the depositions, however, are dry rather than wet.

Secondly, the acidity of the wet deposition is relatively insignificant. In The Netherlands, for instance, rain is neutral rather than acidic, even though it contains oxidised sulphur (SO_x) and oxidised nitrogen compounds (NO_x). Their effect on the acidity of the rain, however, is offset by the alkalinity of the reduced nitrogen compounds (NH_x) that are also present. The neutrality does not prevent the compounds from doing their destructive work. After deposition, each compound undergoes specific chemical conversions that ultimately lead to the damage.

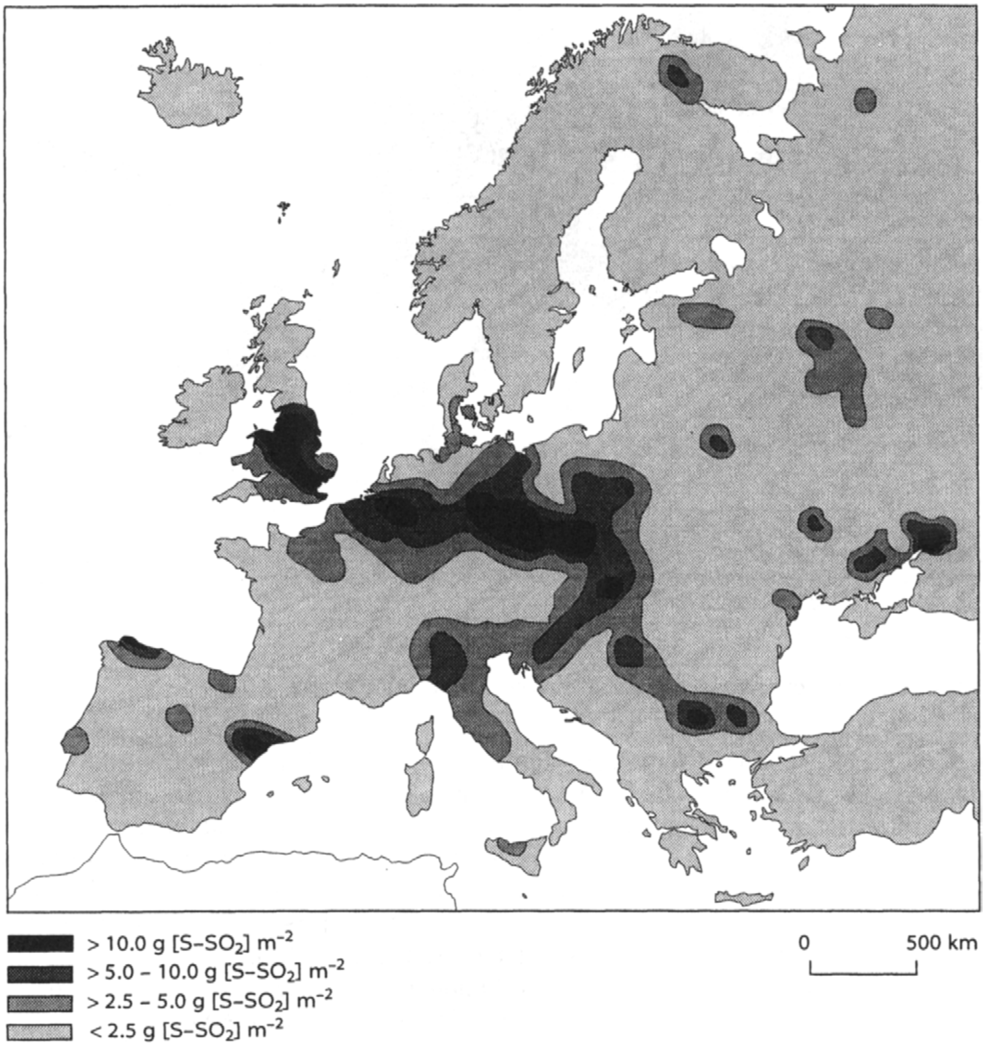
Thirdly, not all depositions are acidic. Some are alkaline and others may have a basically eutrophying (i.e. 'fertilising') effect. It is for these reasons that the term 'acidic atmospheric deposition' rather than 'acid rain' is preferred nowadays, although the less correct term is still in use.

Source: Ivens (1990).

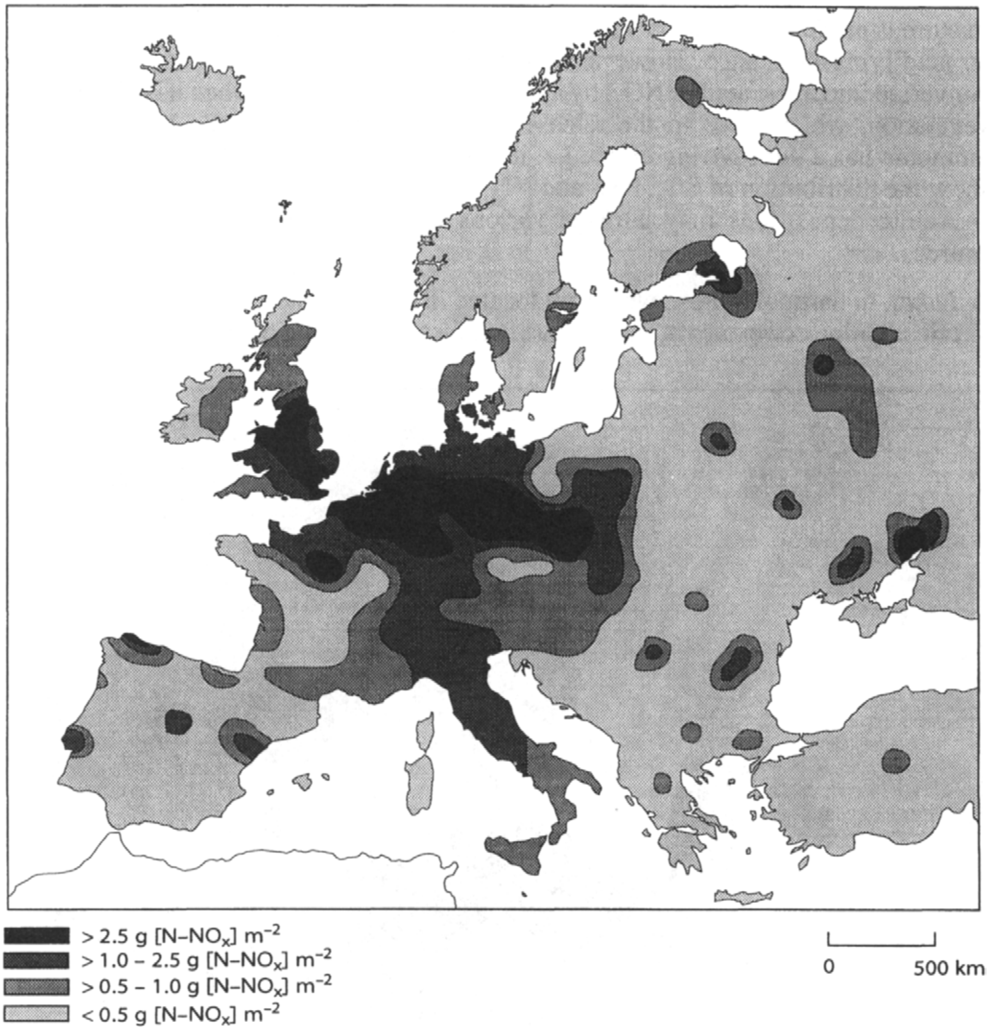
manure is produced by intensive cattle farming (see Chapter 1). Ammonia itself is not an acidifying substance. However, acids may be formed either when ammonia is converted into nitric acid (HNO_3) by nitric bacteria in the soil or when it is absorbed by vegetation, which leads to the release of (acidic) H^+ ions. In the latter case, the ammonia has a *eutrophying* effect, i.e. it works as a fertiliser. Maps 5.1, 5.2 and 5.3 show the distribution of SO_2, NO_x and NH_3 emissions over Europe.

Acidic depositions may damage various kinds of valuable environmental resources.

- *Lakes*, in particular those which are located in regions where the soil does not contain alkaline components, may be easily affected by acidic deposits. The damage is



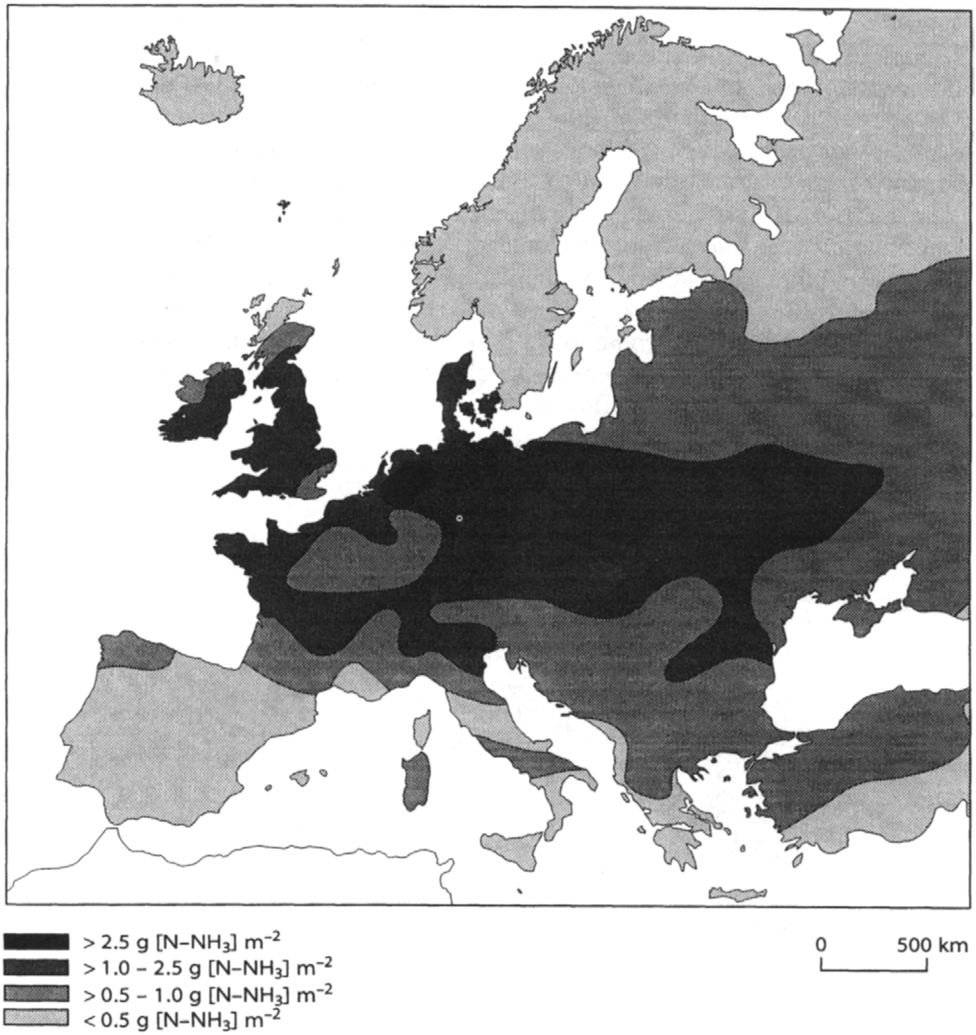
Map 5.1 SO_2 emissions in Europe. Source: Iversen *et al.*, 1989.



Map 5.2 NO_x emissions in Europe. Source: Iversen *et al.*, 1989.

done because the acid mobilises aluminium in the soil. In the springtime, when layers of snow contaminated with acidic substances melt, the aluminium is washed out into streams and lakes. Fish such as salmon and trout spawn at this time of year; their fertility is severely affected by the influx. Other animals and plants in the lakes are affected when the acidity of the lakes surpasses a certain threshold value. The end result of this acidification process is that the majority of the original organisms are no longer found in these lakes (Johannessen *et al.*, 1980).

- *Terrestrial ecosystems* are also affected. Although sandy areas in western, central and eastern Europe may be affected, most attention has so far focused on forest ecosystems. They are affected in two different ways. Firstly, they are affected *indirectly* through changes in the acidity of the soil. When a soil becomes more acidic, *cations*



Map 5.3 NH_3 emissions in Europe. Source: Iversen *et al.*, 1989.

(i.e. positively charged ions) that are vital for tree growth, such as Ca^{2+}, Mg^{2+} and K^+, are leached out, resulting in stunted growth. If the soil contains a high percentage of alkalic components, the acidification due to acidic depositions can be neutralised. This is not the case in large parts of the Alps, the mountain ranges of central Europe and the Scandinavian region. Also, the micorrhizas (i.e. vital fungi in the soil associating with the root systems of plants) are damaged by an increase in acidity. Trees can no longer absorb the nutrients they need, again resulting in stunted growth. Secondly, even if the soil is alkaline and the effects of increased acidity are buffered away, trees can still be affected by the *direct* influence of acidic substances on their needles and leaves. This damage hampers the intake of the carbon dioxide and oxygen which the plants need to absorb from the air for their metabolism.

- In most cases, acid rain does not kill trees but simply makes them more vulnerable to various types of disease and insect. Trees become unable to cope with many, otherwise normal, environmental influences (which is why acidic deposition is often referred to as an *environmental stress*). The result is that trees die on a massive scale, as has occurred in the Black Forest and the Harz mountain range in Germany, in many parts of the Northern and Central Alps and in the forests of Slovakia, Poland and former East Germany (MacKenzie and El-Ashry, 1989).
- It is not only trees that suffer from acidic depositions on the soil. In *nature reserves*, it is also vital that the soil itself is able to function properly. As has already been mentioned, atmospheric deposition may also have a eutrophying effect through the agency of the nutrients it contains. In particular, the ecological value of nature reserves such as peat moors, where the level of the nutrients is normally low, may be affected dramatically by an influx of nutrients.

Plate 5.1 Forest devastated by acid rain in the vicinity of KarlovyVary in the Czech Republic. Photo: Giri Polacek/Lineair

- Acid rain affects the surfaces of *historic buildings and monuments* such as ancient churches, houses, statues and bridges. The damage is particularly great in areas where the type of stone used is extremely vulnerable to acidity, such as Vienna. NO_x and NH_x deposits may ultimately increase the nitrogen content of *groundwater bodies* used to produce drinking water. This threat is particularly significant in regions in which there is intensive cattle farming, as the surpluses of manure and artificial fertilisers add to the overall concentration (see Chapter 1). Deposits from traffic only worsen an already dangerous situation. In The Netherlands, for example, an increasing number of wells that are used for the production of drinking water have recently been closed owing to dangerously high levels of nitrogen.

  Acid rain has also had a considerable effect on vegetable *crops* in many parts of Europe (MacKenzie and El-Ashry, 1989; Van der Eerden, Tonneijck and Wijnands, 1986).

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Reducing NO_x emissions from cars: beating the competition

Most of the cars produced in the Federal Republic of Germany have traditionally been (and indeed still are) relatively large and high powered. The UK, France and Italy have concentrated on smaller cars. Germany dominated the market and the position of manufacturers from the other countries was weaker, with the UK car producers being the weakest. All, however, were united in their efforts to ward off competition from the USA and Japan.

It has been Germany which has suffered most from the effects of acid rain and it was Germany which took the initiative within the European Union in proposing an agreement on the reduction of vehicle emissions. All the various proposed measures would, however, have increased the net price of cars. The UK, France, and Italy were afraid that higher prices would result in a loss of market share. They therefore opposed any plan which was aimed at reducing car emissions.

Basically, there were two instruments for reducing emissions: lean-burn engines and catalytic converters. Lean-burn engines emit fewer pollutants as they are more fuel efficient than ordinary engines (they run on a lower petrol-to-oxygen ratio). Catalytic converters had already been introduced in the USA, where they are now mandatory and have resulted in emissions being reduced by 90%. The maximum reduction in emission levels achievable by using lean-burn technology, however, is only 70%. This implies that a reduction of over 70% can be realised only by fitting cars with catalytic converters. After a long period of negotiation on the necessity of strict reduction targets, the European Commission finally decided that a high reduction percentage was vital. This implied a preference for catalytic converters, an approach which gave Germany two advantages. Firstly, it meant better protection of its forests and secondly, it gave the German motor manufacturers a competitive edge. After all, Germany was already experienced in the field of catalytic converters, as it had been exporting its cars to the USA where converters had been obligatory for some time. The lean-burn engine, on the other hand, had been developed in the UK.

Source: (Dietz *et al.*, 1991).

In the early days, when the scientific process of acid rain formation first began to be understood, sulphur dioxide was perceived to be the main culprit. Emissions of NO_x received hardly any attention at that time. However, the situation has since changed rapidly. Not only has scientific understanding of the problem grown steadily, with researchers identifying a more prominent role for NO_x, but the nature of the problem itself has also changed. The rapid increase in the number of motor vehicles has ensured that NO_x takes up a larger share of total emissions. The European Union has given explicit consideration to the problem of reducing NO_x emissions from motor vehicles. It has established a low limit on the permissible level of NO_x emissions from cars, thus effectively forcing car manufacturers to fit their products with catalytic converters (see Box 2).

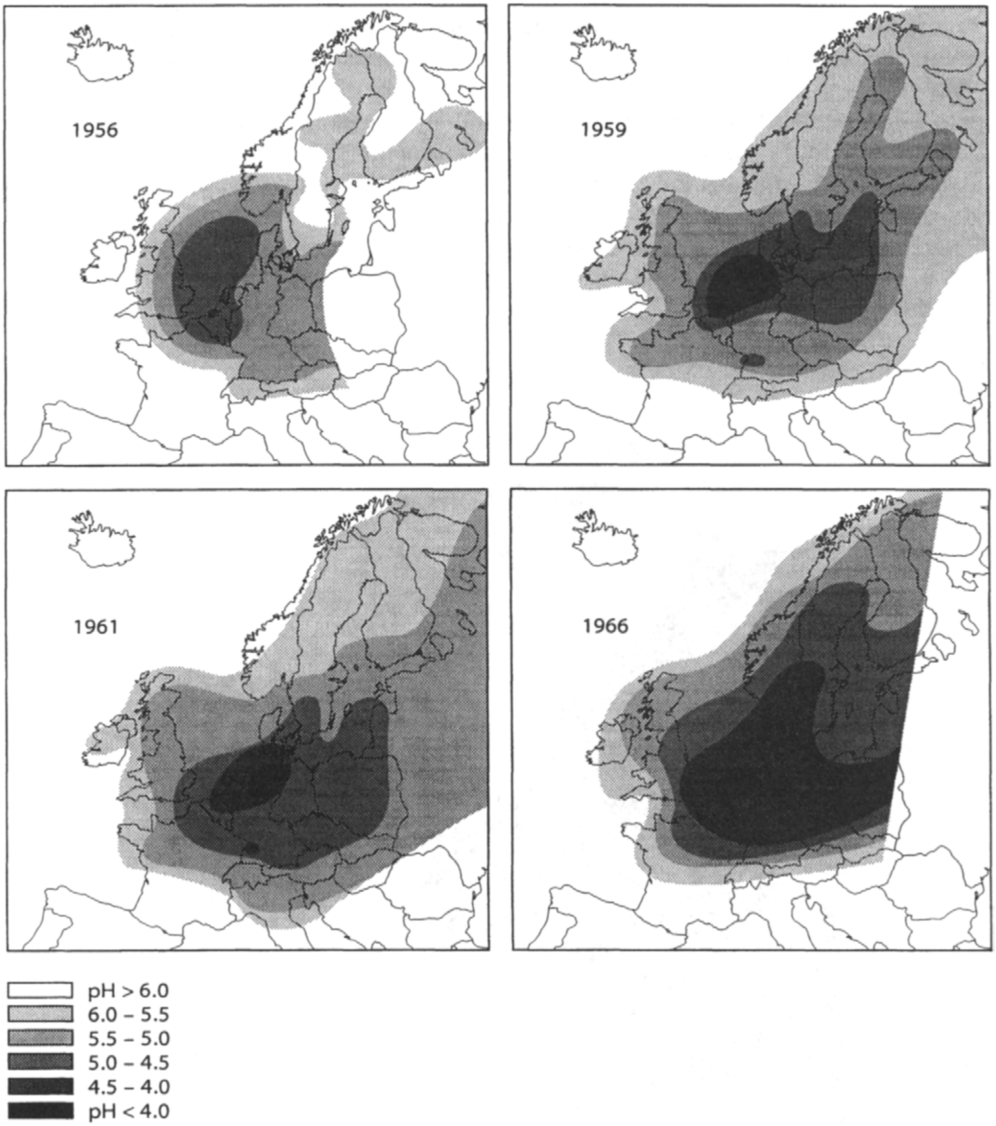
How did atmospheric deposition come about?

Air pollution has been a normal companion of industrial development ever since the advent of the Industrial Revolution. As early as 1872, in his book entitled *Air and Rain: the Beginnings of a Chemical Climatology*, Robert Smith gave a description of air pollution. He demonstrated that polluting emissions were transported over long distances, causing damage to areas far away from the location of the emitters. The book did not attract much attention at the time. One possible reason for this is that, although the effects of air pollution had been felt in the direct vicinity of industrial plants, it was not perceived as a problem in areas further away.

The situation changed dramatically following the Second World War, when the industrial development of Europe shifted into high gear. In this period, air pollution began to affect public health on a wide scale. Higher than normal mortality rates were registered during periods of smog, for instance, in areas such as Greater London in the UK and the Rijnmond region around Rotterdam in The Netherlands (Jansen *et al.*, 1974). As a result, air pollution became a national health problem. In the 1960s, an attempt was made to solve it by building tall chimneys.

Obviously, the taller chimneys only led to the pollutants being dispersed over an even wider area. Indeed, as early as the beginning of the 1960s, scientists were expressing their concern over the construction of tall chimneys (Baker and Macfarlane, 1961). They felt that such action would only spread pollution over the whole of Europe, as it indeed did (see Map 5.4). Alongside the almost explosive rise in road traffic and the growth in polluting industrial farming practices (see Chapter 1), air pollution has now become a problem of *international* proportions.

The spread of air pollution across national borders has a range of consequences. Ecosystems have been affected, many of which are not capable of coping with the threat. The death of large numbers of fish in Scandinavian lakes is a typical example and it attracted a great deal of attention in the Scandinavian countries in the 1960s (Odèn, 1968). Sweden suffered particularly badly from air pollution and ensured that the issue was placed on the agenda of the United Nations Conference on the Human Environment which was held in Stockholm in 1972. Sweden argued that the damage caused to Swedish lakes was a result of acidic emissions from industrial plants in Poland, Germany, the UK and The Netherlands and asked for the emissions to be reduced. The alleged perpetrators were not prepared to comply, claiming that there was no proof that they were responsible for the damage. The Swedes, however, persisted



Map 5.4 The increasing acidity of precipitation in Europe. Source: Vermeulen, 1977.

and an agreement was reached that international research would be conducted so as to gain more insight into the problem.

The initial results of this research were published by the Organisation for Economic Co-operation and Development in 1977 (OECD, 1977). It became clear that transboundary air pollution was a very common phenomenon. The deposition of acidifying substances from abroad accounted for more than 50% of total depositions in countries such as Norway, Sweden, Finland, Austria and Switzerland. This implied that their problems could be solved only by cutting emissions elsewhere, as the Swedes had already requested. In short, the OECD regarded international co-operation as the only means of finding a solution to the problem (see also Hordijk *et al.*, 1990).

However, there were a number of stumbling blocks in the path towards co-operation. One was that many countries with high levels of emissions, e.g. the former Democratic Republic of Germany, Poland and Czechoslovakia, were not members of the OECD. This meant that other organisations would have to take the lead. And indeed, the United Nations Economic Commission for Europe (ECE), of which all these countries were members, stepped in.

Plate 5.2 Liming by helicopter to neutralise acidification in Lake Bergsjon, near Göteborg, Sweden. Since Sweden started full-scale liming in 1982, 5,500 lakes, as well as 100 streams and rivers, have been treated. The operation costs SKR 100 million a year. Sweden would have to spend three times that amount in order to treat all the acid-effected areas. Photo: Mark Edwards/Lineair

The first conference on the formulation of a European policy for the protection of clean air was convened in Geneva in 1979. Agreement was reached on general principles such as the dissemination of information and technology, the significance of public health and the necessity of reducing emissions. However, it proved impossible to agree on specifics such as the type of action to be taken and the scale and distribution of the costs relating to these measures. The problem of the uneven distribution of benefits and costs among countries formed a major obstacle. It took six years and a succession of conferences before agreement was finally reached at Helsinki in 1985 to aim at a flat 30% reduction on 1980 levels of all transboundary SO_2 emissions. The Helsinki conference was followed by a conference in Sofia in 1988. The ECE again took the initiative for this conference, where the European countries agreed in principle on a standstill with regard to NO_x emissions.

All in all, the negotiations on the question of how to put a lid on air pollution in Europe lasted for many years. There are several reasons for the length of this delay. The first hurdle to be taken was the question of how to set *priorities*. Should priority be given to achieving a reduction in emissions with the strongest adverse effects on European ecosystems, as some argued? This would mean that the worst cases would be tackled first. The Southern European countries in particular supported this standpoint, given that, with their low emission levels, they could afford to stand on the sidelines. Or would it be best to give top priority to those emissions that could be reduced at the lowest cost? In that case, the emphasis would be on obtaining the best value for money, i.e. maximum cost-effectiveness, and an entirely different set of countries would now be required to take action.

Another obstacle related to the *validity of the arguments* used to justify particular measures. For example, some countries argued that they had recently taken rigorous measures. They therefore saw no reason to reduce their emissions by the same percentage as other countries which had hardly reduced emissions at all. Also, there was disagreement over the year of reference. Those countries that had already taken strict measures wanted a year of reference early enough for their recent endeavours to count against the required 30% reduction. Finally, some countries, such as the USSR, were of the opinion that only transboundary pollution (and *not* internal emissions, which they regarded as a domestic problem) should be taken into account.

5.3 Conflicting interests

The previous section briefly discussed the science of acidic atmospheric depositions. It also showed how the depositions came to be recognised as a problem and what political attempts were made to find a solution. This section takes a further look at these efforts, not with an eye on their historical significance but from the perspective of their political relevance. More specifically, there is a need to be aware that attempts to solve the problem of acidic atmospheric depositions met with fierce resistance and that various countries used their political power to stall the negotiations. But why is air pollution such a difficult problem to tackle? What are the barriers to its solution? These are the questions that we shall now be addressing.

Clean air: a common property resource

The key to the answers to these questions lies in the specific characteristics of air when it is viewed as a resource. Since time immemorial, it has been taken for granted that unpolluted air is available for everyone to make use of, much like clean water, ample fish stocks and the biosphere's capacity to process organic waste have been taken for granted. (Of course, there have always been places where the air is unfit for breathing, the water unfit for drinking, fish scarce and wastes hardly decomposed. However this does not detract from the general validity of the statement.) It is a characteristic of such resources that they can all be used by everybody, since nobody in particular owns them. In theory, they can all also be used without diminishing their potential utility for others. Such resources are known as *common property resources.*

It has become obvious, however, that unlimited use does detract from the utility of these resources. Both air and water may be polluted, fish stocks may be depleted and the biosphere's recycling capabilities may be compromised. As the *value* of these resources is beyond doubt, there is a general consensus that someone should speak up on their behalf. Since nobody owns them, however, it cannot be the owner. Moreover, if some individual economic actor stood up and invested in measures to guarantee their quality and quantity, he or she would only stand to lose. After all, while all the costs would be incurred by the one actor alone, the benefits would accrue to all users, both actual and potential. This is hardly an incentive for making the investment. The only solution is collective action, for example at governmental level (see also Van der Straaten and Gordon, 1995, pp.130–58).

While it is possible to see how governmental action could protect, say, inland fish stocks, the same strategy does not work for fish stocks in international waters. So, although the UK may have been successful in re-establishing salmon stocks in the River Thames solely by means of national regulations, The Netherlands would not be able to pull off the same result with respect to the Rhine without international co-operation. In other words, whenever a problem with respect to a common property resource exceeds the boundaries of one nation, international co-operation is imperative. And indeed, this maxim applies to the problem of atmospheric deposition, both in Europe and elsewhere. After all, the prevailing winds carry the pollutants across national borders, from the UK across the North Sea into Scandinavia, from The Netherlands into Denmark and Germany, from Germany into Finland, and so on.

In sum, clean air is a common property resource. Only through collective action can it be preserved. As air pollution crosses national boundaries, collective action implies international co-operation. International co-operation is a far from easy task, however. There are political, scientific, and economic barriers that have to be overcome.

Barriers to international co-operation

Barriers to international co-operation come in many different shapes. There are political barriers, scientific barriers and economic barriers. We shall discuss these in turn.

The main stumbling block on the road to international co-operation on acid rain is of a *political nature* and springs from the *uneven distribution of the costs and benefits.* A situation in which one group of countries is required to pay for the profits made by another group is not conducive to a swift negotiating process. The picture that emerges of the actual distribution of costs and benefits, however, is even more complex than that of one group opposing another.

Firstly, countries such as Switzerland, Austria, Sweden, Germany and The Netherlands suffer significantly from the deposition of acid rain on their territories. The damage may be exacerbated by the specifics of the local situation. Only alkaline soils can neutralise acidity. In countries such as Spain, Greece and Italy, where most soils are alkaline and acidic deposition is relatively low, the damage has been relatively minor. These countries therefore do not have a strong inclination to abate acid rain. The damage caused by acid rain in Northern European countries, on the other hand, is significant. Not only is the soil more vulnerable, the amounts deposited are much larger, too. In other words, it looks as if most costs are incurred by the Northern countries, whereas the Southern countries secure the full benefit of their polluting activities.

Secondly, the costs of abatement are not the same in every country because of the differences in the structures of their economies. For instance, the power plants in the Eastern areas of Germany, Slovakia and Poland use lignite as a fuel. This results in considerably more acidification than the modern power plants operated by most Western European countries or the hydroelectric power plants in Switzerland and Austria. So if the European Commission were to decide that all power plants located in the European Union must reduce their emissions to a certain level, this would lead to a rise in costs in all countries, particularly in those in which lignite-fired power plants are used. And, of course, such a policy would enhance the competitive position of the Western European countries even further.

Lastly, the benefits of the abatement policies, once implemented, differ from country to country. Southern countries with a low level of damage from acid rain will not receive high levels of benefits if measures are taken on a European scale. If, for example, European emissions are reduced to a level that, say, will stop the forests in Germany and The Netherlands from dying off, these countries will collect the benefits of the abatement policies. No benefits will accrue to the erstwhile polluters, who have no doubt been compelled to invest heavily in upgrading their industry and conforming to stringent environmental regulations.

Negotiations to bring down pollution levels will undoubtedly be slowed down by this complex pattern of benefits and costs, as one may expect conflicts to arise over how much should be done by whom. The trick is to find an *optimum point of reduction* at which the costs of environmental measures equal their benefits. Only then is there a chance of an agreement being reached between the parties to the debate. In order to do this, however, one needs to know what the levels of costs and benefits are. Unfortunately, for various reasons, such knowledge is not easy to obtain. Uncertainties and other problems abound, not only at a scientific level but also, and predominantly, at an economic level.

Finding out what damage is done at particular deposition levels presupposes that one has knowledge of so-called *dose-effect relations*. Such relations describe, for example, what damage is done to the forests in western Germany at a variety of deposition levels. There are, however, *scientific barriers* to the investigation of such relations. When it became clear, for example, at the beginning of the 1980s, that the forests in western Germany were dying off, it still took several years before it was generally accepted, based on the results of scientific research, that acid rain was indeed the cause. Even now, not all aspects of the process which causes these woods to die off are fully understood. This provides plenty of opportunities for polluting industries and countries to stress that it is impossible to make reliable calculations of the costs because of the scientific uncertainties that still surround the problem.

An argument that is often used for the same purpose is that environmental countermeasures should not be taken as long as all cause-effect relations are not known. After all, the future might reveal new facts and relations in the light of which the proposed action may prove counter-productive. In other words, the actual costs and benefits may differ from the costs and benefits as currently anticipated. It should be pointed out, however, that, in nearly all cases, these arguments are used by those groups or sectors of society which stand to profit from the present situation.

We shall not go into the validity of these arguments. Suffice it to say that, clearly, they may be effective in stalling negotiations. Other, even more powerful arguments may also be used for the same purpose.

There are also uncertainties ensuing from the difficulty, *economically* speaking, of placing a value on the interests affected. This is clearly a problem where there is a need to calculate the cost. What is, for example, the value of an undisturbed forest ecosystem? Of course, there is a consensus that forests have an economic value resulting from traditional economic activities such as logging. However, forests also have an economic value resulting from their use for recreational purposes. But how is it possible to assess this value? And is there an intrinsic value to Nature, as some indeed argue, which has to be calculated too? These questions are difficult to answer. Nevertheless, it will not do to argue that economic value should therefore be restricted to those elements of value which can easily be calculated (see also Box 3). This problem alone may prevent us from calculating the optimum point of reduction.

Valuing environmental resources

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The value which society attaches to natural resources and the environment is not merely the sum total of all the various individual values. Since society has a much longer life expectancy than individuals, society as a whole has values that are likely to deviate from individual values. In addition, an approach based on the summation of individual preferences may imply the extinction of species and ecosystems. All these arguments support the position that the environment is a *merit good*, not merely to be decided upon by the aggregation of individual values and the estimation of willingness to pay at any particular point of time (Opschoor, 1974). This may, at the collective level, lead to the explicit formulation of conservation policies. In this case, economic development must be directed explicitly towards ensuring the sustainability of natural resources and the quality of the environment.

Source: Klaassen and Opschoor (1991).

In order to avoid such a situation, attempts have been made to find a proxy for environmental costs that defy direct economic valuation. In The Netherlands, the ministry responsible has calculated that environmental costs would rise in the short run from 0.35 to 1.1 million guilders (Minister of Public Housing, Physical Planning and the Environment, 1983–4, p.20). These costs may be attributed to agriculture, nature conservation, forestry, drinking water and the protection of ancient buildings and paintings. Recent investigations by scientists at the Agricultural University of Wageningen have made it clear that the costs in the agricultural sector have been underestimated. The costs of acidic depositions have been estimated at 0.87–1.67 billion guilders per year in this sector (Van der Eerden *et al.*, 1986). One should not overlook the fact that the effects of acidic depositions on forestry have been only partly monetarised and that their effects on recreation and tourism and on the value of nature reserves and ecosystems have not been monetarised at all. This implies that the level of the monetarised costs in The Netherlands will be between 1.2 and 2.8 billion guilders. The cost of the disruption of ecosystems is also difficult to indicate, but it seems safe to say that it is substantial. In sum, then, the monetarised and non-monetarised costs are considerable.

Yet another barrier stems from the still widely accepted misconception that environmental problems are not real economic problems. According to this view, economic problems always involve market transactions in one way or another. They are problems of *labour* and *capital*. There is no recognition whatsoever of the close connection between modern environmental problems and market processes. Although, for instance, the economic losses, caused by acidic depositions, to the natural assets of countries such as Switzerland, Sweden, Austria, The Netherlands and Germany are difficult to calculate, it is clear that the economies of these countries incur a loss equivalent to many billions of guilders. The same type of argument can be used when discussing measures aimed at reducing the greenhouse effect, deforestation, the use of pesticides, the pollution of rivers, seas and oceans or nuclear pollution. These environmental phenomena are all associated with a high level of cost. This, indeed, is the very reason why an environmental policy will result in substantial benefits.

Nevertheless, the prevalent opinion in economic literature, and in the public debate for that matter, is that we have 'the economy' on one side and 'the environment' on the other. In other words, the imposition of environmental standards will harm the economy. It is this type of argument that is used primarily by vested economic interests to prevent or put off the implementation of instruments of environmental policy. Where this mode of reasoning is dominant, it is difficult to bring environmental problems to the centre of public debate. This is particularly true where traditional economic problems such as unemployment are relevant. Public debate will then be concentrated on these issues.

There is yet another debate about the foundations of economic theory that impinges upon environmental policy making. Traditional neoclassical (economic) theory is based on an assumption that economic agents behave in a rational way. Major problems arise when dealing with environmental issues, however. This is linked to a fundamental limitation of rational choice theory in the context of environmental issues. In general, the optimisation strategy of rational choice theory implies that production factors are allocated according to the preferences of the economic agents, thereby satisfying as many needs as possible. Put simply, industry produces as much as it can of what consumers want. The same strategy applies to the management of natural resources: resources are used as needed. The present allocation of natural resources is, however, not optimal, as is demonstrated by the degree of undesirable environmental degradation. The neoclassical remedy is to restore optimum resource allocation, for example by means of price manipulation. However, there is considerable doubt as to whether this optimisation philosophy is equally applicable to goal setting in environmental policies (Opschoor, 1987). What is often lacking is essential information on the environmental effects of human actions.

If the effects of so many interventions in Nature are not sufficiently known or are consistently disregarded, an optimum use of natural resources for human production and consumption, as neoclassical analyses and policy recommendations presuppose, becomes problematic. The point is that neoclassical optimisation requires an insight into the effects of alternative behaviour towards Nature with a probability bordering on

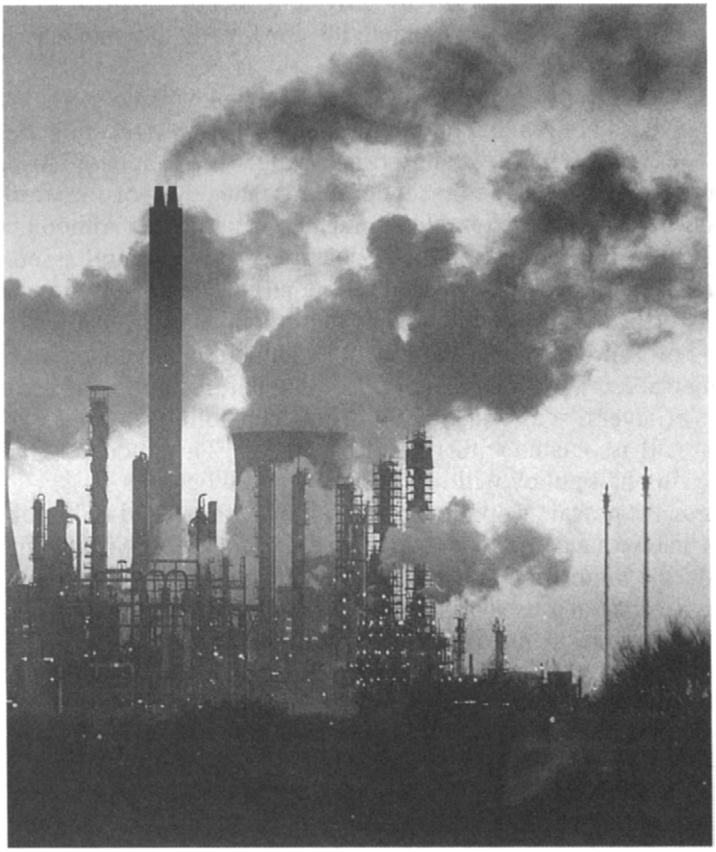

Plate 5.3 Port Talbot, in South Wales, United Kingdom. Extremely severe pollution from industrial plants here not only falls on residential areas, causing increased local incidence of illness, but is also carried long distances, thereby contaminating both the land and the sea. Photo: David Hoffman/Environmental Picture Library

certainty or at least with a probability that can be calculated using the theory of probabilities. The former is the familiar assumption of the existence of fully informed agents and simply ignores the problem of inadequate ecological knowledge.

For various reasons ecosystems can change far more capriciously than economists normally assume. Thresholds, synergetic effects and delayed effects cloud the issue of the relations between emissions and the deterioration of Nature (see Box 4). The neoclassical approach to optimising the use of natural resources is therefore pointless, as the quantity of the natural resources available cannot be accurately assessed, at least not at present. In other words, we cannot optimise the use of natural resources as long as we do not know the specific limits beyond which irreversible effects on Nature will occur. Again, we meet with uncertainty, although in this case its importance is less obvious (though no less relevant).

These arguments all influence the political bargaining process. An additional factor is the fact that industries are in a privileged position with respect to governments. If a polluting industry in a certain country has been able to build up a comfortable competitive position by discharging polluting substances into the air free of charge, such an industry will put pressure on the national authorities in order not to have to relinquish this position. Other forms of pressure can also no doubt be exposed. Suffice it to say, however, that negotiations seeking to protect and maintain common pool resources have to align many conflicting interests. They are therefore difficult to conduct and may well take a long time before being completed.

Problems of prediction

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In general, processes in Nature, and hence human interventions in these processes, are extremely difficult to predict for at least three reasons. Firstly, *synergetic effects* increase the impact of individual emissions on the environment. For example, laboratory experiments have shown that the combined impact on plant growth of the acidifying substances SO_2, NO_x and NH_3, together with ozone, is substantially more severe than the sum total of the impacts of each of these substances separately (Tonneijck, 1981).

Secondly, *thresholds* are very common in ecosystems. Again, acidification serves as an excellent example. As far as most people were concerned, the sudden acceleration in the deterioration of forests and the subsequent death of large tracts of European forest at the beginning of the 1980s came like a bolt from the blue. Apparently, the buffering capacity of the soil had protected trees from serious damage for decades. Once a saturation point was reached, acidifying substances could cause considerable damage to trees, making them vulnerable to many plagues and insects and resulting in so low a resistance to normal conditions that some trees died in just a few years.

Thirdly, many emissions have a *delayed effect* on the environment. It takes decades, for example, before the nitrogen from manure and chemical fertilisers is washed from the top soil into deeper layers, causing severe nitrate pollution of the groundwater, which in most countries is used as a source of drinking water. Even if nitrogen leakages into the groundwater could be stopped, nitrate pollution of groundwater would still continue to increase considerably well into the next century.

In order to gain a better insight into how such negotiations are fed by national policies and how they, in turn, feed into national policies, we will now turn to a discussion of Dutch national policies from the 1980s onwards.

5.4 Dutch acid rain policies

Prior to 1970, air pollution was regarded principally as a threat to public health. In industrialised regions, emissions of SO_2 in particular caused high concentrations of pollutants in residential areas. The aim of the abatement policy was to reduce these concentrations. One so-called solution involved the construction of tall chimneys. However, the total level of emissions increased considerably as a result of constantly increasing production and so pollution spread to all parts of Europe. Measures were taken to clean up the unhealthy residential areas in the London metropolitan region, the Ruhr industrial area in Germany and the Rijnmond region in The Netherlands. In addition, the increased use of natural gas instead of coal and oil and the beginning of the recession in the 1970s lowered emissions of SO_2 (see Zwerver *et al.*, 1984). Yet these measures did not have any positive effect on the acidification of the lakes in Sweden; there was no sound abatement policy.

The massive death of forests in Western Germany led to a sharp reaction in The Netherlands, especially when the same phenomenon became evident in The Netherlands itself at the beginning of the 1980s. The abatement of acid rain became a major political issue. It was recognised that an effective decrease in emissions of acidifying substances would come about only as a result of strict measures. The introduction of such a policy caused many conflicts with vested interests in certain economic sectors. An analysis of these conflicts can provide an insight into the way in which policy on acid rain was effected in The Netherlands. Special attention will be given to the fashion in which polluters tried to influence the format of abatement policies. They used the same type of arguments and mechanisms as were described in the previous section on international negotiations.

As can be seen from Figure 5.1, the deposition of acidifying substances in The Netherlands decreased by approximately 15% between 1980 and 1990. The most important substances were nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3). The decrease in the deposition of acidifying substances was chiefly the result of a decrease in the emission of SO_2.

An Air Pollution Act took effect at the end of the 1960s. Under the new act, the Minister of the Environment was made responsible for publishing periodically an Indicative Long-Term Programme for the abatement of air pollution, indicating how government policy on the abatement of air pollution is to be realised.

Until 1984, these programmes followed a strict neoclassical approach. Cost-benefit analyses were undertaken so as to find the optimum pollution level. In 1984, a different point of reference was chosen, i.e. an ecological limiting condition of 1800 acid equivalents per hectare per year. Instead of performing a cost-benefit analysis, an ecological standard was adopted. The idea was that the disruption of ecosystems should be stopped, regardless of the outcome of an analysis of the balance between costs and benefits. The introduction of this standard represented a fundamental change

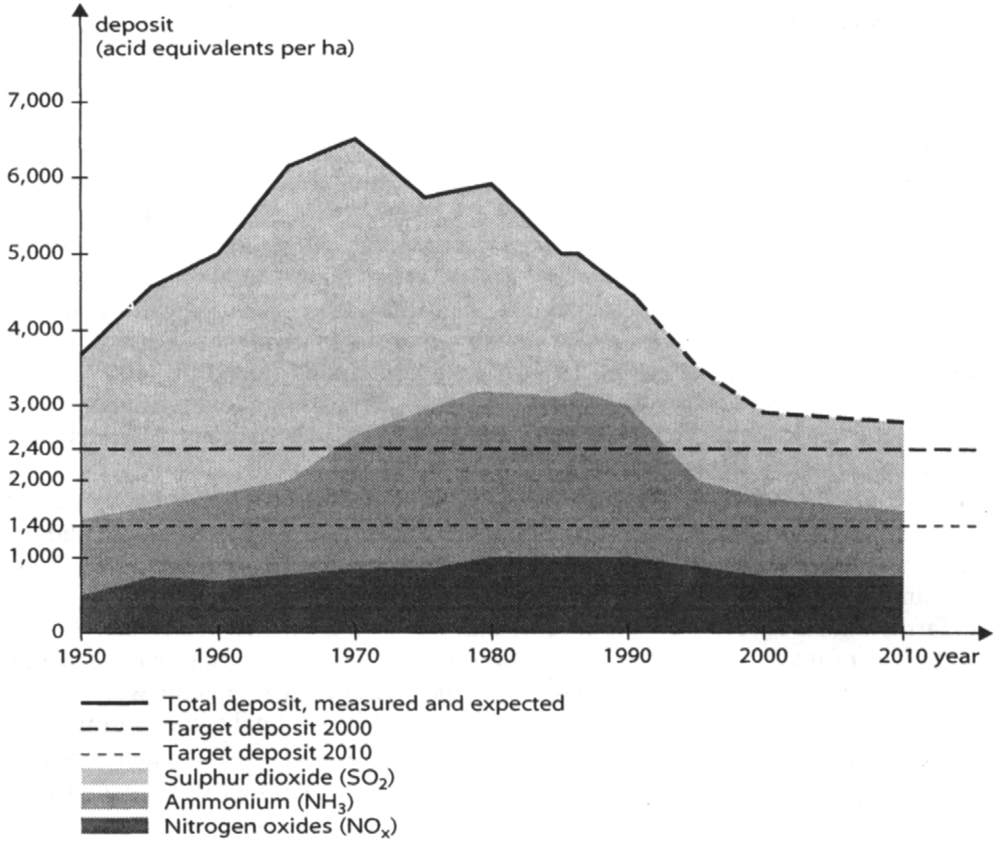

Fig. 5.1 The deposition of acidifying substances in The Netherlands, 1980–1990. Source: Rijksinstituut voor Volksgezondheid en Milieuhygiëne (National Institute of Public Health and Environmental Protection), 1991.

in viewpoint and policy. Meanwhile, the level of total emissions in the course of time was not influenced by this change in paradigm at the Ministry of the Environment. One may conclude that the policy and the measures taken were not effectively influenced by the opinions of the Ministry of the Environment, but that other factors created the actual policy. The question therefore arises as to which factors were dominant in this process of collective decision making. An outline is given below of the most important decisions which were taken on acid rain during the 1980s. This is followed by an evaluation of Dutch abatement policy, focusing on the factors which were dominant in the process of collective decision making.

Summary of policy measures in The Netherlands

The emission of nitrogen oxides by *motor vehicles* is a problem that is virtually global in its extent. If abatement measures are to be successful, international co-ordination is almost always inevitable. An apt example is provided by the introduction of the catalytic converter, a device that reduces nitrogen oxide emissions. Catalytic converters require unleaded fuel, which therefore had to be introduced in all European countries. The problem of its introduction was tackled by the European Union, but a solution was hindered by the divergent nature of the interests of the European countries. The result, after many years of negotiation, was the introduction of a rule that every new car should be fitted with a catalytic converter. The position of The Netherlands was interesting in this respect. On the one hand, the Dutch government posed as a champion of the environment by giving a tax rebate to buyers of cars fitted with catalytic converters. On the other hand, the Volvo plant in The Netherlands, which was unable at the time to produce cars fitted with catalytic converters, was granted a substantial subsidy to protect it against the effects of the various international agreements. This subsidy amounted to donating 400 (Dutch) Guilders to every buyer of a Volvo car (Dietz *et al.*, 1991). High levels of unemployment in the region and previous state support for the Volvo plant were used as arguments to justify this subsidy.

In the *agricultural sector* a Pig and Poultry Farms Act was introduced at the end of 1984. The law was the combined product of the Ministry of the Environment and the Ministry of Agriculture and so included a large number of temporary provisions. Due to the influence of the Minister of Agriculture, these provisions were made so weak that farmers were able to increase production by 30% in the next three years. This act was a piece of interim legislation. It was followed by the Manure Act, which became effective in 1987. This law laid down limits for the total amount of manure which could be spread on the land. Each farmer now has to account for the total quantity of manure produced on his farm. If there is a surplus, it has to be taken to a central agency, which then passes it on to one or more farmers who have a manure shortage (see Chapter 1 for a detailed analysis of this issue).

This law did not have a positive effect on the total amount of ammonia discharged in the agricultural sector. The manure is taken from areas where there is a surplus to areas where there is a shortage yet this does not reduce the total amount of manure, nor does it diminish aggregate ammonia emissions. The idea in the future is for the surplus to be taken to factories where it can be converted into dry compost. Unfortunately, this treatment is very expensive, so much so that such measures are unlikely to solve the problems. In spite of all these measures, programmes, memoranda and laws, every year brings a higher discharge of ammonia than the preceding year. The most important factor in this respect has been the position taken by the Ministry of Agriculture, which has been able to frustrate every measure to reduce the emission of ammonia.

Oil refineries are infamous for their massive discharges of SO_2. The emissions are caused by the sulphur in the crude oil processed by the refineries. In The Netherlands, discharges of sulphur dioxide were lowered by 35% during the period from 1980 to 1989, a rate which was substantially lower than that achieved by power plants, another important producer of sulphur dioxide. Why is this? In order to answer this question, we need to take account of the development of the market for refinery products. The demand for lighter fractions has been increasing for several years and both Shell and Esso have built new refineries in the Rotterdam region to meet this demand.

Esso's Flexicooker refinery started production in 1986. In 1980, Esso was discharging a total of 28,000 tonnes of sulphur dioxide on an annual basis. Esso has stated that the Flexicooker refinery will have the effect of reducing the discharge to just 6000 tonnes. Furthermore, the investment which is needed to reduce these discharges is a profitable one. This means that a considerable reduction in sulphur dioxide emissions can be realised without real cost to the refinery (De Bruin and Van Ooyen, 1986).

Shell's position is completely different. Shell discharged 64,500 tonnes of sulphur dioxide in 1980, 58,000 tonnes in 1981 and 59,000 tonnes in 1982. In 1983, however, the figure shot up to 70,000 tonnes (Rijnmond Region Public Authority, 1983; Fransen, 1985). In 1983, Shell decided to build a new refinery (based on the Hycon process) and requested permission to do so from the local authority for the Rijnmond region (near Rotterdam). Initially, the local authority was willing to grant such permission only if the permit included strict emission limits for sulphur dioxide. Shell replied that such limits would force them to build the new factory elsewhere in Europe, as it would be impossible to comply with the limits. Shell was subsequently granted the relevant permit, but with less stringent emission limits attached to it. In 1985, Shell requested a new permit for all its refineries in the Rijnmond area, which it needed as a result of market developments. Shell now stated that the emission limit for the new Hycon refinery should be 53,000 tonnes of SO_2. Compared with the level of emissions at Esso's Flexicooker refinery, this was still an extremely high level. The local authority in Rijnmond again insisted on a stricter (i.e. lower) limit, but the Minister of the Environment, under pressure from the Minister of Economic Affairs, came to Shell's rescue and agreed to allow the relatively high emission levels (Barmentlo, 1988).

The high level of emissions built into the permit granted to the Shell refinery still has a great influence on the current level of emissions in The Netherlands. Moreover, this information is well known among polluting industries and places them in a comfortable position to use the international competitiveness argument even where there is no real need to do so. The agricultural sector in The Netherlands has been able, for instance, to emit an increasing percentage of the total amount of emissions, as Figure 5.1 demonstrates. The farming sector has frequently used the international competitiveness argument in this debate.

Power plants discharge significant amounts of NO_x and SO_2. It has been the Dutch government's stated policy in recent years to reduce emissions of both nitrogen oxides and sulphur dioxide. As far as nitrogen oxides are concerned, government policy has not had any effect. Why? The price of electricity is the key to the answer here. It affects the competitiveness of Dutch industry in many export markets. By keeping the price of electricity lower than in Germany, where environmental standards are stricter than in The Netherlands (Olthof, 1988), the Dutch were able to secure a competitive edge for their industry. Clearly, competitiveness was given overriding attention when measures to abate the emission of nitrogen oxides were discussed.

The same type of picture can be seen with respect to the reduction of sulphur dioxide emissions, although substantial reductions have been achieved here. In 1980, the Minister of Economic Affairs, who is responsible for electricity distribution, published a paper 'The Coal Memorandum'. This basically outlined the government's decision to diversify the country's energy sources. It argued for the reintroduction of coal-fired power plants. The environmental movement was successful in its campaign to have strict emission limits laid down in the memorandum, leading not only to low levels of sulphur dioxide emissions but also to higher electricity prices. However, it was not industry that had to foot the bill, but households. Indeed, industries got a substantial rebate so that, effectively, electricity prices remained unaltered for them. The government argued that it was this that allowed industry to stay competitive internationally. Clearly, traditional economic arguments were given a higher priority than environmental interests.

An evaluation of Dutch acid rain policy

The abatement policy on acid rain has been largely ineffective. Without exception, the Dutch government has protected polluting industries, i.e. exporters, motor manufacturers, refineries, particularly Shell, and the agricultural sector. This has resulted in significant damage being caused to ecosystems, damage which cannot be monetarised. Additionally, a cost of many billions of guilders has been imposed every year on non-polluting sectors of the Dutch economy.

The level of this damage justifies strict measures. The introduction of the ecological limit of 1800 acid equivalents in 1984 did not have any effect at all. The dominance of traditional economic interests was so great that such standards were relegated to the sidelines.

These examples clearly demonstrate that, although sound plans for abating environmental disruption may be proposed, other factors become more important when actual decisions need to be taken. This is not surprising. A mixture of theoretical economic insights and institutional factors form the basis for this behaviour. On the one hand, the production factors of labour and capital occupy such a strong position in the state machinery that a sound environmental policy can be implemented only once the representatives of both labour and capital are convinced that such a policy will benefit them. On the other hand, the ideas about theoretical economic issues which are promulgated by opinion makers representing labour and capital are not generally in line with the needs of environmental protection. Economics deals with factors such as the growth of production, the mobility of production factors, the government budget, the level of profits, employment, interest rates, etc. Nature and the environment are not seen as important economic production factors that are comparable with labour and capital. In some cases, Nature and the environment are even viewed as limiting factors, which can be put aside when more 'real' economic variables become relevant.

The level of Dutch emissions is substantially higher than the level of depositions in The Netherlands (Van der Straaten, 1990). This implies that The Netherlands is a net exporter of acid rain, a point which has not received any proper attention in Dutch politics. This demonstrates that international complications are given a low profile by the Dutch government, thus enabling it to adopt a more comfortable position in the international arena than its record really merits.

5.5 Conclusion

It is obvious from the previous sections that there is a problem in the distribution of costs and benefits among different groups of society. If the intensive cattle-farming sector, for instance, is able to maintain the same level of emissions while other sectors such as oil refineries and power plants are forced to reduce considerably their emissions, this will impose relatively high costs on the latter sectors. In the intensive cattle-farming sector, the production costs are passed on to other sectors or to other countries. In most situations, this would be a domestic problem as national authorities are traditionally responsible, from a political point of view, for the distribution of costs and benefits in society.

However, this problem has become more and more of an international one due to the transboundary nature of acid rain. International bargaining and co-operation are necessary if environmental problems are to be solved. This opens up the possibility of the national authorities, which are the negotiators in an international bargaining process, being pressured in order to ensure that they secure good results that favour their own polluting industries. One should not forget that the polluting sectors are not the same in all European countries. In The Netherlands, for instance, intensive cattle farming is a more important factor than in other European countries. The percentage of nuclear power plants is relatively high in France, while lignite-fired power plants are more common in Germany. This implies that strategies to reduce emissions by lignite-fired power plants will influence the German economy more than the French one. Additionally, some countries are more advanced in terms of technology and this may place them in a better starting position if certain reductions have to be achieved.

The difference in the vulnerability of national ecosystems to acidification means that some countries suffer more from acid rain than others. The soil in countries, such as Germany, The Netherlands, Sweden, Austria and Switzerland, is such that it does not neutralise acid precipitation. Alkaline soils are better equipped to do this. In other words, the countries which suffer most from acid rain do their utmost to place the acidification problem on the international agenda, whilst others which are less affected tend to play down the problem.

In this debate, traditional economic arguments are used to neutralise the relevance of natural resources (such as forests, ecosystems and nature reserves) as production factors in favour of labour and capital. The recommendations made by economic theories for calculating the social cost of external effects and incorporating them in the burden of polluting industries completely overlooks the difficulties associated with a situation in which there are no markets. Thus, the interests of polluting industries are generally given too much weight compared with the unpriced natural resources.

The uncertainties which are normal in ecosystems are completely different from the uncertainties in traditional economic theories. In many cases, it is not clear what the effects of a certain type of pollution will be in the long run. These uncertainties are often used by polluters to neutralise environmental policies. They claim, for instance, that more research is needed to gain greater insight into the complexity of the ecosystem. In the meantime, however, the polluting activities continue or increase and cause ever more damage to the ecosystem. As has already been argued, acid rain is an international problem which cannot be solved without international co-operation. However, even the plea for international co-operation leads, in most cases, to long delays in the implementation of strict limits.

Traditional conflicts in modern societies are generally focused on income levels among different groups of society, the level of unemployment and public spending on certain public goods. Certain social mechanisms have been constructed over a long period for debating these problems and for finding political solutions based on the power of interest groups in society. However, the distribution of the costs and benefits of an abatement policy on acid rain is such a relatively new phenomenon that there is no institutional framework for solving the problem. International problems are more difficult to discuss and to tackle than national problems and institutional mechanisms for solving acid rain problems are very scarce in the international arena. This means that international negotiations are particularly difficult. New arrangements and institutional frameworks have to be constructed. As long as the economic interests of the European countries remain divergent, this task will be far from easy.

This process of shifting the burden of the abatement policy to other groups in the same state, to other nations by exporting acid rain and refusing to reduce emissions, or to other generations by neglecting the problem, is a normal political issue. The aim of politics is, after all, to maximise the gains to individuals and groups from the national wealth and income and to minimise the costs which have to be incurred in order to obtain these results. This is exactly what happens when acid rain comes up for discussion. All the groups in one country and all countries use the same approach and this results in long processes of negotiation in which reductions in emission levels are difficult to achieve.