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Journal of  
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A. GILL

Chinese Villages and their Sustainable Future

Guest Editors: Heidi Dumreicher and Veronika Prändl-Zika

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Editorial

## Chinese villages and their sustainable future

To develop new perspectives for the rural areas in China, following the premises of sustainability—this was the target of the EU-China-cooperation project SUCCESS—“Sustainable Users Concepts for China Engaging Scientific Scenarios” (ICA4-CT-2002-10007). This special issue gives a selection of the findings from this 5-year-study in Chinese villages.

The results were developed in a multicultural, interdisciplinary and transdisciplinary way whereby the researchers exchanged their findings at numerous face to face meetings, together with field studies in seven case study settlements. It included feed back loops with the stakeholders in Chinese villages, thereby combining scientific findings on a theoretical level and practical results and projects in the case study villages.

The articles assembled in this issue start with an insight into official Chinese documents and how they can be interpreted in the favour of a future sustainability approach that has found its reference in the new 5 years plan starting with 2006, describing the gap between the state and the rural society in the PRC. We then show how a participatory approach can actually be implemented even in a party state like China. Insights in the agricultural situation and the potential for greening the rural production show how long life learning is a concept applicable in the Chinese context. The classical subjects of any comprehensive sustainability approach, namely mobility, energy and housing, find their representatives in future images for these topics.

The example of a public bathhouse which was created during the project shows one example of an integrative approach to the future of a village and how a future image developed by researchers and village dwellers can be put into practice, combining the challenge of the usage of solar energy with the potential for supporting social life in the settlement. One of the villages—the smallest one—gave the start for developing a comprehensive systems model.

The last article shows a theoretical approach whereby social and spatial fields are considered as units supporting possible future scenarios of sustainability and which are the potential levels of implementation (Fig. 1).

### Acknowledgements

The study SUCCESS was carried out with a grant from the European Commission, DG 12—Research, and with the support of the Austrian BMWF—the Austrian Ministry of Science and Research.

The results described here are the outcome of an intense co-operation between the researchers from the following 17 participating institutions. The consortium represented a broad spectrum of disciplines and geopolitical background. Moreover it included a balanced gender proportion.

### SUCCESS Scientific coordinator:

Oikodrom—The Vienna Institute for Urban Sustainability, Austria.

The following research staff of Oikodrom contributed to the overall results of SUCCESS:

Dr. Heidi Dumreicher, sustainability pioneer, linguist, founder and director of Oikodrom, the scientific coordinator of the SUCCESS project. Research fields: theory of sustainability, thesaurus of sustainability, inter-disciplinary generation of knowledge and scenario-making.

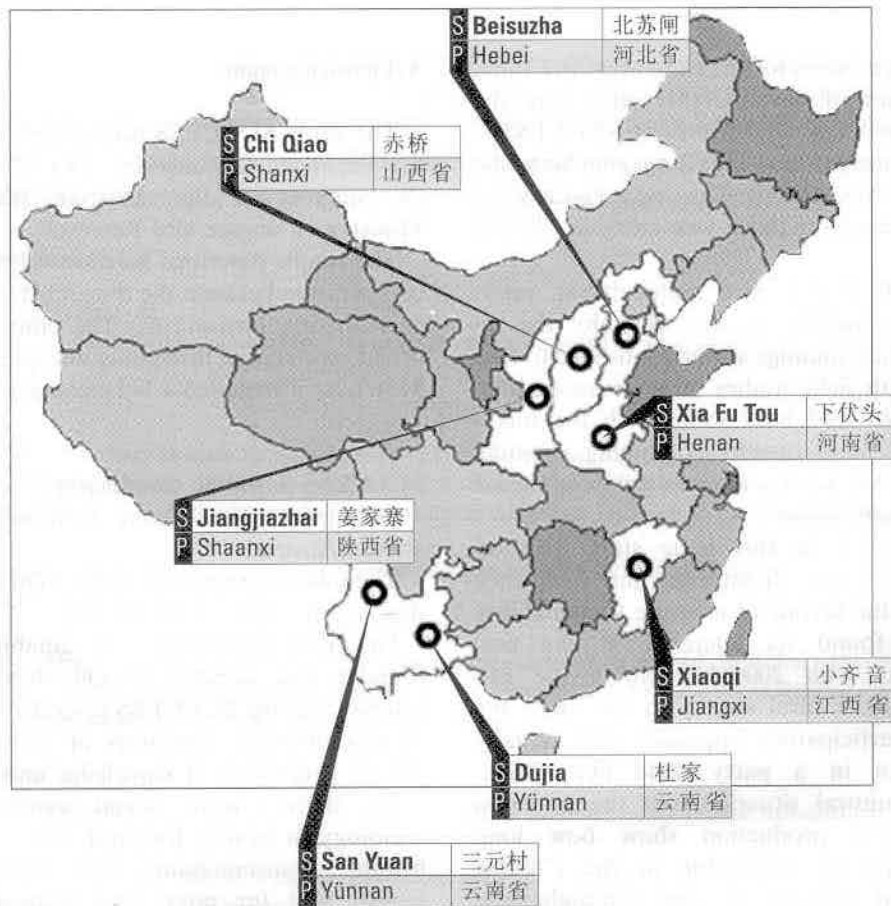
Dr. Bettina Kolb, social scientist, specialist on the sociology of health. Research fields: social sustainability, health and sustainability, the photo-interview as a sociological tool for inter- and trans-disciplinary research. Dumreicher/Kolb, social sustainability in theory and practice, public space and societal encounters, method of objective hermeneutics.

DSA ilse Marschalek, graduated social worker. Research fields: inter- and trans-disciplinary processes, participation and negotiation processes and intercultural exchange.

Dipl.-Ing. Veronika Prändl-Zika, agronomist, developed a comprehensive “concept of sustainable agriculture” and a systems approach for the agricultural analysis regarding the interfaces of agriculture to other research fields as important nodal points of rural sustainable development. Research fields: sustainability-oriented agronomy, sustainable urban-rural partnerships and scientific management.

Dieter Wagner, economist, specialised in sustainable economy with emphasis on sustainable regional networks at Chinese village level.

<b>Seven Settlements</b> in China		Area	9.600.000 km <sup>2</sup>
		Population	1.270.000.000
Project Name	<b>SUCCESS</b>	Participants	<b>18 Institutes</b>
Co-ordinator	<b>Oikodrom</b>		



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Fig. 1. SUCCESS project table 2002: Seven Chinese Case Study Villages.

#### Other participants in SUCCESS:

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Mountain-River-Lake Development Office of Jiangxi Province, China  
 Yunnan Academy of Social Sciences, China  
 Environmental Planning Department, Austrian Research Centre, Seibersdorf, Austria  
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## Chinese villages and their sustainable future: The European Union-China-Research Project “SUCCESS”<sup>☆</sup>

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### Abstract

China has 800,000 villages—one person out of seven on the globe is living in a Chinese rural settlement. Yet the global discussions about the situation in China is currently characterised by a disproportionate focus on the development of towns and until now circumstances have generally been neglected in the rural areas, where 70% of the Chinese population is still living. Within the 5 years of the SUCCESS project research, this set of actual problems has been considered and analysed under the principle of sustainability: “What to maintain?” “What to change?” were the overall research questions asked in the SUCCESS project; the researchers were looking for answers under a sustainability regime, respecting the need to raise the quality of life in the villages. Several interweaving processes were used to achieve results: the inter-disciplinary research process between many areas of expertise, the trans-disciplinary process between the researchers and the Chinese villagers, and a negotiation process that made the connection between these two processes.

The introduction describes the basic sustainability definition that was orienting the whole study. The innovation lays mostly in the methodology: the inter-disciplinary research co-operation related to practice and to involving the affected communities is needed to manage the significant and growing imbalances between urban and rural areas regarding their sustainability.

In the transdisciplinary work, the project developed “village future sentences” that describe the local outcome of the research as one step towards better theoretical understanding of the mechanisms that could lead to a sustainable future, and they also managed to start sustainability processes in the case study sites. The integrated approach of the project helped generating future scenarios for these villages covering all aspects of their development, including urban design issues. Out of these scenarios, the villages developed small projects that could be implemented during the research period. This work made an important impact on community thinking within these villages. However, it can also be seen as contributing to the dramatically changing development process in China, by finding a balance between traditional and contemporary approaches.

In particular, the approach demonstrated a new, inter-disciplinary and trans-disciplinary negotiation processes whereby the local knowledge and the expert knowledge find common ground and outcomes. The article follows the hypothesis that only comprehensive concepts can contribute to an upgraded living standard, where living spaces and rural life should be recognised and esteemed in the future as a complement to urban lifestyles within the Chinese society. Innovative knowledge generation—such as the “systemic structure constellation” technique or the systems model approach—helped to bring out latent needs, hopes and potential of the villagers.

Besides the practical usage of these implemented projects, the process leading there showed the stakeholders their own fields of action. One major impact of these projects is the visibility of the results, which is crucial for villagers’ awareness, their self-confidence and their experience with a successful participation in decision-making processes. Another impact is the potential for replicating results of sustainability-oriented patterns throughout China, especially as three of the villages have been nominated official model villages.

Scenarios of a sustainable future for Chinese villages were the objective of the SUCCESS project. The first condition for this future is the question whether they can persist into the future—and to picture the importance of the rural environment and living space as a relevant element of Chinese life that needs to get a better image and more attention from the authorities and from the public opinion.

Therefore, the final sentence that the whole research consortium, composed of 17 scientific institutions from European Union and China, agreed upon as a common result for the SUCCESS project, is as follows: “China is composed of a rich diversity of villages with many attractive qualities and essential resources for the future growth of the whole country; we recommend that policy makers cherish the human and natural potential of the rural economy and environment so that villages provide the foundation for sustainable

<sup>☆</sup> European Commission 5th Framework Programme Project No. ICA4-CT-2002-10007, 2002–2005, [www.china-eu-success.org](http://www.china-eu-success.org)

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development of this progressive nation" [Dumreicher, H., 2006. SUCCESS—a sustainable future for Chinese villages. International Symposium "Chinese Villages and their Sustainable Future", University of Natural Resources and Applied Life Sciences, Vienna, January 16]. This sentence was used in papers that were sent to different Chinese authorities by the Chinese partners and found its way, as a sort of "unofficial Charta", towards governmental agencies at national and provincial levels.

The team carried out a 5-year-research study in rural China, aiming at establishing future images under the premises of sustainability. But the basic topic that needed to be tackled with was the question whether at all those villages could persist in the coming decades of rapid development. Therefore, the first aim of the study was to establish the importance of the rural environment and living space as a basis for the future of China.

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## 1. Introduction

China has 800,000 villages—one person out of seven on the globe is living in a Chinese rural settlement. Yet the global discussions about the situation in China is currently characterised by a disproportionate focus on development in towns and cities and, until now, circumstances have been generally neglected in the rural areas, where 70% of the Chinese population are still living. The urbanisation process attracts millions of farmers towards the towns and cities; but within a sustainability approach, this process needs a counter-force: showing the potential of life in the rural areas. This needs complex measures that China has started to develop, like raising the living standards in the rural areas, reducing the agricultural taxes, improving the infrastructure, creating new jobs, promoting a health system and providing education. But most of the conversations with the farmers also showed that they want, expect and need more respect for their present and future role in China. Such a complex process would create hope and trust in the possibilities of rural activities. The Chinese Small Town strategies take these needs into account, by creating new human settlements in the neglected rural areas.

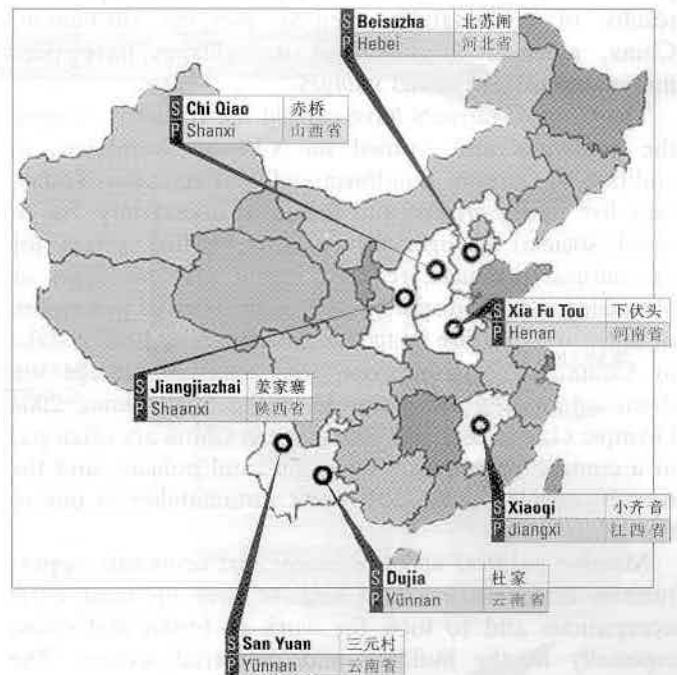
As for the SUCCESS project (Fig. 1), it started from the hypothesis that an inter-disciplinary research co-operation related to practice and to involving the affected communities is needed in order to manage the significant and growing imbalances between urban and rural areas regarding their sustainability. In this context, the European Union-China co-operation project SUCCESS carried out case studies in seven villages in six Chinese provinces, asking the question "What to maintain?" and "What to change?".

The project performed several steps towards a better theoretical understanding of the mechanisms that could lead to a sustainable future, and it also managed to start sustainability processes in the case study sites.

The project followed an integrated approach in order to generate future scenarios for these villages covering all aspects of their development, including urban design issues. This work made an important impact on community thinking within these villages. However, it can also be seen as contributing to the dramatically changing development process in China, by finding a balance between traditional and contemporary approaches.

In particular, the approach demonstrated a new, inter-disciplinary and trans-disciplinary negotiation processes whereby the local knowledge and the expert knowledge find common ground and outcomes. A set of new tools and techniques for such processes, facilitating the face-to-face interchange between experts of very different disciplines has been developed in order to give a broad basis for the common concept of strong sustainability which was agreed upon as the guiding principle for the creation of future images for these villages. This is based on the principle that only comprehensive concepts can contribute to an

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中国 SUCCESS

Fig. 1. China Map showing the 7 SUCCESS Case Study Settlements. See document 01 Dumreicher 7 Chinese settlements.

upgraded living standard, where living spaces and rural life should be recognised and esteemed in the future as a complement to urban lifestyles within the Chinese society. Innovative knowledge generation—such as the “systemic structure constellation” technique or the systems model approach—helped to bring out latent needs, hopes and potential of the villagers.

The SUCCESS project was co-ordinated by Oikodrom, the Vienna Institute for Urban Sustainability, and the research was carried out by a project team from both China and the European Union, conducted together with local Chinese team leaders who initiated a participatory process in each of the case study villages with the aim of involving villagers in a “sustainability negotiation process”. Regular meetings in the so-called future labs assembled village dwellers and representatives to formulate future images for their village. In a next step, the stakeholders developed concepts for sustainability-oriented projects in their villages that could be implemented during the 3-year-period of SUCCESS. At end of the 3 years duration of the SUCCESS project, each of the seven case study villages had worked out small project concepts and realised them.

Besides the practical usage of these implemented projects, the process leading there showed the stakeholders their own fields of action. One major impact of these projects is the visibility of the results, which is crucial for villagers’ awareness, their self-confidence and their experience with a successful participation in decision-making processes. Another impact is the potential for replicating results of sustainability-oriented patterns throughout China, especially as three of the villages have been nominated official model villages.

The Chinese farmers have carried the economy, shaped the landscape and formed the Chinese worldview, in addition to Daoism, Buddhism and Confucianism. Today, they live under present and future of uncertainty due to rapid societal change, urbanisation, falling prices for agricultural products, reduced health care provision or increasing income disparity—but with renewed perception of self-worth. Future images of sustainability have a stake in China, as environmental and societal damage are discussed openly and daily. Even the forthcoming 2008 Olympic Games that will take place in China are often put in a context of necessary environmental policies, and the new 5-year-plan (2006–2010) sets sustainability as one of the official goals.

Massive political encouragement and economic opportunities lead villagers in China to give up their rural occupations and to look for work in towns and cities, especially in the building and industrial sectors. The SUCCESS project has established models in seven Chinese villages that show an alternative: through a participatory process between researchers and villagers, future images and scenarios have emerged, giving rural areas and their inhabitants a new and sustainable role for China in the new millennium. At the same time, the village teams have

established practical projects that have been implemented during the 3-year study period. The SUCCESS project developed the “deep sustainability” approach and showed the “spaces of possibilities” that can be opened with a future image of sustainability, leading to recommendations for governmental agencies as well as for local cadres and activists.

## 2. A concept of deep sustainability as guiding principle

“Sustainability is a local, informed, participatory, balance-seeking process, operating within a Sustainable Area Budget, exporting no harmful imbalances beyond its territory or into the future, thus opening the spaces of opportunity and possibility” (Levine et al., 1999). This was the commonly agreed definition that all researchers considered as guiding principle. The social scientists in the SUCCESS study developed more precise explanations to this operational definition:

*Local:* The local qualities become significant under specific conditions, especially when the past is still alive in a place. People have developed social strategies to explain their past in order to come to terms with it. These strategies still have an impact on changing social situations concerning the present but even more on the capacity of imagining a future.

*Informed:* Getting information is part of communication, which needs societal skills that start at an early stage of individual development. The first formal approach to information is delivered and practised in the schools—and it was found that every selected village, even the one with less than 100 inhabitants, has a village school, often run under difficult conditions. Primary education in these local schools represents a basic system for achieving the skills that allow for communication with the informed part of the world. The villages have a sophisticated mix of formal and informal information systems (neighbours, markets, television, lessons, etc.) and an expressed need for input from the scientific field, which served as a basis for the lively engagement with the SUCCESS scientists.

*Participatory:* This definition is a targeting approach—it does not describe a state but a movement. The sustainability negotiation process needs knowledge and also creates knowledge; it needs participation and also enhances participation. This “learning by doing” approach has several levels of intensity: individual learning (personal skills), community level (village organisation and governance), regional to national level (administrative policy).

*A balance-seeking process:* While the task of the natural scientists and systems analysts should be to develop tools for mirroring the material flow consequences of specific future choices, the social point of view on this balance seeking process takes into account the social balances and social justice in a village during the time of transition and change.

*Sustainability is exporting no harmful imbalances beyond its territory or into the future:* Sustainability deals with a

future that has a quality not yet found in present models. The future is often seen as a continuity of existing patterns, a sort of surrogate future. In the sustainability discourse, the future stands for a new quality of thinking and goes beyond the usual planning horizon.

*Spaces of possibilities—sustainability considers the future as an open space where socio cultural quality of life, economic equity and ecological needs to converge towards a balance:* From the social point of view, spaces of possibilities are opportunities for new human activities within the society. Imagining spaces of possibilities is in itself a social action that shows the participants in the process what their possibilities are. The social group that is undertaking this sustainability process defines its own potential and its own field of action, and can experiment with their own power of transformation—at first in thought, then in practical terms (Dumreicher and Kolb, 2005).

**3. Generation of knowledge in the SUCCESS project: the case study approach**

The main innovation in the SUCCESS project was to develop new techniques and tools for integrated, comprehensive research approaches, applying the research principles of inter-disciplinarity and trans-disciplinarity. A special “communication architecture” was established for face-to-face meetings with innovative moderation techni-

ques that created an atmosphere of trust and an effective means for discussion and collaboration between Chinese and European researchers. Following the definition of the Austrian research programme “Austrian Landscape Research”, trans-disciplinarity means co-operation between researchers and non-researchers (Dumreicher, 2005). The first such co-operation took place by integrating governmental agencies into the SUCCESS project; they took part in the field research as well as in the regular face-to-face-meetings between the 17 participants (Fig. 2).

The SUCCESS project adopted the concept that involving people from governmental agencies in the whole research agenda was the best way to have subsequent results “go up the ladder” of hierarchies within the formal organisational structure of China. At the end of the work, some final comments proved this approach had been successful. In their final papers with semi public character, the participants from the China Centre for Town Reform and Development (CCTRD, a governmental agency dealing with the New Town Strategy) referred to the question of “Learning from SUCCESS” as follows: “The participatory approach learnt from the SUCCESS project has been introduced to the research staff in CCTRD, which have and will improve field visits and investigations in the future when CCTRD is drafting official documents for rural development. The idea of how to improve the capacity of villagers over the management of public goods had been recognised by more and more researchers and officials. The mechanism innovated from the SUCCESS

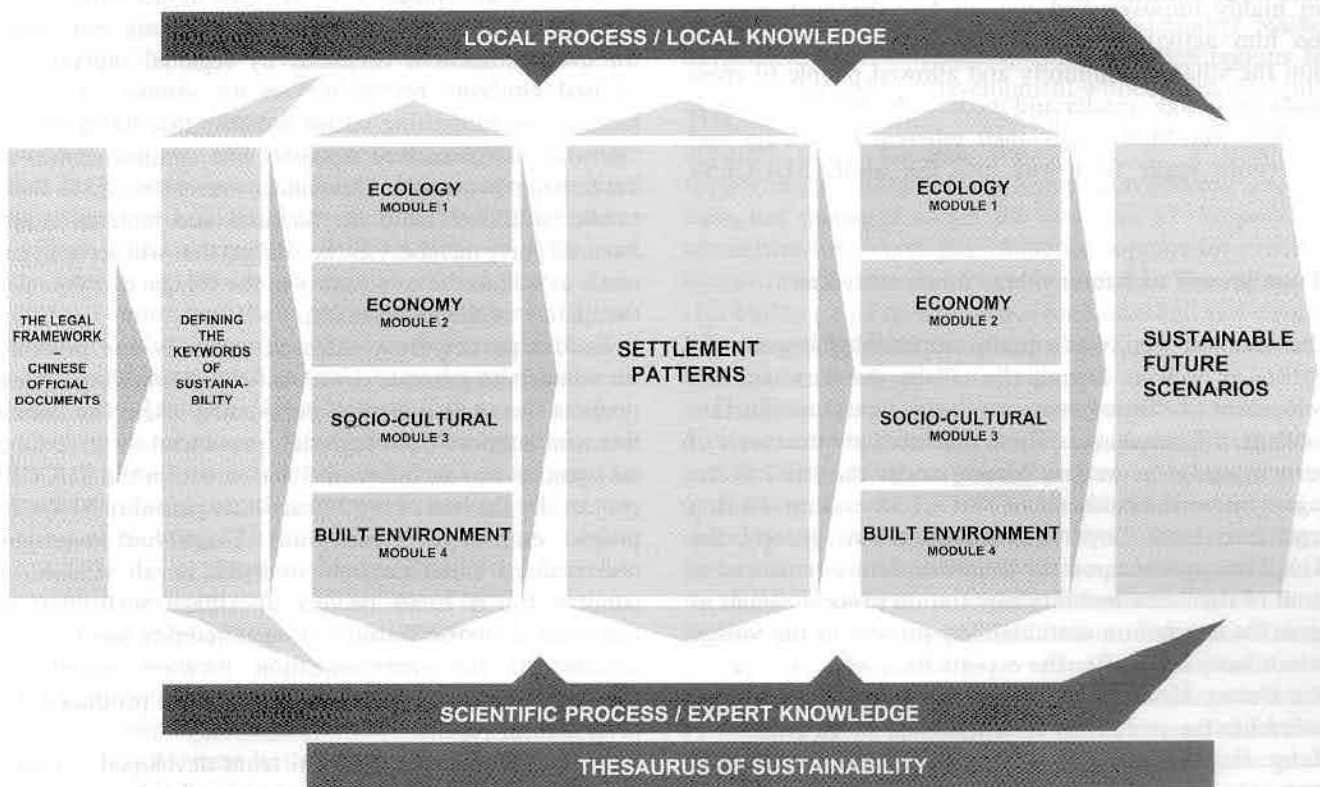


Fig. 2. The Interdisciplinary Negotiation Process. See pdf. Document 01 Dumreicher Graph 2 Negotiation Process.

project could be replicated to more villages to enhance the social development in rural areas.”

After participating in field visits and taking part in integration meetings throughout the SUCCESS project, participants from the Land Consolidation and Rehabilitation Centre (LCRC, another governmental agency working in SUCCESS) referred to Chinese Rural Policies in the following way:

Despite drastic economic development, Chinese government is increasingly aware that sustainable development is the key issue for the whole country and it would be a big mistake if economic development was at the cost of environmental degradation.

Just as important as collaboration with governmental agencies (the “top-down approach”) was co-operation with the villagers (the “bottom-up approach”), whereby the local team leaders initiated a participatory process in each of the case study villages, conducting a sustainability negotiation process between experts on the one hand, villagers on the other. Several innovative tools were used to assure the effective application of the participatory approach—which nearly all researchers saw as a major feature in the SUCCESS project. Besides the methods of PRA and the photo interview (see Chapter Dumreicher/Kolb in this volume), the participatory video film was found to have unexpectedly good results. By providing special skills, such as the use of a video camera in a Chinese village to marginalised people or people who are at the lower ranks of society, such as young women or people from highly impoverished households, the participatory video film activity helped to strengthen their position within the village community and allowed people to cross boundaries of age, gender and income. At the same time, it made sure that their voices, their inherent knowledge and their visions made their way into the whole SUCCESS project.

#### 4. From present to future: village future sentences

One method that was equally applicable between the scientists as well as among the village dwellers was the development of “future sentences” that would reverberate the villagers’ future views. These sentences are the result of experts meetings as well as “sitting under the tree” in the villagers under the guidance of SUCCESS experts. During several feed back loops between these two groups, the stakeholders agreed upon the following future sentences as a result of the “sustainability negotiation process”—and as a basis for a common sustainability process in the village that can have a life after the experts have left:

Xia Futou, Henan: “Xia Futou has a balanced, happy, satisfied life for everybody by integration of all parts.”

Jiang Jiazhai, Shaanxi: “Jiang Jiazhai is a balanced system changing actively. It has increased public community space with manufacturing capacity.”

Chi Qiao, Shanxi: “Chi Qiao is a prosperous adventure park of the Jinci temple with eco-agriculture and historical heritage as resources.”

Xiao Qi, Jiangxi: “Xiao Qi is a paradise landscape with classical architecture and eco-tourism without pollution giving benefit for all villagers.”

Bei Suzha, Hebei: “Bei Suzha is a tourist resort with biological production, having a variety of small industries, working places and services. It has good governance for extending yin and yang into its future.”

Du Jia, Yunnan: “Du Jia is a sustainable village based on agriculture. It has regional and local identity with good education to improve the quality of life.”

San Yuan, Yunnan: “San Yuan is a village with harmony between nature and material, between persons and spirit, between built environment, society and natural environment. It is rich, convenient and comfortable with balance seeking soft tourism and organic farming, it is wealthy in the material life with bright hope.”

These sentences show the overall future concepts that have emerged through the expert discussion on the one hand and through the numerous village “future laboratories” on the other, thereby serving the sustainability negotiation process.

#### 5. The adaptive sustainability negotiation process and small project concepts

Through the intense participatory approach in the village, most village communities have actually started future activities: Some villages were declared model villages, some have managed to establish biogas for heating and cooking for every household (financed by regional offices), some realised concepts for public service utilities or cultural facilities for supporting village integrity that differ from the “normal” infrastructure demands like cultural centres and basketball playgrounds. One village even managed to build a public bathhouse (with the financial and material support from all party members in the village) that will serve hygiene needs as well as the conviviality in the village, thereby raising the quality of life as a whole.

Besides participatory research methods, the possibility for villagers to generate concepts for sustainability-oriented projects in their villages, supporting them by seeking financial support from regional, provincial or governmental agencies was an innovative action within the SUCCESS project. By the end of the 3-year study period of SUCCESS project, each of the 7 case study villages had investigated and realised small project concepts. In all villages, the concept for a small project at village scale that can represent the basic features of sustainability has become a vehicle for the communication between experts and villagers. This participatory procedure produced very diverse local results.

Bei Suzha, Hebei: The local team developed a tool for educating farmers, involving a package for the transition to a rural sustainability farming concept for a village very

near to a big town. They have established a soft ware centre in the village.

*Xia Futou, Henan:* During the “future laboratories” in the village, the hope of the villagers to maintain their village’s integrity became more and more clear. As a symbolical action, the women, especially, pleaded to develop the concept for a public bathhouse. This exercise became an example for a scenario building process in architecture, including the expert knowledge on solar energy, community organisation, economic management and agriculture. By means of interactive work or “research loops”, this scenario was built up. The effect of this common discussion has greatly influenced the atmosphere in the village and the official opening ceremony took place in April 2006. All the party members in the village dedicated several working days each in order to complete the necessary work on infrastructure (road and water supply). A management concept for the future was also put in place, allowing for a system that gives access even to the very poor, at the same time generating some economic revenue for the managers.

*Jiang Jiazhai, Shaanxi:* The main concern in this village is to find its own local identity after the whole village has recently been displaced from its original dwelling place. The discussions turned around the need for economic wealth on the one hand and the search for cultural identity on the other. During the SUCCESS project, the local Chinese team leaders carried out a focused co-operation with the adjacent university and managed to find financial support that allowed for building a paved village road instead of the former mud road. Through the “future laboratories” in the village, this road has a local character that allows for “village life on the street”—a place for working, but also for cultural activities like weddings or funerals that can now be held in a good village environment.

*Chi Qiao, Shanxi:* This village with its connection to the famous Jin Ci temple gets much impact from the past. Yet, in the present, it is looking for its possible future image. The village is the nearest of all SUCCESS villages to an urban area (the provincial capital of Taiyuan) and, therefore, it shows best the rapid societal change in China. However, it is also very aware of the past. The small project concept “hands-in-hands” has led to a partnership between the local school and the University of Taiyuan. Through the vivid discussions and learning in this process, the village has gained attractiveness and could overcome the extremely depressed overall atmosphere that reigned at the beginning of the study. The small old village temple, nearly destroyed, found a group of female Buddhist nuns who have reconstructed the temple by means of local donations as well as from other provinces. Local centres for economic activities have emerged—such as a co-operative for women making clothes that are sold in the city of Taiyuan.

*Xiao Qi, Jiangxi:* In terms of combining old and new qualities, this settlement has a lesson to teach. Over more than a century, it has lived with migration to the outside world, but is also has an experience with people who have

left the village but are still in connection with it, partly by giving donations to the schools, partly by coming back from time-to-time, partly by maintaining contact with the rest of the family that has remained in the village with financial support and partly by coming back during the old age and serving the community as teachers or in other professional capacities. For a sustainable future, this village gives important answers. Suggestions from the architects and urbanists led to the construction of a new parking place for visitors’ buses that respects the “genius loci” of this tourist village. The SUCCESS project also led to changes in the village organisation, adding to the transparency of the appointment and operation of local management.

*San Yuan, Yunnan:* The visit of the SUCCESS experts in itself gave an input to the village. The fact that this poor and remote minority village could attract Chinese and foreign experts were a sign for the villagers that even they, notwithstanding their modest status, might have a good future. One big step was also accomplished in relation to the gender discussion. Whereas at the beginning, men would state “women outside no”, the team leader has established a women’s course for Dongba culture in the village, teaching traditional local dancing as well as Naxi writing. A concept for a better shape for the village washing place has been devised by the SUCCESS architects as a basis for further discussion with local dwellers, regional authorities or donor agencies.

*Du Jia, Yunnan:* With less than 100 dwellers, this was the smallest and most remote of all villages. At the beginning of the SUCCESS project, the local scientific team leader described the village as “proto-sustainability without development” as opposed to other Chinese regions that are characterised by “development without sustainability”. This was the case study for establishing a systems model of material flows through the village as a means for supporting the sustainability negotiation process. The local team has managed to get the attention of the provincial administration, which gave financial support for providing biogas installations for every household. The village has also built a social meeting place for basketball and dancing. Encouraged by these successes, the village has decided to become an ecological model village.

The outcomes of this participatory process are many and diverse according to the applied definition that sees sustainability always as a local process with local features. One major impact of the small project concepts is the visibility of results, which is crucial for the villagers’ awareness and confidence and their successful participation in decision-making processes. Another impact is the replicability of the results. Evaluation of the small project concepts enables correlation with the outcomes of these disciplinary analyses and the village typologies worked out by the SUCCESS Consortium (2005). The regular feedback loops from the villages enhanced and strengthened the research results, increasing the likelihood of greater acceptance and applicability. In terms of “life after the

project”, greater self-organisation and competence in problem solving in the villages has been identified and there was a growing interest of local authorities during formal and non-formal meetings (equally essential). From most villages, information is emerging about ongoing activities based on the research and events during the SUCCESS project.

All villages have a better understanding of a life in harmony between men and nature; they experimented with their own field of action and got some confidence in tackling with their own future.

## 6. Inter-disciplinarity

The research architecture supported not only multi-disciplinary co-operation but also developed multiple methodological tools for the inter-disciplinary generation of knowledge. The consortium was considered as a sort of “learning organisation” where the generation of knowledge is a common endeavour. Therefore, the co-ordinator assembled a set of techniques that can be used in similar circumstances. The project’s communication architecture with its Sino-European character established tools that help to recognise systemic and recursive coherence within the villages, like the future sentences for each village described above, the innovative concept of future images, mind mapping, inter-disciplinary poster-making, a systemic structure constellation approach or matrix methods for future mapping.

Such concentration of results based on the needs for face-to-face communication is a useful tool in order for the researchers, with their diverse backgrounds, to come up with integrated results. These methods also served as vehicles for the exchange of ideas, concepts and input from the researchers to the villagers and vice versa.

## 7. The sustainability approach: future scenarios for the village

In the rapidly changing Chinese context, the SUCCESS project developed future scenarios for sustainability-oriented rural settlements. From proto-sustainable to contemporaneous sustainable village systems—the SUCCESS process supported an emerging future, respecting human needs combined with the needs of nature. The concept of sustainability can be traced back to Chinese tradition. In ancient Chinese texts on ethical attitudes of human to natural resources and to the future of both, nature and humans-as part of nature—can be integrated into the contemporary discourse on “sustainability”, with focus on Confucians and Taoist texts as well as pre-Han period “environmental laws”. Therefore, the persuasive moral dimension of historical experience and ancient good governance practice should have a certain impact on the evaluation of contemporary and possible future scenario building for a “sustainability-oriented” treatment of natural resources and the application in techniques and

methods in the context of a growing interdependent globalising economic and political environment.

Both Chinese and European researchers found a common knowledge base in the definition of sustainability proposed by the SUCCESS scientists Dunreicher and Levine and made their sustainability analysis according to this operational definition. In this way, the definition served as a final cross-disciplinary analysis tool (see above).

This approach opened the discourse to the emergence of sustainable city-regions that use as components, tools, disciplines and methods, those sustainability-oriented means that can be implemented as the building blocks of sustainability for an integrated development of human settlements. This can be a major step in developing the theoretical framework for the forthcoming global sustainability discussion where Europe as well as China will be important players.

## 8. Project management design: interdisciplinary case studies

The SUCCESS project case study approach can be summarised briefly as follows:

- Common field study visits of the whole research team in all 7 selected villages.
- Integration conferences with innovative methodologies for inter-disciplinarity.
- Implementation of 7 local sustainability.
- Official selection of 3 of the case study villages as ecological model villages.
- Systemic approach allowing for numerous feed back loops, including presentations of systemic research results to the villagers, to local government agencies and to the scientific community.

In addition to this general approach, a modular procedure was adopted to field study visits and subsequent work in the SUCCESS project. The modules covered the following topics:

- Ecology.
- Economy.
- Socio-cultural patterns.
- Built environment: buildings and semi-public space.

## 9. Module ecology

The central question for sustainable development in rural areas of China is how to organise the transition from the existing situation to a country that is part of a global economy. Sustainable solutions have to be adapted to the particular regional characteristics and with harmonised development of small- and medium-sized urban centres. Migrations from villages to regional urban centres will empower regions to support the transition processes and to prepare themselves for the necessary framework condi-

tions. A strategy of “diverse regional flowers” will also enhance the capacities of China to solve future challenges. Key challenges are the education of people and the interactions between “bottom-up” and “top-down” approaches for governing the processes.

The traditional strong link in China between climate, local qualities and building, between bio climates and planning, is actually under stress. Learning from the past could give insight in those traditions, combining them with the emerging know how from Europe and the US.

The module ecology performed critique of the existing environmental situation in the Chinese rural areas. Improved water distribution among households, agriculture and industry seems to be inevitable. The sanitary situation is also unsatisfactory. In many villages, the main problem is the unsustainable use of water resources in the whole region. This problem cannot be solved for a single village but needs a master plan involving the whole province and adjacent regions. All villages face a growing waste problem. While, in the past, all waste could be composted and used on the fields, a growing share of persistent and toxic materials will cause long term problems if no proper waste management can be organised. There seems to be a high potential for renewable energy use; some practical results from SUCCESS show the feasibility of renewable energy policies.

#### 10. Module economy

The SUCCESS project has attracted the attention of the Chinese Science and Technology Ministry (MOST) because of the “participatory rural development” speciality of the SUCCESS project. The village Xiao Qi has been selected by MOST as the candidate model project of Sino-European Union science and technology co-operation. The feeling of ownership expressed in the villages will be quite high and translated into more effective maintenance regimes for the assets created in future development.

The future could be a multi-functional agriculture. Food safety should be the major ambition in Chinese agriculture delivering healthy food (not burdened with chemicals) and, at the same time, leaving an intact natural environment. The cultural landscape should become a value in Chinese society and farmers operating an agriculture that preserves natural structures could become the keepers and “architects” of an attractive landscape. Agriculture with gentle tourism, based on good practice in Europe and on similar programmes in China like “Nung jia le”, can be a fruitful combination even for remote villages. Attractive regions and a diverse landscape with rich vegetation, typical regional products and a vital socio-cultural rural life will be in great demand in the future, as the Chinese urban population will also look for places outside the cities for relaxation. A multi-functional agriculture, which could stabilise social and ecological structures in rural areas, needs to find approval by the public; it also rewards and needs to be reflected in

supporting political measures. These should become manifest in fair prices for organic food and financial support for farmers in terms of subsidies, subventions and state-aided credits.

A “better-off life” for farmers and the rural population will be achieved through state intervention in the form of agricultural subsidies, price regulation or production quotas, through larger farm sizes and through the promotion of high-quality labour-intensive agricultural products.

For the present in China, the focus might be directed on at least five aspects for a village developing in a sustainable way: scientific planning, sustainability in economy development, preservation of the social culture and architecture style, intensive utilisation of resources, life-long learning of farmers. “Future village” means that it is a place which can support people’s life within sustainability, which not only includes the material sphere, such as natural resource utilisation, environmental improvement and landscape protection but also the non-material sphere, such as folk arts, traditional dancing and socio-cultural integrity supported by the built environment. The experience of the SUCCESS study showed that there is a manifest potential for such a development, provided these future perspectives get the support not only from the village and its political entities, but also from high level administration.

Concerning the future for economic regional development, a number of important recommendations can be made. In particular, support for stronger communication and organisation between villages in a regional context can encourage the development of new ideas and innovation as well as strengthening of power relations from the small villages vis-a-vis the big conurbations or big enterprises. Such a regional network will encourage villagers to get economically active in a pro-active way taking responsibility for the social and natural environment of their villages. The well-introduced monthly and yearly regional markets can serve a first basis for these networks.

#### 11. Module socio-cultural patterns

This module generated a differentiated picture to the following the essential questions:

- How does the local and neighbouring urban population want to live in the future?
- What is the perception of the quality of life in the Chinese villages?
- Can the answers to these questions be brought in line with a sustainability approach?

In the theoretical results, a link was found between social and spatial aspects of sustainability. The village is not a static entity but a dynamic one that undergoes constant rapid changes in housing, working conditions and moder-

nisation, in general. In this module, 7 fields of spatial and social conditions were considered as a societal basis for future action towards sustainability:

1. “Me”—the human body: Individual safety and integrity, self-respect, health and medical care.
2. “This is my house”—the house with the inner courtyard: right to have a family and a social network supporting the human being and infrastructure of the house.
3. “This is my street”—the village with its streets, shops, public spaces, school, temples, meeting squares and family trees; positioning and living in a given community; challenge for education, information and cultural identity as well as assuming responsibilities for other people; neighbourhood-mobility.
4. “The Village border”—the edge of the village, the spatial “in-between”: the challenge to test new activities within a community, osmotic space of possibilities between inside and outside.
5. “The village and the region”: the village as a part of the broader regional community with chances for urban–rural partnership and mobility into the region with public transport systems.
6. “The National Chinese territory”: visibility and traceability of national rules and regulations, negotiation process between the traditional Yin-Yang rules into modernity and the shared worldview.
7. “The Globe”: accepted place and role in the world community, raising uncertainty.

## 12. Module built environment

### 12.1. Energy

The results show significant differences between villages, even within this small sample of seven villages. These differences are due to a combination of diverse factors including the economic wealth and development of each village as well as its location and specific circumstances. In the majority of instances, the domestic sector dominates delivered energy consumption (fuels and electricity obtained by the villagers to provide basic thermal comfort, light, services, etc.). The industrial, commercial and transport sectors can be significant causes of energy demand depending on local circumstances. In relative terms, the agricultural and administrative sectors have low impact on energy demand. Within the domestic sector, cooking, water heating and space heating account for the greatest contribution to total delivered energy consumption. Whilst local climate conditions play some part in the demand for space heating, other considerations, such as economic wealth and access to suitable fuels, are important. Although primary energy consumption (an indicator of energy resource depletion) and CO<sub>2</sub> emissions (a key factor in global climate change) generally reflect estimated delivered energy consumption, local

differences in the sources of fuels and electricity can modify actual results. This emphasises the need to take into account all relevant local factors when attempting to evaluate the representative magnitude and pattern of primary energy consumption and CO<sub>2</sub> emissions for individual villages.

Assessment of baseline delivered energy demand, primary energy consumption and CO<sub>2</sub> emissions provided the foundation for investigations into potential energy efficiency improvements and the utilisation of local renewable energy sources. Substantial energy savings were found to be possible, especially in relation to space heating and cooking where cleaner and safer equipment and energy sources could be used. It was noted that thermal insulation and natural cooling for existing and new housing would provide significant benefits, particularly when incomes rise and artificial space heating and air conditioning are wrongly regarded as the only practical means to achieve acceptable levels of thermal comfort when it is too cold or too hot, respectively. It was established that all villages have significant renewable energy potential, the specific details of which depend, obviously, on local circumstances. Relevant technologies, which were identified, included biomass energy (biogas, energy crops and wood), hydro-power, and passive and active solar energy. Combining these with energy efficiency improvements would enable substantial cumulative reductions in primary energy consumption (71–96%) and CO<sub>2</sub> emissions (84–98%) to be achieved.

The work carried out in the villages and the proposals made resulted in an increased commitment to sustainable development practices through improved awareness of how energy systems affect the lives of the villagers. These changes were noted both within the study areas and the surrounding districts and through a wider commitment by decision-makers to develop an improved lifestyle by means of “sustainability-oriented” energy development.

### 12.2. Urban design: a modelling process

The systems model investigated the village metabolism. One of the contributions and findings of the sustainability-oriented urbanistic research was the development and implementation of a systems dynamics modelling programme through which the villagers could come to understand the metabolism of their individual family’s lifestyle and economy as well as the village’s sustainability-oriented metabolism and the relationships between the two. Through such a multiple scenario negotiation and modelling process, villagers would be able to ask many “what if” questions about the future of their village and determine, with relatively little outside assistance, how to both work with their families and village on a sustainable basis and at the same time increase their living conditions and life possibilities.

### 12.3. *Semi-public space: the Chinese courtyard as a living space and its vernacular architectural form*

The Chinese courtyards play a vital role for co-living and for socio-economic activities. It is an architectural framework for day-to-day-life that combines living and working. Diverse semi-public space is good at using local materials and realising the ideal solution in terms of local resources, social life, rural economy and local architecture pattern. Semi-public space is a long-term developing process relating to the social pattern of the community in the village which links the public and private life of farmers. Because of the special social structure of Chinese villages, semi-public space provides the basis for public communications among the farmers, especially in old villages. Semi-public space as a transition space from “public to private” creates a relaxed and lively atmosphere in the village “space structure”. Moreover, with changes in the social pattern of the villages, some new functions are being created for public activities, which lead to a more open and vivid communication atmosphere. Compared to most old villages, newly built villages lack of rich semi-public space because of the function-oriented designing process. Therefore, the challenge for urbanistic development of villages is how to preserve the current diverse semi-public space system and adopt it to the modern life in the villages with the participation of villagers.

### 12.4. *Upgrading Chinese traditional rural housing*

The SUCCESS team was impressed by the diversity of local buildings in rural areas. Choosing convenient local material, further developing local technology and local building tradition are the three important steps for localising a process at the scale of the village, at the same time providing examples for replicability. Building a house is a social activity in China: usually, all the family members and many neighbours or friends and relatives will be involved in the building process in a village. So, it is not only a building activity but also a social and non-monetary economic activity, exchanging working hours without money. Moreover, the designers and builders are the users of the house, so it is a well-informed process throughout the whole duration of the building work.

Based on this understanding, it was realised that, in order to keep up a long-term sustainable building process, the architects should follow a participatory way to explore various and complex factors and seek to balance the conflicts between urbanisation and preservation. When facing the big influence of the Chinese urbanisation process to the rural building process, it is necessary to discuss with the villagers how to upgrade their local houses to a modern life with respect to the current cultural landscape in the village and to re-animate the local housing system.

An example of this is the public bathhouse for the village of Xia Futou, a concept that was developed together with the Dumreicher, Kolb and Marschalek, the social scientists

of Oikodrom, and with the two architects Bouillot and Levine. The participatory process for discussing the way to build, manage and maintain such a public bathhouse was initiated and is expected to continue even after the SUCCESS project—and after the actual building process.

### 13. *Replicability and life after the project*

Overview of benefits and successes during the study period:

- An understanding that simple changes in lifestyle offer massive potential for the improvement of the quality of life of the residents and the wider environment.
- A realisation that many aspects of the “traditional” Chinese lifestyles are sustainable and “modern” in their desires and effects with regards to sustainability and environmental impact.
- Improved awareness of how energy consumption affects the lives of the villagers.
- Villagers were given the knowledge that, in many cases, the movement towards what is seen as a “modern” lifestyle has implications, which may reduce rather than enhance the sustainability of village life.

Dissemination is important for the potential replicability of the SUCCESS project approach. Key dissemination activities were facilitated by the “exhibition on the move” and the video films produced during the course of the SUCCESS project. Articles on the villages were published in the local Chinese media (both in print and on television). There were also visits from local and regional officials. At the research level, results have been presented at numerous international conferences (see annex list of international presentations).

The Project inspired a professional documentary film “Jeder Siebte Mensch” by Ina Ivanceanu and Elke Groen, which was selected by the prestigious Film Festival Viennale presented on October 24, 2006, in Vienna.

### 14. *Conclusion*

This article gives an overview to the SUCCESS project, with a specific approach to sustainability embedded in a project framework of four modules, along the scientific areas: ecology, economy, socio-cultural, and architecture, applied on seven Chinese villages, within a transdisciplinary research setting. The aim of the project was to develop scenarios of a sustainable future for Chinese villages, and raising the question whether the village can persist into the future. Based on the findings from the field surveys and results of data analysis the research team formulated “Recommendations for achieving Sustainable Development in China’s Rural Communities” (Beijing 2005), which were presented on the final SUCCESS conference in Beijing 2005. These recommendations emphasise the

importance of focussing on the rural communities in future and include concrete recommendations from all modules.

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# The distance between state and rural society in the PRC. Reading Document No 1 (February 2004)

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## Abstract

While the People's Republic of China appears on a daily basis in all of the important newspapers around the world with its enormous successes in modernizing its economy, life in the Chinese countryside usually does not attract international attention. However, we know from a wide range of reports that the situation in the Chinese countryside is getting more and more complicated with local corruption, pollution and poverty growing in most parts of the country. The Chinese language press reports on a growing number of local uprisings in remote areas. While some analysts regard the situation in the countryside as a potential threat to the ongoing peaceful process of economic reform in China, China seems to be well prepared to cope with this change and the state is comparatively flexible in dealing with unrest among the rural population. So far the system itself has not been challenged by peasant discontent.

This article introduces the idea that the distance between state and rural society is the basis of this flexibility. It will analyze a major policy document issued by the state and party leadership in order to show how state and rural society interact on the basis of a still insurmountable distance between state and rural society.

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*Keywords:* China; Politics; Rural population; Migration; Health care; Rural industrialization

## 1. Introduction

While the People's Republic of China appears on a daily basis in all of the important newspapers around the world with its enormous successes in modernizing its economy, life in the Chinese countryside usually does not attract international attention. However, we know from a wide range of reports that the situation in the Chinese countryside is getting more and more complicated with local corruption, pollution and poverty growing in most parts of the country. The Chinese language press reports on a growing number of local uprisings in remote areas that neither have the privilege of receiving subsidies from the central government in Beijing nor belong to those provinces in the coastal areas where the rural as well as the urban population profits from the booming economy. Analysts such as Minxin Pei regard the situation in the countryside as a potential threat to the ongoing peaceful

process of economic reform in China. He is concerned with unrest in the Chinese countryside taking momentum before the political system can be changed so that it could deal with these problems in a democratic and civilized way (Pei, 2002). Others, such as Jean-Louis Rocca, claim that China is undergoing a process in which some of the state's duties are taken over by society and vice versa. China seems to be well prepared to cope with this change and the state is comparatively flexible in dealing with unrest among the rural population. So far the system itself has not been challenged by peasant discontent (Rocca, 2003).

This article introduces the idea that the distance between state and rural society is the basis of the flexibility Jean-Louis Rocca writes about. That is why so far the situation in the countryside has not destabilized the political system in the PRC. However, as Minxin Pei rightly warns us, the flexibility of the system can sooner or later reach its limits. Recent developments in the PRC show that the central government in Beijing is conscious of this danger and therefore tries to ameliorate the situation. This article will analyze a major policy document issued by the state and

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party leadership in order to show how state and rural society interact on the basis of a still insurmountable distance between state and rural society.

### 1.1. *The Document No 1*

On February 8, 2004, Chinese newspapers in all regions of the PRC published the Document No 1 under the title of “Some political suggestions of the CCP Central Committee and the State Council concerning the question of how to boost peasant incomes” (Zhonggong Zhongyang, 2004). The document argues that it is time to focus on boosting farmers’ incomes as the only guarantee for stability in the rural areas. People should acknowledge that the process of industrialization has reached a point where agricultural production should no longer be forced to support industrialization. On the contrary, so a member of one of the workgroups which did the preparatory work for the document, the state should actively support agricultural production (Zhang, 2004). Consequently, the document reminds the state of its duty to safeguard the interests of the peasants. As a first and important step it asks for a reform of the system of income distribution as well as of government budgets. The system of taxes and fees has to be changed and state taxes for the peasants gradually reduced to zero. The aim of the leadership is to contribute to overcoming the divide between the urban and the rural population: “The difficulty of having farmers’ incomes boost is a concentrated reflection of deep lying contradictions having built up for a long time inside the dual system of city and countryside” (Zhonggong Zhongyang, 2004), the document says. For the first time in PRC history it openly addresses the problem of urban privileges that have so far been based on the exploitation of the countryside. Much to the astonishment of the informed reader, it underlines the positive effects of rural migration to the cities and condemns the widespread attitude among urbanites to criticize the peasants leaving their villages in search of job opportunities in the booming regions of the PRC: “We have to get rid of all regulations discriminative against migrating peasants looking for jobs in towns and cities...Migrating peasants are already an important part of the industrial labour force” (Zhonggong Zhongyang, 2004). As a major step towards enhancing the situation of migrant peasants the document calls for a reform of the household registration system which has so far driven more than 100 million migrants into a situation which does not permit them to claim citizenship in China’s urban areas. The leadership’s call for change in this specific policy field amounts to nothing less than a fundamental turn around in the policy of the state and the party toward the rural population.

Before the leadership had taken this decision, peasants and rural cadres had organized a series of protests voicing their anger caused by what they perceived as miserable living conditions in the Chinese countryside. After an initial rapid growth of incomes during the 1980s, rural

incomes started to stagnate in the mid-1990s with some places complaining about declining incomes and deteriorating living conditions. A recent analysis shows that the gap between rural and urban incomes has been growing since the mid-1990s while taxes, fees and levies are on the rise. This is said to be the main reason for growing unrest in the countryside. Peasants who exclusively live of agricultural production pay taxes, fees and levies that amount to an average of 115.70 RMB p.p./p.a. while those whose incomes come from multiple sources only pay an average of 62.10 RMB (Miao, 2004). This shows that peasants who exclusively rely on agricultural production have to pay even more taxes than those for whom agricultural production is only a supplement and who therefore enjoy higher incomes to begin with. Additionally, peasants complain that the agricultural tax they have to pay is calculated on the basis of their grain output without taking in account what kind of investments they make. Even if they are hit by natural disasters, they have to pay taxes according to the output of the preceding year. And last but not least, they even have to pay taxes for grain their families consume or which they feed to the animals (Zhang, 2004).

Even though the state has subsidized the price for grain for more than 30 years, this has not helped to solve the problem. Peasant incomes from grain production do not help raising incomes in the countryside although the state pays a higher price to the peasants than it can demand from urban consumers. In exchange, it forces the peasants through the so-called household responsibility system to grow grain and thus guarantee grain supply to the cities.

At the same time, decollectivization has proven what many had known before: Too many people have to live of agriculture in China. As long as incomes were on the rise, the problem of surplus labor in the countryside seemed to be of minor importance. But as soon as incomes started stagnating, this problem became more and more prominent. Consequently, peasant unrest has been growing, and migration is increasing while more and more peasants communicate their grievances to cadres from higher echelons of the administration. By leaving their villages, the rural population shows to the government that the stability of the country heavily relies on the stability of the countryside. Through their hidden as well as open forms of protest, the peasants have succeeded in forcing the CCP and the state into revising their fundamental principles of dealing with the peasant population and the situation in the countryside. This is what Document No 1 is about.

## 2. State and society in the PRC

Many outside observers regard the Chinese state as totalitarian or rather authoritarian. In their minds, the state controls every aspect of society (Rosenbaum, 1992; Shambaugh, 2000). Discussions about civil society issues which dominated research on modern China for a while during the 1990s reiterated this point of view putting hope

on the ability and willingness of the urban population to induce political change by resisting against the all mighty state.

In this paper, I will draw upon Yves Chevrier's theory of an insurmountable distance between state and society in China (Chevrier, 1995) focussing on the growing autonomy of the rural areas as a major factor of change in China. This approach is backed by recent research looking at the state in the PRC as at the same time weak and strong (Shue, 1998, 1990; Zweig, 1997; Oi, 1995, 1999; Weigelin-Schwiedrzik and Hauff, 1999; Unger, 2002; Rocca, 2003). The state in rural China is strong in so far as up until the end of the 1990s it was heavily involved in all kinds of economic activities (Wong, 1992; Pi, 1998; Oi, 1999; Weigelin-Schwiedrzik, 1999), and it was weak as a consequence of loosing control over society with clans and families, *guanxi*-networks as well as secret societies growing in influence.

The second aspect of state society relations is the distance between center and periphery. Up until today, the state bureaucracy has not reached the very grassroots level of society. The lowest level of state administration is located at the county (*xian*) or the commune (*xiang*) level. Levels of administration that reach further down such as the village (*cun*) administration are not regarded as part of the state structure neither by the state administration nor by the local population. This is the reason why we have to differentiate between state structures reaching down to the county and commune levels and the local administration in the villages which are not funded by the government. Rural cadres at the grassroots level are not paid by the state, and the village committee (*cun weiyuanhui*) is not supplied with a budget by the state. Instead local cadres have to raise funds for their personal incomes as well as for their administrative activities by collecting money from the peasants or else by drawing onto the profits from township and village enterprises (TVEs) (*xiangzhen qiye*) which functioned under the regime of collective ownership until the late 1990s (Oi, 1999; Weigelin-Schwiedrzik, 1999).

Yves Chevrier's theory not only draws our attention to the geographical distance between center and periphery (Chevrier, 1995). For him the distance between center and periphery is also to be seen in the fact that the state bureaucracy often refrains from exerting its direct influence on local society by leaving the organization of everyday life to society and its ability of self-organization. In most cases, it is not the state but local society that guarantees survival for the local population. The sheer vastness of the territory forces the state into this way of dealing with rural society. Otherwise, with millions of rural cadres on its payroll, the state would have to cope with enormous budget deficits. As long as rural cadres comply with state policies, the state regards the distance between center and periphery as an advantage; however, problems come up as soon as the loyalty of the cadres is unilaterally directed toward their local constituency and conflicts arise between the central and the local perspectives. Whenever crisis has to be dealt

with, grassroots level cadres tend to align themselves with the local population especially as they do not have to fear any financial disadvantages as a consequence of their disobedience. At this moment, the state realizes the disadvantages of its relationship to rural society and regards it as potentially subversive to the political system.

Even "worse" than this is the situation where local power holders neither work for the benefit of the state nor of society. Corruption and misuse of power which have been spreading through rural areas in recent years have incited a lot of dissatisfaction and unrest in the countryside. Very often local protest is directed against local power holders, and protest that is directed against them is—according to the logic of distance between center and periphery—not targeted against the state. However, with the number of local upheavals growing year by year, they might develop a destabilizing effect on the system as a whole and are interpreted by local society as well as the state bureaucracy as a sign of diminishing authority (Weigelin-Schwiedrzik, 1999, 2000; Rocca, 2003; Pei, 2002).

As a consequence of the above-described circumstances, rural society in the PRC is much more powerful than our general assumption on the authoritarian character of the party state would make us assume. It has the power to force the state into bargaining about the conditions under which it is willing to refrain from destabilizing the political system. And this means that rural society plays a decisive role in making the comparatively peaceful and privileged life in the urban areas of China possible—or not.

### 2.1. The CCP's attitude toward the rural population

The CCP's attitude toward the peasants is characterized by a fundamental paradox. Although the peasants are said to have contributed decisively to the victory of the CCP, they turned out as the most neglected part of the population once the CCP had taken over mainland China. The CCP had had its power bases in the countryside before the founding of the PRC, but turned away from them and decided to grant privileges to the urban population as the best guarantee for the consolidation of the newly established regime. It supplied the urban population with free health care and education, inexpensive transportation and accommodation as well as highly subsidized food, privileges that were not granted to the peasants who basically had to take care of themselves (except for in times of natural disasters). In the course of collectivization, especially through the establishment of People's Communes during the Great Leap Forward, the peasants were forced into a contract system with the state that guaranteed adequate and inexpensive supply of grain and other foods for the cities at the risk of malnutrition in the countryside. According to this system, peasants were to pass food on to the cities before taking care of their own needs. The food they gave to the state was sold at state prices and to state-dictated conditions. After the introduction of the household registration system in the

1950s, peasants were no longer allowed to leave the village without official permission, while the state claimed the privilege to send as many people to the countryside as deemed necessary. The peasants were on a system of self-supply combined with a form of state control that set severe limits to their ability of self-government while the urban population grew more and more dependent of the state as a consequence of modest wealth and security (Teiwes and Sun, 1999; Zweig, 1997, pp. 3–42).

## 2.2. The peasants' attitude toward the party state

Even under the above-mentioned disadvantageous conditions have the peasants been able to force the state into granting more and more autonomy to the localities and the families. One example of this hidden power of rural society could be the introduction of a family-based form of agricultural production (*baochan daohu*) after the Great Famine (1959–1961) and the establishment of the People's Communes during the Great Leap Forward. First a survival strategy developed at different places in the PRC, the tuning down of utopian concepts as propagated during the early phase of the Great Leap was later on legalized by the party leadership and contributed effectively to the relatively quick overcoming of the Great Famine (for a different interpretation of this process see Yang Dali (1996)). A second example could be the introduction of the household responsibility system at the very beginning of the CCP's policy of reform and opening which eventually led to the dissolution of the People's Communes in 1983 (Yang Dali, 1996; Unger 2002; Zweig 1997). In both cases, even the most orthodox version of party history could not deny that these fundamental changes were initiated from the grassroots level. (For a different view see Unger, 2002). In both cases, as a consequence of the state compromising with the demands of the peasants', agricultural production rose within a surprisingly short-period of time ameliorating the income situation of the peasants and the food supply for the urban population (for a very unorthodox view on this question see Gao (2002)).

How can we explain the above-mentioned instances of system change under authoritarian rule? If we look at the PRC as a political system with a strong rural society, the explanation is quite easy to find. System change is possible if induced by society in the periphery where the state is neither able nor willing to exert as much control on everyday life as in the locations closer to or at the center. As part of its survival strategy, the state has to grant autonomy to the localities, but as part of the survival strategy developed by local society, the peasants have to aim at enlarging their realm of autonomy and preserving the distance to the center. Gao Wangling reminds us with his work that the power of the peasants stems from their ability to cut down food production and thereby resist to the state's demands for an adequate food supply in the cities. Grain production did not rise during the 1950s, and even when grain output started growing in the 1970s it

never grew faster than population growth. On the top of that, peasants tried by all means to keep surplus grain in the villages (Gao (2002); for data on grain production see Zweig (1997, p. 350)).

This kind of subversive attitude among the rural population contrasts sharply with the CCP's ideology underlining the altruistic and revolutionary enthusiasm of the peasants. As part of this ideology, young people, intellectuals and cadres were sent to the countryside to learn from the peasants and their revolutionary thought. However, once the urban youths arrived in the countryside, they realized that the peasants were much more independent of the state than the urban population and did not correspond at all with the image defined by the state propaganda machinery. (There are several recent accounts that reflect this experience, see, for example, Yang Rae (1997) and Shen (2004).)

The party was the only connection between state and rural society and between center and periphery. As long as it was present in all the villages, it guaranteed through its administrative power as well as by symbolic means that the ideas of the center were transmitted to the villages. Local cadres were loyal to the party and on this basis loyal to the state. In return they gained status and standing in the villages. This is how the party and the state forced the peasants into the above described disadvantageous contract system. However, this loyalty was never uncontested. It had to compete with the solidarity local cadres felt for their local people. With the party and the state unable to pay for the services of the cadres, chances were high that in case of major conflicts local cadres would turn to acting according to local necessities rather than acting as transmitters of the party's will (Shue, 1988, 1990).

## 2.3. The distance between state and society in China

As mentioned above, to keep a distance between state and society is advantageous for the state and welcome by rural society. The advantage for the state consists of keeping the bureaucracy smaller and avoiding high costs for its alimentation. Even if the state does not fear the high cost a bureaucracy reaching down to the grassroots level of rural society would cause it still has to consider the fact that controlling a bureaucracy of this size from the center is very difficult. Without allowing for participatory means to set the checks and balances for what is going on in the periphery the central state takes the risk of being blamed for local mistakes. A centralized authoritarian system does not dispose of the means to make misuse of power in the periphery unfeasible. Therefore, the state runs the risk of being blamed by the local people for malpractices displayed by local bureaucrats if it does not prevent malpractices from happening. As a consequence, the local population could turn to viewing individual failings by local state cadres as signs of a failing state. Only by keeping a distance to local society can the highly centralized state in China avoid this problem.

However, the communist state came into power by using the inability of the Guomindang state to control the rural areas. It should therefore be conscious of the fact that the advantage of keeping the distance between state and rural society goes along with the disadvantage of uncontrollability. Mao's (1928, 1930) strategy to establish "liberated areas" in border regions was based on this disadvantage for the state. Nevertheless, as soon as the CCP took over mainland China, it realized that centralization had its limits in a country with a territory of the size of China. In his speech "On the Ten Great Relations", Mao Zedong warned against an overdrawn centralism and championed the idea of shared responsibility between the center and the regions (Mao, 1956). At the time he made his speech, he could still rely on the grassroots party organizations in the villages and therefore never considered the possibility of rural society getting out of control. The decision on reform and opening taken by the CCP's Central Committee in 1978 initiated yet another wave of decentralization (Goodman and Segal, 1994; Goodman, 1994; Wong, 1991). In order to solve its growing budget problems the CCP central leadership had to agree to the government demanding lower levels of the administration to act as investors whenever the center did not dispose of the financial means to intervene itself. This is how regional and later local administrations gained in independence as they generated income independent of central control.

Rural industrialization, even though not initiated by the central state, had a similar effect on the situation of local administrations. In the aftermath of decollectivization the commune (*xiang*) took over the administrative duties of the former People's Communes. At the same time, commune and township administrations got involved in the development of TVEs under the regime of collective ownership. These enterprises supplied local administrations below the state bureaucracy with the kind of budget they needed in order to act on behalf of their local constituencies or for their own benefit. This is how rural industrialization formed a basis of growing rural autonomy in those regions where TVEs generated profits (Oi, 1999; Weigelin-Schwiedrzik, 1999).

Those villages, however, which have been unable to develop rural industries, are confronted with a difficult situation. Li Changping who is an experienced cadre at the grassroots level has decided to act as their spokesman. In his speeches and articles he time and again makes the point that villages from poor areas without TVEs are on the losing side of the ongoing reform process: "Even people who are 100 years old and one year old children have to pay for something [which they actually could never make use of]" (Li, 2003). In his letter to the then Premier Zhu Rongji he deplores the fact that especially in rice and grain-producing areas peasant incomes do not surpass the production costs any more (Li, 2001). Local administrations put an enormous burden on the shoulders of the peasants forcing them to pay all kinds of (often illegal) additional taxes, fees and levies. They claim that they need

this money for the budgets of the village committees and for their personal necessities which rise with the number of local people (especially clan members!) getting involved in local administration. Since privatization was used as a means to overcome the difficulties of TVEs hit by the Asian Financial Crisis, more than 90% of the TVEs are no longer in collective ownership and therefore can not serve as a source of income for local administrations any more. This means that even in those places where TVEs existed and were doing relatively well local administrators have to apply the same method as in those places that have not gone through a period of successful rural industrialization: They collect as much money as they think they need directly from the peasants (Oi, 2003; Weigelin-Schwiedrzik, 2003). This is one of the reasons why local uprisings are getting more and more numerous (Rocca, 2003, pp. 17–18).

As long as the CCP was present in the villages, local CCP cadres gained in reputation and standing and were thus compensated by "social capital" for the fact that their loyalty towards the CCP leadership did not necessarily materialize itself in the form of higher incomes. Due to the decline of ideology in Chinese society as a consequence of an efficiency oriented reform policies, the CCP leadership has had to cope with the loss of standing and reputation among its local cadres. When everybody is oriented towards earning money (*xiang qian kan*), the kind of "social capital" that local CCP cadres had enjoyed for so many years is no longer regarded as an adequate reward. Consequently, the CCP's influence on local politics has diminished. Instead local networks have taken over. This, too, adds to the many factors responsible for local unrest.

The system of tax collection is another factor responsible of peasant dissatisfaction. It gives them the impression that they are not even regarded as citizens of their own right, but have to pay taxes in order to be granted citizenship. Tax collectors come to their homes and insist on them paying their taxes while people with much higher incomes in the cities seem to be able to always find a way to avoid contributing to the state budget through their income taxes (for many examples see Chen and Chun (2004)).

During the Mao era, the basis for the reputation of local cadres in the villages was the charismatic nature of Mao's leadership (Teiwes, 1984; Zweig, 1989). Peasant localism and the relative autonomy of the grassroots level were matched by a strong orientation towards the center and the charismatic leader. That is why even during the Mao era China was not the totalitarian state many thought it to be. Donnithorne (1972) regards society in those times as to be characterized by its "cell structure", and Shue (1988, 1990, p. 62) compares it to a honey web. This system used the distance between state and rural society to its own advantage; it was based on local autarchy in the economic sense of the word, and it was fragmented politically. With the death of Mao Zedong, this system lost its charismatic leader, and since the beginning of the reform era, ideology no longer has the strength to cover up organizational and

fiscal weaknesses. As a consequence of decollectivization, the party and the state have lost their last institution in the countryside that could act on their behalf, and although the peasants are still controlled by “unequal treaties”, they have gained in autonomy through their growing economic independence gained from their activities on the market. The introduction of local elections, in which villagers can stand for election no matter whether they are party members or not, has added to strengthening the ties between local administrations and the local population (Levy, 2003; Unger, 2002, pp. 197–222; Weigelin-Schwiedrzik, 2000; O’Brien, 1994; Manion, 1996). Party membership is no longer a guarantee for political power in the villages. Local cadres either have to prove their efficiency in managing local problems or else have to rely on their clans and local networks to gain the majority of votes. What was regarded to be a lifelong position (as long as the party had not changed its mind and turned against its own cadres!) has now turned into a job, which needs a lot of networking, bargaining and power play rather than good connections to the state and party bureaucracies.

### 3. The power struggle between state and society in the PRC: the case of township and village enterprises (TVE)

The distance between state and rural society, which simultaneously is the distance between center and periphery is the basis on which the power struggle between state and society is taking place in the PRC. One interesting and important recent example of this peculiar kind of power struggle is the development of TVEs. The TVEs were—as many PRC publications confirm—an “invention” of rural society that the party and the state needed a long-time to recognize. As mentioned above, the collective ownership of the TVEs made it necessary and possible for local administrations to act as legal owners of the enterprises. In return for that, they claimed often unforeseeably parts of the enterprises’ profits to generate income for their local administrations (Oi, 1999; Weigelin-Schwiedrzik and Hauff, 1999). This is where cadres at the grassroots level got their salaries from, how schools received subsidies and rural health care could be maintained. Whenever these enterprises were hit by crisis, the local administration intervened and helped out as a return for the financial support they had enjoyed in earlier years. Thus a symbiotic relationship developed between rural enterprises and rural administrations which was the basis of their success. However, this success did not conform to the principles of a market economy and the idea of modernization that was advocated by the mainstream of the CCP leadership and of academic publications in the PRC (Dou, 1999; Liu, 1999). Consequently, the state was hesitant in legalizing this form of enterprise. Only in 1994 did the central government release a law as the legal basis for TVEs (Hauff, 1999).

The fact that collectively owned TVEs did not comply with the principles of market economy was not the only

reason why it took so long for the central government to bestow them with a legally acknowledged position in Chinese economy. More importantly, the central government tended to perceive of TVEs as a threat. TVEs turned out to be a strong competitor for resources and markets weakening the position of state-owned enterprises. At the same time, they were the basis for growing local autonomy, as described before. That is why the central government started inventing a counter strategy. At the same time it acknowledged the legal status of the TVEs, it demanded their reorganization under the slogan of “taking politics and business apart” (*zheng qi fenkai*). It argued that the ownership structure of TVEs was unclear and suggested that local administrations should give up their shares of the TVEs and privatize them (Lüdke, 1999). As a result, most of the TVEs which were running under collective ownership in the 1990s were reorganized by the late 1990s with 85% under private ownership at the beginning of the 21st century (Weigelin-Schwiedrzik, 2004). Consequently, local administrators have lost their extra budgetary source of income and now turn to the peasants to make up for their losses.

The history of TVEs is in this sense the history of a fierce struggle between state and rural society. The state is unable to procure the kind of services for the peasants it offers to the urban population. It leaves the rural areas to the peasants’ ability of self-organization. However, as soon as the peasants make use of their autonomy the state becomes aware of the other side of the coin and is worried about its loss of authority. That is why TVEs had enough room to develop during the 1980s and 1990s before the state spotted them and recognized their potential. TVEs resisted against the demand of privatization for most of the 1990s, and it took the state until it could make use of the Asian Financial Crisis to force TVEs into privatization. It not only used the crisis to make its demands become true, it also won over local cadres by encouraging them to change into private owners and benefit from TVEs as a direct source of personal income.

Document No 1 stresses the importance of rural industrialization, however, it demands continuous reorganization without addressing the problem resulting from the privatization of TVEs. As TVEs stand for about 30% of China’s GDP they are of enormous importance for the country’s national economy. Whereas in former times, the contribution they make to enhancing the social situation in the countryside was stressed, today their contribution to making China look like a full fledged market economy is more important. That is why the problem of rising fees and levies as a consequence of the privatization of the TVEs has to be addressed without touching on the problem of ownership and the formerly symbiotic relationship between TVEs and local administrations. As peasants profit from TVEs individually no matter whether they are privately or collectively owned, the state does not need to fear direct protests related to the privatization of TVEs. It can stick to its policies.

### 3.1. Rural migration as a case study in state society relationships

Rural migration is yet another interesting example of the struggle between state and society. In the 1950s, the household registration system was introduced with the aim of hindering all citizens of the PRC from moving around the country without limitations and state control. The efficiency of this system was enhanced by combining it with the rationing of food which made it nearly impossible for anyone, but especially for peasants, to survive in a place other than his home without official or family support. That is the reason why for most of the Mao era and with the exception of turbulent times such as during the Great Leap Forward, migration was impossible unless the state decided to either resettle urbanites in the countryside or vice versa. Only when the rationing system was complemented by free market supply was it possible to migrate without state orchestration. That is why migration has gained momentum since 1978 when the introduction of the household responsibility system led to the revival of free markets in the PRC. Simultaneously, more cheap labor was needed for the modernization of the cities and therefore migration tolerated as long as peasants did not claim permanent residence in the cities.

Surplus labor posed a major problem in the countryside and a shortage of construction workers was a problem that needed to be solved in the cities. So allowing the peasants to legally move to the cities would seem like a rational solution to the problem. Instead, even if, as in some places, peasants were given “green cards” to legalize their temporary stay in the cities, other members of the families accompanying the migrants were refused legal status. They had no access to the urban health care systems, their children were not allowed to go to public kindergarten and school facilities, and they could be sent back to their home villages whenever the police decided to make a raid on them. They soon formed the “lumpenproletariat” of the cities, and—as Li Changping puts it—the most exploited and maltreated people in China (Li, 2003; Sharping, 1997; Pieke and Malleen, 1999) who work without the right to form or join unions and therefore have to accept whatever conditions they are confronted with. Quite obviously, the “rational” solution of granting legal status to migrants would have had a positive effect on working conditions for migrant workers, but a negative effect on those who hired them.

Document No 1 of February 2004 makes clear that the Chinese leadership has finally come to the conclusion that the continuation of the household registration system is less advantageous than its abolition (Zhonggong Zhongyang, 2004). In the face of millions of migrants in mega-cities like Beijing, Shanghai and Guangzhou and as a reaction to a situation in the countryside that forces more and more peasants into migration the central government demands a change of attitude towards the migrants from the municipalities and from the urban population. This

includes acknowledging the legitimate interests of the migrants, legalizing their status and rejecting prejudices against them. They should be regarded as part of the “urban proletariat” and thus integrated into the municipal social security system. Migrant workers and their families should have the chance to get registered under a new registration system as legal inhabitants of the cities (Zhonggong Zhongyang, 2004).

Municipal governments are to understand that the migrant workforce is an important factor in the economic growth of their cities. They should allow the children of migrant workers to attend public schools. From the perspective of the central government the abolition of the former household registration system is a fundamental change of policy. The central government tries to convince municipal governments that this solution is of their advantage and will help them to better cope with major social problems as a consequence of rural migration. As long as the rural population had been kept at a certain distance from the cities through the old household registration system, city life was easy to handle. However, when they started moving into the cities, they had to stick to their rural habits of self-organization and to their rural way of life as the cities refused to integrate them and to help them assimilate to the urban way of life. This is how a rural sub-culture came into being that developed according to its own rules far beyond the reach of the government and the security forces.

The SARS crisis showed that illegal migration could be a major threat to the urban population. Had the migrants had a legal status during the SARS crisis the state could have known about their movements and their whereabouts. Without access to health care in the cities rural migrants could not but leave the cities and return to their villages. Had more migrants been infected by SARS this would have had a disastrous effect on the spread of the disease. This shows how the illegal status of the migrants provokes uncontrollable reactions in emergency situations.

Even though we are not aware of any political movement voicing the demand of peasant migrants to be acknowledged legal status in the cities, the very fact that they are in the cities on a permanent basis is enough to invoke the policy change. In this context, experiments in several cities with legalizing the status of migrants must have played a crucial role. The Document No 1 indirectly refers to these experiments by calling for a nationwide establishment of a new registration system. These experiments make it possible for the leadership of the party and the state to refer to institutionalized policy makers as the basis of their decision. This is how the fact that the illegal migration of millions of peasants forced the government into action is disguised.

### 3.2. Rural health care and why local society does not take action

The rural health care system has posed a major problem ever since the PRC was founded. During the Mao era,

many experiments were tried out and eventually a cooperative system (*hezuo yiliao*) established. This system was financed by the collectives and by the peasants individually, and it was in most places financially sound enough to allow for basic health care in the countryside. If peasants had to be treated in a hospital outside their commune, their treatment had to be paid for by the commune and/or by their families (Lampton, 1974). After decollectivization this system dissolved with the marketization of medical facilities developing rapidly. Medical doctors who had previously worked in hospitals run by the communes became private doctors demanding fees that more often than not surpassed the financial possibilities of their patients. Illness has since then turned into one of the major reasons for poverty in the Chinese countryside. Simultaneously, the marketization of medical services in the countryside has generated regional disparities as doctors choose to offer their services only in those locations where they have enough patients to pay for their treatment (Bloom and Gu, 1997; Klotzbücher, 2006).

Up until recently, the government has refrained from intervening directly although it has been appealing to local administrations to take care of the problem. This is how the problem has been on the agenda for many years. Now, Document No 1 refers to it again although it does not come up with a straight-forward solution. Instead it turns to those comparatively well off regions asking them to establish a cooperative system guaranteeing basic health care to the peasants (Zhonggong Zhongyang, 2004). Document No 1 offers no solution for the most affected regions: The poor regions continue without health care.

In this special case it looks as if the central government is interested in establishing some kind of health care system in the countryside, but the topic is not yet important enough for the central government to actively go about investing money into the system and imposing a health care institution on the villages. On the other hand, local administrators do not seem to recognize the urgency of the problem as they refrain from action even though the central government has time and again asked them to come up with adequate solutions. In this situation, the state can only reinforce its presence in the countryside by strengthening the county level health centers which are under state control and on a state budget. They do not reach to the grassroots level, however, and therefore are no solution to the problem of the affordability of health services at the village level. As a consequence of this dilemma, the PRC government started introducing the New Cooperative Medical Scheme (*xin xing hezuo yiliao*) in 2006 adding to peasants' individual fees subsidies given by the central and provincial governments. Doctors at the village level are still not part of the state's health care system but are provided with a modest allowance in exchange for state fixed prices for medical services. Although this move did not change the organizational structure of the system, it promotes the visibility of the state in the countryside.

This example shows quite vividly, that change in the countryside is difficult to induce from the outside. If the peasants do not see the advantage of certain policy measures they do not respond to the appeals of higher levels of the administration which is why local administrators do not feel any pressure for action. The central government cannot make its voice heard in the countryside without appealing to the peasants. But because of the distance between state and rural society chances are higher that peasants invent their own survival strategies than that they listen to what the central government says. In the case of public health, preserving the distance between state and society seems more important to the peasants than having access to medical care. That is the basic reason why they do not exert any pressure on local administrators to respond to the demands of the central government. Or to put it the other way round: If public health were of central concern for the peasants they would have invented a solution which sooner or later provokes a reaction from the central government. Up until now they have refrained from any action in this field. Whether or not the New Cooperative Medical Scheme will survive the next years to come, is still open to question.

#### 4. Conclusion

Reading the Document No 1 of February 2004 in the context of the above-explained distance between state and rural society reveals the surprising strength of rural society in the PRC. Instead of controlling society in every aspect, we see the state losing control and trying to re-establish its authority by compromising with the peasants. This implies that Document No 1 with its turn around in major issues concerning the situation of peasants in the PRC is a sign of changing state society relations with the state trying to overcome the distance between state and society in order to stabilize the situation.

Comparing the different policy fields of rural industrialization, migration and public health we detect three different patterns of conflict resolution. In the case of rural industrialization, the initiative to found and develop TVEs first came from the countryside. The central state tried to neglect this invention for a long-time while lower levels of the bureaucracy soon learned from the experiences of the villages how to exploit rural industrialization for their own benefit. Rural industrialization strengthened local autonomy, and as a counter strategy, the central state demanded the privatization of TVEs under the slogan of "taking politics and business apart". Rural society as well as local administrations did not respond to the central state's demands for a long time. However, when the Asian Financial Crisis hit China, it only took 2 more years to privatize more than 80% of those TVEs that had survived the crisis. The reason why this sudden change could happen lies with the change of attitude on the side of the cadres at the local level. As soon as they realized that the privatization of TVEs could be of benefit to them they

gave up their resistance (Lüdke, 1999). The state found a solution for how to overcome the distance to rural society by winning the support of local cadres.

Migration is a policy field where peasants demanded change and the state had to seek compromise. The peasants overcome the distance to the state by migrating and putting pressure on the bureaucracy by their mere presence in the cities. With their experience of self-organization they can survive in the cities without state support; however, as soon as they become aware of the many privileges urbanites enjoy in the PRC, they demand equal rights and opportunities. For a long-time, the state administration showed no reaction until the SARS crisis revealed that with the number of migrants growing at great pace uncontrolled migration would pose a major threat to urban society in China. Peasant migrants as the “lumpenproletariat” of Chinese society have no lobby to articulate and fight for their demands. Document No 1 shows that nevertheless they are able to convince the state of the necessity to seek compromise.

The case of public health in the countryside stresses the fact that the state needs local support in order to implement its policies in the countryside. Without local support, state demands are met with negligence, and—as we see in the case of rural health care—no change is possible. This example is especially important as it shows that the peasants react with negligence although a better health care situation would be of clear benefit to them. From the point of view of state society relations, the main reason why the state has so far been unable to convince the countryside to take actions in this policy field is the fear of state intervention. Peasants in China know that state intervention into rural society has more often than not brought disaster to the villages. That is why they rather cope with an enormously difficult health care situation than allow for the state to enter the realm of rural society by means of enhanced state health care services. Document No 1 has a realistic assessment of the situation. It refrains from imposing a system of health care on the countryside and confines itself to encouraging those villages to find a local solution to the problem where economic conditions make the establishment of a cooperative system feasible. The only conceivable way for the state to overcome the unresponsiveness on the side of rural society is by investing money into the rural health care system. Wherever outside money is used to enhance the health care situation in the countryside peasants cooperate. However, no sustainable solution has ever generated from these local models as they seem to collapse as soon as the extra money is spent (Klotzbücher, 2006). The state's capacity to finance a rural health care system is too limited to force the peasants into action. At the same time, no local stakeholder is willing to act on behalf of the state in the villages. That is why any change of policy imposed from the outside faces the problem of sustainability.

As there are no institutions bridging the distance between state and rural society and as there are no political

procedures of conflict resolution between state and rural society, conflicts can only be resolved by informal means with unforeseeable outcomes. Peasants take to all kinds of methods including migration, social unrest and protest actions in order to voice their demands. Whatever they do, they have to put legal constraints and considerations aside. There is no legal channel for them to put forward their demands. But at the same time, the state does not dispose of any legal means to implement its policies in the countryside either. Without local support, its demands are met with unresponsiveness. And without the necessary budget for state intervention into the countryside there is no way to impose change. The distance between state and rural society forces the state into compromise as soon as it is threatened by the destabilization of rural society having an effect on life in Chinese cities. It is this threatening effect of rural society on the stability of the cities which makes it strong in using informal and often illegal means to force the state into action. This is what Document No 1 is about.

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# The concept of participatory local sustainability projects in seven Chinese villages

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## Abstract

SUCCESS was a scientific, multi-disciplinary case study of seven selected villages in China, coordinated by the Viennese research institute Oikodrom in which I have been a team member for 6 years. We assembled an international team of researchers to work together with local team leaders with the aim of involving village dwellers in a sustainability negotiation process. The project had a strong bottom-up approach, combined with top-down elements. Using participatory research methods, village teams discussed and developed ideas for concrete sustainability-oriented projects in their villages. By the end of the 3-year study of SUCCESS, equipped with the seeds of a multiple-scenario building process and the appropriate funding, each of the seven case study villages had generated ideas for local sustainability-oriented projects and put them into practice. The outcome of this participatory process is manifold.

One major impact of the implementation of local projects was their visibility which was crucial for the village dwellers' confidence and their motivation to become engaged in a decision making process. The experience of their successful participation in a decision making process empowered them for self-organisation processes or a civil society process. The small projects offered interesting theoretical insights into how local contexts impact upon village dweller's decision on appropriate sustainability interventions. How they are as well in line with characteristics of different types of villages that were carried out within the study will be shown in this article.

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*Keywords:* Participation; Sustainability negotiation process; Village typology

## 1. Introduction

To achieve the complex task of a sustainability research, the SUCCESS project followed three main approaches: a case study approach, involving seven villages in six Chinese provinces, an interdisciplinary approach with a consortium consisting of European and Chinese representatives of sustainability relevant disciplines from the fields of ecology; economy; socio-culture and built environment, and a transdisciplinary approach, aiming at the integration of the local dwellers in a participatory research process.

A strong bottom-up process was combined with top-down strategies involving governmental agencies into the consortium and providing directives for the participatory work in the villages.

The case study approach involved the research team having to facilitate the participation of peasants in Chinese rural areas in a decision making process. According to the definition of sustainability, which was agreed by the SUCCESS consortium (Levine et al., 1999), sustainability—among other indicators—has its local expressions. This concept is highly context dependent in so far as it means different things to different people depending on local contexts. Detecting and considering those local contexts was one major aspect of the field study work in collaboration with the village dwellers in the respective case study villages.

In principal, the SUCCESS study followed the approach of “trans-disciplinary research”, a term we understand to mean scientists working together with non-scientists and tending to transfer scientific results into praxis, although there is still no common understanding of the term (Loibl, 2005). Furthermore, there do not exist consistent evaluation criteria for such public participation methods (Rowe

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and Frewer, 2000). That means adequate tools and methods had to be developed and adopted with regard to the specific research questions of SUCCESS.

The villagers did not only work together with the scientists during their field study visits, but continued a discussion process aiming at sustainable future images for their villages and the decision about an exemplary small sustainability project in their villages. “China has a long history of community participation, though community participation in China has historically leaned to the content of neighbourhood mutual help, and lacked the context of decision making.” (Xu, 2005, p. 4) Therefore, it was of high importance to invite local dwellers to actively take part in a decision-making processes concerning tangible small projects from the first ideas to their implementation.

To bring together the knowledge of the residents and the scientific knowledge of the project consortium, we (Oikodrom) introduced a negotiation process between the consortium of SUCCESS and the village dwellers. The sustainability negotiation process raised the awareness of the present and future situation of the villagers and at the same time brought data from first hand that offered deeper insights for the researchers into the local situation.

This combination of theoretical analyses with practical implementation was carried out by the Oikodrom team after our long experience in theory and practice, which is based on the general assumption that inviting the public to be part of decision making processes improves the likelihood that the resulting decision will be considered appropriate and acceptable (Renn et al, 1995). In the Chinese context this process meant activating residents to experience a process that led to a successful implementation of their own ideas.

## 2. Methodology

### 2.1. The concept of local sustainability projects

Supporting tangible actions within an EU-funded research project is very innovative. For each case study village we have organised to provide a small amount of money to enable the villagers to realise tangible local sustainability projects in their village. The discussion about ideas for those projects and the continuous work on them including their implementation were important elements of the participation process, because village dwellers could checkout directly the possibilities and the limits of their engagement. For example in one of the case study villages the suggestion was to renovate and enlarge the little school building, not only for the lessons but also for holding villager’s meetings there. At that time, only one representative of each household could join such meetings, due to the lack of space. In consultation with local authorities, villagers got the information, that the school which only had just six pupils at that time, should have been closed and another bigger school for all concerned villages should be built at the township. Therefore, the decision about the

school building became redundant while the need for a community house became obvious.

Being aware and interested in their (built) environment is the main aspect of an “emotional co-ownership” within a community. “It is the specific social actions that produces this kind of vicinity which creates the relation to a village or district” (Dumreicher and Kolb, 2003a, p. 247). The debate about the small projects always contained aspects of infrastructure, which led to larger issues that finally demanded the attention of the village as a whole. In other words, within a village or city it was nearly impossible to enact small-scale change without affecting the larger system. For example, in the case of the village dwellers who decided to build a new community house in one village, this raised the question of where to locate the new building. In the process of defining a place which was finally accepted by all the villagers, an unuttered conflict about an illegally, but accepted occupation of this (public) place was uncovered.

The villagers were empowered through the local sustainability-oriented projects, which were worked out and managed by the villagers themselves, because they had the experience of successfully completing the negotiation process from the scenarios’ inceptions to the final realisations of the small projects. “The project has brought to the village lots of fresh ideas and the awareness of initiative and self-confidence.” (Qiu Aijun, questionnaire, impact evaluation data).

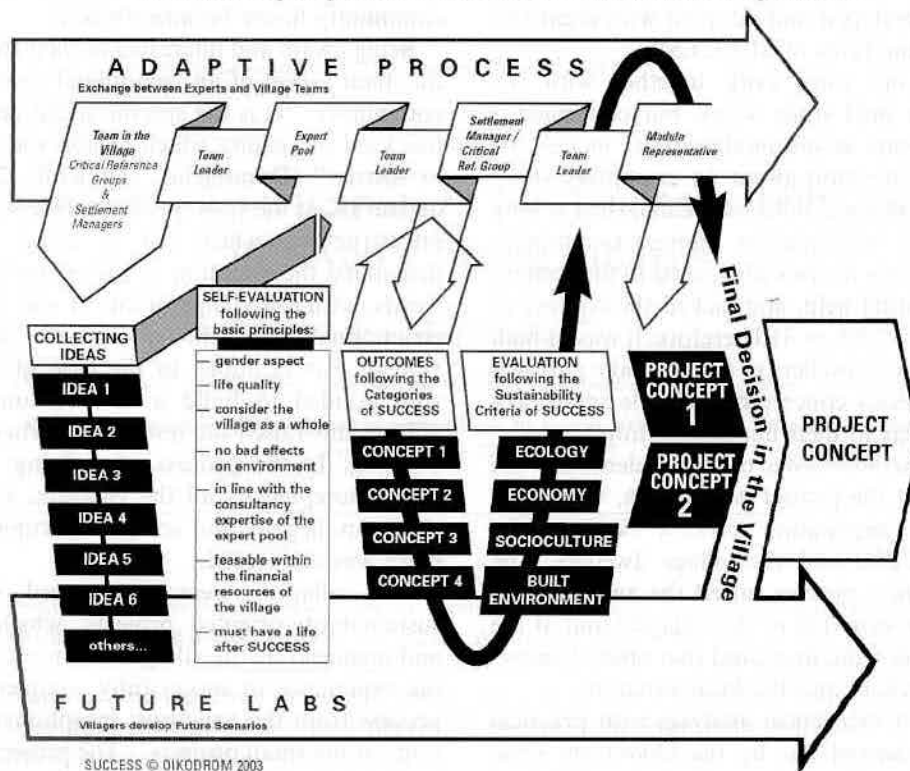
Participation is empowering because it means concerned people are taking an active role in defining their own interests and potentials to achieve both a heightened awareness for their local conditions and a strengthened capacity for self-reliance (Ondrusek et al, 2003).

For the research team, the results of the villager’ discussion about the local project ideas offered the opportunity to deal actively with the real conditions in the respective villages and make sure that the partners in the village were the owners of their own questions, needs and wishes.

### 2.2. Sustainability negotiation process

During the SUCCESS project each case study village was visited at least two times by smaller groups of researchers, several times by the project co-ordinator and regularly by the respective team leaders. With the help of participatory data survey methods (see the general SUCCESS introduction of this volume), the common presentations and workshops and the ongoing village discussions helped dwellers to articulate their needs and interests and communicate them to the scientists according to the sustainability definition (see above). The implementation of the ideas which were expressed by the villagers as they began to visualise their future were to be negotiated: first, with the villagers who have generated the ideas and concepts; and second with the scientists. Feed back loops guaranteed the exchange between these two levels of

## Sustainability Negotiation Process / Researchers and Village Teams



Graph 1. Sustainability negotiation process. See document: 03 Marschalek Graph 1 negotiation process © Oikodrom 2003.

decision making, insuring that both the villager's and scientist's decisions and recommendations were properly informed and grew in complexity with each iteration of the negotiation process. The final decision was made by the villagers themselves.

For the researchers, the concepts for local small projects were concrete measures that could be discussed along the line of sustainability. Developing the idea of a small project was important for both processes in the SUCCESS project: the local participatory process as well as the elaboration of scientific results. When negotiating about the small projects, both sides could show their different views, i.e.: what were the scientific views on the proposals that were generated by the villagers? What were the villagers' views on the comments made by the expert-group? The negotiation process increased the effectiveness of the research and improved the meaningfulness of the information which had been generated. In this way, the scientific results were directly tested in the settlement process (Graph 1).

### 2.3. The staff in the villages

The key persons who were involved in the local participation process and the exchange with the scientists were the following: The SUCCESS team leaders: As scientists they were part of the SUCCESS consortium with their specific expertise, as Chinese who have established the contact to the case study villages they were responsible for the collaboration with the respective village.

They conducted the village teams, which consisted of the settlement managers—village dwellers who organised the participatory process in the villages—and the critical reference groups—village dwellers who had expressed their interest in collaborating with the SUCCESS consortium and participating in regular group meetings.

#### 2.3.1. The SUCCESS-team leaders

The leaders of the teams in each case study village played a significant role within the SUCCESS study. Besides their specific expertise in the pool of scientists they had many other tasks, beginning with the selection of appropriate case study villages. Much preparation work had to be done to inform village representatives about the project and to get the necessary local commitment. The team leaders conducted the participatory process in the village. They nominated settlement managers (see Section 2.3.2) and helped in building up critical reference groups (see Section 2.3.3). The team leaders initiated regular meetings of the village teams, which were organised by the settlement managers. The team leaders were in constant contact with the village teams and gave regular reports to us as scientific co-ordinators about the progress of work in the village. At the four SUCCESS integration conferences of the SUCCESS consortium in which the field study visits were embedded and the findings were discussed in an interdisciplinary context, the team leaders conducted village related working groups and communicated key information which had been gathered from the village dwellers.

The team leaders were also responsible for communicating back the outcomes of these conferences to the villagers.

In addition, the field study visits of the researchers (see Section 2.5.4) were organised by the team leaders with support of the village teams. For the negotiation process the team leaders acted as communication links between the local dwellers and the SUCCESS scientists by interjecting their scientific expertise and making use of their good local relations.

### 2.3.2. The settlement managers

In order to carry out the participatory process, each SUCCESS case study village had at least two village dwellers (a woman and a man) who were on site SUCCESS-partners and were remunerated a modest monthly salary for their effort. These settlement managers were responsible for facilitating a good working relationship between the villagers and the respective team-leaders. They were in constant and direct contact with the SUCCESS team leaders and were widely accepted by the village dwellers. The settlement managers were also responsible for the transparency of the participatory process in the villages and the documentation of the villagers meetings (see Section 2.5.4).

### 2.3.3. Critical reference groups

The SUCCESS team leaders and the settlement managers established a critical reference group, consisting of 8–25 village dwellers, who had expressed an interest to engage themselves in a decision making process. The installation of these groups allowed the villagers to identify more with the process and made them feel more willing to be involved. The groups also enhanced the relevance and creativity of the new agreed upon actions and the commitment to further research. Within SUCCESS they had the formal status of subcontractors to the respective team leader, which means that personal costs for their participation were budgeted. By deciding to make their fees available they enabled the villages to provide this money as budgets for the local sustainability projects.

The critical reference groups assisted the research process by attending the consultation meetings and providing helpful feedback. They had regular meetings in the village to discuss and decide on the sustainability process and the implementation of the small project ideas. The team leaders sent ninety records of such meetings, that documented issues discussed at and persons involved in the meetings.

Following the advice of the Chinese team leaders, it was important that at the end of the project, members of the critical reference groups got a certificate confirming their participation signed by the scientific co-ordinator. These documents gave their participation work the character of education and training.

### 2.4. Selection criteria for the projects

The following criteria were elaborated by us in order to help the self-evaluation process in the villages and to

shortlist the range of collected ideas. These criteria were circulated before the start of the process to give a framework in which the project ideas had to be located.

The small projects had to be selected on the basis of the following criteria:

These are criteria that every project must fulfil

- All project ideas must include a gender perspective and take into account the relationship between men and women; how can the project idea contribute to more balanced gender relations in the villages.
- The project must contribute to the life quality in the village.
- The concept must consider the village as a whole.
- The project cannot have any bad effects on the environment.
- It must be in line with the consultancy expertise of the SUCCESS expert pool.
- It must be feasible within the financial resources of the village.
- The project must have a life after SUCCESS.

(Dumreicher and Marschalek 2003, p. 319)

### 2.5. Implementation process in the villages

The phases of the settlement process followed the general timetable of SUCCESS and used the face-to-face-conferences of the SUCCESS consortium for developing the inter- and trans-disciplinary negotiation process. The process, beginning with the preparation work and ending with the implementation of sustainability projects in each case study village was organised according to the following phases.

#### 2.5.1. Phase of declaring the interest

The villages expressed their interest in the process. This phase had been accomplished before the start of SUCCESS. The team leaders had selected the case study villages very carefully. Good relations between team leaders and villages and their openness for sustainable development were two major conditions. The villages had also not to already be part of any other international development programmes. Before the SUCCESS kick-off meeting, all case study villages had prepared a written document showing their interest in the study. These letters of interest were the basis for further collaborations.

#### 2.5.2. Phase of basic information

The settlement dwellers were informed about the SUCCESS study, about the role and expertise of the scientific expert pool as well as of their own role. The information also contained reflections on the limitations of SUCCESS ("this is not a development project") and the villagers' expectations. This information was either

given to a group of representatives of the village or presented to the villagers during a public assembly.

### 2.5.3. Phase of ideal-making

This process was the core activity of the SUCCESS project. It involved the dwellers defining the potential of the settlement in relation to sustainability. At villagers' meetings (Shu Xia—sitting under the tree) local topics were defined starting from the question "What is it that we are proud of?" One aim of this phase was to formulate one common sentence describing the profile of the village (Example: We want to keep our identity as a village, at the same time raising our life quality).

### 2.5.4. Phase of field study visits of the researchers

Every case study was visited at least two times by an interdisciplinary researcher's group and regularly by the responsible team leaders. The groups of research applied participatory data research methods, like PRA,<sup>1</sup> photo-interview, participatory video making, mapping, future images and attended several group meetings and workshops with different target groups. Each field study visit involved a presentation given by the research team to the villagers, presenting and opening up discussion on their preliminary results. By giving reciprocal feedback both sides could check whether they were well understood. Villagers considered ways of thinking about the topics of concern reframed<sup>2</sup> by the scientists. The critical reference groups continued their regular group meetings led by the settlement managers in which they developed proposals and ideas for local sustainability projects following the selection criteria mentioned previously.

### 2.5.5. The phase of negotiation

The negotiation process between the expert-pool of SUCCESS and the village looked for ways in which both knowledge bases, the knowledge of local dwellers (internal knowledge) and the scientific knowledge (external knowledge), could be combined. This process used proposals for 3–15 activities and projects that the village had worked out, including defined responsibilities and the time frame. As the agreement of all dwellers was important, the last step of the negotiation process involved, in many cases, the whole village.

### 2.5.6. Implementation phase

After finishing the negotiation process all villages started the implementation of the projects chosen. At this point in time all local projects were effectively implemented with options for further activities.

<sup>1</sup>PRA: Participatory rural appraisal methods: Transect walks, mobility maps, time diagrams, historic time walks and the like (Jones, 1996).

<sup>2</sup>Reframing: Putting articulated needs in a wider context. Example: By stating "I need a car", the wider meaning could be "I need mobility".

### 2.5.7. The phase from participation to self-organisation

In this phase dwellers themselves continued the process, which was initiated and conducted by the SUCCESS team leaders. During the process the dwellers experienced new fields of activities. The discussions, the decision making process and their contributions for the realisation of the small projects opened new spaces of opportunity and possibility (Levine et al., 1999). That did not only mean the newly created (public) space in the villages, but also the empirical knowledge about their competences. The motivation to engage themselves in the process came out of the successful participation and the gained awareness of the dwellers about their potentials and possibilities. As the SUCCESS project activities gained much awareness in neighbouring villages, the negotiation process in one community could then become a starting point in a certain region for the development of an upcoming civil society (Graph 2).

### 2.6. The timetable for the small projects

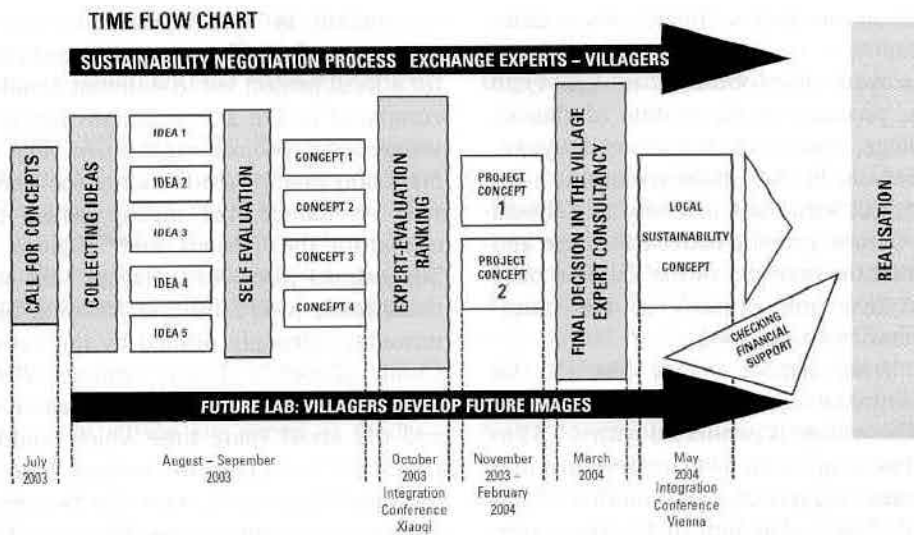
The time planning of the negotiation process was in line with the overall SUCCESS timetable. Within the first year of the study, after the teams in the villages had been established, the team leaders issued a call for small projects from villages to put sustainability into practise. (Dumreicher and Marschalek, 2003). Until the subsequent integration conference of the SUCCESS consortium, the village groups collected project ideas and evaluated them according to the selection criteria mentioned earlier. The team leaders presented those first ideas to the consortium members who discussed them against the background of their scientific disciplines. As a first feed back loop to the villagers, the SUCCESS consortium worked out a ranking list of villager's ideas by using different interdisciplinary methods like if-then scenarios and cross-matrix discussions (Marschalek, 2005a, b) referring to their scientific expertise and their field work experiences in the respective case study village and gave recommendations for the particular proposals.

The village groups had time until the next integration conference to reconsider the proposals and agree upon two final proposals. The final decision had to be found within the villages. In a further feed back loop, the villagers consulted the expert pool for realising their small project ideas.

## 3. Results

### 3.1. Local projects relating to village types

At the final public SUCCESS conference we presented a strategic paper for policy makers (Liu et al., 2005). This policy paper sought to provide recommendations to relevant governmental bodies at various levels and communities for facilitating the formulation and implementation of rural community development strategies and



Graph 2. Timeflow chart. See document: 03 Marschalek Graph 2 timeflow chart © Oikodrom 2003.

programs. The procedures and methodologies recommended in this document identified opportunities and potentials existing in different types of communities which have been identified out of the seven SUCCESS case study villages.

The agreed upon small projects illustrated the situations in the villages and the identified needs of the village dwellers which were also in line with the characteristics of the different types of villages.

Table 1 shows the three types of Chinese villages we encountered within the SUCCESS study and the effectively implemented small projects in each of the case study villages.

Table 1 illustrates the concrete outputs of the case study villages corresponding with the characteristics of each village type.

We have called villages that are situated close to the next biggest city and likely to be integrated into them peri-urban villages. In villages belonging to this village type, education was the most important issue.

Bei Suzha (in the Hebei province, south of Beijing) is located at the edge of Hengshui, the prefecture city<sup>3</sup> that is nowadays 50 times bigger in its area and 20 times in its population than it was in the 1960s. In Bei Suzha, the villagers decided, through the final process of a secret election, to invest in new computers and Internet access for their village school. Results of other participatory methods like the photo-interview (see more details in Dumreicher and Kolb article in this volume) confirm this: education was crucial within the surveys. "For the young generation, the school carries one more important significance: it is the place for good education, it is also a basis for the future: learning Putonghua, is learning the right Chinese language at school for the professional biography". (Village interviewee, in: Dumreicher

Table 1  
Village typology

Village type	Village Implemented project name	
Agriculture-based communities	Du Jia	Solar panel Biogas pit Basketball court
	San Yuan	Dongba evening school Entrance door to the village
	Jiang Jiazhai	Concrete roads within the village Garbage boxes European Trees
Rural-urban partnership communities (peri-urban communities)	Bei Suzha	Internet/computer
	Chi Qiao	"(Big)Hands-in-(Small)Hands" meaning frequent friendship parties of college students (Big-Hands) and the children of Chi Qiao primary school (Small-Hands)
Eco-tourism-based communities	Xia Futou	Public bath house
	Xiaoqi	Drink water system completed (pumping station, water storage tower, pipes to the households)

and Kolb, 2003b, p. 127). Having good teachers that are able to speak Mandarin and a good school infrastructure was the wish of the villagers so that their children

<sup>3</sup>Zhou—Chinese administration level under the province level.

could get better education and find well-paid jobs in cities in future.

Comparable results were also obtained in Chi Qiao (located in the Shanxi province in the middle of China), another peri-urban village, close to the big city of Taiyuan. The local project carried out by the village group was a co-operative education project with the University of Taiyuan and the school of Chi Qiao to provide better education and job opportunities. In fact the majority of the Chinese rural population tends to have job options in the cities<sup>4</sup> (Stockholm Environment Institute, 2002).

In an agricultural based remote village like Du Jia (Yunnan province, southwest of China), the situation is completely different. This village is connected with a 7.5 km sand road to the next township (with 5000 inhabitants) and 50 km away from the next biggest city and another 25 km to the province capital. The arable land of Du Jia is very limited, so too are the possibilities for further income sources because of the lack of market access. The village dwellers have to deal with the existing resources. One seemingly possible solution for them was to intensify the agricultural production, another one was to reduce labour force and costs to set these resources free for other applications. The ideas for small projects generated by the villagers were very different to those of Bei Suzha and Chi Qiao. Suggestions were: The covering of the village drinking water tank, better waste management, buying processing machines, raising of livestock, etc.

One further outcome of the relatively small amount of money provided by the SUCCESS project was the effect of what we call “seeding money.” That meant that villages could use the money for smaller pilot projects which allowed for a better negotiation basis with governmental representatives at different levels in applying for further support. This was also the case in Du Jia. With the SUCCESS local project money together with financial support of the government Du Jia was able to build solar energy panels and biogas pits for each household. They thereby saved energy and working labour—because the necessity of collecting fire wood for cooking and heating had been nullified—thus new capacities for further development ideas had opened up. In San Yuan, another agricultural based village, (also located in Yunnan province, but in the northern part), the situation is similar to that of Du Jia in many aspects but differs because of the cultural origin of this village. The majority of the village dwellers in San Yuan are represented by the cultural minority of Naxi people. Affiliated to Dongba religion, the Naxi people are strongly connected to nature and the environment. Until the cultural revolution, the village also had a high local value for its wood products. With the rise

of tourism in that region and the present danger of extinction of the Naxi language and culture, the possibility for a local project led to different results in San Yuan when compared to Du Jia, although they are both agricultural villages. All project suggestions, like training classes for Naxi language or (re-)building the tree tower—a symbolic relic—contained the strong wish for keeping or re-activating the cultural and religious life of the village. Suggestions made by villagers that were comparable to those made in Du Jia, like building biogas pits—which is nowadays strongly pushed by the national government in China (People’s Daily Online, 2005)<sup>5</sup>—had different implications in San Yuan: the environmental protection and the saved spare time which could be spent for Naxi education, especially for women, who are usually obliged to collect fire wood, were the two main motivations for making proposals in this direction. Finally, the villagers decided to invest directly in keeping their cultural tradition.

The village of Jiang Jiazhai is situated between a peri-urban village-4 km away from Yangling, where a famous agricultural university is situated—and an agricultural based village with incomes for the most part from agricultural production. We call this subtype: community based on intensive agriculture. The numbers of agricultural production have to be understood in a different way from other agricultural based villages (also see chapter Prändl-Zika in this volume). In Du Jia for example the approximate 100% income of agricultural production means a subsistence economy. This is not the case in Jiang Jiazhai. It has intensified milk and greenhouse production, which cover the main income sources. The dairy products and vegetables find a booming market in the city nearby. As there is no industry, only few villagers offer services (like street lunch for university students) outside of Yangling.

Proposals for small projects in Jiang Jiazhai were: to build a training centre for high tech agricultural knowledge; to improve the roads inside the village; to prepare rubbish boxes; and to buy some European trees for planting at the side of the main road.

Here we see the combination of the wishes first for improving education, precisely the know-how about agricultural production, and second for raising quality of life in the village. The citizens’ desire to rid themselves of rubbish, and dusty, muddy boots from the unpaved roads (see Dumreicher and Kolb in this volume) and improve the appearance of the village with exotic trees reflected attitudes of an urban life style, to which the villagers were aspiring.

Two of the case study villages represent the third type of Chinese villages we have faced within the SUCCESS study. Xiao Fu Tou (Henan province, middle China) and Xiao Qi (Jiangxi province, Southern China) are eco-tourism based

<sup>4</sup>“Most migration in China is to urban areas. During 1980–1998 urbanisation levels grew from 19% to 30%—a net movement of well over 100 million people. The level of urbanisation is forecasted to grow to 45% by 2010 (United Nations Team in China, 2000). Thus, within the next 10 years, over 200 million people will move to the already stretched urban areas.” (China Human Development Report, 2002).

<sup>5</sup>China will expand the scope of six categories of small rural projects: water-efficient irrigation, potable water supplies, road building, methane production facilities, hydroelectric plants and pasture enclosures. (Report on China’s economic and social development plan)

communities. They have a relatively high percentage income from tourism activities, are rich in tourism resources, rich in natural environment and have convenient transportation facilities (Liu et al., 2005).

According to the SUCCESS Strategic Paper the main characteristics of villages of this type are to: improve daily life quality, improve hygiene and sanitary condition, and maintain the village pattern within the surrounding landscape and the local traditional style. In these two respective villages, the following small project ideas were the wishes of the dwellers.

Xia Fu Tou is situated next to a river which has a recreation area that attracts many tourists; most of the undertaken activities by the village are aimed at modernisation and improving the sanitarian system. That is why the villagers—in an exemplary participation process, that united the former split between the up hill and downhill parts of the village—have built together a public bathhouse with modern energy and hygiene facilities.

Xiao Qi, a village which is located within a beautiful landscape, is a booming tourist area with a very traditional architectural style. The dweller's wish to maintain the natural landscape and tradition by continuously upgrading of the living conditions led within in their village to an extension of the village water supply system within the small project budget.

### 3.2. Impact

One major aspect within the SUCCESS project was the participatory process in each case study village, implemented by the local team leaders together with the established critical reference groups. With the help of participatory data survey methods of the research team, common presentations and workshops and the elaboration of local projects, the villagers got new ideas for decision making and involvement of the dwellers. Equity and transparency were recurrent issues. The SUCCESS project had much impact on the awareness of the villagers concerning their potentials and possibilities. The emerging sensibility for sustainable development also included social aspects, like gender questions. Villagers also became aware of their own present and future. They highlighted their self-value and the importance of a sustainable future (as cited in evidence from the impact evaluation material). The SUCCESS project also promoted new activities in each of the case study villages. These included tangible actions such as building activities (bathhouse, playground, road, cultural centre, picture board, village entrance, garbage boxes and many more) as well as participatory discussions and processes. Future laboratories, meetings of critical reference groups and village discussions about concepts for their future were also conducted. Many new spaces were created in the villages such as public spaces and community buildings which could be used for various common activities. Building activities also led to the need for proper meeting places for negotiating village affairs and

conflicts concerning labour, money, communal shares or ownership structures. Many common activities were set this way which further led to fruitful debates among the villagers.

Awareness raising processes concerned many societal and economic issues but also local potentials of the villages. The citizens' self-confidence rose with the empowerment to protect their own culture which allowed certain idiosyncrasies to become more evident. For example in San Yuan which is a Naxi minority village, the drinking water is protected by the patron saint God Dragon King. So on the one hand, they could enhance the administration of a clean village water source, make full and effective use of water power, and advance epidemic prevention and health. On the other hand, through traditional water culture activities they could exhibit Dongba culture and propagandise the environmental idea of traditional Dongba culture and the ecology of harmoniousness between human and nature.

Villagers also became aware of their own present and future. They highlighted their self-value and the importance of a sustainable future. This led to increased self-reliance which was a precondition for the self-organisation in the villages.

The SUCCESS project gained much attention from the local governments on the township level and also on the county level, which is the next step up in the hierarchy of the Chinese bureaucratic system. The case study villages got more assistance, either in becoming model or pilot villages for implementing regional based concepts (like tourism) or in supporting certain projects (like funding for constructing a public space in Du Jia).

As people "can never be convinced by words" (Huang Jiansheng at the SUCCESS integration conference in Austria, May 2005) the SUCCESS project showed examples of many kinds of activities on site, which attracted much interest. The participatory approach of the SUCCESS project, involving villagers, based on their needs and potentials gave a well-observed example both for villagers and the local authorities. Innovative democratic and empowerment strategies (like election secrecy in Bei Suzha or open villager's discussions, focus groups, especially with marginalised groups, etc) implicated much awareness for the importance of participatory and transparent decision-making. Villagers themselves recognised their own interests and potentials and learned to lobby for them and become advocates of their own. "Advocacy" (Cohen, 2004)—when residents begin to take over their own responsibilities for their issues using democratic instruments—is defined as a precondition for strengthening civil society and influencing policy.

The benefits of villager's involvement and diverse methods that consider the complexity of sustainable development also became obvious to policy makers. The researchers had many meetings with local government representatives and gave presentations of the SUCCESS findings. These contacts gave both sides much insight in

their work and new ideas that led to a lively discussion considering the sustainability concept.

Different data surveys and integration methods were used and which not only benefited the villagers but also exposed the researchers to new experiences within a trans- and interdisciplinary exchange of ideas. In linking these varying ideas together the researchers got a wider understanding than from a single disciplinary point of view. Within the evaluation process the SUCCESS researchers noted a higher quality of their results, because of the regular interdisciplinary exchange (Marschalek, 2005a). So far neglected data became more relevant in exchange and in combination with other disciplines. For example the number of “in-marriages”, meaning how many women move into the village compared to how many women leave their village after marriage, could be seen as an indicator of wealth of the village.

#### 4. Overall topics and conclusions

The implemented small projects are the visible result of decision-making processes in the villages. As the villagers had to negotiate their proposals and had the final decision on what project would be implemented, the researchers could identify what were the villagers’ main concerns.

Besides the characteristic outputs specific to the village types, there are topics and ideas that are common to all the villages, but could not be realised within the small project budget. Two main ideas for example were recurrent in every village which found different ways of realisation. These were the ideas for a public community centre and for new roads. Jiang Jiazhai opened a small training centre, not with the small project budget, but because of personal engagement of a village dweller: An empty shop was placed by the owner at the villager’s disposal as a meeting place. In Du Jia the villagers could build a basketball court with a community house. This was possible after the first project decisions for biogas pits and solar panels could be realised with provincial and local governmental financial support. Other villages are still working on plans for a community centre.

Every case study village developed proposals for local roads: Village entrance roads, roads within the villages and access roads (see also Dumreicher and Kolb in this volume). The proposals differed depending on the location and the condition of the villages. According to the results of other SUCCESS disciplines, the road stands for urbanisation and wealth. It is a precondition for access to the outside world, which was a strong wish in all case study villages. How to consider these topics which were carried out within the participatory process has to be worked out in further research and development strategies.

As shown above the combination of research and development activities offers the positive effects of participatory processes (Handler et al., 2005) within the villages and at the same time complements the scientific research. That means that the carried out project ideas represent the

fundamental needs of the dwellers. This was one part of the study that had to be explored by the research team.

To establish a successful participation process a set of pre conditions was needed:

- (1) The agreement and the will of local authorities to support the process. Village leaders of all seven case study villages had signed letters of interest before the start of SUCCESS.
- (2) On the other hand, the trust of the village dwellers in their village leaders was important. Villagers that articulated good governance of their village leaders were more motivated to engage themselves in such a process.
- (3) Responsible persons with specified functions within the process had to be defined. The constitution of critical reference groups guaranteed the procedure of the ongoing negotiation process which led to further participation of more people concerned. Finally, the small project could only be realised with the acceptance and the support of all villagers. The settlement managers were the constant bridge to the team leader and through them to the research consortium. They were important for organising the meetings and keeping the process ongoing especially during those periods of time, when the process could not carry out visible results. The team leaders of the respective village were the key persons of the process. Depending on their communication basis in the village and their personal engagement the process was equivalently fruitful.
- (4) A set of framework conditions and criteria for self-evaluation had to be communicated to sensitise both villagers and policy makers to the concept of sustainability.
- (5) A predefined sum of money was allocated for the small projects to ensure their realisation and a story of success for the villagers.
- (6) The transparency of the decision making process and the assignment of the project money was crucial for the whole process.
- (7) The villagers generated future images. These defined perceptions of their future lives will enable the villagers to trace their ideas step-by-step (backcasting).

In the meaning of sustainability the projects not only addressed ecological and economic aspects. The highlighting of social and cultural aspects was of great importance in each case study village and should be considered even deeper. “Social sustainability determines how people conceptualise their environment, their relations with nature and their attitude as well as the way of behaviour towards nature. And it is important that people recognise their present value. So training, education and self-awareness of the local people are important for the future.” (Team leader Huang Jiansheng) The SUCCESS project has taken first steps in this direction.

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# From subsistence farming towards a multifunctional agriculture: Sustainability in the Chinese rural reality

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## Abstract

The rural economic situation in China—with a living standard mostly at subsistence level—lags far behind the prosperous development in the cities and coastal areas. To balance this disequilibrium, comprehensive concepts and endeavors are necessary keeping in view all—not just economic—interests and needs that contribute to lively rural identities. In this context the role of agriculture, where still 50% of the Chinese population are working, will be newly defined, and sustainability concepts can help to find a readjusted position within the Chinese economy focusing on environmental health and food safety as main targets of political and other supporting measures.

Within the SUCCESS project, a Concept of Sustainable Agriculture was developed and it drafts one conceivable relation between the exposure to natural resources and economy and tries to find new answers to the broad range of rural challenges in China. It is a qualitative model and, therefore, not always fully applicable, but in the concrete situation of villages, it shows possible directions of sustainability-oriented development by considering the typical local potentials. In the Chinese context that means identifying the different functions of agriculture—the well-known and the hidden—to make them explicit for the Chinese public and therewith to give them new significance.

The article is based on a 3-years study within the EU-China Project SUCCESS with field research in four Chinese rural communities. It analyzes the agricultural sustainability potential of these selected villages against the background of massive structural changes within the next 20 years in rural China. Starting from the current agricultural reality, based on a qualitative analysis of the actual situation, local potentials and needs towards sustainable production and marketing are identified, and possible functions of the Chinese agriculture are formulated for the future.

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*Keywords:* China; Sustainable agriculture; Food safety; Environmental health; Qualitative approach

## 1. Objectives and approach

### 1.1. Sustainability

This paper introduces the concept of sustainability in rural China as it was applied in the SUCCESS project, within which future scenarios for seven Chinese villages were drafted in an interdisciplinary research process. In the Chinese context, strong sustainability claims the valorization of rural areas with balanced ecological concepts and leads to socially acceptable adaptations

of economic structures: "... strong sustainability recognizes the unaccounted ecological services and life-support functions performed by many forms of natural capital and the considerable risk associated with their irreversible loss. Strong sustainability therefore requires that natural capital stocks be held constant independently of human-made capital" (Wackernagel and Rees, 1996).

Objective of the paper is to report a qualitative analysis of four Chinese agricultural village communities with the help of four Principles of Sustainable Agriculture (Prändl-Zika, 2005, see Section 3.1), and to draw conclusions for the adaptability of these principles for the development of Chinese agriculture.

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## 1.2. Systems approach

This paper applies a qualitative systems approach (see Section 3.2), using a comprehensive description and structured analysis of the rural reality in the cases studied. It assesses potentials towards sustainable agriculture and their possible impacts on relevant structures.

The concept of sustainable agriculture as Feenstra et al. (1997) have defined it, is adopted here: “A systems perspective is essential to understanding sustainability. The system is envisioned in its broadest sense, from the individual farm, to the local ecosystem, and to communities affected by this farming system both locally and globally. An emphasis on the system allows a larger and more thorough view of the consequences of farming practices on both human communities and the environment. A systems approach gives us the tools to explore the interconnections between farming and other aspects of our environment.”

## 2. Introduction

### 2.1. The rural economy in China

China is currently undergoing rapid changes mostly noticeable in big towns and cities in terms of economic growth and consequently with effects on social, environmental, infrastructural and political systems there. In contrast, the rural areas, where 70% of the Chinese population are living (Wikipedia, 2006), are nearly not affected by these tendencies until now. Poverty alleviation has remained the biggest issue outside the cities and it has different reasons: on the one hand, 70% of the rural population are still farmers and live somewhat above subsistence level. Land resources in proportion to the large number of farmers are very limited and, consequently, Chinese agriculture is based on very small-scale farming with an estimated average size of farmland/farm below 0.5 ha. This shows the narrow scope of Chinese farmers in managing their farms, as they are too small to take advantage of economies of scale. On the other hand, income sources are not yet adequately diversified in the rural areas to stabilize the economic situation mainly in the villages. They suffer from a lack of job availability in appropriate small and medium scale industries and service companies, and a shift of agricultural work force into the second or third sector of economy is almost impossible, until now, without migration to towns and cities.

### 2.2. The rural–urban interdependency

Rural development is influenced by the situation in the cities. The increasing wealth of the registered urban population linked to the rapid economic growth will also affect rural structures in the long run, offer new economic possibilities and afford peasants to participate in the prosperity of the country. Rising living standards in the cities are going hand in hand with changing nutrition

habits, as, e.g. the shift from mainly grain demand towards vegetables, fruits, milk products and meat (see Brown, 1997), and will influence land use, agricultural structures and production systems in future (Fig. 1).

“The largest increase in production was for fruits, aquatic products and meat. These production trends reflect the trends towards a more diverse, protein-rich diet in China” (Heilig, 1999).

Hence, new crops, processed products and high quality food will reach higher economic significance and can become a potential for diversified income sources both in the agricultural production and in the processing sector. Additionally, the recreation potential of nature and the allure of rural life will be realized by the urban population in future and can be the basis for different types of tourism.

### 2.3. High pressure on natural resources

Large numbers of farmers all cultivating on very limited arable land resources have led to highly intensive land use. Chinese agriculture is mainly characterized by conventional production systems achieving high land productivity due to the Green Revolution, which reached China by the late 1970s (Heilig, 1999). After 25 years of intensive farming, water shortage—which today is the main limitation in agriculture in many regions—soil degradation, desertification, erosion consequences of poorly structured agricultural landscapes can be partly ascribed to the exhaustive cultivation practices and will cause further limitations in future—a vicious circle.

### 2.4. Current major tasks of China's agriculture

“China ... is now feeding 22% of the world's population on about 1.3 billion hectare, which only accounts for 7% of the world's cultivated land” (Guo, 2002). The per capita arable land comprises about 0.11 ha, which equals only one-third of the world's average (Liao, 2005). This means an extraordinary tightrope walk between the production of enough food, by exploitation of natural resources by technical and chemical means, the production of safe food not polluted with chemicals and the protection of a healthy environment.

#### 2.4.1. Food security

One important aim of China's agricultural policy is to maintain a high self-sufficiency ratios for primary food commodities such as wheat, maize and rice, which presently have reached their limits. However, future strategies for Chinese food production and consumption should be developed considering the inevitable certainties that lie ahead and the impacts of economic growth on land use.

These inevitable certainties are:

- The still-growing population of China estimated until the year 2030 (Lahmeyer, 2005) will demand increasing amounts of staple foods.

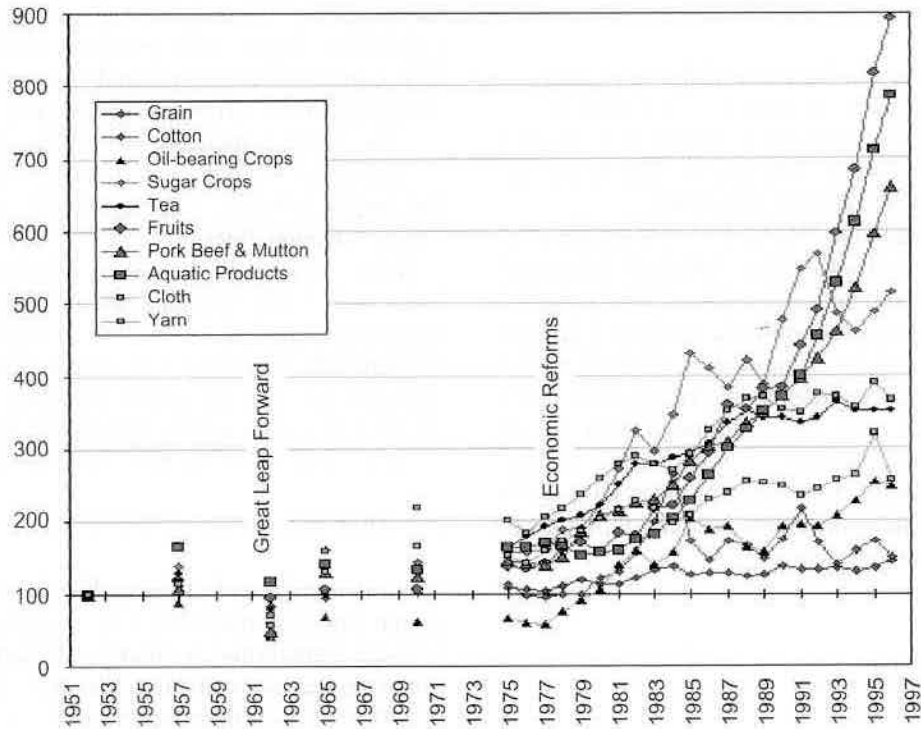


Fig. 1. Per capita production indices for selected agricultural products (1952 = 100). Source: China Statistical Yearbook, 1997. Beijing, p. 41, following Heilig (1999).

Table 1  
Energy and land demand in comparison to energy delivery of winter wheat

Product	Energy demand in production, Megajoule	Energy delivery in nutrition, Megajoule	Demand of cultivated land in m <sup>2</sup>
1.00 kg winter wheat	2.65	13.14	1.54
4.41 kg potatoes	3.53	13.14	1.46
4.76 kg milk	9.52	13.14	8.00
2.63 kg beef	100.81	13.14	57.86

Source: own calculations following Steinmüller et al. (1999).

- The ever-increasing need for land for construction and technical infrastructure will reduce arable land more and more.
- Erosion and desertification are major dangers in China and are increasingly reducing arable land.
- The change of nutritional habits in urban areas, where the living standard is rising, will affect agricultural production. The shift from grain-dominated nutrition towards a higher share of vegetables, fruits, milk products and meat will prompt farmers to convert their production. The consequences are that more land and more energy are required for those products delivering the same nutrition energy as grain products (Table 1).

From Table 1 it is evident that milk and meat production are much more land consuming than plant production for human nutrition.

Food security in China has various dimensions. Limited land resources and growing land demands cause high

pressure on the natural environment and will make priority decisions on land use necessary. In food production, e.g., the question will be posed how to provide the necessary nutrition energy in future.

#### 2.4.2. Food safety

Healthy food and clean drinking water are declared aims of the Chinese government. But it is an official fact that food safety cannot be guaranteed in many cases (Kent and Zhao, 2004). Main reasons are false exposure to agrochemicals because of inappropriate application and storage, lack of regulations, of controlling measures and of adequate education and knowledge in agricultural production and food processing. Sometimes farmers are illiterate and cannot read instructions on the packaging. Following Guo (2002) "the nitrogen and phosphate are largely abused in most areas and the three main elements (N,P,K) are applied in unscientific percentage (sic). In some main grain production areas like the east of Shandong, the south of

Jiangsu, the east of Zhejiang, the fertilizer application per hectare reached 500–700 kg.” In comparison the European margin lies at 170–210 kg N/ha (EU Council Directive 91/676/EEC).

Both the individual interest of achieving high yields in order to gain more money, and the public concern of sustaining food security lead to the need of ever increasing land productivity by chemical means. Still prevalent among farmers is the fallacy that if more chemicals are applied, proportionally higher yields can be expected (see Mitscherlich, 1948). Side effects like chemically burdened crops and drinking water, as well as degraded soils, are the consequence, and compromise food safety, health and also environmental safety.

The Chinese answer to the conflicting interests of food safety and food security was the introduction of “Green Food Production”. “Influenced by the idea of sustainable development, the development of green food in China was proposed in 1989. This development defined the basic concept of “green food” as uncontaminated, safe, good quality and healthy food produced in a specific mode in keeping with the principle of sustainable development and permitted to be sold under the label of green food” (Liu, 1999).

The Chinese Green Food Production is the pendant to the western concept of integrated cropping which tries to combine different, sometimes contradictory, purposes. “It considers aspects of food production, economic viability, producer and consumer safety, social responsibility and conservation of the environment in a well-balanced manner” (EISA, 2001). This concept intends to hold a high level of productivity but with a more efficient use of agrochemicals. “Using crop protection products as much as necessary, but as little as possible, always applying legally and in a targeted manner” (EISA, 2001). How to define and control this “well-balanced manner” remains unclear.

### 3. Theory

The different challenges in Chinese rural regions—the ecological and economic crises and consequently the social crisis—can only be overcome by comprehensive approaches taking into account different interests.

Hitherto, sustainability concepts within agronomy concern predominantly the production side of agriculture and differ widely from efficiency-oriented approaches e.g., integrated or low-input agriculture to systemic approaches, e.g., “permaculture” (Mollison and Holmgren, 1983) and organic farming (see Mason, 2003). Many of these concepts mention the importance of socially appropriate economic strategies in agriculture but do not go into further detail. Sustainable marketing and processing strategies, as well as structural and organizational dimensions, are rarely considered in these concepts although there exist already many models of good practice. “No single definition for sustainable agriculture has yet emerged.... Sustainable agriculture encompasses, but is not limited to, farming systems known as biological, ecologically clean, low-input,

organic and alternate” (Hatfield and Karlen, 1994). Pretty has comment on the lack of definition of sustainable agriculture, “Precise and absolute definitions of sustainability, and therefore of sustainable agriculture, are impossible” (Pretty, 1997).

Feenstra subsumes the different dimensions of sustainable agriculture in the notion of a “community food system”: “A community food system is one in which sustainable food production, processing, distribution and consumption are integrated to enhance the economic, environmental, social and nutritional health of a particular place” (Feenstra, 2000). This concept is very near to the here-presented understanding of sustainable agriculture.

#### 3.1. Four principles of sustainable agriculture

Sustainability in the context of agriculture has a special significance. Drastically spoken, agriculture is one of the biggest environmental polluters and destroyers. Conventional, intensive agricultural production systems all over the world show very high-energy demands and contribute largely to the green house effect and climate change. They pollute soil and water with agro-chemicals, reduce biodiversity, lead to degradation, desertification, erosion of soils and, in many cases, result in poorly structured, monotonic agricultural landscapes. This is to a large degree also the case in China.

Hence, there is an urgent call for action in developing new locally adapted concepts for sustainability-oriented agriculture. They should include a paradigm shift from a short-term quantitative towards a long-term qualitative approach wherever possible. Following a strong sustainability approach, organic agriculture—which is well established and regulated in Europe (Council Regulation (EEC) No. 2092/91)—is the core of the concept since it causes the lowest environmental impact of all cultivation systems. “The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people” (El-Hage Scialabba and Hattam, 2002).

However, organic agriculture should not be regarded isolated but always in relation to local and regional, social and economic circumstances. As organic agriculture describes the sustainability interface between human activities and ecosystems, the concept of sustainable agriculture goes further and incorporates the system of organic agriculture into the local economy and the social potential.

Within the system of sustainable agriculture, the farmer transforms into an entrepreneur organizing his farm by organic crop and land management, local and regional product processing and marketing. All this needs a new self-perception of farmers, to be less dependent in processing and marketing on state-owned enterprises, big cooperatives and companies, but to become more active, to develop own ideas and to realize them by establishing local networks (Wagner, 2004). These new activities should lead

to more economic stability of farms and contribute to regional identity and profile (Fig. 2).

The farm is the smallest productive and economic entity in agriculture. Influenced by the agricultural policy and market conditions, the decisions on what to produce and how to produce are made on the farm. Sustainable agriculture describes one possible relationship between the use of natural resources and the needs of the market

and tries to balance ecological capacities and economic interests.

The Four Principles of Sustainable Agriculture form a conceptual framework following in the first instance the intention of protecting natural resources as soil and water—with emphasis on

1. organic plant production and animal husbandry.

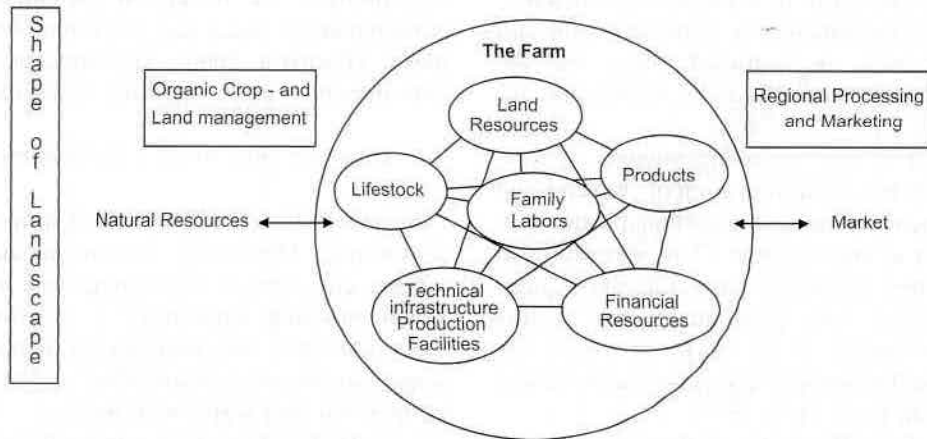


Fig. 2. The farmer as sustainability manager between natural resources and the market.

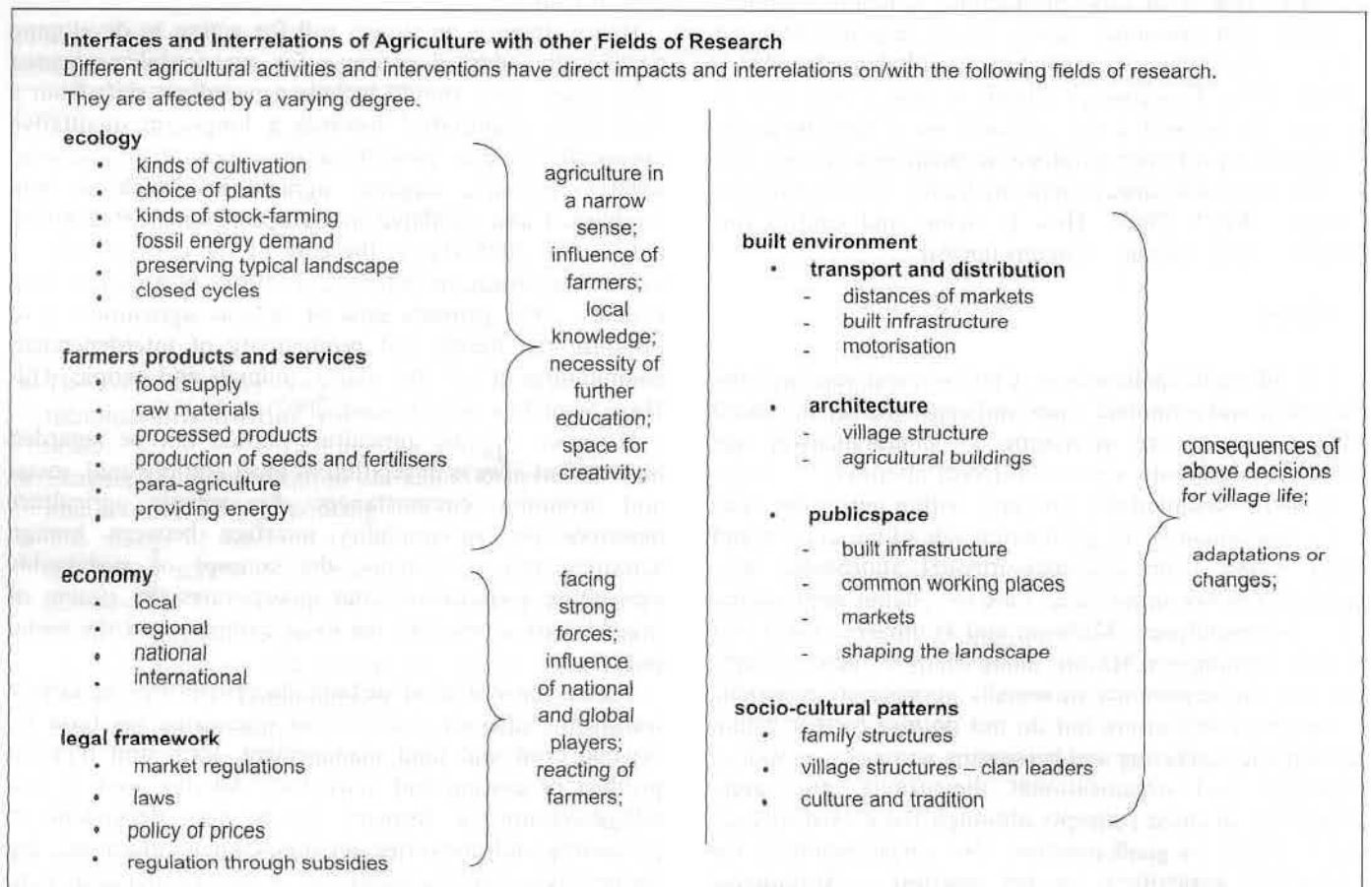


Fig. 3. The systems approach for the analysis of agriculture (Prändl-Zika, 2005).

2. regional processing,
3. regional marketing, and
4. additional income through para-agricultural activities (Prändl-Zika, 2005).

With this focus, the actual situation of agriculture in four SUCCESS case-study villages was analyzed qualitatively and local potentials and needs towards sustainable production and marketing were identified.

### 3.2. The systems approach for the analysis of agriculture

As sustainability research has to consider many different aspects of ecology, economy and socio-culture with respect to special local conditions systemic approaches are the most appropriate ones. The “Systems Approach for the Analysis of Agriculture” gives the possibility to estimate which consequences can be expected for different aspects of village life if, e.g. methods of cultivation will be modified. Based on such estimations the identified potentials for changes—here towards sustainability—show further impacts and needs for changes in other domains which should also be considered for sustainability movements (Fig. 3).

Hence, the sustainability demand in research itself means to consider and balance several interests when formulating future scenarios and recommending sustainability-oriented movements. Sustainability research and implementation are highly dynamic local processes corresponding to each other continuously.

### 4. Four Chinese villages under agricultural investigation

During the SUCCESS 3-years study, four Chinese villages in four provinces (see Fig. 4) have been visited for agricultural investigation.

During field studies, difficult research situation on site—lack of official data, translation problems, different measuring and unit systems—was met by various methods of investigation and interdisciplinary exchange. For the agricultural survey in this interdisciplinary setting, methods of the Participatory Rural Appraisal (Liu, 2003)—household and stakeholder interviews, transect walks mainly through fields and agricultural facilities—were chosen. Participatory workshops with farmers, as well as feedback presentations of findings to the villagers at the end of data collection, helped to assure their correctness. (see also ilse Marschalek in this volume: “The Concept of Participatory Local Sustainability Projects in Seven Chinese Villages”.)

Each of the four villages shows quite different conditions starting with climate, topography, traditional and adapted crops and also in concerns of farming systems, access to knowledge and to the market. All villages have in common a relatively high share of farm land used for subsistence ranging from 16% up to 55% of the cultivated land per farm.

Table 2 gives an overview over average land resources per farm in all four villages, which are rather limited. It shows the proportion between land needed for subsistence and land available for cash crops, and outlines the

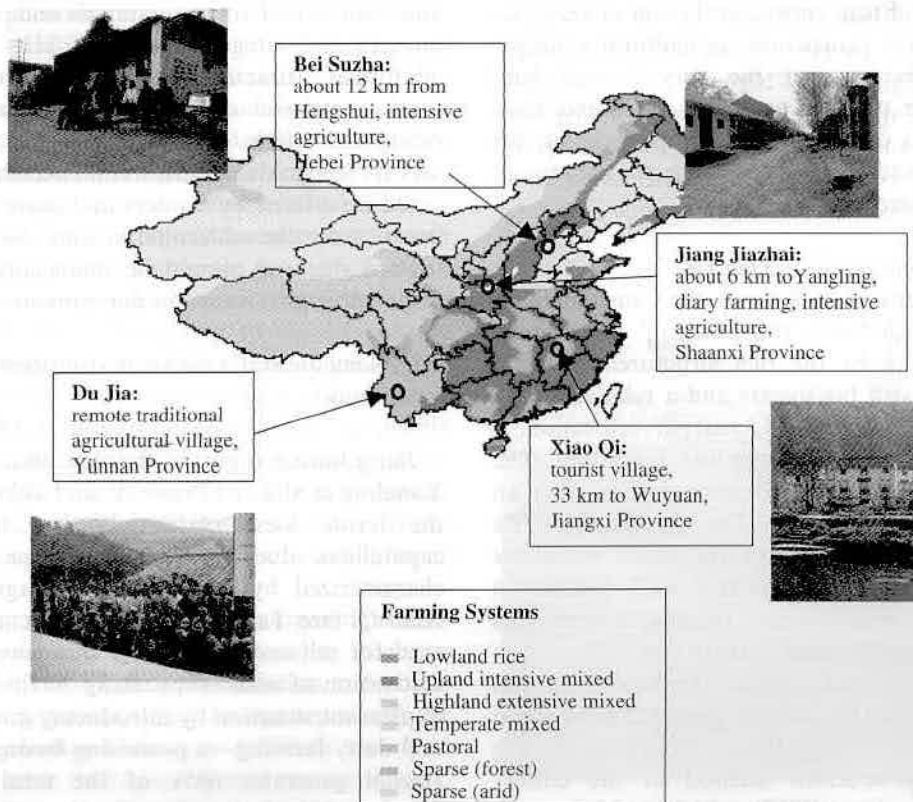


Fig. 4. China farming systems with SUCCESS case study villages under agricultural investigation.

Table 2  
Overview over agricultural structures in four analyzed SUCCESS case-study villages

Village	Average cultivated land (CL)/farm (ha)	CL/farm used for subsistence (ha)	CL/farm for cash crops (ha)	CL/farm for cash crops in % of average CL/farm (%)	Persons/farm
Xiao Qi	0.220	0.120	0.100	45.46	3.60
Jiang Jiazhai	0.300	0.145	0.155	51.67	4.36
Du Jia	0.631	0.141	0.488	77.34	4.23
Bei Suzha	0.780	0.125	0.655	83.97	3.76

Source: own calculations according to collected data and the statement of the village leader of Jiang Jiazhai, who assumed 0.15 ha grain growing land with two harvests for subsistence for a family with 4.5 persons and one pig.

economic situation in these villages: while Bei Suzha can be considered as well-off, Xiao Qi is rather poor.

#### 4.1. Xiao Qi: a combination of agriculture, tourism and tradition

Xiao Qi in Jiangxi Province is a village with extremely small-scale agriculture. Approximately half of the cultivated land/farm is needed for subsistence and just 0.1 ha/farm can be used for cash crop production. This poor situation has led to a problematic diversification of income sources: already 40% of the total household income result from labor migration mostly out of the region, 30–40% from agriculture and 10–20% from tourism. Tourism is promising in Xiao Qi as this village is famous for its beautiful mountains and ancient architecture. It is part of guided tourist bus trips through Wuyuan County and attracts people from all over China and also from abroad. From agricultural point of view, the possibilities to establish prosperous agricultural concepts are rather limited because of the very limited land resources. Small-scale tourism providing beds and food for individual tourists could be an additional option for income generating and will help mitigate the tough economic situation there.

##### 4.1.1. Sustainability potentials in Xiao Qi

4.1.1.1. *Organic cultivation.* From the sustainability point of view Xiao Qi holds the potential for organic farming which is given by the rich structured and still diverse environment with big forests and a relatively high share of wild vegetation, e.g. field margin vegetation, a varied topography and a rich-structured landscape. The pressure of pests and diseases in cultivation in such an environment is comparatively low. The conversion of rice production towards organic cultivation would be rather favorable as organic rice yields are not much lower. "In developing countries, well-designed organic systems can give better yields, profits and returns on labor than traditional systems" (FAO, 2002). Besides, Wuyuan County is already famous for organic green tea production (mainly for export to Germany). Hence, there is an existing know-how of this production method in the county following IFOAM directives (2002), which could theoretically also be introduced in Xiao Qi.

4.1.1.2. *Additional income through para-agricultural activities.* Xiao Qi has already prosperous tourist activities. The natural beauty and the famous ancient architecture combined with culture and tradition are the basis for tourism in this region. But, until now just a few villagers are able to benefit from the profits out of the tourism business, because tourism in Xiao Qi is managed by outside companies and travel agencies who organize sight seeing bus trips to the village cooperating with special restaurants and hotels run also by outsiders. Thus, it is difficult for small local hotels and restaurants to acquire guests and only just a few additional local jobs were created (Wagner, 2004).

From a sustainability point of view, Xiao Qi has big potential to combine a sort of gentle tourism with agriculture. There should be endeavors for comprehensive concepts on community level including all potentials of the region. These concepts should predominantly pursue the ambition to find an adequate role and position for the local farmers and integrate nature, forests and mountains as additional attractors for walking, hiking, looking for mushrooms and eventually for mountain biking, horse riding and others. It should be an aim to entice tourists to stay for longer durations, so that accommodation and food could be offered by farmers and more local citizens could benefit from the additional income. Necessary investments toward this end should be financially supported by the responsible governmental department.

#### 4.2. Jiang Jiazhai a village in transition to modern intensive agriculture

Jiang Jiazhai is part of the agricultural high-tech zone of Yangling in Shaanxi Province, and although it is located on the fertile loess plateau, it has limited agricultural capabilities due to water shortage. Jiang Jiazhai is characterized by very small-scale agriculture similar to Xiao Qi (see Table 2). Half of the cultivated farmland is used for self-consumption so that leaves just 0.155 ha for cultivation of cash crops. Jiang Jiazhai has overcome this unpleasant situation by introducing green food production and dairy farming—a promising business. Currently Jiang Jiazhai generates 60% of the total income by dairy farming, 20% by crop production and 20% by off-farm activities like labor migration. Milk production was

introduced about 10 years ago and traces back to a governmental initiative with massive financial support. This new production branch was developed together with the Northwestern Sci-Tech University of Agriculture and Forestry and the Yangling Agricultural High-Tech Zone. It is growing rapidly. Additionally Jiang Jiazhai has introduced fruit trees, green house production and different forms of intercropping. Main crops in Jiang Jiazhai are wheat for self-consumption, maize for human nutrition and cow feeding, rape, green house vegetables and fruits.

#### 4.2.1. Sustainability potentials in Jiang Jiazhai

*4.2.1.1. Organic cultivation and animal husbandry.* Jiang Jiazhai is an example for Chinese modern agriculture. Intensification and industrialization of agriculture are the main strategies here to overcome the difficult economic situation. To create new markets like the milk market (China has started with milk production and consumption just about 15 years ago) may be justifiable from an economic point of view but not always from an ecological or cultural one. Jiang Jiazhai shows that consequences of globalization have already reached village level. Milk and dairy products have not been part of Chinese nutrition for thousands of years and the high lactose intolerance of the Chinese population underlines this fact. Even dairy farmers in Jiang Jiazhai do not drink milk themselves; they produce milk for better-off people in cities.

In Jiang Jiazhai, ambitions related to milk production are very high. Number of cows has increased to 600 heads in the year 2004 and even more in 2005, although total cultivated land of JJZ is rather little (120.67 ha) and cow density comes up to almost 5 cows/ha. Considering two harvests a year, one maize and one wheat, animal husbandry can be appraised as decoupled from cultivated land in feed production. A considerable part of the feed has to be bought outside of the town, mainly concentrate, with a quality and consistence that is not clear. In manure and, therefore, nitrogen production, dairy farming is at its limits even regarding two harvests a year (Prändl-Zika, 2004, 2005). According to the EU nitrate directive which postulates one harvest/year, there are not more than 2.83 cows/ha allowed to be kept (EU Council Directive 91/676/EEC). Besides farmers in JJZ use mainly mineral fertilizer. The surplus of animal waste causes already problems and will lead to harmful nitrate concentrations in the groundwater in the long run. Moreover, there is a lack of knowledge in animal waste treatment methods.

The potentials for a movement towards organic production appear to be relatively low at the moment. Intensive agriculture in this region is a declared ambition and is also supported by the government. Jiang Jiazhai represents the overall Chinese agricultural strategy fulfilling the food security task at the same time opening new income sources. However, the consequences of such a strategy are already visible here. Agriculture leaves a monotonous landscape

with low bio-diversity (see Fig. 5) and the use of mineral and organic fertilizers and pesticides is rather high. The unbalancing impact on environment is deep.

Suggesting a paradigm shift towards qualitative organic farming with two milk cows/ha (concerning nitrogen production in animal waste), milk production would have to be reduced strongly (estimated to 242 cows for the whole village). Thus dairy farming in right proportion to cultivated land could be an option to lead to a balanced nitrogen budget assuming that no mineral fertilizers are used additionally. In Jiang Jiazhai the potential for a shift towards organic crop production and dairy farming is seen primarily in the close link to the North-Western Sci-Tech University of Agriculture and Forestry in Yangling and to the Yangling Agricultural High-Tech Zone and this link could help farmers of Jiang Jiazhai to develop and initiate appropriate organic agricultural systems in addition to their present pursuits.

*4.2.1.2. Regional processing and marketing.* In all likelihood, milk production will persist in future, and it could be recommended to fulfill also in this production branch a paradigm shift from the production of high quantities of raw-milk to the production of value-added milk products, e.g. yoghurt, butter and cheese. These processes do not require too large investments in technology. It is more important to meet hygienic demands by furnishing kitchens adequately. Such investments should be financially supported by the government. A small farmers' co-operative for milk processing can be supposed to process milk more efficiently than a single household. In addition, direct selling from this co-operative dairy or through a farmers' shop in Yangling would lead to higher profits for farmers, strengthen their position and help them to become more independent of big enterprises. Jiang Jiazhai could position itself in the new market sector of milk products, which soon will conquer the Chinese shops.



Fig. 5. Monotonous agricultural landscape in Jiang Jiazhai (Prändl-Zika, 2004).

#### 4.3. Du Jia a remote village with difficult access to the market

Du Jia, located in Yunnan Province, is a very small and remote village, 65 km from Mile, the nearest town. Agricultural structures in Du Jia are a bit larger, and Table 2 shows that 23% of cultivated land per farm is used for subsistence. Income in Du Jia is generated just from agriculture. Sugarcane covers 35% of the agricultural land and is the most important cash crop. Sugarcane demands large amount of mineral fertilizers and pesticides to achieve high sugar yields. Farmers are economically dependent on a sugarcane factory about 35 km away. Stock farming includes buffaloes, pigs and goats whereat the number of goats with 120 heads is already at its ecological limits (see Huang, 2004). This fact combined with the expansion of cultivated land on the mountain slopes caused uncontrolled deforestation during the last years. These are the major problems in Du Jia.

##### 4.3.1. Sustainability potentials in Du Jia

**4.3.1.1. Organic cultivation and animal husbandry.** Du Jia disposes of some educated and well-rooted villagers, who started already to think about new movements in agriculture, e.g. there are attempts to introduce orange trees or flax in the region. These villagers represent a potential for agricultural innovation. Along sustainability considerations, the rethinking sugarcane cultivation with high inputs of agrochemicals and introduction of balanced crop rotation systems in its place should be encouraged. Furthermore, to develop sustainably managed agro-forestry and to establish a balanced animal husbandry concept is highly recommended.

As methods in organic rice cultivation are advanced and achieve good yields (FAO, 2002), it is also an option for Du Jia. The high diversity of the natural environment with field margin vegetation and a very diverse forest in the surroundings are good preconditions for it.

**4.3.1.2. Regional processing and marketing.** For Du Jia finding appropriate cash crops apart from sugarcane, that suit the conditions here, and further are not damaged easily in transport, have a lower risk of deterioration and (as niche products of high quality) have good market at distant from Du Jia is a big challenge.

People in Du Jia have high skills in conserving food which can be enhanced and form a potential for economic processing in future. Farmers in Du Jia have also a high ability in cooperation and organization of heavy work due to the lack of mechanization. They could apply these social abilities furthermore in economic concerns. To cooperate in production and marketing could strengthen their position and help them to get more independent from outside forces, e.g. from the powerful sugarcane factory.

**4.3.1.3. Additional income through para-agricultural activities.** The beauty and intact environment of the surround-

ing of Du Jia can be seen as a potential for gentle hiking and trekking tourism in a longer future. A further increase of weekend tourism to the countryside can be expected. So to preserve a native and diverse landscape in this region through an environmentally sound agriculture can secure a valuable future capital.

#### 4.4. Bei Suzha a village with potentials for urban–rural partnerships

Bei Suzha in Hebei Province is an agriculturally advanced village situated near the city of Hengshui and in close to an agricultural high-tech zone. The share of cultivated land for subsistence is 17%. In Bei Suzha, 94% of the total income in Bei Suzha is generated in agriculture. Main crops are wheat, maize, cotton and peanuts. Bei Suzha has set in motion many efforts to promote green food production and green house vegetables. Farmers there can be regarded well-off because of higher incomes resulting from bigger farm sizes and direct marketing to the city of Hengshui.

##### 4.4.1. Sustainability potentials in Bei Suzha

**4.4.1.1. Organic cultivation.** Bei Suzha with its favorable location near the Dengzhuang Agricultural High-Tech Zone has the advantage of good access to knowledge and training. As several farmers in Bei Suzha converted already to green food production, the agricultural high-tech zone would be an appropriate partner to develop concepts going further towards organic or a Chinese approach of environmentally sound agriculture. In Bei Suzha the limiting factor for agriculture is water shortage. Inefficient irrigation methods and the cultivation of highly water-consuming crops, such as cotton and tomatoes, are aggravating this situation. New concepts for agriculture should include appropriate plants, adapted crop management, efficient water use, e.g. sprinkler systems, and water saving methods, e.g. permanent green soil cover to avoid evaporation and seepage losses.

**4.4.1.2. Regional processing and marketing.** The city near Hengshui, offers many different potential customers in markets, shops, hotels, restaurants, social institutions, etc. Moreover, the consciousness for healthy non-chemically burdened food originates mostly in cities and often starts with the wish of parents to provide healthy food for their children. For Bei Suzha, it could be an option to specialize in producing high-quality food and safe infant products out of its vegetables and fruits and to initiate and set up direct partnerships with shops and institutions in Hengshui.

**4.4.1.3. Additional income through para-agricultural activities.** Bei Suzha with its three ponds holds also a potential for recreation for nearly city dwellers in the weekend. This will additionally establish and strengthen rural–urban relations. For this purpose, the village appearance can be

upgraded with a little effort. Ponds could be revitalized and become an attraction for fishing and boating. Additional services, offers and facilities as boat rental, fishing accessories, a tea house, a restaurant and a farmers shop would complete the tourism offer. Tourists should, therefore, also be regarded as potential clientele for local agricultural specialties and farmers should adapt marketing strategies to their behaviors and demands: booths on the streets, sales rooms, and offering products for consumption in convenient atmosphere.

### 5. Conclusion—sustainability criteria for Chinese agriculture

The above-described potentials of the SUCCESS case-study villages make explicit that sustainability movements are highly local processes. They emanate from the very specific economic, ecological and social conditions and they have to respect human abilities and traditions in these villages. Top-down measures primarily provide a general framework and should meet the major challenges of Chinese agriculture to reach economic and social stability in future. These challenges will be:

- A. to diminish irreversible environmental interventions by different means of cultivation methods and techniques,
- B. to diversify and create new appropriate rural income sources for peasants thereby, and
- C. to enlarge farming structures to economic and ecologically reasonable size.

#### *A. To diminish irreversible environmental interventions by different means of cultivation methods and techniques*

All four case-study villages—even the most remote and traditional village Du Jia—have shown that the appropriate exposure to agro-chemicals is not yet realized and has left strong impact on the environment (degraded soil and water quality, reduced biodiversity). This has several reasons: primarily farmers mostly do not get adequate instruction handling fertilizers and plant protection agents. They overestimate effectiveness of these and, aiming at higher outputs, they deploy more and more chemicals (see Mitscherlich, 1948). Additionally chemicals are deemed to be “high tech” and modern among farmers, whereas organic fertilizers such as animal waste are regarded old fashioned.

Consequently clarification, education and training are the first steps to meet the challenge of chemical misuse. Chinese Green Food Production represents an endeavor to get this problem under control, but it is not clear how this production system is regulated. The case-study villages Bei Suzha and Jiang Jiazhai operate already Green Food Production. The situation there shows that an intense long-term exchange of practical experiences and theoretical knowledge is of high importance to succeed with new

agricultural techniques. Farmers in Bei Suzha and Jiang Jiazhai being excluded from this education system failed in most cases. The same holds true for the introduction of organic agriculture. Farmers operating environmentally sound production systems need to be supported with appropriate know-how.

From a sustainability point of view, it shall be emphasized that agriculture, which benefits directly from natural resources and their maintenance, has to be seen in the systemic context of natural interdependencies. For the Chinese reality that means, e.g. (re)introducing compensating crop rotation systems (which could not be found in one of the case-study villages) coupled with adequate animal husbandry concepts to keep nutrient budgets balanced. Partly it can be helpful to reclaim traditional Chinese farming practices, to set them into a modern context of agriculture and combine them with new techniques. Moreover, to enhance biodiversity and to compensate farming activities the protection and re-naturalization of islands and corridors of original “wild” vegetation is highly important. Organic agriculture will may not be realizable in many cases, considering the importance of food security. But several methods like proper animal waste treatment and organic fertilization, green fertilization, wider crop rotation systems and integrated pest and weed management can help mitigate the environmental burden.

#### *B. To diversify and create new appropriate rural income sources for peasants*

To contribute to rural poverty alleviation, there will not be any other option than to set up appropriate small and medium industries and enterprises in the countryside.

The case-study village Xiao Qi shows this very clearly. Small-scale farming in this village is comparable to gardening and under the prevailing circumstances agriculture will never lead to higher profits. Labor migration has been the consequence with the side effect that social structures—leaving women, children and old people behind with the hard field work—are destabilizing. Jiang Jiazhai with a similar agricultural situation also suffers from labor migration to remote cities, but has partly met these poor conditions with the introduction of dairy farming. To a certain extent this strategy can mitigate the situation, but that also should not be the only one.

Furthermore, economic activities on farms should become more diversified and product processing, direct marketing activities and the provision of additional services, such as farm holidays, can contribute to higher profits for farmers.

To improve the economic status of these villages, agricultural processing and other appropriate industries, as well as service enterprises, e.g. tourist institutions and recreation facilities, should be established in rural areas to unburden economically the agricultural sector. Rural agricultural manufacturing could partly be organized as farmer’s cooperatives so that the local population is the

main beneficiary. Diverse rural economies will provide jobs but will also offer services for the local population to fulfill their needs. Sustainable rural development aims at keeping the rural population in the villages.

### *C. To enlarge farming structures to economic and ecologically reasonable size*

A labor shift out of agriculture to other sectors of economy leads to enlargement of farming structures. This has, in the first line, the consequence of increasing farm sizes regarding cultivated land and opens more economic possibilities for remaining farmers in managing their farms and in making use of economies of scale. “The large number of very small farms is one of the factors, which prevent further modernization in China’s agriculture. Larger farm sizes should be promoted by gradual privatization of the arable land” (Heilig, 1999). As a consequence farmers become economically more flexible and are able to react to the demands of the market. The economic risk for farmers is getting lower by increasing land resources, and the willingness to try out new environmentally sound cultivation methods, techniques and measures is also rising. Pressure on natural resources and the ambition for high land productivity could theoretically decline at the individual farmer’s level as he is not any more much dependent on each square meter of land. But the Chinese policy to maintain food security and farmers economic interests counteract these aims. Hence accompanying environmentally sound measures to land consolidation should be considered and taken already in the course of transition.

Following the sustainability approach the following question suggests itself, “What is a reasonable size for a farm in China?” Regarding the case-study village Bei Suzha which is considered by the Chinese SUCCESS experts to be wealthy and which shows the biggest average farm size of 0.78 ha/farm generating 94% of the total household income in agriculture induces us to consider that average farm size of 1 ha lead to an economically stable situation for Chinese farmers at the moment. To reach this target at least 50% of farmers would have to leave agriculture and find new jobs in other sectors. Presently nobody can assess the consequences of such a movement for the country.

## **6. Perspective—a multifunctional agriculture for China**

“The multifunctionality of agriculture can be defined as the joint production of commodities and non-commodities by the agricultural sector. Finding the right balance between the produced goods is a matter not only of agricultural policy, but also of changes in management at farm and territorial level” (Durand and Van Huylenbroeck, 2003).

Chinese agriculture will have to undergo a paradigm shift from being a pure production branch fulfilling the

food security task by all means to a diversified sector providing different products and services. These could reach from offering safe healthy food and regional specialties over environmental services as protecting water and conserving nature and landscape to the provision of tourism services. Moreover, to succeed in establishing new agricultural functions, it could be a strategy to abandon temporarily present food security ambitions in favor of food safety and long-term food security, which is in the long run dependent on environmental health.

The Chinese policy will have to set the course for a balanced rural development—whose key goals, according to Conway (1994), should be productivity, equity, sustainability and stability—with the establishment of a subvention system, the initiation of programs of education and trainings for farmers and stimulations in rural areas to attract enterprises and to subserve the foundation of new regional companies. Rural development has to take several different measures to promote diversity of rural life in the villages with its typical socio-culture, traditions and all its elements of intact environments and rich structured landscapes.

### *6.1. Adaptive education systems*

Basic and further education of farmers is an important precondition to implement new concepts in agriculture in China. Following Zhang (2004) life-long education is the basis to motivate and empower farmers to become active players in production, processing and marketing and to lead them to adopt environmentally sound farming practices.

The network of agricultural high-tech zones in China can support the requirement of farmers’ education and training. As governmental institutions in the countryside, with close links to agricultural universities, they have the potential to develop efficient instruments and methods for a better knowledge transfer to the village level.

For implementation, an adaptive education system based on conducted trial-and-error processes operated by farmers in their fields is recommended. Continuous knowledge transfer and exchange of experiences between farmers, agricultural trainers and scientists should accompany these processes to come to locally adapted solutions. To involve farmers from the very beginning into a process of education and exchange will influence the success of new strategies to a large degree and will encourage them to find their own appropriate solutions.

### *6.2. Subsidies and state-aided credits*

Farmers provide—often under hard and poor conditions—elementary products and services for the whole society of a state, as food, raw materials, fuels, but also—as side effect of their cultivation—different shapes of typical landscapes. Therefore and because of the low price level in agriculture, it is justifiable—especially for farmers in

difficult economic situations—to balance their inadequate reward by financial governmental support. “The major aim of an agricultural subsidy system should be to provide farmers with a reasonable standard of living and consumers with quality food at fair prices” (EU, 1992).

In China, an agricultural subsidy system would contribute to poverty alleviation of farmers and their allocation should be bound to laws and regulations of environmental standards. Thus, subsidies induce farmers to operate an environmentally sound agriculture and such a policy will establish the value of healthy, balanced ecosystems as a need for the whole present and future society.

State-aided credits in agriculture should be awarded for investments in small-scale holdings with innovative long-term concepts which are embedded in superior concepts on village or regional level. They should also be coupled with environmental requirements.

### 6.3. Laws and regulations

Agricultural laws and regulations have to include the compilation of environmental standards and strategies to fulfill them and they have to set up thresholds for dangerous chemical toxins (EU Council Directive 91/676/EEC, 1991). A legal framework for organic or similar agricultural production systems has to be elaborated, and controlling authorities have to be established to guarantee their abidance.

All these and other accompanying measures on different administrative levels should follow a wider understanding of agriculture at the interfaces of ecology, economy and socio-culture with the overall objective of a multifunctional agriculture for China. As a comprehensive conception, it has the potential to meet the various challenges of rural China and aims at the stabilization and valorization of social and environmental structures in rural areas. It needs approval and reward in the public, and reflection in political programs.

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## Sustainable mobility in rural China

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### Abstract

Rural areas in China suffer from various problems. The stagnating economic development and a lack of (sufficient) job opportunities and basic services, etc., lead to disadvantages for great parts of China's population. In this context, the transport sector plays a crucial role for the development of rural settlements.

Although the degree of undersupply varies between villages, the situation of Chinese villages is often worsened by an insufficient developed transport sector. Regarding mobility in rural China, major constraints and therefore challenges are the difficult access to the transport infrastructure, bad road conditions and the lack of public transport systems. Improvements within the transport sector can be regarded as crucial for the economic and social development of (rural) China and should be carried out in a sustainable and holistic manner using participatory approaches. The aim should be the development of mobility strategies considering the specific needs within the field of transport, which shall have a decisive and positive impact on related sectors.

This paper is based on experiences made during the 3 years lasting Sino-European research project SUCCESS (Sustainable Users Concept for China Engaging Scientific Scenario) that analyses the present and the potential future role of transport systems in selected rural areas of China. Referring to the case studies of three villages in rural China, some mobility-related projects that present a favourable impact not only on the transport sector but also on the social system and the economy shall be highlighted. Finally, based on the analysis, instruments and measures for the development of a pathway to a sustainable mobility in rural China will be outlined.

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*Keywords:* China; Rural transport; Sustainable mobility

### 1. Introduction: the relevance of sustainable mobility

As poor access to social services, markets and other facilities is widespread, and often leads to isolation, transport is of outstanding importance in rural areas of low- and middle-income countries. A sufficient and efficient transport system not only ensures the integration into a broader social and economic life, especially regarding the employment market, but also access to information and new opportunities for all parts of the rural society (Dawson and Barwell, 1993).

In contrary to urban areas, where increasing motorisation has led to problems of air pollution, congestion, etc., rural areas are affected by these problems to a lower extent. Rural transport takes place to fulfil a broad variety of subsisting, economic and social purposes. Beside from

needs like the access to markets and social services, many transport activities are associated to basic needs such as purchasing water, food and firewood. Some of these trips take place in motorised vehicles along well-maintained routes, but the bulk of translocations are carried out by feet or on rough roads often with intermediate transport modes like animal-carts (Donngess, 2001).

This paper processes results from the SUCCESS project that has been worked on between October 2002 and August 2005. A major aim of the interdisciplinary research is to analyse the present situation and to develop solutions for a sustainable development. Thereby, solutions are developed participatory through elaborating ideas in cooperation with local people. Applied methodologies within the field studies, carried out between October 2002 and October 2003, were mainly qualitative interviews with different stakeholder as well as quantitative inquiries in terms of household surveys. Furthermore, additional materials like maps, statistics, etc., have been provided

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from local and regional governments and the Chinese joint project partners. Adjacent to the field studies, a workshop held in China has provided further findings—above all on appropriate development strategies for the project villages. These informations have been treated for this paper as well.

The paper focuses on the future role of transport systems in selected Chinese rural areas and is linked to related disciplines to provide general guidelines for a sustainable mobility. The focus was set on the analysis of effects from the implementation of activities to ameliorate the specific living conditions of three selected villages in different Chinese provinces. Thereby, mobility and the provision with transport systems shall not be regarded as an isolated topic, but pulled together in a causal relationship to other economic and social sectors.

The lack of public transport modes and deriving difficulties for mobility are key issues for the development of rural China. In this context, it is certainly important to give precise policy advises on how to cope with transport and mobility challenges in Chinese rural areas. As the respective conditions are extremely different, global recommendations cannot master the diversity of problems concerning transport provision in rural China.

### 1.1. The Chinese pathway to motorisation

Motorisation is identified as a key factor in the improvement of economic and social life in China. A number of joint ventures with international automotive manufacturing companies and a “family car strategy” (1994) were implemented to boost automotive industry and related businesses. For example, an interregional road network project, the “National Trunk Highway Network”, consisting of 12 interprovincial motorways, was launched to create connections between the countries’ major cities (Jiang, 1998; Fulcheri, 2005).

According to the lack of fuel, the transport system was designed to be highly effective and of low-energy consumption. In 2000, car traffic was already consuming 65.6 million tons of oil a year, which comes up to one-third of China’s total annual consumption (Schipper; Ng 2004). In 2004, the number of cars for civilian use reached 9.2 million; 6 million of them were privately owned (Statistical Communiqué, 2005). The expected growth for the following years is 10–15 per cent annually (Li Jian, 2004).

While the largest part of China’s air pollution is still caused by coal burning, the State Environmental Protection Agency (SEPA) estimates that the share of traffic-induced pollution in urban areas will reach 79 percent in 2005 (www.chinadaily.com.cn, 2003-12-22). Another consequence of motorisation is the decline of the bicycle use, which used to be the most important vehicle for personal traffic in China. The ratio lowered within 4 years from 1.8 bikes per household in 1998 to 1.4 in 2002.

The degree of motorisation within urban and rural areas varies considerably. In urban areas motorisation

has reached a critical point, often hindering mobility. According to estimations from 2003, in “developed China”<sup>1</sup> 165 vehicles per 1000 inhabitants are in circulation whereas for the whole country the rate is 14 vehicles per 1000 inhabitants (Fulcheri, 2005). This implicates a relative low rate of car ownership in rural areas and proofs that economic development is an obvious precondition for an optional vehicle ownership that are often linked directly. In fact, the rate of motorisation in rural areas is pretty low, although the number of agricultural vehicles is growing continuously—from 3.4 million in 1990 to 19.1 million in 2000, which eases the life of the rural population and supports economic development. Most of the vehicles are used in the wealthy coastal provinces, while they remain unaffordable for the rural population in poorer regions of the land-locked provinces. Therefore, especially remote villages are endangered to be excluded from the economic development (Fulcheri, 2005; Shen et al., 2002; china-view.cn 2004-04-16).

### 1.2. The transport sector in China’s rural areas

Along with China’s rapid economic growth, the Chinese transport policy has been changed, and the demand for (new) transport services has substantially increased over the last decades.

Occurring in line with a fast growing economy, structural changes contribute to altered patterns of transport demand—not only in urban centres, but also in rural areas as well. These alterations are expressed by a significant shift within the modal split in favour of road transport: from 1985 through to 2002 the share of railway transport in passenger traffic volume (in billion person-kilometres) declined from 54 to 35 percent while the rate of road transport increased from 39 to 55 percent (see Fig. 1) (APER, 2004; ADB, 2003).

In rural areas, road traffic is expected to grow with lower rates—for obvious reasons: traffic networks are of a lower density, areas are sparsely inhabited and economic activities cannot keep pace with the respective urban performance.

In spite of the general economic boom, most provinces in Central and Western China off the prospering coastal belt suffer from economic problems. About one-third of China’s counties are officially designated poor counties. Predominantly agrarian, the Chinese province Sichuan for example has a per capita rural income that ranges below the national average for rural incomes (ADB, 2003).

Carrying two-thirds of total passenger traffic and one-third of total freight traffic, the road network has to be classified as underdeveloped. Due to the fact that the provinces’ budget is relatively low, necessary investments in transport infrastructure could not be performed.

<sup>1</sup>“Developed China” in this context means the large cities of central and eastern China (population: approximately 110 million) (Fulcheri, 2005)

## Box 1

## A new national policy: the small-town strategy

The Chinese government is aware of the problems deriving from the markedly rapid population growth in large cities. As a response to this development, the people's congress launched the small-town strategy. The formulation of the new policy will concentrate on the urbanisation of rural areas by developing cities for 300,000–500,000 inhabitants. The aim is to control the cities' expansion in their size and number of inhabitants through the creation of satellite towns and the construction of medium-sized or small cities. Indeed, the aim is not just controlling the excessive growth of urban areas. The development of small towns is also regarded as an important strategy to promote economic and social progress in rural and remote areas. Developing small towns provides an important instrument to canalise the population who is willing to migrate out of rural regions. One aim of the small-town strategy is to revise general plans for regions and existing cities, and to set up a restrictive planning procedure for towns and villages. Moreover, respective authorities at all levels are advised to initiate the construction of model towns that could be "reproduced" in other parts of the country (ACCA21, n.d.; Beijing Review, 1999).

In balance, road traffic in Sichuan grew at a slower pace—compared to the national average<sup>2</sup>—with 6.5 percent per annum for passenger traffic and 3.4 percent per annum for freight traffic (billion passenger kilometres) (ADB, 2003).

The Chinese government has now decided to support the development of rural areas, and has therefore agreed on the so-called "small-town strategy" (Box 1).<sup>3</sup>

According to the official political position, the strategy aims at supporting the economic and social progress of rural settlements and is regarded as the third great leap forward of China's rural reform. With a size of 300,000–500,000 inhabitants, the new cities are going to promote the phenomenon of urbanisation. To encourage the development of smaller rural settlements through strengthening the economy and likewise preserving their typical character is not planned. Although, this would be an opportunity to create human settlements that could—in economic, ecologic and social terms—present liveable counterparts to cities of any size.

In general, the (lacking) development in Chinese rural areas can bear favourable opportunities from an environmental point of view: bad roads should be improved, remote and hardly accessible areas should be connected to regional roads and the restrained development of the road transport system offers the opportunity to focus on alternative traffic routes like railways and waterways. In case of remote areas, railways systems are not recommendable, as they cannot work cost efficiently (ADB, 2003). Unfortunately, quantitative data analysing transport structures on rural level are hardly available. While politics starts to consider the rural development more seriously, the huge programmes dealing with the issue of transport usually focuses on highway development (like the Great

<sup>2</sup>The national average in road traffic account for 9.4 percent (passenger) respectively 6.1 percent (freight) per annum (ADB, 2003).

<sup>3</sup>As country conditions are quite different, a single definition for "medium" or "small cities can not be adequate. In larger countries like China, a range between 1 and 4 million inhabitants can provide a point of reference.

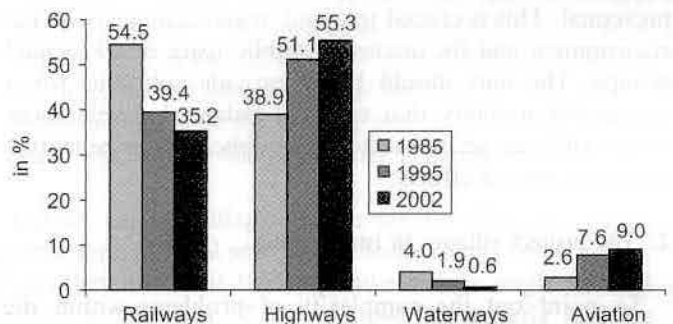


Fig. 1. Share of modal volume of passenger traffic in China (related to driven person-km).

Western Development Plan (GWDP)) neglecting crucial local problems like the accessibility to remote areas.

The bulk of the rural population in China has to face the same shortcomings concerning the provision of adequate and sustainable transport systems like the rural population in other low- or middle-income countries. Unreliable services, low-density transport networks, the need for frequent changes of transport modes as well as the rarely developed integration of services and planning are often responsible for service gaps and high costs for rural transport.

Economic stagnation, isolation and the reliance on inadequate transport modes are widespread. As in many regions no public transport system exists, the better part of the rural population relies on non-motorised transport modes, like bicycles and walking. However, it has to be considered that the situation of rural villages in economic and infrastructure terms varies enormously. Economic performance, integration into the transport network, local provision with social services as well as the distance and functional linkage to regional economic centres can differ considerably. Accordingly, the villages are affected by specific problems of mobility, transport provision and related issues. Small settlements in the urban fringe for example are closely connected to the urban economy with

people commuting daily to and from the cities. Their mobility needs and the resulting transport patterns differ substantially from those of people in remote villages in the rural hinterland. These areas are often characterised by poor maintained roads making them only seasonally passable—a fact that is caused by the lack of funds rural public authorities in general dispose of. Hence, many rural settlements are not even accessed to the traffic network and suffer from isolation.

As a strong motivation for (individual) motorisation exists in rural areas, improvements in the transport sector have to be developed carefully. On one hand, the integration of rural areas into the transport system is of great importance for further economic development and for reducing the dichotomy between rural and urban areas. On the other hand, an over-development of the rural transport sector in form of full motorisation and inappropriate transport infrastructure and modes should be prevented. This is crucial to avoid negative impacts on the environment and the quality of public space of all societal groups. The aim should be to provide solutions for a sustainable mobility that enable a balanced development where different related sectors of public life are benefiting from the derived efforts.

## 2. The project villages in rural China

To point out the complexity of problems within the transport sector and its interrelation to other sectors, it is helpful to depict some cases in more detail. The following chapter examines the transport sector and directly related fields of three villages in China. Subject to the analyses are the villages' current economic, social and ecological situation and the identification of future development potentials. Thereby, it is intended to reveal the differences and to develop a kind of model villages.

### 2.1. Typing small settlements in rural China

The structural conditions within rural settlements in China can differ significantly from each other. Thus, the term *rural village* cannot describe a settlement situated off the urban areas comprehensively. With the development and classification of certain criteria, an approach to typecast settlements will be introduced. To a certain degree, the typology allows to generalise the results from the case studies: problems occurring in specific contexts can be better classified, both respectively and schematically, and the provision for further development of solutions for rural transport problems can happen more quickly.

As human settlements form complex entities that underlay a constant change, a simple differentiation of settlements into "rural" and "urban" is not sufficient. Small-sized suburban appendices, regional towns with distinctive rural character (e.g. agrarian-based economies) are types of settlements that show a mix of urban and rural "functions" and do not fit into this pattern. Furthermore,

the spatial or scalar context (national, regional, local) has to be considered. Related to their specific situation, each country defines *urban/rural* in different ways.

Existing approaches to classify settlements can be different as well as the utilised criteria vary. Although it was argued that the simple differentiation between urban and rural constitutes a simplification and needs to be replaced with the rural/urban continuum, distinctions into urban and rural have become fundamental to census systems worldwide. A broad range of variables—using classical dimensions like the educational level—has been defined and their characteristics have been illustrated. However, this has taken place merely two-sided: in the urban and the rural context.

Another approach defines *urbanness/ruralness* as one spatial dimension of an area besides settlement size, population density and the degree of accessibility. In addition, the former criteria form the independent key dimensions to "modern human settlement patterns". This approach stresses the clear conceptual difference between these dimensions—implicating that individual areas can be urban and remote at the same time (Graeme et al., 2001).

Other approaches overcome the dichotomous classification and recognise the continuum that exists between the two extremes *urban* and *rural*. Different types of settlement categories like the ex-urban fringe area have been worked out. The concept of *Functional Urban Regions* for example depicts this zone as distinctive from the proper city in function and population, that can be further described and differentiated by additional criteria like land use, use of media hinterlands (e.g. areas served by television station based in urban centres) or journey-to-work data. Several other scholars classify beyond the rural/urban dichotomy as well. They categorise counties and cities according to the degree of urban influence, using characteristics like population size and density, commuting patterns, adjacency and the level of urbanisation (Graeme et al., 2001). This raises the question of how to classify urban or rural—or further categories—when using the level of urbanisation as a distinguishing pattern. Another option to arrange operational categories is the morphological approach, which identifies the residential density of settlements. Basic indicators are settlement size, population density and the rate of built-over land (Bibby and Shepherd, n.d.).

As mentioned above, the characteristics of Chinese rural settlements can vary enormously. For a better understanding of their individual problems, an adapted classification of rural villages in China has been developed. It allows a uniform treatment of economical, ecological and social problems of the regarded villages more easily. The classification should be regarded as a suggestion that based on field experiences made during the SUCCESS project. It has to be stressed, that further enhancement of the typology is highly recommended for future research, as it promotes an intense examination for the further development of rural areas.

Three pilot villages, intensively examined during field trips to China, constitute these categories and are classified as *future suburban*, *rural—but tied to villages/towns* and *remote and poorly accessed*. In a first step, a two-dimensional figure shall demonstrate how the development within different villages can vary. Thereby, the annual average household income and the access to social services (e.g. health centres, educational institution) serve as key indicators for the economic performance and the spatial location of the villages. In this context, a correlation between spatial location and economic development can be observed (Fig. 2).

As human settlements form complex structures that are not easily explicable, a systematic enhancement of the above-described approach is recommended. Through the involvement of further indicators, a more precise classification is possible: the degree of economic diversification, the income structure and the access to transport infrastructure and modes are possible elements that should be added to the typology.

The different types of rural settlements analysed in this paper can be depicted as follows:

*Future suburban*: This type of rural settlement lies in spatial proximity to a large city, the access to transport infrastructure is well developed and translocations are sufficiently ensured through individual and public (non-motorised and motorised) modes. Social services are

easily accessible, the economic structure is diversified and the average income per household is at the top of the rural income scale.

*Rural, but tied to villages/towns*: This type of rural settlement lies in relative spatial proximity to a medium-sized town or to larger villages with higher functional relevance. Access to a transport system (including transport modes and infrastructure) is moderately developed while access to social services is possible but often accompanied by difficulties. The economic structure is dominated by the primary sector with a less developed secondary respectively tertiary sector. The average income per household is at the middle of the rural income scale.

*Remote and poorly accessed*: This type of rural settlement lies in isolated areas, and is poorly connected to towns or villages of higher functional relevance. The access to transport systems is poor and translocation is usually limited to non-motorised means. Social services are not or hardly accessible. The economic structure is confined to the primary sector and the average household income is at the bottom end of the rural income scale—producing for subsistence is common.

Indeed, not all villages can be clearly allocated to one specific type of rural settlement. Some criteria may belong to another one, and the respective village might form a kind of hybrid type. Table 1 shows the criteria and the typecasting of the case study villages.

In the following, the typecasting will be completed by a more detailed analysis of the respective villages. In spite of the fact that each village is a unique construct, this typology may contribute to the development of solutions for sustainable development in the transport sector and related fields.

### 2.2. Bei Suzha—the future suburbia

Bei Suzha is a village of approximately 1600 inhabitants, situated in the province Hebei in eastern China. It is located with a 12 km distance to the province capital, Shijiazhuang, which has a population of approximately 2 million (Dalkmann and Vogelpohl, 2004).

The local economy is mainly based on two major sectors: agriculture and rubber industry. Additionally, small shops

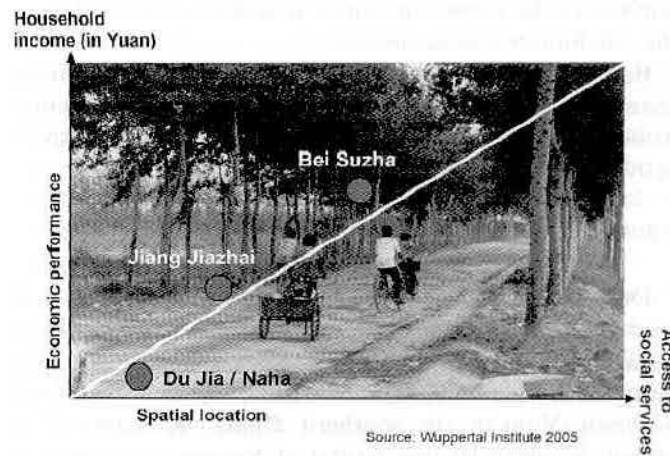


Fig. 2. A schematic approach to typecast the villages.

Table 1  
Characterising rural settlements: Bei Suzha, Jiang Jiazhai and Du Jia /Naha

	Bei Suzha	Jiang Jiazhai	Du Jia/Naha
Type	Future suburban village	Rural, but tied to villages/towns	Remote and poorly accessed
Province	Hebei	Shaanxi	Yunnan
Distance to town	10 km to Hengshui City province capital	10 km to Jiangling, one of the major regional towns	79 km to Mile/district capital
Transport infrastructure access	Well developed	Developed	Weak
Integration in transport system	Public bus service	Public bus service	None
Major transport modes	Motorcycle, bicycle	Bicycle, motorcycle	Walking, bicycle, buffalo

and handicraft activities complete the economical sector of Bei Suzha. Summing up, the economy of Bei Suzha is rarely diversified and does strongly depend on export (see Table 1).

Bei Suzha's transport system is relatively well developed. The village is integrated into the regional transport system in relative proximity to Shijiazhuang and it disposes of a considerably good road network. Moreover, it has access to the regional transport infrastructure (like public bus services) and has, thus, been classified as "future suburban".

The transport infrastructure is—besides small footpaths—confined to a paved trunk road to Shijiazhuang and a smaller paved road, leading directly to the centre of the village. There is a non-signed bus stop, from where every hour a bus departs to Shijiazhuang. Furthermore, a new motorway with a direct exit approximately 1 km west of Bei Suzha is under construction.

The main transport modes used within the village are bicycles and motorcycles (see Table 1). Nearly all of the 420 households own a motorcycle as well as a small tractor, the latter being not only used for agricultural work, but also as a transport vehicle to Shijiazhuang. Furthermore, almost every villager owns at least one bicycle.

Despite the rather good transport and mobility situation, for future perspectives of Bei Suzha it will be crucial to develop the local and regional mobility in a sustainable manner. Many measures discussed during the SUCCESS project to diversify the local economy and decrease the dependence from export (e.g. setting up a local market and promoting activities in the tourist sector) demand a good integration of the village into the regional transport infrastructure. Concerning the future development of the transport and mobility situation, the main challenges will therefore be to support and enlarge the advantageous local conditions in order to reduce the villagers' migration and commuting to the province capital.

Concerning freight transport, opportunities for strengthening the regional market, especially for products cultivated in the so-called "agro-high-tech-zone", should be developed. Opportunities of selling products directly in the province capital as well as the establishment of an additional market place inside the village present options to reduce the freight transport out of the village. Therefore, a better access to the local and regional markets, which offers sufficient capacity and is affordable for all villagers, will be crucial.

Especially in order to promote tourism as a new additional income source, a good and comfortable access to Bei Suzha is a precondition. This could either be achieved through a better bus service or through a Light Rail Transit (LRT). The establishment of an LRT-system in the province, with stations at the edge of the village, has been suggested as a sustainable infrastructure solution, as, in the long-term, the importance of access to the province capital will remain crucial in the region. Thereby, the LRT-system should be integrated into the regional transport

network to assure a maximum of mobility. It should be envisaged that Bei Suzha's population would not only be connected to the province capital, but to surrounding (suburban) areas as well. This could be established through providing and serving interconnection as well as through the connection to transport nodes and therefore to other transport means. As this transport system is very expensive, it should be regarded as a long-term perspective that would have to be discussed within the regional government, regional planning and rail organisation. An opportunity to minimise the costs is to operate the existing infrastructure that is currently only used for rail freight.

Besides, to ensure overall individual mobility without increasing the total number of cars (and therefore congestions and air pollution), the establishment of a sustainable form of individual transport should be initiated. One suggestion is to establish a car-sharing system. This option, which has been developed in Europe during the 1980s, constitutes a well-established growing market. As opposed to private ownership, a small number of different vehicles would be acquired on a collateral level. As members of the cooperation, users would only pay for the time and distance they need a vehicle. This offers a chance to avoid total motorisation and social exclusion of less-income households. The idea of implementing a car-sharing system is based on long experiences of the farmer cooperative in Bei Suzha, which has organised the cultural tradition of sharing tractors.

To realise the idea of a car-sharing system, a detailed analysis of the current situation as well as of the wishes of the inhabitants will be necessary.

Both suggested measures (LRT, car-sharing) offer chances to ameliorate the public transport infrastructure without negative effects from a total increase of transport activities (Dalkmann and Hutfilter, 2004).

### 2.3. Du Jia and Naha—remote and poorly accessed

Du Jia and Naha are two isolated twin villages, with approximately 460 inhabitants in total, located in a distance of 500 m to each other. They are situated 65 km away from Mile (400,000 inhabitants) in the north of the province Yunnan, in southern China. Kunming (5–6 million inhabitants), the capital of Yunnan, is located at a distance of 300 km. On the regional scale, Jianbien is the most important focal centre. With only approximately 400 inhabitants, the village at a distance of 8 km from Du Jia/Naha hosts the major regional market.

As it is the case in the whole region, the economy of Du Jia/Naha is mainly based on agriculture (see Table 1). But the agricultural production is rarely diversified and mainly oriented on export products (e.g. sugar cane), and cultivation for self-consumption is limited to rice and small-scale fruit and vegetable production.

The situation of the two villages regarding their infrastructure is very poor. As there are no regular shops, in order to buy clothes, additional food, gas, etc., people

from Du Jia and Naha have to travel to the market in Jianbien. The same can be said referring to other services, like health centres and schools. Due to the lack of daily transport provision, pupils of higher degree have to stay in Jianbien during the week. The higher costs for overnight stays and meals pose a burden for family and social life.

This situation is worsened through the lack of both adequate transport means and transport infrastructure. There is only one unpaved road from Du Jia/Naha to Jianbien, which is in a rather bad condition, and the closest railway station is located in Mile. Therefore, railways do not play a significant role for the regional transport. Inside the villages the inhabitants are walking, cycling and driving with small buffalos-carts using the narrow unpaved muddy paths at the same time. Besides these pathways, there is no opportunity for the movement of bigger vehicles.

In the two villages Du Jia and Naha altogether five tractors, five motorcycles and six bicycles exist. As long as the road condition allows, one hired truck drives to the market in Jianbien in the morning and gets back in the afternoon. Furthermore, one villager from Du Jia provides his tractor. As at the moment nobody owns a truck, for all bigger freight transport activities people have to rent a truck in Jianbien.

To ameliorate the economic and social situation of the villagers, an adequate integration in the transport sector is needed. The main identified problems associated to the transport sector on the local and regional scale are the high costs for the sugar cane transport and the limited opportunities for moving goods and people to the regional market as well as to social infrastructures like schools and health centres. Besides, the bad condition of paths inside the villages limits the mobility especially of the elderly.

As the people of the villages are primarily dependent on selling sugar cane to the nearby factory, it would be of great advantage to diversify their production and to develop new marketing opportunities, which would make them more independent from the sugar factory.

To improve the mobility of traders as well as of consumers, an appropriate and affordable transport service that provides a regular travel opportunity, especially to enhance the integration in the regional economy, is needed.

To solve some of the transport-related problems of Du Jia and Naha, the acquirement of a shared “Village Truck” has been recommended by the SUCCESS project. Actually, Du Jia and Naha do not dispose of a public transport service and the only opportunity for translocation is to go with tractors provided by locals. The cost for such a trip amounts for one Yuan. Private investments in transport provision can be more effectively done through purchasing a truck—on a cooperative level—that dispose of much greater capacity than a tractor, that might serve several destinations, etc.

The truck-sharing system constitutes a suitable and affordable solution. With several households joining the cooperation, the costs associated with buying the vehicle and maintaining the business can be shared and therefore

minimised for the individual households. Compared to the present situation, the amount of goods and passengers being transported could be increased, and the “Village Truck” could serve as a regularly freight and passenger transport device. Besides the above-described collective system, it could be considered of an individual financed one—as long as it is affordable for the villagers.

As in present the regular transport for carrying pupils to middle and higher school presents a problem for many villagers, the “Village Truck” could also serve as school bus or as transport option for people needing to visit further towns like Mile.

Such cooperation might therefore have some positive secondary effects. It might not only optimise the overall transport situation and economic performance, but also improve the social life within the two villages.

Thereby, it is recommended to broaden the service and to establish a transport network with other surrounding villages. Additionally, the newly established transport provision, the destinations, fares and schedules should be clearly communicated to the villagers.

The “Village Truck” could offer the chance of a higher participation in the regional economy and, at the same time, create new jobs and new socio-cultural contacts. In the context of remote Du Jia/Naha, this private initiative constitutes an appropriate alternative to a state-financed public service system. However, local authorities are—in the medium term—responsible to support the above-mentioned broadening of this system—to promote the regional integration into the transport system (Dalkmann and Hutfilter, 2004).

#### 2.4. Jiang Jiazhai—rural but tied to towns

The village of Jiang Jiazhai has approximately 1800 inhabitants and is located 10 km off Jiangling, the major regional town in the province of Shaanxi, in the central East of China. Xian, with ca. 2.5 million inhabitants, is the province capital and is located ca. 100 km off Jiang Jiazhai (Dalkmann and Hutfilter, 2004).

The local economy of Jiang Jiazhai mainly relies on local products, local material and work power and predominantly serves local and regional markets. Like the other case study villages of the SUCCESS project, Jiang Jiazhai's economy is mainly based on agricultural production (see Table 1). Apart from crop production and some off-farm activities, cattle breeding represent the major income source.

As a result from the predominantly local production processes and the direct use of the products, goods are usually transported rather short distances. To promote the peasants and to strengthen the local economy, the regional government is planning to establish a bigger market within the village. Considering the freight flows, the current situation is, therefore, judged environmental friendly.

Unlike the other project villages, Jiang Jiazhai disposes of a public transport service with buses serving the main

road at the edge of the village, which connects Jiang Jiazhai to other villages and towns in the region. As information on this transport service is rarely available, access and usage of the service is very limited.

Generally, the transport infrastructure is bounded to roads. Apart from the main road, where the weekly market and most shops are located, all other roads in the village are unpaved and in a rather poor condition. The main transport means in Jiang Jiazhai are walking, cycling and—increasingly—motorcycles, which all compete for the narrow space of the small roads and paths of the village (see Table 1). The current modal split in Jiang Jiazhai is composed as follows: 70% bicycle, 13% motorcycles, 12% public bus transport, 5% walking (Dalkmann and Hutfilter, 2004).

Additionally, the roads serve as storing place for private property, like building materials and cows, which are stored in front of the houses. The latter also has negative effects on the overall hygienic conditions of the public space, where social activities take place.

The major transport problems identified in Jiang Jiazhai are the bad road conditions inside the village, the lack of information about the public transport and the increasing motorcycle traffic that will cause an increase in air pollution, public space consumption and possibly accidents.

Especially concerning the minor roads in Jiang Jiazhai, there is a need for improvement recognising both the transport demands and the use of the public space. Therefore, it is essential to improve the bad road conditions as well as the hygienic conditions caused by the cattle stock that is currently stored on the roads.

In Jiang Jiazhai, the regional government provides public transport service. However, the use of public transport provisions is clearly insufficient. This is caused by the lack of information on destinations, frequently, time schedules, etc. Therefore, a better information policy concerning the public bus transport is crucial to help stabilising the service and to prevent the increase of individual motorised trips. Through a better information policy, a greater accessibility to public transport means would be provided for all villagers. Thereby, relevant information could be communicated through the local broadcast—respectively through the well-known announcement per speakers within the village that has formerly been used for political instructions. Additionally, the regional transport network should be optimised. Hereby, the regional government is demanded to develop appropriate concepts and to establish relevant (planning) structures.

Furthermore, the expected increase of motorcycles should be embanked through specific traffic calming measures. Trees, some of which already exist along the roads today, could be used for redesigning the streets. Local material and work power could be used to improve the overall quality of public space, e.g. by providing shadow especially for the elderly people and women, who

spend most of their time in the streets. Furthermore, the expected increase of the motorcycles and at the same time danger of accidents could be reduced. Thus, such a utilisation of public space in Jiang Jiazhai would present a good compromise between the different road users and therefore offers a chance to further support especially the social future development of the village (Dalkmann and Hutfilter, 2004).

### *2.5. Sustainable mobility—possible side effects on other development aspects*

The suggested measures during the SUCCESS project directly and/or indirectly affect not only the range and diversity of economic activities, but also ecological and social aspects as air quality, travel safety and access to services. The ecological, the social as well as the economic aspect constitute the three pillars of sustainability and have to be well considered when achieving lasting and comprehensive improvements within the chosen fields. Although the measures primarily focussed on serving existing transport needs and solving current mobility problems, opportunities to benefit from the amelioration in the transport and mobility sector apply for several other sectors (OECD, 1996).

In some cases, the promoted pilot ideas refer to rather broad development concepts like the establishment of a local market in Bei Suzha or the overall organisation of public space in Jiang Jiazhai. These enterprises might, therefore, generally influence the future development of social life within the villages.

In the following, the key development measures of the pilot villages as well as the derived impacts that grasp all three dimensions of sustainability will be visualised and described.

The establishment of a local market in Bei Suzha would not only reduce the distances and total number of trips necessary for the villagers to sell or buy products for daily life consumption and, therefore, reduce possible environmental impacts from motorised trips. It would also ensure the access to these products as well as marketing opportunities for all households regardless of their income and family situation. Such a measure obviously does not only affect the transport sector but might also create benefits for the local agricultural sector, the production of local handicrafts and the establishment and/or expansion of tourism.

The major social advantage of a village truck system in Du Jia/Naha is the facilitation of the access to regional markets as well as to social services like schools and hospitals. Beyond, economic benefits derive from both the reduced costs for transport and overnight stays, e.g. for pupils in the middle school as well as from the creation of new jobs and opportunities for entrepreneurship. As a result, apart from the improvement in the overall mobility, not only the agricultural sector and, thus, the local economy in general, but also areas of social life like the

education and health sectors might benefit from the village truck.

The restructuring of public space in Jiang Jiazhai through traffic calming measures would not only improve the air quality as well as the hygienic and safety situation within the narrow village roads, but would also create additional space for social activities (like playing or doing handicrafts). Thus, initiated by an improvement of the transport/mobility situation, the local economy could be diversified through an increase in the sector's handicraft production and stock farming.

In other cases, rather specific suggestions, e.g. the acquirement of a shared village truck in Du Jia/Naha, have been made. Nevertheless, measures like these also affect various development aspects of the village.

Summing up, it can be stated that promoting a sustainable mobility on the local and/or regional level offers chances of initiating an overall development, which integrates positive ecological, economic and social effects far beyond the transport and mobility sector and, thus, promotes a development, which all population groups can benefit from.

### 3. Pathways to a sustainable mobility in rural China

In the previous chapter, the villages' key development issues have been depicted in detail, and appropriate solutions have been suggested. Each village presents a specific type in terms of its spatial location, its economic performance and its existing infrastructure. Additionally, every village stands for specific measures, which have been allocated out of the existing policy-mix that will be depicted as follows.

The complexity of problems that often occur in rural areas in low- and middle-income countries requires a complex catalogue of problem-solving measures. Different institutions pursue different approaches to categorise those measures and therefore to provide a better operational flexibility. The Organisation for Economic Cooperation and Development for example has identified instrument packages—fiscal-oriented, regulatory-oriented, investment-oriented, education-oriented and governance-oriented—to group single measures (OECD, 2002). In comparison, authors from the Institute for Transportation Studies at Leeds developed six categories, which are primary related to urban transport: land use measures, attitudinal and behavioural measures, infrastructure measures, measures on the management of the infrastructure, pricing measures and compensatory measures off the transport field (May et al., 2001). In the presented case of rural mobility in three selected pilot villages of the SUCCESS project, a mix of these existing approaches and newly developed ones has been composed.

As the preceding sections have shown, improvements of the transport sector and mobility do not just have a crucial impact on the sector itself. In fact, related—economic, ecologic and social—sectors can benefit as well, and the

result can be the amelioration of the overall settlement situation. In this regard, it is crucial to follow an integrative and holistic approach that considers all three dimensions of sustainability to achieve a balanced system.

To reach a sustainable mobility, improvements of the rural transport sector in China have to be regarded considering the specific economic, social and cultural context of the country—and under consideration of the respective environmental situation. In line with China's economic growth, a constant process of individual motorisation can be noticed. Such process might influence the implementation of alternative and sustainable transport systems in a negative sense, and efforts to prevent from this way have to be made. In this context, the Chinese tradition of riding bicycles should be strongly promoted—and the strengthening of other appropriate non-motorised transport modes, like buffalo carts, should not be neglected. As non-motorised means could be just one element in a complementary transport system and full individual motorisation is out of question, public transport modes constitute an affordable and environmental friendly solution. These transport systems have to be adapted to the specific "conditions" of the respective village or region. Appropriate solutions and measures can be selected for example from the policy-mix for rural areas in China (see Fig. 3). High-technology systems like LRT for example are reasonable solutions for future suburban villages that are closely connected to larger urban areas. Whereas villages that are more rurally locked and geared to surrounding towns without a vital connection to big cities do not offer a market for this kind of system. In that case, adequate public transport modes that address the needs of the rural population might be supply-oriented measures, e.g. a car- or truck-sharing system. The rethinking and the reanimation of the well-tried principle of common share could support the invention of such a system. Furthermore, adequate transport means have to be affordable and accessible for the people—to prevent from disclosure of parts of the population. Likewise, the financing of measures like new transport modes and infrastructure has to be ensured by the responsible body.

To reach this ambitious goal, suggestions on a broad range of measures should be developed that promote and strengthen local knowledge and potential. First of all, the villages' key development issues have to be identified as visualised for the three pilot villages in the previous chapter—for example by using a participatory approach (see Figs. 4–6). To analyse sectors related to the field of transport and mobility, the use of local knowledge is recommended for a better identification of possible fields of intervention. It is essential for the organisation and implementation of agreed activities to create institutional structures that integrate local authorities, villagers and experts. The support of local structures for public participation and good governance could be realised through the invention of an institutionalised discussion

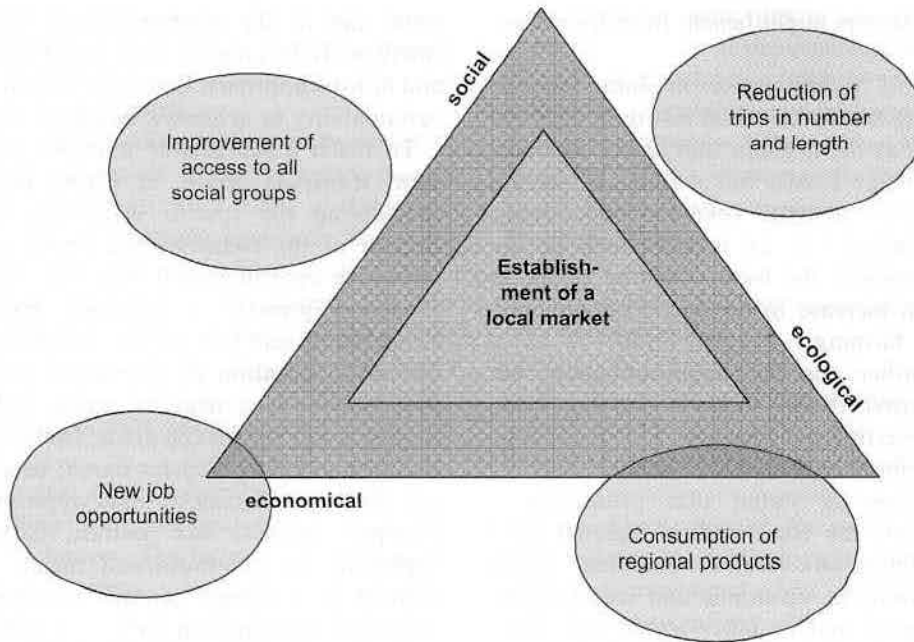


Fig. 3. Categorising the policy-mix related to rural mobility in China.

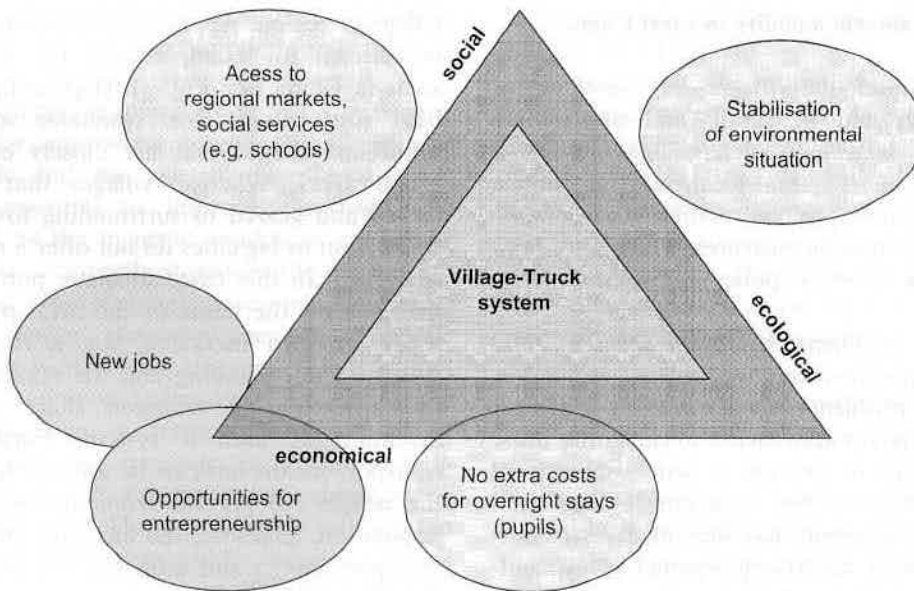


Fig. 4. Key issues for a sustainable (transport) development of Bei Suzha.

forum. Thereby, the involvement of the population leads to a better consideration of their interests. Regular information of the residents on the achieved efforts, e.g. in meetings or through local wall newspaper can assure transparency and acceptance. These meetings can be broadened to a forum of knowledge management, where experts provide educational training for the population on sustainable mobility and balanced development. The above-described activities are extracted from a pool of soft measures including those for capacity building, information policy, etc., and constitute an important part of the policy-mix.

To build up a system whereby all parts of the rural community—in social and spatial terms—are well provided, an integrative transport and spatial planning is necessary. Key criteria are besides other an appropriate network of both routes and modes. Furthermore, a hierarchical system of different modes with different capacity should be developed. Low capacity modes like minibus taxis could serve areas of minor demand and could in some parts serve as feeder to large capacity means, like big buses or railways. In order to guarantee a well-functioning public transport system, it is of utmost importance to coordinate the public transport means, but

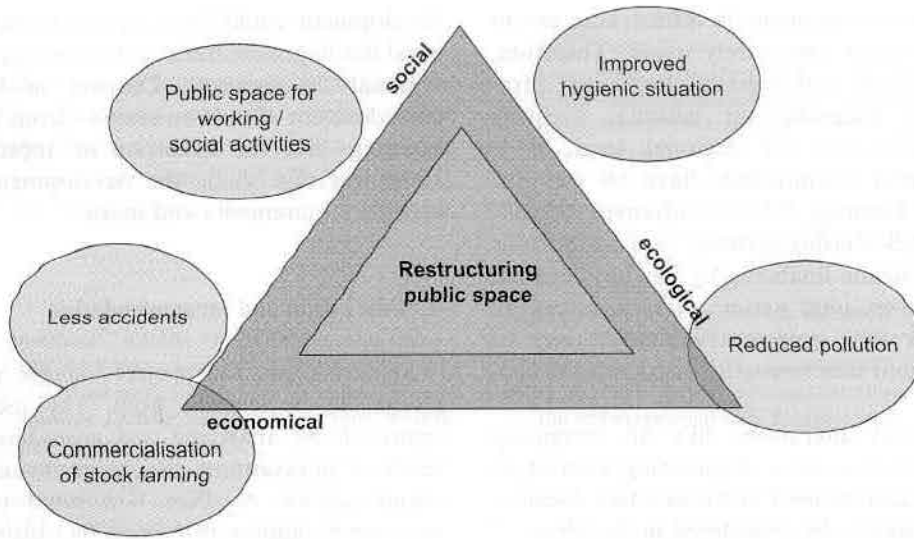


Fig. 5. Key issues for a sustainable (transport) development of Du Jia/Naha.

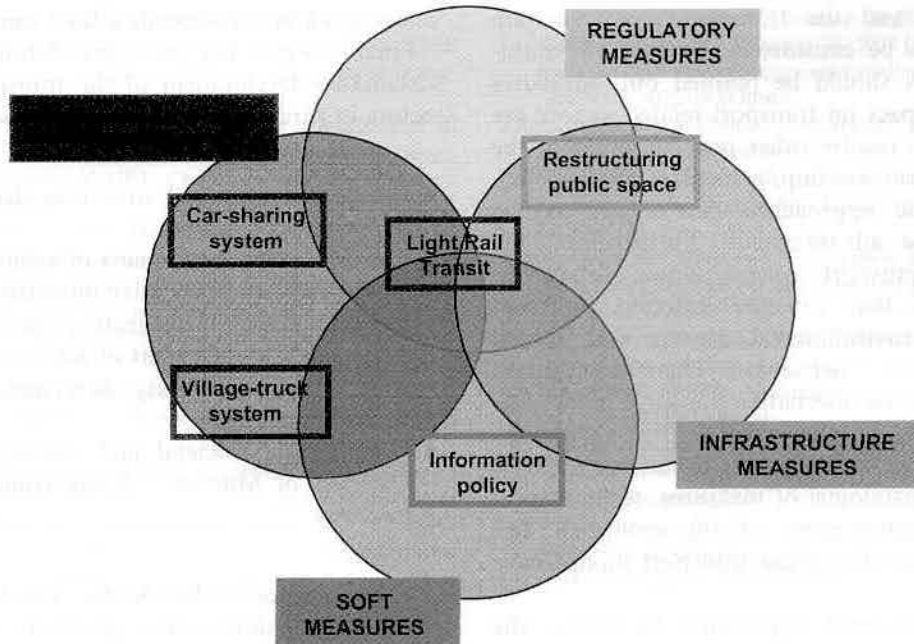


Fig. 6. Key issues for a sustainable (transport) development of Jiang Jiazhai.

also to develop connections between the existing regional transport modes, especially to non-motorised ones. Integration should also be realised through linking different functional areas. Of great importance in this context is an analysis of the responsible planning bodies, as an overall mobility concept has to be developed jointly by all relevant planning departments and not separately.

Integrative planning is not limited to the integration of different transport modes, but the integration of spatial and transport planning is at least of same importance, as the spatial structure and the rural environment influence the mode of transport that will be used. With the challenge of overcoming the restrictions deriving from lasting old

structures, the demand for new concepts is enormous. As former concepts and structures based on the policy of exclusion of peasants out of cities, the new one should pursue the idea of integration. Thereby, spatial planner should bear the growing social and economic linkages between rural and urban areas in mind.

To ensure the viability of suggested measures, financial facilities for building up, maintaining and running transport services and other facilities have to be checked. A road network for example can only function effectively if affordable and appropriate (public) transport modes are provided. Thereby, it has to be kept in mind that rural communities often dispose of a marginal budget, but

comprehensive national investments in infrastructures—in particular in remote areas—are rarely made. Therefore, more investment in local and regional transport infrastructure instead of focussing on national highway construction is crucial. On the regional level, it is indispensable that rural communities have to seek for alternatives to state funding. Private initiatives of self-organisation—like truck-sharing systems—are useful to be more independent from the financing by local or regional authorities. Furthermore, joint action and the successful realisation of such projects support the establishment of local social networks and thus strengthen structures of civil society.

Societal and cultural alterations like an increasing process of individualisation or a diminishing interest in common share have been realised in the last two decades. These changes are worth to be considered in the phase of developing new projects, as they could constitute a veritable obstacle for their realisation.

If sustainability constitutes the primary aim of measures related to mobility and the transport sector, certain requirements have to be considered. First of all, multi-dimensional solutions should be pointed out. Measures that show a clear impact on transport-related sectors are also recommended to resolve other problem areas of the community (no entrepreneurship, ecological decline, etc.). Especially micro-scale approaches that adapt to the specific situation are advantageous. Furthermore, the provision of any transport system should follow an integrative approach that consider different transport modes as well as environmental aspects and spatial requirements concerning other sectors. Therefore, it might be favourable to integrate alternative transport modes like water-taxis, Bus Rapid Transit or LRT. High-technology solutions that do not fit to the specific situation should be avoided. Within the catalogue of measures, technological solutions for the improvement of the ecological and economic performance of popular transport modes have to be considered.

Generally, it is of great importance to reduce the rural–urban dichotomy. Rural and urban areas should be linked more tightly in order to connect the two economies, which is supposed to cause substantial benefits especially for the rural economy. In this context, the new policy on the urbanisation of rural areas, the small-town strategy, is not adequate as the unique motor for community development. It has to be kept in mind that this strategy is to be applied to support the alteration of rural towns to larger cities of a size up to 500,000 people. A modification—in sustainable terms—through the use of local potentials intended to preserve the distinct character of the rural settlements is not planned. In contrary, the new policy might even lead to economic and social stagnation in smaller settlements like the analysed project villages as public funds will rather pour into the newly built towns than into rural communities. In comparison, a restructuring in terms of economic diversification and social

development could have a positive impact on the overall rural development and could be appropriate for a balanced regional development. Decisive in this context is the consideration of soft measures—from the field of capacity building—like the invention of appropriate institutional structures that guide the development according to the specific requirements and needs.

#### 4. Conclusion and recommendation

Summing up, the project villages provide a range of lessons to be learned from. The use of an integrative approach by analysing and considering mobility-related fields of intervention also promotes other economic and social sectors. As Figs. 4–6 point out, each identified measure multiplies its impacts by causing positive effects in several other sectors. The participatory approach leads to an initiation of projects and processes that otherwise cannot be carried out: the purchase and running of a village truck on a cooperative level constitutes an example.

Finally, some key recommendations that promote a sustainable development of the transport and its related sectors in rural areas can be summarised:

- Develop institutional structures that allow controlling the process.
- Ensure the appropriateness of solutions through avoiding needless and expensive infrastructure.
- Pursue a policy of integration concerning sustainability dimensions, involvement of actors, etc.
- Attach the community development to appropriate national policies.
- Consider the societal and cultural context, e.g. the “shadow of Maoism”<sup>4</sup> where common share is unattractive.

The examples of Bei Suzha, Du Jia/Naha and Jiang Jiazhai have shown that problems and potentials for development of rural settlements vary enormously. The Chinese economy undergoes a radical—economic and social—change. Thus, the presented recommendations constitute merely a kind of framework and have to be modified always according to the specific cases and contexts—on the macro- and the micro-level.

<sup>4</sup>The so-called “shadow of Maoism” is a phenomenon that derives from political conditions and restrictions in the era of Mao. In brief, basic thoughts in this era are built around the classless society, achieved by continuous class struggle to eliminate bourgeois behaviour—in terms of intellectuals and corrupt party functionaries—and capitalism. This was accompanied—amongst other—by the promotion of collectivism, likewise by the denial of individualism and individual property, by the negation of both elitism and the development of own and creative thoughts. The rigid enforcement of these policies continues to have an effect until today, and they still influence people’s attitudes and behaviour in China. Alterations in attitudes derive from the rising attractiveness of the western way of life, and the fact that traditional living is considered less liveable.

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# Regional climatic mapping as a tool for sustainable development

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## Abstract

In the framework of an EU project on sustainable village development in China (SUCCESS), the natural climate resource was evaluated. Climate is seen as a potential for sustainability, an improvement of social life, agricultural production and reduction of air pollution problems. In this respect, thermal comfort conditions, microclimates and ventilation patterns were studied in seven Chinese villages and climate maps were drawn. Following planning recommendations, they can be transferred to decision-makers for their village development. In this framework, the paper presents a general methodology of urban climate mapping, carried out in China, applicable to all countries and climates.

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## 1. Introduction

Urban climate studies can be used to support ideas for sustainable development in urban planning, social lives and agriculture production. Thermal comfort is of especial importance for open spaces and their design while the mesoscale urban climate analysis of heat island and ventilation is adapted to air pollution problems. From the definition of an 'ideal urban climate' (Katzschner, 2002), the different planning levels and climatic scales can be combined.

The urban development in the villages analysed leads to an increasing roughness with reduced ventilation and higher air pollution, which can also produce an increased heat island effect with thermal stress conditions. Urban climate studies have to meet these issues in order to provide assessment for planners and decision-makers. The basic knowledge about urban climate has to be evaluated and transferred to planning practice in order to provide support to their urgent questions about thermal comfort and ventilation, and identify areas that could be free for development, as well as defining building density limits, which gaps have to be maintained, or which areas are well adapted for social life.

For eight Chinese villages general problems were identified, the mean meteorological data were calculated following climate maps, while geographical situations and links to planning were established, shown in Table 1 with the climatic-related issues. It turned out that the following problems were of primary concern in these villages:

- development and improvement of social conditions;
- regaining new open spaces;
- support of service centres in the inner city, like hospitals, administrations or service companies;
- layout of development of the infrastructure including traffic;
- provision of nearby recreation areas (development of green spaces);
- development of cultural awareness;
- agricultural possibilities and climate potentials.

## 2. Method

### 2.1. Mapping procedure

The results from Table 1 show a qualitative description of problems and linkages, demonstrating the importance of defining the spatial distribution of these variables. This was done by creating an urban climate map of each village. But,

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Table 1  
Villages with their geographical situation and problem identifications

Village	Main topics related to climate	Geographical number (NN)	Problem areas and tools
Bei Suzha	Aridity, wind, and thermal conditions	37.5°N/116°E 55	Water, energy, forestation human behaviour
Chi Qiao	Culture/tourism and thermal conditions	37.8°N/114.2°E 800	Human behaviour
Xia Fu Tou	Precipitation and soil erosion	34.2°N/113°E 350	Forest and agriculture
Jiangjiazhai	Precipitation and microclimate	34.3°N/112°E 400	Agriculture, economy, human behaviour
Xiaoqi	Regional and microclimate for agriculture	29.5°N/117.8°E 600	Agriculture, climate
Dujia	Precipitation, regional- and topographical climates	23.8°N/103.4°E 1000	Forest and agriculture, climate
San Yuan	Precipitation and regional climates	27.0°N/100.3°E 2300	Economy, social

as there were no meteorological data available for the villages, all climate conditions had to be derived from existing climatic charts, and climatic maps. From near by stations, monthly mean values were adjusted to the village's conditions as a result of an interpolation of the geographical (NN, long/lat) and land use situation. In a second step, the computer program METEONORM was used to calculate average values of solar radiation and temperatures. Fig. 1 shows the result of Beijing used for the village Bei Suzha. Additionally, more general climatic data, such as mean values of air temperature and its mean daily variation, humidity and wind, were obtained from the Handbook of World Meteorological Stations (Müller, 1983).

The next step was the combination of land use data, topographical information and the climatic data. Through the geographical information system (GIS Arc.Info), geographical and land use data were classified and transformed to urban climate functions, such as thermal aspects (i.e. heat and cooling rates), with a wind classification with air paths and topographically influenced downhill movements of air masses. The building fabric was classified according to roughness length and thermal radiation processes.

For this purpose, the following factors were used:

- land use classifications for thermal conditions and radiations, with categories of city structures, industrial areas, gardens and parks, forests, green and agricultural areas;
- topographical and geographical data which influence the local circulation pattern;
- ventilation through an analysis of the roughness length.

The final result of this methodology is a climate map, which contains a thermal and ventilation pattern. These maps were derived for all villages involved and provide recommendations to support the village development plans. Important to mention is the accuracy achieved by these maps as they were carried out in a mesoscale applied at neighbourhood levels.

Criteria:

- warm areas without ventilation heat island [H]
- moderate warm areas and heat island but sufficient ventilation ventilated [H-]

- cool and humid areas and dynamical situation cold wind protection in winter [C]
- main strong winds from NW cold and windy [C-] → with rainfall
- south-easterly winds and village heat island [H-] ⇒ ventilation
- air paths ⇔

In order to use climate maps for planning assessment it is important to see the connection between administration, planning levels and climatic factors. In Table 2, European examples are shown to link planning scales and urban climate issues. For the case of Chinese villages, the city neighbourhood level is of most importance for open space use and cultural events and, therefore, focus was directed towards heat island and air pollution problems to give people a high environmental quality.

Derived planning proposals:

- use of forest plantation preventing the strong winds from the north;
- use of microclimate for tourism;
- use of microclimates for agriculture.

## 2.2. Bioclimatic aspect

Thermal comfort conditions on a microclimatic scale were conducted for the open spaces. The thermal comfort level was calculated with the physiological equivalent temperature (PET). The calibration of PET, which has a neutral temperature with 22 °C (similar the predicted mean vote (PMV) = 0) was taken from European projects questionnaires (Nikolopoulo, 2004, 2005). Following Table 3, the PET values could be correlated to activities (Katzschner, 2004).

For all villages, the thermal index PET was calculated and included in the village climate maps to identify comfortable and uncomfortable places. The input values, air temperature, air humidity, and wind velocity were taken from the neighbourhood stations, while the mean radiation temperature had to be calculated from globe radiation plus a weighting factor the village situations. Southerly slopes and deep valleys also increase the used weighting factor for radiation. The absolute height above sea level

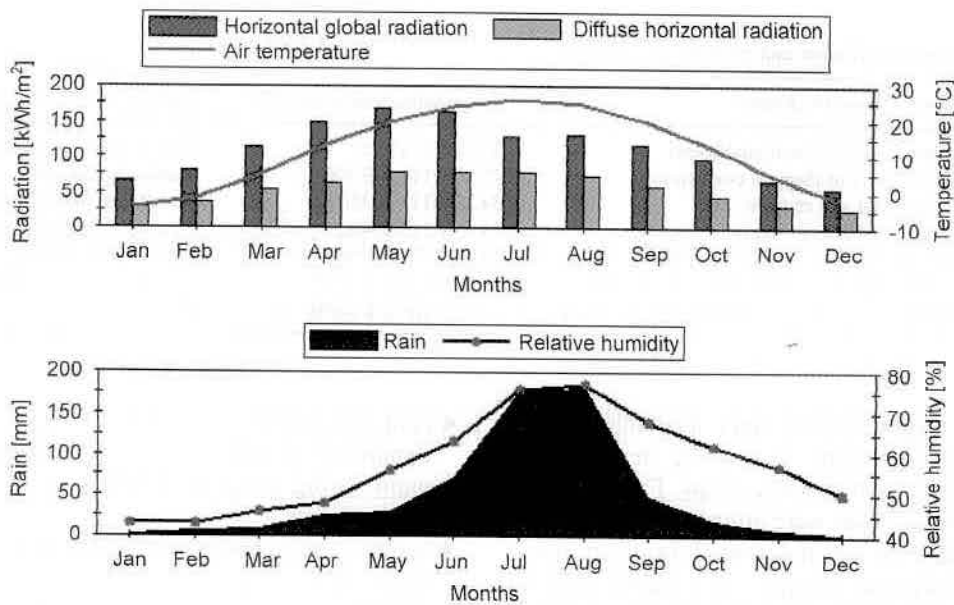


Fig. 1. Example of Beijing with long-term climatic values calculated with METEONORM, with the annual variation of air temperature, radiation and rain, relative humidity.

Table 2  
Urban climate and planning scales

	Administration level	Planning level	Urban climate issue	Climatic scale
City	1:25,000	Urban development; master plan	Heat island effects; ventilation paths	Mesoscale
Neighbourhood	1:5000	Urban fabric system	Air pollution	Mesoscale
Block	1:2000	Open space design	Thermal comfort	Microscale
Single building	1:500	Building design	Radiation and ventilation effects	Microscale

Table 3  
Thermal comfort index used from Matzarakis and Mayer (1996)

PMV	PET (°C)	Thermal sensation
-3.5	4	Very cold
-2.5	8	Cold
-1.5	12	Cool
-0.5	16	Slightly cool
0.5	20	
	24	Neutral
Activities	Needed thermal conditions for use of open spaces	PET (°C)
Sitting	Warm	30
Calm activities	Warm moderate	26–32
Children play	Warm moderate	24–26
Recreation	Neutral	16–24
Light movement	Neutral	16–26
Shopping	Warm moderate	26–32
Movement	Lightly cool	14–24
Strong movement	Cool to cold	12–24
Garden activities	Lightly cool	12–24
Work outside	Neutral to cold	16–22

was considered through the normal air temperatures decrease with height. Although this method is very approximate, it provides sufficient information to discuss

the mean range of the thermal values in the villages analysed:

Chi Qiao	from cold -10 to 26 °C PET, which means that here wind shadow in winter and sun shading in summer are both needed
Xiaqi	from cold 0 °C PET in winter to 30 °C PET in summer, here the cold season is less important
Duja	from 3.5 to 20 °C PET means moderate thermal conditions, but can be very extreme due to slope situations
San Yuan	because of topographical height thermal conditions are very moderate, from 7 to 20 °C PET; it means that there is no influence on the behaviour of people dependant from PET values

The conclusion is that for northern Chinese villages the range of thermal comfort is very high and that cold stress has to be considered by wind protection, while in the more southern parts ventilation is needed for cooling.

### 3. Results

For all villages analysed in the SUCCESS Project, the three main steps were carried out to discuss climate results

with developing processes: (a) regional climate analysis, (b) the climatic map and (c) recommendations.

The result is shown for one village (Bei Suzah). It can be classified as BSK climate (Köppen, Geiger) with dry winters and some periods of rain in summer. The mean rain with 462 mm in average already assumes that there will be water problems. The wind direction between summer and winter is very different. This has to be considered for open space planning and thermal comfort. Moreover, there is a high daily variation of air temperatures and with that the thermal sensations differ between night and day as well as during the seasons.

From the climate map, as seen in Fig. 2, the evaluation and recommendations are as follows: although the rainy seasons is in summer, there is a considerable dust pollution against which protection is needed. In winter north-easterly winds with very cold situations lead to cold stress and a reduced possibility for the use of the open spaces. As, at the same time, radiation can be observed, wind protection from this direction is needed.

Actual activities in the village of Bei Suzah and the climatic suitability are:

- agricultural development by green houses and a green agriculture, which keeps humidity inside the vegetation—this can be done if rain is stored in summer;
- recreation areas for the near by city by industry and shadow places near the village for summer situations—shadow in summer and dust protection from south east;
- renewal of village housing by a concept of inside an outside use of space depending on season—summer places for meetings with shadow;
- wind protection zones against thermal and erosion problems—planting of vegetation against northerly and easterly winds around the village.

It is evident that the main problem in Bei Suzah is dust in summer and low temperatures in winter, and that both need improvement. This is proposed through the use of vegetation such as wind-breaks to reduce channelling effects. The map in Fig. 2 shows the location of these barriers. This recommendation follows the above-mentioned topic of wind protection against cold and dust. It can also be used to avoid erosion problems. Any frequency of occurrence and mean values for the village

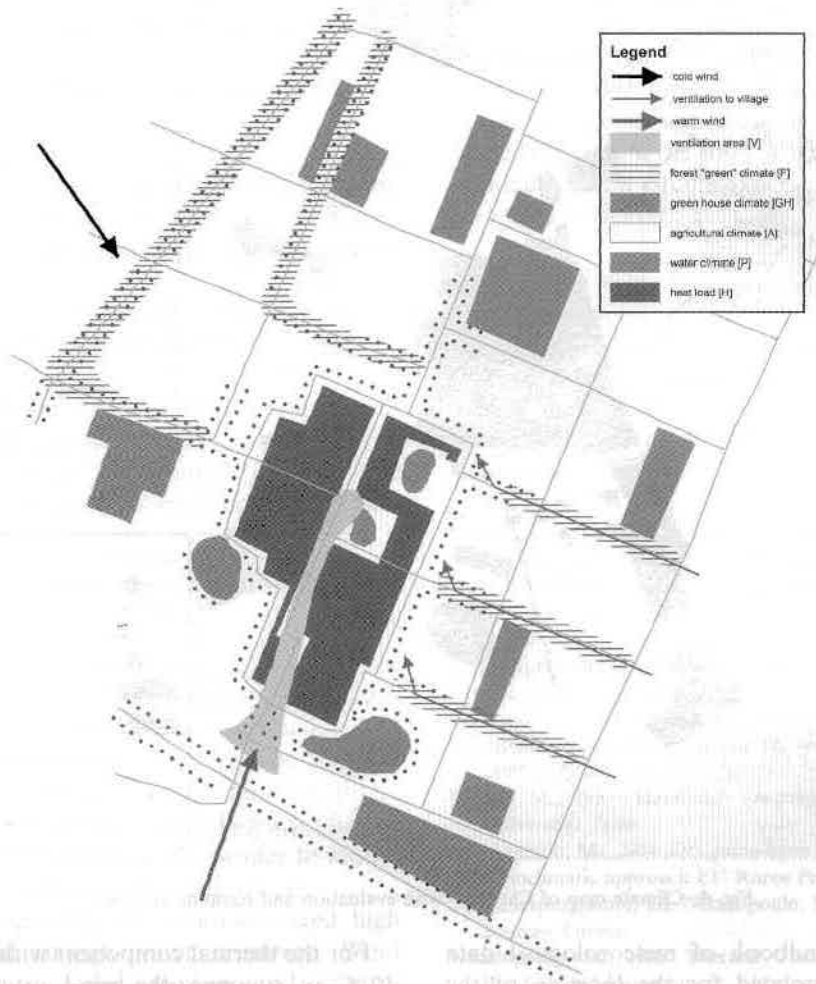


Fig. 2. Bei Suzah climate map.

village: Beisuzha		Elevation NN: 55 m												Climate Type: Köppen BSk	
geographical number: 37,50B/1160L		J	F	M	A	M	J	J	A	S	O	N	D	Jahr	Z
1 Mean Temperature	in °C	-2,6	-1,6	6,6	14,7	16,1	25,9	27,6	26,3	21,6	10,2	6,6	0,5	13,8	38
2 Mean max. Temperature	in °C	1,7	5,4	12,5	20,9	27,5	32,3	32,7	30,9	26,9	20,9	11,4	3,9	18,9	17
3 Mean min. Temperature	in °C	-7,2	-4,5	1,4	5,3	15	20	23,4	22,2	16,7	9,8	1,7	-4,7	8,9	17
4 Absolute max. Temperature	in °C	16,2	19,3	30,6	35,9	41,1	42,6	42,8	40,4	36,2	33,6	26,9	16,6	42,8	4
5 Absolute min. Temperature	in °C	-19,8	-16,9	-12,7	-2,4	3,1	9,9	16,6	13,5	4,6	-2,6	-11,8	-17,8	-19,8	5
6 Mean relative Humidity	in %	63	62	55,5	51	54	58	74,5	77,5	69	63,5	63,5	63,5	63	6
7 Mean Rainfall	in mm	3,5	4	10	16	27,5	51,5	142,5	126,5	47,5	18,5	12	4,5	482	43
8 Max. Rainfall	in mm	23	15	43	41	66	175	447	353	135	41	48	25	33	8
9 Min. Rainfall	in mm	0	0	0	0	<1	5	46	28	5	0	0	0	33	9
10 Max. Rainfall 24 h	in mm	23	10,5	55	37,5	49,5	75	98	118	54,5	40,5	55	14,5	119	10
11 Days with Rainfall > 0,1 mm		3	3	4	5	6	9	13	12	7	4	4	3	73	11
12 Hours of Sunshine	in h	184	184	226,5	238,5	277,5	274	248,5	230	230	241	189,5	178	2701,5	12
13 Global radiation	kWh/m2	65	81	115	150	169	164	130	131	117	98	66	56	1340	13
14 Potential Evaporation	in mm	0	0	18	59	115	160	180	155	100	54	12	0	851	33
15 Mean Wind Velocity	in m/sec.	2,4	3	3,3	3,6	3,4	3	2,4	1,9	2,6	2,5	2,6	2,5	2,8	15
16 Predominant Wind Direction		SW	ENE	SW	SW	DW	NE	NE	NE	ENE	SW	ENE	SW		16

Fig. 3. Long-term interpolated meteorological data (Müller, 1983).

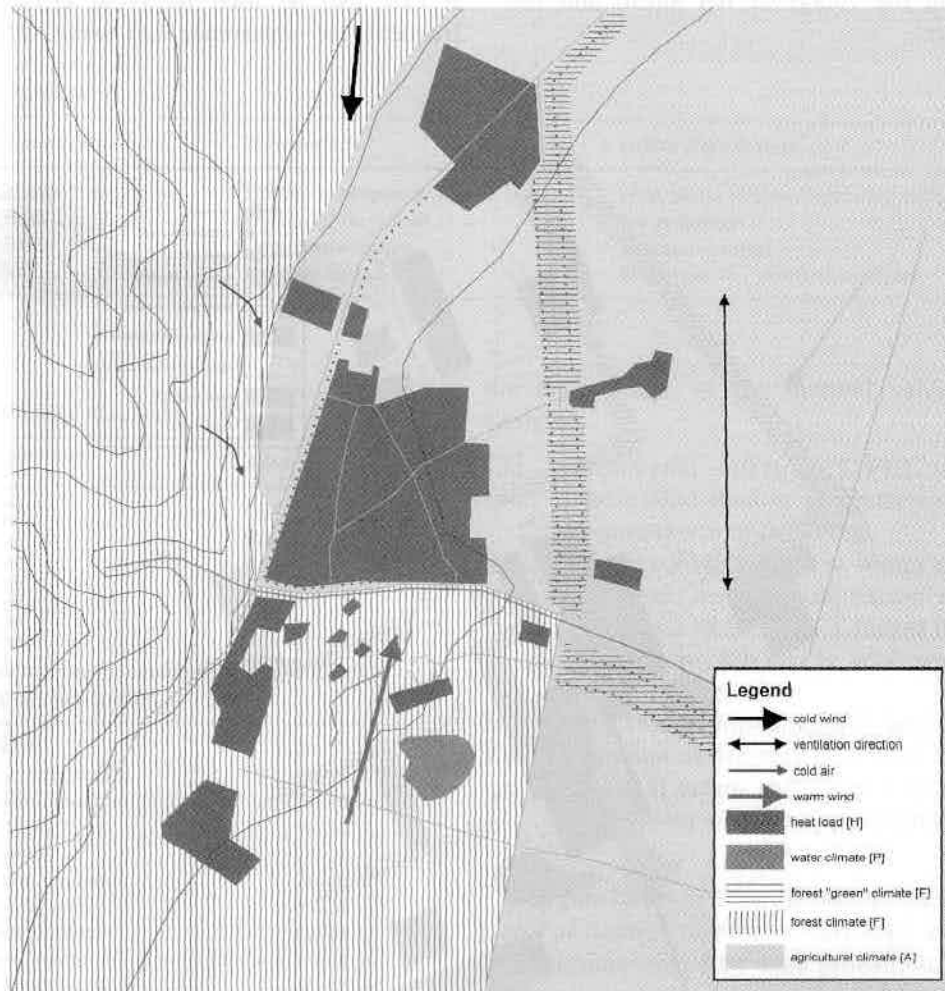


Fig. 4. Climate map of Chi Qiao with evaluation and recommendations.

are derived from the handbook of meteorological data (Müller, 1983) and interpolated for the location of the village (Fig. 3).

For the thermal component with PET values, more than 30 °C in summer, the wind protection zone inside the village leads to heat stress. Therefore, the houses at the

edge of the village should develop their shading system inside their own courtyards.

As a second example, Chi Qiao is taken. The village can be classified as BSK climate (Köppen, Geiger) 37°N, with dry winters and some rain in summer. The annual rainfall is only 396 mm, but because of the seasonal circulation difference, this rainfall only occurs in summer. This effect must be considered for agricultural planning and for the erosion problems, which are combined with dry summer conditions. The daily variation of air temperatures in summer is very high but no heat stress occurs, while the seasonal variations with the strong cold stress situations in winter need wind protection. Heat stress, defined with PET values above 26°C, is only observed during some summer days. Means values lead to very frequent use of open space for recreation and work.

Rain occurs in the hot summer months with heavy showers, when water runs quickly away along the surfaces or is evaporated. The problem of dust pollution exists, therefore, throughout the year requires careful planning. Coal mining is one of the reasons for this situation. In the climate map in Fig. 2, the solution for this problem is wind protection in specific zones using vegetation belts. The wind barriers in the north-west (NW) of the village provide protection to improve winter thermal comfort. In Fig. 4, the recommendations can be seen in more detail.

Generally, the following recommendations are derived from the climate maps:

- Prevention of dust from cars and mining by increasing vegetation areas and planting trees near the roads.
- Ventilation areas should be kept air mass exchange near the roads.
- Recreation areas for the near by temple should be developed by adequate bioclimatic conditions during the summer period.
- Provision of measures for wind protection against cold NE winds from the mountains.
- Future extensions of the city should consider the recommendation to promote thermal comfort conditions and dust reduction through green zones.

#### 4. Conclusions

Through the climate analysis, different planning approaches can be supported. Agricultural production and thermal comfort improvements need specific climate conditions, which have to be presented in an appropriate spatial and time resolution. In nearly all villages studied of north China, wind protection is needed in winter to reduce cold stress and support daily work in open spaces.

Agricultural areas, especially green houses, need high incoming radiation and enough water resources. Wind protection is needed to avoid erosion and control

evaporation. Both aspects were combined in the spatial resolution of recommendations. The climate maps show best places for the location of green houses and open agriculture. Places for forest developments lead to a buffered climate zone which may be positive for the extension of the vegetation period.

For the thermal human–bioclimatic conditions the climate maps provide information of thermal sensations in open spaces. Although peoples' well-being and encouragement of frequent use of outdoor spaces are the basic aims of thermal comfort analysis, the information can also be successfully applied to promote tourism.

The major information which can be derived from climate maps, such as those developed in the project, is related to ventilation and detection of the heat island effect. Through a simple approach using the information of land use and topographical situation, combined with meteorological data from the near by stations, the complete climatic situation is defined by interpolation and adopted to improve village development. Location of open spaces in housing layouts, as well as industrial development and traffic planning are the main issues where climate mapping can provide a useful and effective tool for planning decisions and where climate information can be used to encourage sustainable development.

It is relevant to note that the use of these simple methods of climate mapping provides a practical tool for easy and widely available use. Detailed analysis can follow afterwards. It is also important to realise that the research carried out within the framework of this project is aimed to respond to local circumstances, conditions and demands.

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# Analysis of energy use in a sample of Chinese villages

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## Abstract

This paper summarises the methodology and results of work involved in the investigation of energy demand in six Chinese villages included in the SUCCESS Project. The procedures used to collect data associated with local energy demand are explained and the approach to data analysis is explained. Results are provided in terms for delivered energy consumption, as an indicator of energy demand; primary energy consumption, as an indicator of energy resource depletion; and carbon dioxide emissions, as an indicator of global climate change. Similarities and differences between results for this sample of villages are considered. The important causes of differences in results are investigated.

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**Keywords:** Energy demand; Delivered energy consumption; Carbon dioxide emissions; Rural energy use in China; Sustainable development in China

## 1. Introduction

Work Package P within the Sustainable Users' Concepts for China Engaging Scientific Scenarios (SUCCESS) Project, funded under the INCO-DEV Programme by the Directorate-General for Research of the European Commission, addresses "Energy Systems and Sustainable Settlements". The principal activities within this Work Package were undertaken by the Resources Research Unit of Sheffield Hallam University assisted by North Energy Associates Ltd. The main aims of the Work Package were to investigate and determine current and possible future energy demand and supply within case study villages in relation to options for sustainable development. The first objective in this work was to estimate current energy use of each village, so that baselines could be established as essential reference points for the subsequent of evaluation of future projections of energy demand, energy efficiency improvements and local renewable energy potential. In total, baselines were derived for six of the seven case study

villages included in the SUCCESS Project. Basic information on the villages considered here is summarised in Table 1. It should be noted that the population data presented in Table 1 refer to the actual number of people living in each village during the period of the SUCCESS Project. Migrant workers from the villages have been excluded from these data to ensure meaningful interpretation of subsequent results. In general, the number of households recorded in Table 1 can be related to the number of houses in each village.

## 2. Methodology

A number of standard methodologies exist for collecting and analysing data on energy use in villages, towns, cities and regions, especially in developed countries, and these have been summarised and reviewed elsewhere (Grant et al., 1994; Shaw, 2004). In order to undertake such work in rural China, it was necessary to adapt these methodologies to the specific circumstances encountered in each village by using an appropriate combination of procedures. These procedures included accessing official statistics on energy consumption from government sources at national, province, county and township levels, obtaining data from village committees and associated personnel, conducting

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Table 1  
Basic information on the SUCCESS Project case study villages

Village	Province	Grid reference	No. of households	Population	Persons per household
Bei Suzha	Hebei	37°30'N, 116°0'E	423	1590	3.76
Chi Qiao	Shanxi	37°48'N, 114°12'E	600	3337	5.56
Du Jia	Yunnan	23°48'N, 103°24'E	39	165	4.23
Jiang Jiashai	Shaanxi	34°18'N, 112°0'E	402	1756	4.37
Xia Futou	Henan	34°12'N, 113°0'E	139	550	3.46
Xiao Qi	Jiangxi	29°30'N, 117°48'E	215	534	2.48

interviews and questionnaires with people in selected households, and performing energy surveys in specific buildings and facilities.

The SUCCESS Project Teams in the villages played an essential rôle in assembling existing information from local sources prior to visits by the SUCCESS Partners to each village. During site visits by SUCCESS Partners, meetings were held with relevant local officials and administrators, as well as with key personnel such as the village leader, members of the village committee, and the village accountant and electrician. In combination with parallel work by SUCCESS Partners involved in socio-economic studies, a representative sample of households were selected on the basis of the pattern of family income within each village. Interviews, questionnaires and energy surveys were undertaken in these sample households so that results could be extrapolated over the total number of households in the village. A similar approach was adopted with commercial enterprises, such as shops, hotels, restaurants and workshops, in the villages. Special interviews and energy surveys were directed towards energy intensive operations, such as industrial activities, within the villages. Throughout this work, the assistance of the Chinese Partners in the SUCCESS Project, especially the interpreters, was essential to the process of data collection.

Details of the actual procedures applied in each village, including the questionnaires used during interviews, are contained in the Energy Reports which have been prepared for each village (Grant and Mortimer, 2003a, b, 2005; Mortimer and Grant, 2004, 2005a, b). Data collected with these procedures were combined to provide a summary of total energy use within each village. Where possible, data from different sources were compared and any major discrepancies were noted and resolved. This was necessary in order to avoid mistakes related to the description of energy use, the conversion of Chinese units of measurement and the meaning of numbers, especially those given in multiples of 10. Preliminary findings were assembled during each visit and any obvious problems with missing data or errors in data were mainly addressed before presenting these findings to the villagers. Subsequent inquiries over data were directed through the local SUCCESS Project Team after visits had been completed and before final results were derived.

### 3. Data analysis

In order to meet the requirements of the SUCCESS project, data collected in the villages was analysed so that estimates could be derived for energy use broken down by sector, fuel type and end use. The sectors, or groupings of activities, within the villages were categorised as domestic, agricultural, commercial, industrial, administrative and transport. The domestic sector refers to household living activities that occur within dwellings. The agricultural sector relates to all farming activities that take place within the fields surrounding the villages. The commercial sector includes activities that happen within shops, hotels, restaurants, etc. The industrial sector consists of all manufacturing and engineering activities in small workshops and larger factories. The administrative sector covers the activities within the village committee buildings, the village school and communal facilities such as street lighting. The transport sector only reflects transportation activities organised by the villages themselves. Hence, the use of motorcycles, motorcars, minibuses, trucks and lorries by the villagers are associated with this sector, whilst the provision of bus services by external companies and the use of coaches by visitors to the village are excluded.

The fuel types specified in the data analysis depend on the actual fuel supplies available in each village. In terms of the villages included in this particular sample, the fuel types were composed of biogas, biomass (specifically agricultural, forestry and woodland residues), coal, coal briquettes, diesel, electricity, liquefied petroleum gas (LPG), petrol, solar water heating and wood. Relevant end uses identified in these villages consisted of space heating, space cooling, water heating, cooking, process heating, lighting, other electrical applications (commercial equipment, refrigerators, washing machines, televisions, etc.) and motive power for various forms of transport. It should be noted that it is sometimes difficult to draw precise distinctions between some end uses in the village situations encountered in countries such as China. For example, although some water heating may be provided by dedicated facilities, such as solar water heating systems, water for personal and clothes washing is often heated on cooking stoves. Additionally, it can be impossible to separate end use applications properly between sectors. For example, in

some villages, the same pumps are used to provide water for both domestic and agricultural purposes. Hence, a degree of flexibility must be accepted in the precise interpretation of the categorised results for energy use presented here.

### 3.1. Delivered energy demand

Delivered energy is the energy available to consumers from the fuels that they collect or buy and the electricity that they purchase. As such, it represents their demand for energy. The original data collected for the villages was provided in a variety of units of measurement. These were converted into relevant units specified by the Systeme Internationale d'Unities (SI). Where necessary, estimates of delivered energy consumption were derived from such data by means of calorific values which specify the amount of heat produced when a given fuel is burnt. The standard calorific values used for the fuels consumed in the villages are recorded in the Energy Reports (Grant and Mortimer, 2003a, b, 2005; Mortimer and Grant, 2004, 2005a, b). In some instances, it was necessary to adopt local data to derive approximate calorific values for certain fuels. In particular, information on the composition of coal briquettes was required to assess their likely calorific value. Following the conversion of original data, estimates of delivered energy consumption were obtained in standard SI energy units of kilowatt hours (kWh). In recognition of the limits to the accuracy of these estimates, results are quoted to the nearest 1000 kWh, with any figure less than 500 kWh

not being recorded. Subsequent breakdowns of total annual delivered energy consumption (kWh/a) by sector and fuel type are summarised for each village in Tables 2–7. For ease of comparison, the breakdowns by sector and total estimates of annual delivered energy consumption per capita (kWh/ca a) are presented in Tables 8 and 9, respectively.

### 3.2. Primary energy inputs

Since the focus of the SUCCESS Project is sustainable development, it was helpful to produce suitable indicators of sustainable energy use in the villages. One concern for sustainability is avoiding reliance on depletable energy resources. Primary energy, which equals the energy required, directly and indirectly, from finite energy resources to satisfy delivered energy consumption, is a suitable measure of energy resource depletion. Consequently, suitable conversion factors were used to evaluate primary energy inputs to each village from previous estimates of delivered energy consumption. These conversion factors, which are summarised in the Energy Reports (Grant and Mortimer, 2003a, b, 2005; Mortimer and Grant, 2004, 2005a, b), take into account of all the finite energy resources needed to supply a given amount of delivered energy in the form of fuels or electricity. For example, the conversion factor for electricity generated from coal includes the primary energy of the coal and associated inputs to coal mining, transportation, construction of the power station and the electricity transmission

Table 2  
Total annual delivered energy consumption by sector and fuel type for Bei Suzha

Sector	Total annual delivered energy consumption (kWh/a)					
	Coal	Coal briquettes	Electricity	LPG	Petrol	Wood
Domestic	0	675,000	298,000	1,550,000	0	270,000
Agricultural	0	0	160,000	0	0	0
Commercial	0	0	0	0	0	0
Industrial	970,000	0	140,000	0	0	0
Administrative	0	0	0	0	0	0
Transport	0	0	0	0	1,999,000	0

Table 3  
Total annual delivered energy consumption by sector and fuel type for Chi Qiao

Sector	Total annual delivered energy consumption (kWh/a)					
	Coal	Coal briquettes	Diesel	Electricity	LPG	Petrol
Domestic	27,810,000	7,123,000	0	203,000	293,000	0
Agricultural	0	0	0	32,000	0	691,000
Commercial	0	0	0	0	0	0
Industrial	4,833,000	0	0	497,000	0	0
Administrative	0	0	0	0	0	0
Transport	0	0	54,534,000	0	0	1,535,000

Table 4  
Total annual delivered energy consumption by sector and fuel type for Du Jia

Sector	Total annual delivered energy consumption (kWh/a)							
	Biogas	Coal	Diesel	Electricity	LPG	Petrol	Solar	Wood
Domestic	98,000	0	0	12,000	5000	0	39,000	610,000
Agricultural	0	0	3000	6000	0	0	0	0
Commercial	0	0	0	0	0	0	0	0
Industrial	0	257,000	4000	0	0	0	0	0
Administrative	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	34,000	0	0

Table 5  
Total annual delivered energy consumption by sector and fuel type for Jiang Jiazhai

Sector	Total annual delivered energy consumption (kWh/a)							
	Biogas	Biomass	Coal	Coal briquettes	Diesel	Electricity	LPG	Petrol
Domestic	23,000	1,833,000	0	907,000	0	468,000	50,000	0
Agricultural	0	0	0	0	25,000	982,000	0	0
Commercial	0	0	497,000	0	0	85,000	0	0
Industrial	0	0	0	0	0	0	0	0
Administrative	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	160,000

Table 6  
Total annual delivered energy consumption by sector and fuel type for Xia Futou

Sector	Total annual delivered energy consumption (kWh/a)						
	Coal	Coal briquettes	Diesel	Electricity	Petrol	Wood	
Domestic	0	517,000	0	30,000	0	60,000	
Agricultural	0	0	95,000	0	0	0	
Commercial	0	0	0	5000	0	0	
Industrial	14,834,000	0	0	0	0	0	
Administrative	0	0	0	0	0	0	
Transport	0	0	0	0	98,000	0	

Table 7  
Total annual delivered energy consumption by sector and fuel type for Xiao Qi

Sector	Total annual delivered energy consumption (kWh/a)						
	Charcoal	Coal briquettes	Electricity	LPG	Petrol	Solar	Wood
Domestic	231,000	22,000	66,000	342,000	0	0	990,000
Agricultural	0	0	0	0	0	0	0
Commercial	30,000	7000	57,000	389,000	0	2000	800,000
Industrial	0	0	0	0	0	0	0
Administrative	0	0	10,000	0	0	0	0
Transport	0	0	0	0	210,000	0	0

network, and losses in transmission. This approach applies to all means of producing relevant fuels and electricity. Hence, it applies to the provision of biomass such as wood from local forests. In this instance, the sustainability of the practices used to provide wood fuel is taken into account.

In particular, if wood is extracted without planting replacement trees, it is regarded as depletion of a finite energy resource and a primary energy input is recorded. Sustainable management of forests avoids such depletion so that such wood fuel attracts no or very low direct

Table 8  
Comparison of annual delivered energy consumption per capita

Sector	Annual delivered energy consumption per capita (kWh/ca a)					
	Bei Suzha	Chi Qiao	Du Jia	Jiang Jiazhai	Xia Futou	Xiao Qi
Domestic	1757	10,612	4630	1868	1104	3092
Agricultural	101	217	55	573	172	0
Commercial	0	0	0	314	0	2406
Industrial	698	1602	1582	0	26,980	0
Administrative	0	0	0	0	0	19
Transport	1257	16,802	206	91	178	393

Table 9  
Comparison of total annual delivered energy consumption per capita

Sector	Total annual delivered energy consumption per capita (kWh/ca a)					
	Bei Suzha	Chi Qiao	Du Jia	Jiang Jiazhai	Xia Futou	Xiao Qi
Total	3813	29,233	6472	2864	28,434	5910

Table 10  
Comparison of total annual primary energy consumption per capita

Sector	Annual primary energy consumption per capita (kWh/ca a)					
	Bei Suzha	Chi Qiao	Du Jia	Jiang Jiazhai	Xia Futou	Xiao Qi
Total	4691	32,100	5709	3477	30,065	6702

Table 11  
Comparison of total annual carbon dioxide emissions per capita

Sector	Total annual carbon dioxide emissions per capita (kg CO <sub>2</sub> /ca a)					
	Bei Suzha	Chi Qiao	Du Jia	Jiang Jiazhai	Xia Futou	Xiao Qi
Total	1272	8542	1964	1096	8878	2232

primary energy inputs. Subsequent comparison of estimates of total annual primary energy inputs per capita (kWh/ca a) for each village are shown in Table 10.

### 3.3. Carbon dioxide emissions

Another important issue for sustainable development is the contribution to global climate change. This can be represented by carbon dioxide (CO<sub>2</sub>) emissions which are associated with the combustion of fossil fuels, such as coal, natural gas and petroleum products, as well as the combustion of wood from unsustainable sources. In this latter case, if no trees are planted to replace those extracted for fuel then subsequent CO<sub>2</sub> emissions will not be re-absorbed by new growth thereby leading to an increase in CO<sub>2</sub> emissions. This is taken into account in the conversion factors used to derive estimates of CO<sub>2</sub> emissions associated with the delivered energy available from wood, other fuels and electricity. The conversion factors adopted here include adjustments for CO<sub>2</sub> emissions released by all

the processes involved in the provision of fuels and electricity. Relevant values for these conversion factors are given in the Energy Reports (Grant and Mortimer, 2003a, b, 2005; Mortimer and Grant, 2004, 2005a, b). A comparison of subsequent estimates of total annual CO<sub>2</sub> emissions per capita (kg CO<sub>2</sub>/ca a) for each village is presented in Table 11.

## 4. Interpretation of results

The results illustrated in Tables 2–11 demonstrate considerable differences amongst the sample of Chinese villages investigated in the SUCCESS Project. There are a variety of reasons for these differences. In all the villages, energy demand by the domestic sector is a prominent contribution to total delivered energy consumption. However, before this is examined in more detail, factors affecting energy demand by the other sectors will be considered. Order of magnitude differences in annual delivered energy consumption per capita can be observed

in these non-domestic sectors for these villages. These differences are a consequence of a combination of specific local circumstances, including economic activity, relative wealth and location.

#### 4.1. Non-domestic sectors

Agricultural activities occur in all of the villages in the sample, although the nature of these activities and their relative contributions to the economy of each village vary considerably. Agriculture is important in Bei Suzha, Du Jia, Jiang Jiazhai and Xia Futou. However, whilst arable farming takes place in all the villages, cattle and dairy farming is particularly significant in Jiang Jiazhai. The use of tractors specifically for farming in Chi Qiao, Jiang Jiazhai and Xia Futou accounts for petrol and diesel consumption in the agricultural sector. In Bei Suzha, tractors are also used for transportation to the neighbouring city of Hengshui. Because it was not possible to separate out the alternative uses of tractors, the associated consumption of petrol has been allocated entirely to energy demand in the transport sector. In two of the villages, Du Jia and Xiao Qi, draught animals are used instead of tractors. The reasons for this vary. In Du Jia, the steepness of the terrain favours the use of animals instead of tractors. In Xiao Qi, traditional farming methods have been preserved because the village relies increasingly on Chinese tourism. In Bei Suzha, Chi Qiao, Du Jia and Jiang Jiazhai, energy demand in the agricultural sector is influenced by irrigation water pumping requirements. Although electricity is commonly employed for such purposes, diesel-powered water pumps are also used in Du Jia.

Significant energy demand by the commercial sector is only recorded for two of the villages: Jiang Jiazhai and Xiao Qi. Both these villages contain a number of shops and restaurants. Additionally, there is a commercial bathhouse in Jiang Jiazhai; and Xiao Qi has hotels to cater for the tourists. Substantial energy demand by the industrial sector occurs in Bei Suzha, Chi Qiao, Du Jia and Xia Futou. The main industrial energy demand in Bei Suzha results from the operation of a small factory which manufactures small industrial wheels. The region where Chi Qiao is located was a major paper-making area until recently. Although most of the paper mills have been closed down due to stricter environmental regulations, there is a small paper recycling plant within the boundary of the village. Additionally, there are a number of small workshops, attached to houses, which produce clothes. Local brewing has been included in the industrial sector for Du Jia even though the resulting alcohol appears to be mainly for local use. A factory, which uses a considerable amount of coal to make ceramic bricks from local minerals for metal smelting, is situated in Xia Futou. There are no apparent industrial activities in Jiang Jiazhai or Xiao Qi.

In comparison with other sectors, energy demand by the administrative sector is relatively low. Recordable amounts of energy use by this sector were only identified in Xiao Qi.

In this village, income generated by tourism supports a quite substantial village committee building and fairly extensive street lighting. These facilities combined with a relatively modern school account for a measurable consumption of electricity. In the other villages, schools form the main part of the administrative sector but they contain few energy-consuming equipment apart from basic lighting, resulting in comparatively low delivered energy consumption.

There are marked variations in annual delivered energy consumption per capita by the transport sectors in this sample of villages. It would appear that this is influenced mainly by the relative wealth, economic activity and location of the each village. Bei Suzha is still a principally agricultural village which is situated near a large city. Agricultural produce and purchased goods are transported to and from this city mainly by means of tractors. Chi Qiao is on the outskirts of Taiyuan which is a large, rapidly expanding city. Many villagers commute for work in this city and its surrounding developments. Additionally, villagers operate taxi services with motorcars and mini-buses, as well as road freight businesses with lorries. The diesel and petrol consumed by these vehicles has been allocated to the transport sector of the village since these activities support its economy. Du Jia is relatively remote and small road vehicles are used to transport produce and supplies to and from the nearest town. Jiang Jiazhai is located near a growing new city in the Yangling Demonstration Zone. Tractors transport produce and goods to and from this city. Motorcycles are the main form of transport used by villagers in Xia Futou due to its relatively remote situation and limited road network. A new road into Xiao Qi has been essential for developing its tourist industry. However, many surrounding villages are only linked paved paths so that motorcycles are still popular even though a truck and a minibus are now available for use on the main road in Xiao Qi.

#### 4.2. Domestic sector

Apart from the influence of the brick factory on total energy demand in Xia Futou, the domestic sector accounts for the largest single contribution to total delivered energy consumption in this sample of villages. This supports the view that, in general, the domestic sector still dominates energy demand in rural China. However, substantial differences in domestic energy demand occur, even within this small sample of villages. In particular, there is almost an order of magnitude difference between the minimum (Xia Futou) and maximum (Chi Qiao) values of annual delivered energy consumption per capita for the domestic sector. Investigation of the possible causes of these differences can be assisted by comparing the breakdowns in annual domestic delivered energy consumption for these villages, as presented in Table 12. This shows that the largest contributions to total energy demand are due to either cooking and water heating, or space heating.

Table 12  
Comparison of annual domestic delivered energy consumption per capita

Sector	Annual domestic delivered energy consumption per capita (kWh/ca a)					
	Bei Suzha	Chi Qiao	Du Jia	Jiang Jiazhai	Xia Futou	Xiao Qi
Cooking and water heating	1419	2222	4558	558	940	2455
Space heating	189	8334	0	1044	109	513
Space cooling	35	1	0	0	0	6
Lighting	39	22	42	136	22	49
Other	78	37	30	91	9	69

Table 13  
Comparison of a selection of climatic data for the sample of Chinese villages

Temperature (°C)	Bei Suzha	Chi Qiao	Du Jia	Jiang Jiazhai	Xia Futou	Xiao Qi
Mean minimum in January	-7.2	-13.9	2.8	-5.0	-5.0	1.1
Absolute minimum in January	-19.8	-29.7	-7.5	-19.1	-19.1	-13.0
Mean maximum in July	32.7	31.1	25.0	33.9	33.9	33.9
Absolute maximum in July	42.8	41.1	34.9	45.2	45.2	41.1

Relatively large amounts of delivered energy are used for cooking and water heating in Bei Suzha, Chi Qiao, Du Jia and Xiao Qi. Cooking is a fundamental use for energy in houses, as these figures indicate. However, water heating is also important and this may be the reason for the relatively low estimates of energy demand for these combined end uses in Jiang Jiazhai and Xia Futou. There is a commercial bathhouse in Jiang Jiazhai and, consequently, water heating for personal washing is provided here rather than in villagers' homes. In contrast, water is only provided intermittently in Xia Futou and, hence, opportunities for water heating are limited. Indeed, villagers must travel by public bus to the local county town of Bo Ai for shower facilities.

In a developed country, it would be expected that space heating and/or space cooling would dominate domestic energy demand. However, the results summarised in Table 12 demonstrate that this is not necessarily the case in the rural areas of developing countries such as China. Space heating makes a relatively small contribution to total domestic energy demand in Bei Suzha, Du Jia, Xia Futou and Xiao Qi. Du Jia is located in the "no heating zone" of China's official climate region categorisation for heating specification (MOC, 1996) and, hence, zero space heating energy demand was to be expected. The limited space heating is used in Xiao Qi which is situated in the "transition zone" characterised as having "hot summer/cool winter". This is reflected in the quoted mean and absolute minimum temperatures for January and July shown in Table 13 which presents a selection of derived climatic data for the sample of villages (Katzschner, 2003). Even so, lower winter temperatures are experienced in Bei Suzha and Xia Futou which have smaller space heating demand per capita than Xiao Qi. Both these villages, as well as Chi Qiao and Jiang Jiazhai, are in the official "heating zone". Hence, this suggests that temperature alone does not explain the variations in delivered energy consumption per capita for space heating. Instead, it seems

likely that a combination of wealth and relative ease of access to heating fuel exert a significant influence. Both wood and charcoal derived from local forests is readily available in Xiao Qi. The villagers in Chi Qiao have access to relatively cheap coal produced locally in Shanxi province. Biomass, in the form of straw and waste wood, is available locally for essential bed heating in Jiang Jiazhai. More expensive coal briquettes are used for space heating in Bei Suzha. This is probably less affordable in Xia Futou where the alternative use of wood is limited by scarce local supplies.

Space cooling is not widespread in any of the villages despite the fact that some are subject to extremely high summer temperatures, as indicated in Table 13. The most notable annual delivered energy consumption per capita for space cooling is recorded for Bei Suzha where some air conditioning units have been installed in the more wealthy households to supplement more conventional electric fans. Such fans are also used for space cooling in Chi Qiao and Xiao Qi. Apart from Jiang Jiazhai, the amount of annual delivered energy consumption per capita for lighting is fairly constant across this sample of villages. The reason for this is probably that energy inefficient tungsten filament and fluorescent tubes were commonly used for lighting in Jiang Jiazhai, whereas energy efficient compact fluorescent bulbs were used in the other villages to varying extents. Other domestic energy demand in the villages resulted from the electricity consumption of refrigerators, washing machines, televisions and other domestic electrical appliances. Whilst the ownership of such appliances is comparable in most villages, it is particularly low in Xia Futou which is considered to be a less wealthy village.

#### 4.3. Development, energy demand and sustainability

Each village in the sample has achieved different levels of economic development and this has had an effect on the

magnitude and pattern of delivered energy consumption. Differences are also reflected in the estimates of total annual primary energy consumption and CO<sub>2</sub> emissions per capita presented in Tables 10 and 11. However, the results for primary energy consumption and CO<sub>2</sub> emissions do not mirror exactly the estimated delivered energy consumption summarised in Table 9. The reason for this is that the types of fuels and their sources affect the amounts of primary energy and CO<sub>2</sub> emissions associated with the provision of a given quantity of delivered energy. For example, coal-fired power plants are used to generate the electricity consumed in Bei Suzha, Chi Qiao, Jiang Jiazhai and Xia Futou. In contrast, the electricity used in Du Jia and Xiao Qi is provided by hydro power plants. Bei Suzha is fairly dependent on fossil fuels, especially coal, LPG and petrol, although waste wood is used in the village. Chi Qiao relies very heavily on the use of fossil fuels, particularly coal which is readily available locally. Similarly, coal is the main source of delivered energy in Xia Futou. Although fossil fuels are used in Jiang Jiazhai, biomass is a major source of delivered energy which is derived from agricultural residues and waste wood. Renewable energy sources, including biogas, solar energy and wood, account for the majority of delivered energy supply in Du Jia. Wood is also an important source of delivered energy in Xiao Qi. However, in both these villages, it is considered that wood is not derived from sustainably managed forests and woodland. Such considerations influence subsequent estimates of primary energy consumption and CO<sub>2</sub> emissions.

## 5. Conclusions

A practical methodology for estimating energy demand in Chinese villages has been demonstrated. This methodology is capable of evaluating the breakdown of delivered energy consumption by sector, fuel type and end use. The key features of this methodology are a flexible means to data collection, which adapts to local circumstances and accommodates information from a variety of sources, and an investigative approach to data analysis, which involves cross-checking results and resolving discrepancies. Subsequent results show significant differences between villages, even within this small sample. These differences are due to a combination of diverse factors including the economic wealth and development of each village as well as its location and specific circumstances. In the majority of instances, the domestic sector dominates delivered energy consumption. The industrial, commercial and transport sectors can be significant causes of energy demand depending on local circumstances. In relative terms, the agricultural and administrative sectors have low impact on

energy demand. Within the domestic sector, cooking, water heating and space heating account for the greatest contribution to total delivered energy consumption. Whilst local climate conditions play some part in the demand for space heating, other considerations, such as economic wealth and access to suitable fuels, are important. Although primary energy consumption and CO<sub>2</sub> emissions generally reflect estimated delivered energy consumption, local differences in the sources of fuels and electricity can modify actual results. This emphasises the need to take into account all relevant local factors when attempting to evaluate the representative magnitude and pattern of delivered and primary energy consumption and CO<sub>2</sub> emissions for individual villages.

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# Evaluating the prospects for sustainable energy development in a sample of Chinese villages

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## Abstract

This paper describes the methods used to evaluate the potential for achieving sustainable energy development in six Chinese villages included in the Sustainable Users' Concepts for China Engaging Scientific Scenarios (SUCCESS) Project by examining energy efficiency potential and local renewable energy prospects. The approaches needed to obtain and analyse information on possible energy efficiency measures and renewable energy resources are summarised. Results are presented in terms of cumulative net savings in primary energy consumption, as an indicator of energy resource depletion, and associated carbon dioxide emissions, as an indicator of global climate change. Options for sustainable energy development are ranked in order of likely implementation and practical actions which could be considered in each village are identified.

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**Keywords:** Energy efficiency improvements; Renewable energy resources; Carbon dioxide emissions; Rural energy use in China; Sustainable development in China

## 1. Introduction

Energy is one of the fundamental factors in the functioning of any civilised society. In particular, access is required to energy services which satisfy the needs of human beings for acceptable levels of thermal comfort, adequate lighting conditions, necessary means of preparing food, suitable provision of mobility, etc. Currently, most means for providing energy services, principally from fossil fuels, are unsustainable because they are wasteful, they depend on finite resources and they have major environmental impacts, chiefly in the form of global climate change. In contrast, sustainable energy development is based on means of providing energy services which enhance the quality of life whilst reducing, to a minimum or, ideally, eliminating resource depletion and significant damage to humans and the environment. Since traditional models for development have been based on the profligate

exploitation of depletable resources and the natural environment, the realisation of sustainable energy development presents a substantial challenge for all communities, especially those in developing countries where considerable economic growth is necessary to achieve and maintain acceptable living conditions for an expanding population. This challenge is no more so evident than in China where rapid economic development relies on the ever-increasing consumption of natural resources with little apparent regard for the environmental consequences. At the same time, the social impact of accelerating migration from rural to urban areas and widening disparities in incomes are a major political concern for social stability. In the light of this, sustainable development, in general, and sustainable energy development, in particular, are pressing issues for the villages of China which support the economic livelihoods of the rural population which still feeds and must continue to feed the whole population. Consequently, formulating and applying practical procedures for sustainable energy development in villages form an important component for the future progress of Chinese society.

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## 2. Methodology

Sustainable energy development is founded on two important principles; improving the efficiency with which energy services are provided and supplying energy services from renewable energy sources. The starting point for evaluating the prospects for sustainable energy development depends on establishing the level of current demand for energy services. In effect, this is achieved by assessing baseline delivered energy consumption. Since this baseline only reflects the existing pace of economic activity, it is usually necessary to speculate about the future demand for energy services by exploring possible scenarios. Usually, this involves constructing a “business-as-usual” scenario which assumes that recent trends continue into the future. In this scenario, no major changes in technology or behaviour are incorporated so that it assumes, implicitly, that the future is simply a continuation of the past. Typically, reliance on existing energy technologies combined with significant increases in population and/or economic wealth result in substantial depletion of energy resources and degradation of the environment. Using the “business-as-usual” scenario as a basis, the effect of improving energy efficiency and utilising renewable energy resources can be investigated. In order to do this, it is necessary to identify and quantify the options for implementing energy efficiency measures and renewable energy technologies within any given community. The relative impacts on energy resources and the natural environment can be represented by subsequent primary energy consumption, as an indicator of energy resource depletion, and associated carbon dioxide (CO<sub>2</sub>) emissions, as an indicator of global climate change. Resulting savings from energy efficiency and local renewable energy options can be ranked in likely order of possible implementation, often based on qualitative judgements of their relative economic, financial, social, etc., considerations. Options can then be combined sequentially to demonstrate the cumulative effect of progressive savings on delivered energy demand, primary energy consumption and associated CO<sub>2</sub> emissions.

## 3. Data collection and analysis

Most of the data required to evaluate the prospects for sustainable energy development in Chinese villages can be collected as part of the procedures for establishing current energy baselines. This was part of the activities of Work Package P on “Energy Systems and Sustainable Settlements” within the Sustainable Users’ Concepts for China Engaging Scientific Scenarios (SUCCESS) Project, funded under the INCO-DEV Programme by the Directorate-General for Research of the European Commission. In particular, this work was undertaken by the Resources Research Unit of Sheffield Hallam University assisted, subsequently, by North Energy Associates Ltd. The principal means of data collection consisted of a general

exploration of the each village and its surrounding area by means of a “transect walk”, interviews with villagers, questionnaire and survey work in sample households, and meetings with the village leader and village committee members, and township and provincial officials. In particular, survey work for the evaluation of current delivered energy consumption yielded information about the efficiency of existing equipment and appliances. Specifically, the types of lighting systems were recorded and the nature of the cooking stoves were noted. Basic visual inspection, combined with established knowledge, were used to form assumptions about the relative efficiency of these and other items of equipment, such as space heating systems, refrigerators, etc. In subsequent analysis, it was necessary to rely on a combination of quantitative information (from equipment nameplates, etc.) and qualitative judgements since the systematic measurement of the energy efficiency of individual appliance and pieces of equipment was not possible within the time and cost constraints of the SUCCESS Project.

Direct observations and measurements were used along with published statistics and maps provided by officials, villagers and local team leaders to assess local renewable energy resources. Climatic data, mainly extrapolated from neighbouring weather stations, provided annual and monthly statistics on average solar irradiation and wind speed (Katzschner, 2003). Whereas data on solar irradiation, or insolation, were useful for evaluating the potential for solar water heating, the relative low wind speeds found for all the villages within the SUCCESS Project indicated no significant prospects for wind power development. Specifically, the recorded average wind speeds were all below the “cut-in” values at which modern wind turbines begin to operate and generate power. On this basis, wind power was discounted as a major renewable energy resource in the six villages investigated from the energy perspective in the SUCCESS Project. Hydro power also had limited prospects in these particular villages. However, in certain locations with a reasonable head (vertical distance through which the water falls) and flow (quantity of water flowing per unit time), basic hydro power resource assessments were conducted. Both direct measurements and documents, such as maps and published statistics, were used to estimate water head and flow.

In many villages, the most prominent renewable energy resources consisted of biomass energy. This included human and animal wastes for biogas production, wood and/or charcoal from existing waste wood sources and forests as well as potential short rotation coppice (SRC) cultivation for heat and power generation, and energy crops, such as oilseed rape and wheat, for liquid biofuel production. Local data on the number of people and the types and numbers of domestic animals were combined with standard conversion factors to determine the quantities of biogas which could be generated using small- and large-scale digesters. Local agricultural statistics and maps were used with typical productivity and conversion

efficiency factors for producing charcoal or gasifying wood to estimate the potential generation of heat and/or electricity, and liquid biofuels, such as biodiesel and bioethanol as replacements for conventional fuels in transport applications. In terms of assessing the total future potential of biomass energy resources, a number of other factors have to be considered to establish the total amount of energy that could be available. This included the future number of people and animals in the village as well as future land use. These factors depend on other considerations, such as changes in the nature and level of economic activity, which are influenced by future scenario development. Hence, instead of evaluating the theoretical future potential of biomass energy, assessment was restricted to determining whether such renewable energy sources could satisfy existing or foreseeable future energy demands.

Current uncertainties about the form and details of future development scenarios during the early stages of the SUCCESS Project also limited opportunities for formulating “business-as-usual” scenarios for all the villages. Hence, in the majority of the villages, only baseline energy demand could be used in evaluating prospects for sustainable energy development. However, in one village, data on recent trends were available to prepare a near-term future “business-as-usual” scenario for illustrative purposes. Another modification to the evaluation methodology consisted of taking preliminary account of the net primary energy and CO<sub>2</sub> emissions associated with the provision and, where relevant, operation of energy efficiency measures and renewable energy technologies (Mortimer, 2004). This involves estimating the difference between the total primary energy inputs and associated CO<sub>2</sub> emissions of current energy supply and those related to its displacement by sustainable energy options. This incorporates the total amount of primary energy inputs and associated CO<sub>2</sub> emissions, mainly arising from the combustion of fossil fuels, in implementing energy efficiency measures and renewable energy technologies. Although resulting adjustments in net savings are relatively small for energy efficiency measures and most renewable energy technologies, these can be more significant for certain biomass energy options, especially those involving the conventional production of liquid biofuels.

#### 4. Results

The potential and relative significance of energy efficiency measures in any given village depends on the breakdown of delivered energy consumption by sector, fuel type and application. Additionally, the availability of specific renewable energy resources and their applicability to demand for given energy services are both site-specific and dependent on local circumstances. For these reasons, it is necessary to examine the results of this evaluation of prospects for sustainable energy development in each village separately. This involves outlining prominent

features of current and, where possible, future demand for energy services in each village before estimating net savings in total annual primary energy consumption and associated CO<sub>2</sub> emissions. Detailed results for each village can be found in the SUCCESS Project Energy Reports (Grant and Mortimer, 2003a, b; Mortimer and Grant, 2004; Grant and Mortimer, 2005; Mortimer and Grant, 2005a, b), along with summaries in the Future Perspective Energy Report (Grant and Mortimer, 2004).

##### 4.1. Bei Suzha

The village of Bei Suzha is located in the Yellow River delta of Hebei Province in North East China. Its farming activities consist of growing a variety of staple crops although there have been recent attempts to diversify by, for example, planting trees for fruit and paper production. Additionally, polyethylene sheet and earth wall greenhouses are used to cultivate early seasonal crops. The proximity of Bei Suzha to the local city of Heng Shui results in considerable movement of outgoing agricultural produce and incoming purchased goods. Some villagers also commute to and from jobs in the city. Consequently, transportation constitutes the largest demand for delivered energy in the form of petrol mainly used by small three-wheel tractors/trailers.

Existing agricultural activity in the entire region is highly dependent on water supply from aquifers which are steadily depleting. Although various water conservation practices are being applied and planned, the villagers appreciate the need to develop other economic activities to maintain the viability of the community. Driven by commercial opportunities and higher economic returns than agriculture, industrial activities are expanding in the village. Coal is a significant source of industrial process heating. Cooking dominates domestic delivered energy consumption although the fuels used to satisfy this demand are changing as household incomes increase. There is a continued shift from wood, which is regarded as a “poor families’ fuel” to coal briquettes, which are a relatively cheap, available yet polluting form of fuel, and finally, to liquefied petroleum gas (LPG) which is more expensive but regarded as a clean and convenient cooking fuel. Space heating is less common in the village even though the average minimum temperature in January falls to  $-7.2^{\circ}\text{C}$  (Katzschner, 2003). Ready access to electricity means that this source of energy, which is generated by regional coal-fired power stations, is available for a typical range of domestic appliances.

A summary of the possible net savings in total annual primary energy consumption and associated CO<sub>2</sub> emissions in Bei Suzha is provided in Table 1. Whilst energy efficient lights are not uncommon in many Chinese villages, there are still some opportunities to replace tungsten filament bulbs with compact fluorescent lamps in Bei Suzha. Considerable potential is available to replace existing inefficient wood and coal briquette cooking stoves with

Table 1  
Summary of possible net savings in primary energy consumption and associated carbon dioxide emissions for Bei Suzha

Option	Net savings of annual primary energy consumption (kWh/a)	Net savings of annual carbon dioxide emissions (t CO <sub>2</sub> /a)
<i>Energy efficient lighting:</i> 40 W tungsten filament bulbs replaced by 18 W compact fluorescent bulbs	108 000	31
<i>Biogas cooking stoves:</i> coal briquette stoves with thermal efficiency of 20% replaced by biogas stoves with a thermal efficiency of 47%	627 000	180
<i>Conversion of LPG cooking stoves to biogas:</i> 34% of existing propane stoves converted to use remaining biogas available	533 000	114
<i>Industrial gas heating:</i> coal replaced by gas, efficiency increased from 60% to 80% and gas from 148 t/a of wood grown on 18 ha of land	983 000	296
<i>Domestic gas heating:</i> coal replaced by gas, efficiency increased from 60% to 70% and gas derived from 52 t/a of wood grown on 6 ha of land	366 000	148
<i>Conversion of LPG cooking stoves to gas:</i> 66% of existing propane stoves converted to use gas from 207 t/a of wood grown on 26 ha of land	1 085 000	247
<i>Electricity generation from wood chips:</i> gasification of 324 t/a of wood grown on 41 ha of land	1 448 000	443
<i>Bioethanol:</i> 269 t/a of bioethanol from wheat grown on 118 ha of land to supply fuel for vehicles	1 299 000	358

modern designs, especially those with proper chimneys which would reduce indoor air pollution significantly (FAO, 1993; Edwards et al., 2004). At the same time as improving the efficiency of stoves, all existing coal briquette stoves and some LPG stoves could be converted to biogas generated from human waste processed in a central digester with an estimated output rating of approximately 100 kW. This would solve an existing waste disposal problem as well as satisfying some of the local energy demand.

However, there is inadequate biogas potential to meet all heating needs in Bei Suzha. Instead, a more comprehensive solution is required. This could be achieved by growing SRC poplar to provide wood chips for a centralised

gasification combined heat and power (CHP) unit in the village. To meet current delivered energy demands for the remaining cooking and all space heating, industrial heating and electricity requirements, a CHP unit with a 250 kW heat rating and a 65 kW electricity rating would be required. This would consume 731 tonnes of dried wood chips per year from SRC which would have to be cultivated on 92 ha of land or 28% of the area currently committed to growing trees in Bei Suzha. In order to satisfy the current transport needs of the village, 118 ha of land or 37% of the area used currently to grow wheat in Bei Suzha, could be devoted to growing wheat for bioethanol which would replace petrol from crude oil.

The replacement of inefficient lighting and cooking stoves represent relatively simple and cost-effective energy efficiency options. The centralised biogas digester with a local distribution pipe network is a more expensive option which would require village-scale co-operation to construct and operate, especially in terms of waste collection. A wood chip gasification CHP unit is relatively new technology that would be a very expensive option for providing heat and electricity compared with the prices of coal briquettes and LPG for cooking and space heating, and the price of grid electricity. The option of supplying bioethanol from local sources would only be viable if large-scale production facilities were available regionally and if petrol prices were higher than those of to-day in China. However, in terms of technical potential, if all the options identified here were implemented in Bei Suzha, total annual primary energy consumption and associated CO<sub>2</sub> emissions could be reduced by 84% and 90%, respectively.

#### 4.2. Chi Qiao

Due to expansion of the nearby city of Taiyuan and its surrounding developments, the village of Chi Qiao in Shanxi province of North East China is rapidly losing its rural features as it transforms into a peri-urban community. Whilst villagers still cultivate the adjacent fields, many receive part or all of their income from commercial or industrial enterprises within the village or by commuting to jobs in the neighbouring city. Prior to expanding urbanisation, this and other villages in the area already had a substantial industrial economy based on paper making. Most of the paper mills have now closed down due to stricter environmental regulations. However, there is still a state-owned paper mill just outside the official boundary of the village and a smaller private paper mill, which has been converted to recycled paper production, within the village. This mill consumes a substantial amount of coal for process heating. Other significant enterprises within Chi Qiao consist of workshops which manufacture children's clothes and transport businesses which provide lorries for freight haulage along with bus and taxi services. The clothes workshops rely on electricity to power their equipment, whilst the transport businesses consume large quantities of diesel and petrol.

In rural terms, the village is relatively wealthy and fuels for space heating and cooking are fairly abundant. Coal is widely available and this is used directly or by means of commercially manufactured or home-made briquettes. Quite low temperatures are experienced during the winter, with a mean minimum of  $-13.9^{\circ}\text{C}$  in January (Katzschner, 2003). Consequently, there is a significant need for space heating and this is mainly provided by coal-fired heating systems. Coal is also used for cooking but there is an increasing use of LPG. Water for irrigation as well as industrial and domestic uses is pumped from underground sources using electricity. Electricity, generated by local coal-fired power stations, is also used in the village in the increasing range of consumer appliances which are found in many households. Energy efficient lighting is fairly commonplace in Chi Qiao.

Opportunities to reduce primary energy consumption and associated  $\text{CO}_2$  emissions in Chi Qiao are influenced by two main considerations. First, some energy efficiency improvements have already been realised due to the use of compact fluorescent light bulbs and modern fluorescent tubes, the presence of relatively efficient domestic appliances, the existence of moderately efficient space heating systems and the penetration of LPG for cooking. Second, delivered energy consumption is dominated by diesel for lorries and buses, petrol for cars, tractors and motorcycles, and coal for space heating and cooking in the domestic sector and process heating in the recycled paper mill. Hence, the focus of assessment of options for sustainable energy development was directed towards local opportunities to provide potential replacements for the current main energy supplies from local large-scale renewable energy sources.

Table 2 provides a summary of the possible net savings in total annual primary energy consumption and associated  $\text{CO}_2$  emissions in Chi Qiao. Given that the importance of agriculture in this village is gradually declining due to a growing internal and external industrial and commercial economy, it seems reasonable to propose that existing fields could be converted to the cultivation of biomass for energy production. Biodiesel produced from oilseed rape could substitute for diesel obtained from crude oil. However, current diesel consumption is so high that existing land area in the village could not support the estimated 5268 tonnes of biodiesel per year required. Approximately 45000 ha of land would be needed to provide this and the cultivated land area of the village is only 38 ha. Hence, the overwhelming majority of biodiesel would have to be imported into the village. It might seem that replacement of petrol from oil by bioethanol from wheat is more achievable locally, since only 300 tonnes of bioethanol per year would be required. This could be derived from only 131 ha of land but it still exceeds the area for cultivation in this village.

A major option for supplying all process and space heat as well as all electricity currently demanded in Chi Qiao consists of a wood gasification CHP unit with a peak heat

Table 2

Summary of possible net savings in primary energy consumption and associated carbon dioxide emissions for Chi Qiao

Option	Net savings of annual primary energy consumption (kWh/a)	Net savings of annual carbon dioxide emissions ( $\text{t CO}_2/\text{a}$ )
<i>Biodiesel</i> : 5268 t/a of biodiesel produced from oilseed rape grown on 45000 ha of land to supply fuel for all commercial vehicles	36 770 000	14 625
<i>Wood gasification combined heat and power plant</i> : 1.5 MW electrical output plant supplying all electricity and heat requirements by using 19000 t/a of wood chips obtained from residues of 4000 ha of forest	37 735 000	11 698
<i>Bioethanol</i> : 300 t/a of bioethanol produced from wheat grown on 131 ha of land to supply fuel for all cars, tractors and motor cycles	1 157 000	571

rating of 3.7 MW and a peak electric power rating of 1.5 MW. Located centrally in the village, possibly on the site of a derelict paper mill, this CHP plant would provide steam and hot water through a small district heating network and electricity through a localised power grid. Such a plant would require 19000 tonnes of wood chips per year. There is insufficient land to grow this amount of wood by means of SRC. Instead, suitable supplies would have to be obtained from residues collected from 4000 ha of forest in the neighbouring Tian Long Mountains. However, the actual sites for the extraction of such residues may be limited since many of those which do occur in the arid mountainous areas are protected. Hence, it will be appreciated that the realisation of sustainable energy development in Chi Qiao would be extremely challenging. Indeed, the potential options have more in common with typical solutions for an urban rather than a rural community. This simply reflects the increasingly urbanisation of this particular village. Assuming that all these options could, somehow, be implemented in Chi Qiao, total annual primary energy consumption and associated  $\text{CO}_2$  emissions could be reduced by 71% and 94%, respectively.

#### 4.3. Du Jia

Du Jia is a relatively remote village in the Yunnan province of South West China. Due to its remoteness, its economy is almost entirely dependent on agricultural activities. A variety of semi-tropical crops are cultivated including maize and sugar cane. Pig farming is also practiced which leads to a demand for fuel to heat pig

food. Because of adequate local supplies, wood is used for this purpose as well as for cooking in houses. However, biogas and LPG is also used for cooking. Space heating is not a requirement in Du Jia because of its mild climate which sees an average minimum temperature of 2.8 °C in January (Katzschner, 2003). The village also brews its own alcohol and imported coal is used as a process heating fuel. Given the expense of and constraints on imported fuels, along with a favourable level of solar irradiation, solar water heating is fairly common. Petrol is used in the small number of vehicles in the village. Indeed, transportation in Du Jia is limited as a result of its remote location and poor road access. Diesel fuel, as well as electricity, is used pump water for irrigation from the local river to the fields. The village is connected by the grid to regional hydro electric power schemes so supplies are available for a modest amount of lighting, domestic appliances and other electrical equipment.

Although Du Jia has a substantial utilisation of local renewable energy sources with could be extended further and enhanced by introducing energy efficiency measures. Table 3 summarises the possible net savings in total annual primary energy consumption and associated CO<sub>2</sub> emissions in Du Jia. Since tungsten filament bulbs are still quite common, these could be replaced with compact fluorescent lighting. The concept that local forestry must be used in a sustainable manner has been introduced and propagated in the area. This is one reason for the growing number of solar water heating installations in Du Jia. However, there is considerable potential to use wood from sustainable forestry in more efficient systems. Instead of using wood directly as a fuel, it would be more appropriate to convert it into charcoal, thereby improving its ease of transport from the forests in the surrounding hills in addition to offering the opportunity of using this fuel in more efficient stoves and boilers. It was assumed that modern charcoal cooking stoves and brewing boilers would achieve an increase in thermal efficiency (FAO, 1993; Edwards et al., 2004). As part of a programme of conversion, LPG cooking stoves would be replaced by charcoal cooking stoves. Although this might reduce thermal efficiency, there are significant benefits from switching from LPG to a more sustainable fuel source. Du Jia's cultivatable land is quite sufficient to support the production of the relatively small annual amount of 5 tonnes of bioethanol from wheat, requiring 2 ha, used in transportation, and the production of 0.3 tonnes of biodiesel from oilseed rape, requiring only 0.3 ha of land, for use as a fuel in the water irrigation pumps. Combining these options together in Du Jia, it is estimated that total annual primary energy consumption and associated CO<sub>2</sub> emissions could be reduced by 96% and 98%, respectively.

#### 4.4. Jiang Jiazhai

Jiang Jiazhai is situated in the agricultural zone of the expanding new city of Yangling in the Shaanxi province of

Table 3

Summary of possible net savings in primary energy consumption and associated carbon dioxide emissions for Du Jia

Option	Net savings of annual primary energy consumption (kWh/a)	Net Savings of annual carbon dioxide emissions (t CO <sub>2</sub> /a)
<i>Energy efficient lighting:</i> 40 W tungsten filament bulbs replaced by 18 W compact fluorescent bulbs	500	0.09
<i>Charcoal cooking stoves:</i> wood stoves replaced by charcoal stoves (thermal efficiency increased from 20% to 47%) using 32 t/a of wood obtained from 7 ha of sustainable forestry	605 000	231
<i>Charcoal cooking stoves:</i> propane stoves replaced by charcoal stoves (thermal efficiency decreased from 70% to 47%) using 5 t/a of wood obtained from 1 ha of sustainable forestry	4850	1
<i>Charcoal brewing boilers:</i> coal boilers replaced by charcoal boilers (thermal efficiency increased from 20% to 47%) using 14 t/a of wood obtained from 3 ha of sustainable forestry	268 000	79
<i>Bioethanol:</i> 5 t/a of bioethanol from wheat grown on 2 ha of land to supply fuel for vehicles	21 000	6
<i>Biodiesel:</i> 0.3 t/a of biodiesel from oilseed rape grown on 0.3 ha of land to supply fuel for irrigation pumps	2000	0.5

North East China. Although it is a traditional farming village, its economy is being transformed by local demand for higher value products. In particular, this includes meat and dairy products as well as out-of-season vegetables. Cattle farming, which was based on the individual family ownership of one or more cows, is now being increased by the collective use of stabling and dairy facilities. Currently, 450 cows are kept in the village as well as 460 pigs. The total area of land for arable farming amounts to 121 ha, of which the majority is used to grow wheat and maize (100 ha). However, land is also provided for vegetable growing and polyethylene greenhouses (16 ha), orchards (6 ha), seedling and flower nurseries (2 ha) and protected woodland (1 ha). In general, the village is considered to the relatively wealthy since it has reached or exceeded the national standard for "well-off" life. Apart from agricultural activities, Jiang Jiazhai supports a number of commercial facilities including shops, wood, metal and other workshops, restaurants, a mill and a bathhouse.

The use of straw, other agricultural residues and waste wood for domestic space heating and cooking dominates total delivered energy consumption in Jiang Jiazha. Due to local availability, coal briquettes are also used for cooking whilst some families can afford to use LPG. However, many households have small-scale digesters which utilise human and animal wastes to generate biogas. This is mainly used for domestic cooking although it is sometimes applied to a specific form of space heating in this part of China. This involves providing means to heat beds due to the cold nights that can be experienced in winter. For example, the average minimum temperature for this area in January is  $-5.0^{\circ}\text{C}$  (Katzschner, 2003). Traditionally, the heating of beds was achieved by burning wood, agricultural wastes or coal and this practice still continues in the village. Coal is used for cooking in the shops and restaurants, and for water heating in the bathhouse. A significant amount of electricity is consumed by the water pumps which are used irrigate the fields. Electricity, generated from regional coal-fired power stations, is supplied through a grid connection. Domestic electrical appliance ownership includes domestic water pumps, washing machines, refrigerators, radios and televisions. Electricity also supports the activities in the workshops, the mill and the dairy. Diesel is consumed in the tractors and petrol in the road vehicles.

As shown in Table 4, there is considerable potential for saving electricity consumption and associated  $\text{CO}_2$  emissions by replacing tungsten filament bulbs with compact fluorescent lights in all types of building in Jiang Jiazhai. Unfortunately, opportunities to improve the energy efficiency of the buildings themselves are somewhat restricted. In common with many villages in China, there has been a move away from traditional building forms and materials. Previously in this region, earth-sheltered housing, or "jao dong", were common, making use of the deep layers of thick clay soil, or "loess", which can extend up to 10 m in depth, to create underground dwellings. Although such homes required no space heating, without the benefit of careful orientation and proper design, daylighting and ventilation, these dwellings often provided poor internal environmental conditions. An alternative tradition involved building houses on the surface with rammed earth brick and cavity walls. Such building techniques provided more comfortable living conditions. However, new housing that has replaced traditional dwellings meets village building regulations which require homes to face the existing roads. Subsequent disregard for orientation reduces the opportunity to maximise passive solar gains for space heating, space cooling, natural ventilation and daylighting. Furthermore, fired bricks and concrete used in non-cavity wall construction are now very common building materials which have lower thermal mass and lower insulation properties.

In terms of appliances within buildings, there are opportunities to replace existing coal stoves in houses, shops and restaurants with improved stoves which can increase thermal efficiency from around 20–47% (FAO,

Table 4  
Summary of possible net savings in primary energy consumption and associated carbon dioxide emissions for Jiang Jiazhai

Option	Net savings of annual primary energy consumption (kWh/a)	Net savings of annual carbon dioxide emissions ( $\text{t CO}_2/\text{a}$ )
<i>Energy efficient lighting: 40 W tungsten filament bulbs replaced by 18 W compact fluorescent bulbs</i>	177 000	51
<i>Solar water heating for bath house: 40 m<sup>2</sup> evacuated tube panel and heat storage</i>	119 000	35
<i>Biogas cooking stoves: coal stoves in houses, restaurants and shops replaced by biogas stoves (thermal efficiency increased from 20% to 47%) supplied from centralised digester</i>	1 507 000	590
<i>Electricity from biogas: 75 kW electrical output biogas engine generator supplied by centralised digester</i>	1 353 000	392
<i>Electricity from straw and wood chip: 125 kW electrical output gas engine generator supplied by gasification of 378 t/a of straw from 100 ha of land and 194 t/a of wood chips from 24 ha of land</i>	2 150 000	675
<i>Bioethanol: 22 t/a of bioethanol from wheat grown on 10 ha of land to supply fuel for vehicles</i>	104 000	29
<i>Biodiesel: 3 t/a of biodiesel from oilseed rape grown on 2 ha of land for tractors</i>	17 000	5

1993; Edwards et al., 2004). Additionally, these stoves could be supplied with biogas since there is adequate supplies animal waste available in the village. Indeed, there is sufficient scope for supplying this biogas from a centralised digester in the village for cooking and heating as well as some electricity generation. Further local electricity generation could be achieved by gasifying straw, as an agricultural residue, and wood chip derived from locally grown SRC. This would use up the straw available from existing cereal-producing land. The extra source of biomass, in the form of wood chip, would be necessary to ensure that the village could supply all current electricity demand from local renewable sources. SRC cultivation would require about 24 ha of land which could be accommodated within the fields around Jiang Jiazhai. There should also be enough land to grow wheat for bioethanol production and oilseed rape for biodiesel production which would eliminate the current need, respectively, for petrol and diesel from crude oil. Taken

together, such potential biomass energy production, using dedicated crops rather than residues, would require about 30% of the agricultural land around the village. When added to savings that would be achieved by installing solar water heating in the bathhouse, it is estimated that current total annual primary energy consumption and associated CO<sub>2</sub> emissions in Jiang Jiazhai could be reduced by 89% and 93%, respectively.

#### 4.5. Xia Futou

The immediate future and eventual fate of Xia Futou, a mountain village in the Henan province of North East China, will be determined largely by the local presence of a prominent and growing minerals extraction industry. Despite its continued reliance on agricultural activities, the economy of this village is affected by the minerals industry in two important ways. First, there is an industrial ceramic brick factory in the neighbourhood of the village which distorts the delivered energy demand of the community very significantly. The brick factory uses substantial quantities of coal which is readily available in this region from neighbouring Shanxi province. In fact, the railway line which brings this coal into the region runs through the valley where Xia Futou is situated. Second, the minerals industry provides alternative sources of income, especially when villagers are short of cash. This can involve temporary employment in the legal minerals enterprises as well as encouraging illegal mining activities. Indeed, the whole area is riddled with new and disused small-scale mining operations which present dangerous local hazards as well as causing damage to the river bed and threatening channelled water supplies. Although the brick factory dominates local delivered energy consumption, its future is uncertain due to fluctuations in demand for its products. Indeed, there is an ever-present possibility that the factory will close.

The majority of the remaining delivered energy demand in Xia Futou is accounted for by the use of coal briquettes for cooking. This fuel is readily available for purchase from traders who tour the area. The village has reasonably good transport links to other communities down the valley, the county town and beyond by means of a recently constructed concrete road. However, this is only a single-track road and parts of it are heavily used by lorries carrying minerals. Whilst the road continues up the valley, links to some surrounding villages are restricted to rough tracks. For this reason and due to the limited wealth of the village, by far the most common form of local transportation is by motor cycles which use petrol. Alternatively, there are some limited bus services available although, ironically, the local station on the main railway line through the valley was closed some time ago.

Despite the availability of coal in the region, the more remote location of Xia Futou means that wood is still used as an important fuel for space heating in the village. This is necessary because the average minimum temperature for

this area in January is  $-5.0^{\circ}\text{C}$  (Katzschner, 2003). Although the village is relatively remote and poor, electricity is readily available and used in a range of domestic appliances including washing machines, refrigerators and televisions. There is also some electricity demand by commercial enterprises such as small mills and bakeries. Electricity is provided by grid connections to a coal-fired power station further up the valley. Previously, electricity was generated locally by small hydro power schemes but these have been closed down in the area around Xia Futou due to diversion of the local river to supply water for industrial and commercial purposes elsewhere in the county. Consequently, water supply in the village is now a major concern since it is only provided when required by channels cut into the mountainsides. In general, the quality of this water is poor.

In terms of energy and associated CO<sub>2</sub> savings, the main issue for Xia Futou is the brick factory. Obviously, if this closes local delivered energy demand will fall dramatically, as indicated by Table 5. However, the resulting loss of income would be a substantial problem for the village. Hence, it was necessary to investigate the possibility of improving the energy efficiency of the brick factory and of using renewable sources for furnace heating. Based on typical practice elsewhere, it was estimated that energy savings of about 20% might be achieved by increasing the furnace insulation. Even with this improvement, a very substantial amount of fuel would still be required for firing the furnaces. This could not be provided by known biomass sources in Xia Futou and its immediate surroundings. Instead, other options would have to be considered. As it happens, in the county town and neighbouring area, there is a quite large wood industry, ranging from basic timber production to wood product manufacture. Significant amounts of waste wood are generated by this industry and, since it appears to have no other use, it could be utilised to fire the brick factory furnaces by means of gasification. A number of considerations would have to be taken into account to realise such a solution, including the economics relative to cheap coal, the availability of adequate financial investment and the problems of transporting 24 000 tonnes of wood waste along a heavily used but narrow road. If these and other difficulties could be overcome, the effect on primary energy consumption and associated CO<sub>2</sub> would be significant and this is demonstrated in Table 5.

Simpler potential energy efficiency improvements in Xia Futou include the replacement of tungsten filament bulbs with compact fluorescent lighting and existing cooking and space heating stoves with more efficient models incorporating external flues or chimneys (FAO, 1993; Edwards et al., 2004). In addition to reducing delivered energy consumption and associated CO<sub>2</sub> emissions, this latter proposed change would significantly improve air quality in the majority of homes. Even with such stove improvements, local energy demand would still rely on the supply

Table 5  
Summary of possible net savings in primary energy consumption and associated carbon dioxide emissions for Xia Futou

Option	Net savings of annual primary energy consumption (kWh/a)	Net savings of annual carbon dioxide emissions (t CO <sub>2</sub> /a)
Closure of brick factory	15 576 000	4552
Waste wood gasification for energy efficient brick factory: 20% energy savings in furnace firing and use of 24 000 t/a of wood	15 018 000	4441
Energy efficient lighting: 40 W tungsten filament bulbs replaced by 18 W compact fluorescent bulbs	7000	6
Improved cooking stoves: thermal efficiency increased from 20% to 47% by replacing current stoves with new stoves with flues	424 000	146
Charcoal from coppiced poplar for cooking and space heating: 35 t of charcoal per year derived from 22 ha of short rotation coppice	196 000	104
Solar water heating: 1 m <sup>2</sup> evaluated tube solar panel for each of the 139 households to provide all water heating requirements	6000	2
Small-scale hydro power: 125 kW hydro turbine using constant flow down the water supply channel to the village	74 000	22
Biodiesel: 9 t/a of biodiesel from oilseed rape grown on 8.5 ha of land to supply fuel for tractors	62 000	18
Bioethanol: 13 t/a of bioethanol from wheat grown on 5.8 ha of land to supply fuel for motor cycles	50 000	25

and combustion of coal briquettes. This could be mainly alleviated by using charcoal obtained from local SRC plantations. This would be a more sustainable and substantial source of wood than current supplies. Adequate land is available locally to grow SRC since government-sponsored schemes are already taking terraced agricultural land out of production by tree planting to stabilise mountainsides. However, the current approach would have to be changed to ensure that suitable types of trees were planted and regulations would have to be relaxed to enable villagers to coppice such wood.

Savings in water heating could be realised by the installation of solar panels on houses in the village. The total global insolation of 1241 kWh/m<sup>2</sup>a in this region

(Katzschner, 2003) is adequate to support the majority of household water heating requirements provided that suitable systems are installed and supplementary water heating systems using biomass are available to provide hot water during overcast days and during the winter. Although electricity is readily available in the village its source is not sustainable. Unfortunately, the option of refurbishing the existing small-scale hydro schemes may not be feasible since the river bed has been damaged by mining activities even if the political decision was made to re-establish the water flow. Instead, the current water supply could be harnessed to provide some or all the current electricity demand. This water supply is delivered via a 60 m high sloping channel from the main channel into the village. If a small hydro power scheme were installed at this point and given an adequate flow, which is currently determined by the county authorities, it would be possible generate electricity for all existing demand in the village. Although there is relatively low demand for petrol and diesel in this village, the areas of land would be required to grown oilseed rape and wheat for bio-diesel and bioethanol, respectively, to replace diesel and petrol from crude oil would exceed the 11 ha of cultivated land around the village. Hence, these options could only be realised by importing supplies from elsewhere. If these diverse options could be implemented in Xia Futou, total annual primary energy consumption and associated CO<sub>2</sub> emissions could be reduced by 96% and 98%, respectively.

#### 4.6. Xiao Qi

Until recently, the village of Xiao Qi, in the Jiangxi province of South East China, was only accessible by means of relatively narrow paths over quite difficult terrain. Although these paths were well paved with local bluestone flags, they constrained the movement of people and goods to walking and transportation by motorcycle. As part of the development of this quite mountainous region, a new road has been driven through the village providing good connections with the county town and other areas. The region has an attractive natural environment with many rivers and forests. Because of this and due to the work of developers, Xiao Qi has become a tourist village which is visited by increasing numbers of Chinese visitors, mainly from urban areas, who want to see how their parents used to live in the countryside. Hence, Xiao Qi has a number of preserved traditional houses as well as a growing number of new hotels, restaurants and shops. There is an expanding influx of day visitors, who arrive by coach to walk around the village in guided tours, and an element of longer-stay visitors who want to participate in cultural activities. Such tourist development has generated rapid and substantial change in Xiao Qi. Apart from the pressures for facilities created by the visitors, village income has increased dramatically. Although these changes have manifest themselves in many different ways, the effect

on local delivered energy demand are very pronounced with annual growth rate of over 6%.

The pattern of delivered energy consumption has also altered very greatly. In 1999, energy demand reflected the nature of a relatively isolated rural community which depended largely on cultivation of the limited flat land around the rivers and between the fairly steep and wooded mountainsides. Wood and charcoal were used for cooking and space heating and electricity, provided by a grid connection to regional hydro power schemes, was used for modest purposes in houses and the local school. Motor transport and the use of mechanical equipment in the fields was almost non-existent. By 2003, estimated annual delivered energy consumption had increased by 31%. This growth affected all sectors of the community and all end uses. In particular, there was substantial consumption of wood, coal briquettes and LPG for cooking, charcoal and wood for space heating, petrol for motorcycles, trucks and minibuses, and electricity for a range of applications including air conditioning. In 2004, based on construction plans, it was predicted that this growth would continue with the expansion of existing and new applications, such as electricity for cooking and space heating. Many of these new demands are being driven by the expectations of visitors for space cooling in summer, when the average maximum temperature for July is 33.9 °C (Katzschner, 2003), and the ability of residents to pay for moderate levels of space heating in winter, when the average minimum temperature in January is 1.1 °C (Katzschner, 2003).

Such growth, which mirrors Chinese urban rather than rural development, might be expected to present an insurmountable challenge for the implementation of sustainable energy measures such as energy efficiency improvements and the utilisation of local renewable energy resources. However, rapid development offers opportunities for adopting energy efficiency measures and renewable energy technologies, as illustrated in Table 6, for the possible net savings in primary energy consumption and associated CO<sub>2</sub> emissions for Xiao Qi. Even though compact fluorescent lighting is quite commonplace, there are still opportunities for replacing tungsten filament bulbs. Existing cooking stoves could be replaced by more efficient models (FAO, 1993; Edwards et al., 2004) and saving in primary energy consumption and associated CO<sub>2</sub> emissions could be enhanced by using charcoal obtained from sustainable forestry, instead of coal briquettes, and wood and charcoal which is currently derived from forests without any replacement tree planting. Sustainably sourced wood and charcoal could be used to meet space heating requirements. Given the local availability of electricity from hydro power, electric cooking could also be considered. Although existing petrol demand is quite low, it might not be easy to replace this with bioethanol derived from wheat as local growing conditions are probably not suitable even though the land required would only account for 5% of that available. It seems more likely that any

Table 6

Summary of possible net savings in primary energy consumption and associated carbon dioxide emissions for Xiao Qi

Option	Net savings of annual primary energy consumption (kWh/a)	Net savings of annual carbon dioxide emissions (t CO <sub>2</sub> /a)
<i>Sustainable charcoal cooking stoves:</i> wood, charcoal and coal briquette stoves replaced by improved charcoal stoves (thermal efficiency increased from 20% to 47%) and supplied with 107 t/a of charcoal produced from 533 t/a wood derived from 114 ha of sustainable forest	2 391 000	883
<i>Electric cooking stoves:</i> propane cooking stoves replaced by electric cooking stoves	795 000	176
<i>Bioethanol:</i> 28 t/a of bioethanol from wheat grown on 12 ha of land to supply fuel for vehicles	107 000	54
<i>Sustainable wood and charcoal space heating:</i> space heating provided by 19 t/a of wood derived from 4 ha of sustainable forest and 4 t/a of charcoal derived from 19 t/a of wood derived from 4 ha of sustainable forest	161 000	61
<i>Energy efficient lighting:</i> 40 W tungsten filament bulbs replaced by 18 W compact fluorescent bulbs	3000	3

bioethanol would be provided regionally from another crop such as cassava (Zhiyuan Hu et al., 2004). In combination, these options for sustainable energy development could reduce future total primary energy consumption and associated CO<sub>2</sub> emissions in Xiao Qi by 94% and 96%, respectively.

## 5. Conclusions and recommendations

It is possible to collect and analyse relevant data in Chinese villages to identify energy efficiency improvements and prospects for utilising local renewable energy sources. Possible net savings can be quantified and used to evaluate the potential for achieving substantial reductions in total annual primary energy inputs and associated CO<sub>2</sub> emissions. As might be expected, different options and combinations of options are appropriate in different villages, depending, in particular, on local circumstances and site-specific conditions. The realisation of these options for sustainable energy development depends, chiefly, on relative market prices of energy, availability of relevant techno-

logies in rural locations and accessibility of investment capital. Until quite recently, the energy market in China has been influenced by very low prices for fossil fuels, especially coal and coal products and grid electricity. However, it is likely that these will increase with rising global oil prices and incomes in China. Energy efficiency and renewable energy technologies are becoming more widely available in China, partly due to significant and sustained growth in national manufacturing capability. Access to investment capital is expanding as the national economy grows, particularly in the form of personal loans from family members rather than financial institutions. In order to make the most of the opportunity these conditions create for sustainable energy development, a replicable approach is needed which can be applied in villages throughout China by the Chinese themselves. It is essential that this approach takes into account the more robust formulation of future scenarios for rural economic development, since, despite mass migration from the countryside to urban areas, a solid base of food production still needed to support the industrialising Chinese national economy. If this can be addressed successfully, it will provide a sound foundation for sustainable energy development in Chinese villages.

#### Acknowledgements

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# Climatic design of vernacular housing in different provinces of China

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## Abstract

For 2000 years, the inter-connexion between the specific structure of the Chinese eastern climates and the cultural background have produced remarkable vernacular housing types, both well adapted to the local conditions, and reflecting consistent values and knowledge. Stemming from a similar archetypal form, each house plan is translated through the specificity of the climate and resources of its site. One can think that the value and the diversity of this housing stock is due to the combination of the specific structure of the Chinese eastern climates, which creates the contrast of cold-dry winters and hot-humid summers, with the structure of the *Ming t'ang*, which contains the opposition of the *yin* and the *yang*. These two strong factors imprint a substantial cultural and conceptual unity upon all these housing types. Moreover, on the one hand, the geographical variations and, on the other hand, the local building materials generate a large diversity of housing types, of building techniques and of climatic devices which can be observed all around the country. These lessons could be valuable design guidelines from the past for the future.

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**Keywords:** Climate; Culture; Vernacular; Housing

## 1. Climatic introduction

Between the Siberian anticyclone winter influence and the Pacific Ocean monsoon influence, all the Chinese eastern provinces experience considerable seasonal variations, with the double distortion of each one following the latitude from the north to the south.

At the small scale, the local conditions are further diversified according to the topography, the altitude and the sea distance, influencing the temperatures and the precipitation, the whole remaining within the major contest between the two main seasonal influences.

This opposition affects the living space in particular and its influence is structural; protection from the winter conditions must be provided against the cold northwest wind to form a shelter, while aperture disposition is dominated by the summer humid southeast wind so as to provide the necessary ventilation.

These two needs can be satisfied by a structure oriented to the southeast or the south and closed northwest or

north, and moreover the sun seasonal solar needs can also be satisfied with a welcome maximum winter sun radiation and an easy summer sun shading on the southeastern or southern façades.

By accepting these, it can be seen that the Chinese climate strongly influences the structure of Chinese housing.

The analyses of several Chinese climates (Fig. 1) reveal the persistence of the winter/summer opposition, but with important nuances such as

- diminution of the rainfall with the altitude of the northern provinces: at latitude near 37°, one observes 629 mm at the low altitude of 35 m and 180 km far from the sea (Bei Suzha, Hebei) and only 462 mm at the higher altitude of 817 m and 440 km far from the sea (Chi Qiao, Shanxi);
- reduction rainfall with the altitude of the southern province on Jiangxi: at a latitude of 29°, one observes 1468 mm at the low altitude of 46 m and 560 km far from the sea (Nan Chang), and 1811 mm at the higher altitude of 600 m and 320 km far from the sea (Xiao Qi);
- generally, from the north to the south one observes higher yearly rainfalls and higher yearly average

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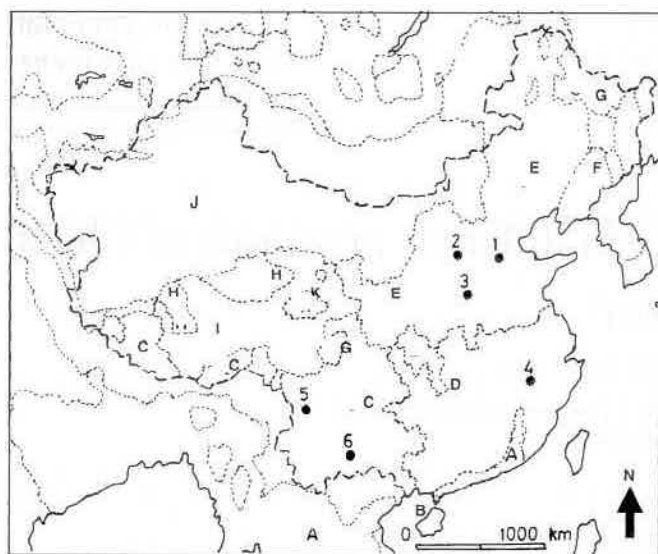


Fig. 1. Climatic map of China and location of villages: (A) TROPICAL HUMID, with a long dry season; (B) TROPICAL HUMID with a short dry season; (C) TEMPERATE with dry winters and mild hot summers; (D) TEMPERATE without dry season; (E) DRY moderate and dry; (F) SUB-POLAR with dry winters and mild summers; (G) SUB-POLAR with dry winters and cool summers; (H) DRY, cold and very dry; (I) DRY, cold and dry; (J) DRY, moderate and very dry and (K) POLAR, very cold and dry. (1) Bei Suzha, (2) Chi Qiao, (3) Xia Futou, (4) Xiao Qi, (5) San Yuan and (6) Du Jia.

temperatures: 14.7 °C (Bei Suzha) and 10 °C (Chi Qiao), 17.2 °C (Nan Chang) and 16.7 °C (Xiao Qi);

- the same range can be observed in the Yünnan province further south: 912 mm with 17.9 °C at latitude 24° and 540 km from the sea (Du Jia), and 1357 mm with 13.6° at latitude 27° and 950 km from the sea.

## 2. Cultural background

If the entire Chinese vernacular housing stock is not only one housing type, “the four wings” buildings around a courtyard have at least a 2000-year history. This housing type can be seen all around the country, but the natural conditions and the way of life in the different regions have led to a large variety of plans and elevations. Thanks to their organization and their scale, these houses occupy an essential place in Chinese architecture; in every respect, the symmetry of the plan and the closed look from the outside are the main characteristics.

According to the Tao principles from Lao-tseu, the magic square which is the basis of the four-wing buildings relates to the *Ming t'ang* (Fig. 2) which is a Calendar House, where Space and Time are identified so as to produce an identification to the universe.

Four lines cut the basic square into nine squares where the central square remains the Time pivot and the four peripheral squares (buildings) to the cardinal orientations and the four seasons.

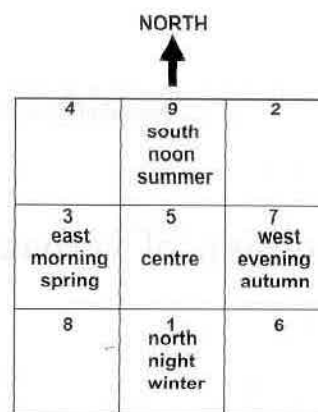


Fig. 2. The *Ming t'ang* structure, “the House of the Calendar”. The different areas of the square are associated to orientations, seasons and periods of the days. To each moment of the time exists a place in the space and specific environmental conditions.

The Chinese climates and their structure as described above find here a strong space identification, where the different buildings around the courtyard can create the microclimate suitable for each season, thanks to their different orientations with respect to the seasonal winds and solar radiation.

Starting from a theoretical concept, the principle reaches a very tangible result.

The magic square can be the foundation of different forms depending on the squares which can be built among the nine internal areas, as demonstrated by the different possibilities of plans.

## 3. Experiences in Chinese vernacular housing

Three opportunities have been useful to the author to appreciate the relations between the Chinese vernacular housing and the climatic conditions.

The first one dates back to the time of his architecture studies in 1969–70, with the book *La Pensée Chinoise* by Granet (1968), and *Chinese Architecture* from Boyd (1962); the main lesson was the Space–Time identification, but at that time local experience was lacking.

The second one was the 1999 UIA Congress in Beijing where he presented a paper *Climatic Guidelines for Building in China*; the main lesson was the great unity of eastern Chinese climates with their winter/summer contrast; however, this study was also completely theoretical, with only a short, but fundamental experience of urban Beijing during the congress.

The third one is the Sino-European project SUCCESS which was completed in the autumn of 2005. This is a real and thorough experience of six provinces in China after four local missions in seven villages (Fig. 1): *Bei Suzha* in Hebei, *Chi Qiao* in Shanxi, *Xia Futou* in Henan, *Jiang Jiazhai* in Shaanxi, *Xiao Qi* in Jiangxi, and *San Yuan* and *Du Jia* in Yünnan; the main lessons were the cultural unity and the diversity of the creative climatic design of the vernacular housing.

Maybe the word *vernacular* is not totally correct due to the strong cultural impact of codification on the building techniques, forms and choice of materials, leading everywhere to quasi-classical local standards, even within the most isolated confines of the country.

#### 4. Lessons from Chinese vernacular architecture

Six house case studies, one per village (as above), except Jiang Jiazhai, are analysed following the same successive steps:

- climatic questions and bioclimatic analysis;
- building responses: interpretation of the *Ming t'ang* square; and
- building responses: orientation, materials, volumes and proportions of the typical house.

#### 4.1. Bei Suzha, Hebei province

##### 4.1.1. Climatic questions, bioclimatic analysis (Fig. 3) (Givoni, 1978; Szokolay, 1987)

The building bioclimatic chart shows the contrast between the two extreme seasons with two short inter-seasons. The temperatures fall below zero and remain below comfort for 2 months in winter with north and northwest winds, while they can exceed 30 °C with south wind and 80% of the rainfalls during summer.

The bioclimatic requirements for housing are also contrasting:

- shelter against the cold north and northwest winds, solar gains and heating during winter; and
- shelter against the rain, ventilation with south winds and shading during summer.

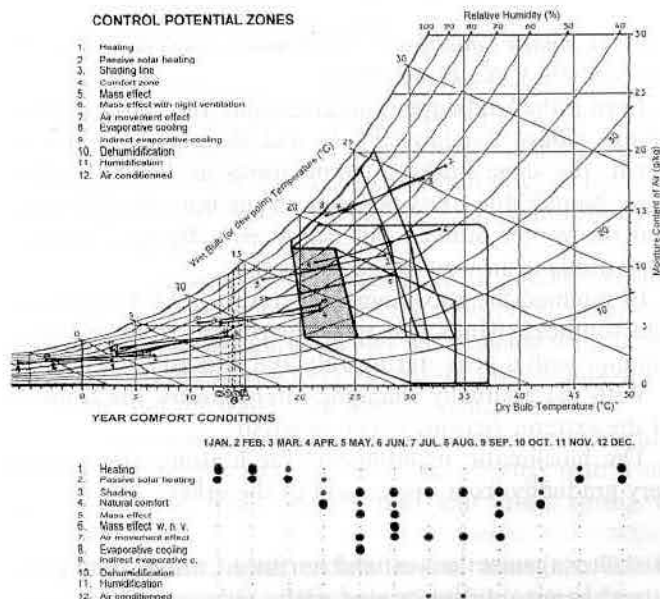


Fig. 3. Bei Suzha, Hebei: latitude, 37°30'; alt., 35 m; sea, 180 km; temp. mean, 14.7 °C; rain, 629 mm.

#### 4.1.2. Building response

4.1.2.1. Interpretation with respect to the *Ming t'ang* structure (Fig. 9). In the centre (5) is the courtyard; the three top squares of the figure (4,9,2) are occupied by the main hall facing south and the two sides (3 and 7) are built with a secondary hall facing east and service rooms facing west.

Two small service courtyards separate the main hall from the two side buildings, and they can be considered as part of the squares of these two last ones.

The bottom squares are occupied by outdoor spaces: the entrance porch and the waste yard with a toilet.

The overall shape of the three main buildings is closed to the north side and open on the south one. One can say that this interpretation of the archetypal *Ming t'ang* structure is not classical and somehow incomplete, probably because of the joint ownership with the neighbouring house which repeats the same plan by the south wall.

The plan is complete and broadly symmetrical, the main axis of the courtyard and the main hall running from slightly east of north to west of south.

4.1.2.2. Interpretation with respect to the climate (Figs. 9, 15 and 21). The *Ming t'ang* interpretation gives the main decisions with respect to the climate: closed to the north, open to the south. The orientation of the house is suitable with respect to the climatic and the seasonal bioclimatic conditions analysed above, even if the orientation is not exactly north–south.

The courtyard has an oblong shape, elongated north–south which provides morning and afternoon shading during summer, except at noon, and which can limit the penetration of the northwest winds during winter.

The high volume of the main hall facing south is largely open towards that direction so as to collect maximum sun radiation and closed to north with a double-pitched roof, which shelters the courtyard against the north winds during winter. The roof overhang is useful to shelter the façade against rain and to shade it during summer, while the north wall, opened with a little window to the main room, allows some cross-ventilation.

The flat mud roofs of the side buildings and their separation from the main hall help the penetration of winds inside this hall during summer.

In summer, the north-facing entrance porch (an extension of the main courtyard), shaded and sheltered from the rain, can be a pleasant place during the noon hours, but the air movements remain limited.

Flood risks caused the mud walls to be built on brick foundations up to the high-water mark, with inter-position of a reed water barrier for similar protection, with the outside of walls covered with a brickwork facing.

#### 4.2. Chi Qiao, Shanxi province

##### 4.2.1. Climatic questions, bioclimatic analysis (Fig. 4) (Givoni, 1978; Szokolay, 1987)

High on a plateau at 817 m (see above Section 1), Chi Qiao is cold with a 3-month winter below zero and minima

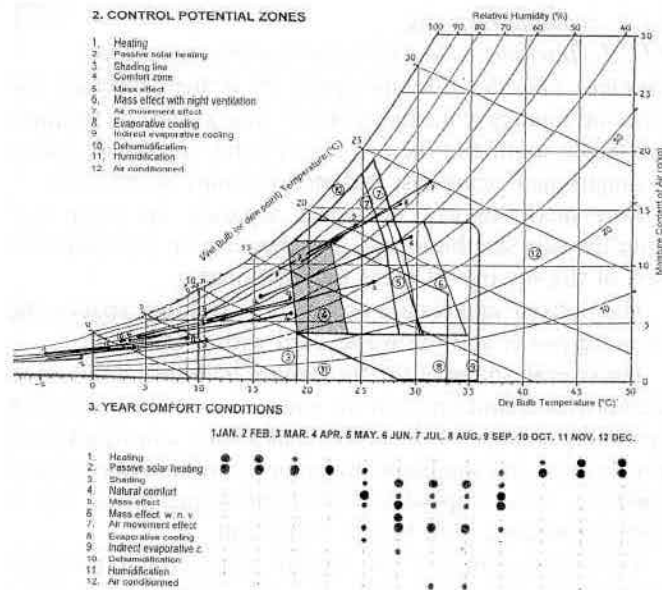


Fig. 4. Chi Qiao, Shanxi: latitude, 37°54'; alt., 817 m; sea, 440 km; temp. mean, 10 °C; rain, 462 mm.

down to -14 and northwest wind; in summer the temperature rarely exceeds 30 °C and the wind blows from south. The few rains are limited to the summer months.

The bioclimatic requirements are much more demanding with the harsh 6-month winter:

- shelter against the northwest wind, capture of the south sun radiation and heat during winter; and
- shading all the façades, shelter against the rain and cross-ventilation.

#### 4.2.2. Building responses

4.2.2.1. *Interpretation with respect to the Ming t'ang structure (Fig. 10).* The courtyard is located in the centre (5), surrounded by four buildings, which enclose four intermediate courtyards.

The three top squares (4, 9, 2.) are occupied by the largest volume of the main hall facing south and divided into a main room and a smaller one. An outside corridor on the west side (square 4) leads to services.

Two identical single-room lower buildings are built on squares (3) and (7), with the top lateral courtyards taken as parts of these squares.

Squares (8) and (1) are occupied by the bottom building facing south and open to the street.

The porch and the entrance court occupy square (6).

The plan is in agreement with the *Ming t'ang* structure and symmetrical, except the little service room, with courtyard and main hall on the same axis running slightly west of north to east of south.

4.2.2.2. *Interpretation with respect to the climate (Figs. 10, 16 and 22).* This is one of the cases where the theory of the *Ming t'ang* and the reality of the building meet together in the best way.

The courtyard is narrow, elongated in the north–south direction, planted with a tree and equipped with a water basin which collects the rainwater from the roofs.

The tall volume of the main hall presents a fully glazed façade, while the north façade is totally solid. It is covered with a flat mud roof with overhang to the south.

The lower side buildings have the same kind of roof with overhangs above the courtyard façades.

The street-facing building presents two overhangs, both on the street and the courtyard sides.

Seen from the air, the house seems to be a compact block cut in four parts by three yards. During the cold winters, the courtyard is sheltered from the northwest wind by the narrowness of the courtyard and by the large volume of the main hall which captures the solar radiation through the branches of the tree and the glazing of the south façade.

During summer, the overhangs of the four buildings act as shelters against the rain and as shading devices against solar radiation, the narrow proportions of the courtyards and the leaves of the tree contribute to the shading of the outside spaces and façades.

The high south-facing façade of the main hall raises its eaves above the others to act as a wind catcher to direct ventilation inside the hall and to the courtyard.

The self-shading of the south building (8, 1) and cross-ventilation through its volume can produce a pleasant microclimate on its north side facing the courtyard during the noon period.

The archetypal figure is fully confirmed by the climate and the building.

#### 4.3. Xia Fu Tou, Henan province

4.3.1. *Climatic questions, bioclimatic analysis (Fig. 5) (Givoni, 1978; Szokolay, 1987)*

Even if the landscape is mountainous, the 200 m altitude of this village is relatively low and the climate is not so harsh: the same kind of temperatures as Bei Suzha but more humid, due to its position on the bottom of a valley and the winter minima fall below zero during 3 months with winds from west and northwest.

In summer, the maximum temperature is 32 °C, with east and southeast winds and rains distributed from spring to autumn with a peak during July and August.

With the gradually changing inter-seasons, the contrast of the extreme seasons is not so harsh.

The bioclimatic requirements for housing also change very gradually from one season to the other:

- shelter against the west and northwest winds, solar gains and heating during winter; and
- shelter against the rain, ventilation with east and southeast winds and shading during summer.

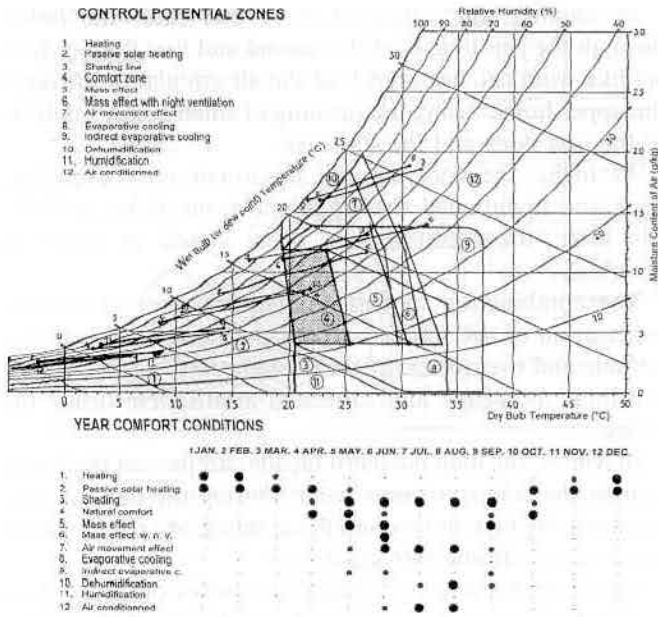


Fig. 5. Xia Futou, Henan: latitude, 34°2'; alt., 200 m; sea, 750 km; temp. mean, 14.6 °C; rain, 580 mm.

4.3.2. Building responses

4.3.2.1. Interpretation with respect to the Ming t'ang structure (Fig. 11). The courtyard occupies the square (5) and a part of the (7) shared with a little service room; the main hall is doubled with two rooms on the (9–2) squares and on the periphery of the courtyard, two other service rooms on the (3–1) squares.

This house is isolated in the village, and remains incomplete, mostly because of the west–east slope and the narrowness of the site.

The plan is asymmetric with the entrance gate, courtyard and main hall on the same axis running north–south. This organic and partial interpretation demonstrates the flexibility of the Ming t'ang principle.

4.3.2.2. Interpretation with respect to the climate (Figs. 11, 17 and 23). The main interest of this house is the intention to orientate the main hall to the south on a site sloping west to east. The necessity of cutting on the west and fill on the east side were big constraints, but they had positive results.

Another interest is the choice of a totally mineral building—stone is the material of the walls of the main hall, the enclosure of the courtyard and the retaining walls of the west and east sides; brickwork is used for the vaulting of the main hall and the wall of the kitchen facing east.

The courtyard is closed on the north and west side, fully open on the south and east side, and planted with a tall paulownia tree which comes into leaf from spring to autumn.

During winter, solar radiation can reach the façade through the branches of the bare trees from sunrise to the beginning of the afternoon and enter the kitchen and the main hall; the thermal inertia of the stone-wall, as it is

buried in the hill on the west side, can keep a basic temperature, only if the fire stoves are kept alight.

The courtyard and the façade of the main hall, protected by the hill slope, are sheltered from the west and northwest winds.

During summer, the surrounding trees and the tall paulownia limit the solar radiation as soon as the sun rises and maintain the courtyard and the building in the shade, the winds from the east and southeast can enter the courtyard, the main hall and the kitchen.

Inside the main hall, the thermal inertia of the building, contrary to winter, absorbs the warmth and produces a cool atmosphere.

In the case of this house, thanks to the shading trees, a north-facing outdoor space would not be necessary.

4.4. Xiao Qi, Jiangxi province

4.4.1. Climatic question, bioclimatic analysis (Fig. 6) (Givoni, 1978; Szokolay, 1987)

The climate of Xiao Qi differs from those above, as the rains are present all around the year with 1811 mm.

The latitude 29°30' is low, the altitude 600 m is medium and the distance of 320 km from the sea is quite close if one recognises that the mountains of this region are the first ones to be encountered by the monsoon-clouds.

Despite the altitude, the latitude maintains the climate above zero in winter with winds following the valley from northwest. In summer, the winds from south and southeast can push the temperatures up to 30 °C.

Winter is not so cold but uncomfortable because it is humid; summer is hot and humid.

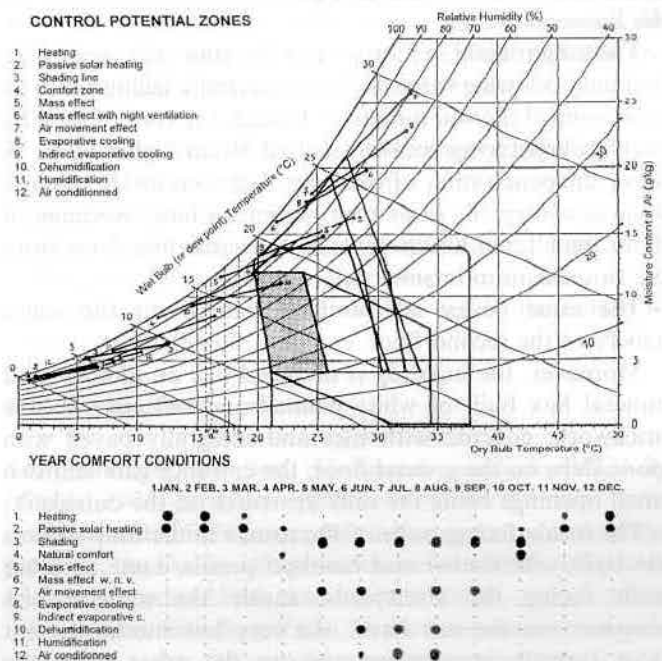


Fig. 6. Xiao Qi, Jiangxi: latitude 29°30'; alt., 600 m; sea, 320 km; temp. mean, 16.7 °C; rain, 1811 mm.

For these reasons, the bioclimatic requirements for housing are very much influenced by the rains and the humid conditions:

- shelter against the rain and the northwest winds, solar gains and heating in winter; and
- shelter against the rain, ventilation with southeast winds and shading in summer.

#### 4.4.2. Building responses

4.4.2.1. *Interpretation with respect to the Ming t'ang structure (Fig. 12).* The centre courtyard occupies the square (5) and it is extended on the four sides into squares (9, 7, 1, 3). Four closed rooms are built in each of the four corners (4, 2, 6, 8).

In this case, the position of the peripheral rooms at the corners has the advantage of enlarging the centre courtyard and creating a single and organic central space.

The plan is symmetrical except for the extra service rooms on two sides, with entrance gate, courtyard and main open courtyard on the same axis running northeast southwest.

4.4.2.2. *Interpretation with respect to the climate (Figs. 12, 18 and 24).* The house of Xiao Qi is very different from all the others in the sense that the courtyard is more an atrium in the Roman-Pompeian style than a courtyard in the Chinese style.

Indeed as Fig. 18 shows, the central space is almost entirely covered by the roof except a central rectangular *impluvium* opening just above the water basin to collect rainwater.

Moreover, this zenith aperture elongated north and south sides is the unique daylight source for both floors of the house.

The longitudinal section reveals the stair structure of the building following three floors theoretically facing south so as to control the sun radiation. Indeed, the roof of the first floor gallery facing south is shifted 80 cm higher so as to allow the penetration of the solar radiation inside the first floor in winter; the same roof presents a long overhang of more than 1.2 m which protects the same first floor from the sun radiation in summer.

The same device is also implemented for the south gallery of the second floor.

Moreover, the building is designed like an almost solid mineral box built of white painted and reflective hollow brickwork, covered with tiles and integrally paved with stone slabs on the ground floor; the entrance gate and two small openings being the only apertures on the outside.

The inside-facing walls of the rooms in the four corners are built with timber and bamboo panels, same as other walls facing the courtyards, inside the mineral box *claustras*; on the one hand, the very low inertia do not store warmth in summer and on the other hand the insulating qualities of the wood protect the rooms during the cold season.

In summer, the southeast wind can enter the house through the penthouses of the second and first floors which act like wind catchers and lead the air circulation through the upper house, using the opening of small south windows of the first floor and the staircase.

At night, the cool air can be stored on the ground floor and maintained thanks to the stone slabs until the day after, the entrance gate being closed as much as possible.

The combination of this ventilation effect, a minima penetration of the sun in a zenith position due to the low latitude and the storage of the cool air on the ground floor can limit the heavy and saturated atmosphere inside the house.

In winter, the high northern façade can protect the house against the cold northwest wind. During the day, the sun can enter the first and second floors which are the favourite living spaces during this season.

At night, the small wooden room boxes on every floor are the best-adapted spaces thanks to their limited volume, and their wooden insulating low inertia envelope.

The house is oriented diagonally, designed for a position inside the northeast/southwest//northwest/southeast sector; however, in the case of Xiao Qi the orientation northeast/southwest is not the most convenient considering the prevailing winds following the valley directions from northwest in winter and southeast in summer.

Still this orientation turning tail to the slopes of the mountains can provide the best protection from the cold air descending from the mountains during winter, if it is proved that these are more hard to endure than the winds following the valley.

Another reason could be the plots distribution dominated by the river and the topography of the valley.

### 4.5. San Yuan, Yunnan province

#### 4.5.1. Questions from the climate, bioclimatic analysis (Fig. 7) (Givoni, 1978; Szokolay, 1987)

The Yunnan province presents three remarkable features: low latitude (27°), high altitude (between 1000 and 5500 m) and long distance from the sea.

San Yuan, close to Lijiang city, is located on a plateau 2400 m above the sea near the Yulong snow-capped mountain.

If the influence of the Siberian anticyclone is not so hard in winter, the Pacific monsoon influence is important.

Even at so high altitude, the annual thermal range is much less important than in all the other villages of this study; the temperatures do not drop below zero with winds from northwest and north in winter and they vary up to 20–25° with winds from the south in summer.

The rains beginning to fall strongly in May, culminating in July and ending in November, totalling 1357 mm a year.

The climatic conditions maintain a medium cool situation without any high warmth during summer. The

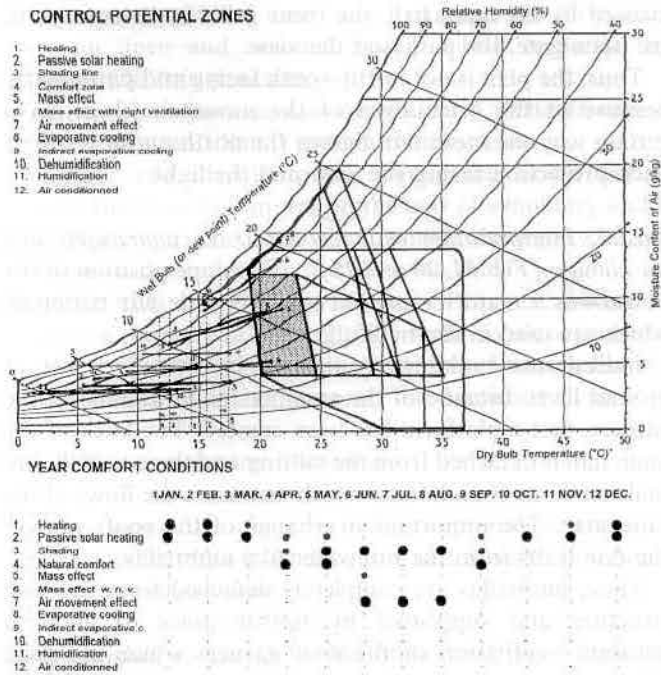


Fig. 7. San Yuan, Yunnan: latitude, 27°; alt., 2400 m; sea, 950 km; temp. mean, 13.6 °C; rain, 1357 mm.

bioclimatic conditions remain inside a modest range thanks to the altitude:

- shelter against north and northwest winds, solar gains and a little heating in winter; and
- shelter against the rain, ventilation with south winds and shading in summer.

#### 4.5.2. Building responses

4.5.2.1. Interpretation with respect of the Ming t'ang structure (Fig. 13). Three buildings are on the west, north and east sides on squares (3, 9, 7) with galleries surrounding the main square courtyard which occupies the centre (5).

The corner squares (2) and (4) are entrance courts on the side from the street, on the other side from the farmyard.

The building facing west between the street and the main courtyard (7) is the highest of the house, with a garner upstairs and the main rooms facing west downstairs.

The building facing south (9), usually the main one, only contains a secondary room and a service room on the ground floor.

The third building (3), facing east, houses the kitchen and store rooms.

There is a symmetry along a north/south axis on the ground-floor plan but not in the volumes of the buildings—the south-facing building (9) is not the main one and the west-facing one (7), which is the most important in dimensions and functions, creates a second east/west axis with the kitchen building (3) and the farming courtyard on

the west side of the house; this second axis which emphasises the link between the east mountain and the west plateau, is locally of major importance.

The housing grid used in this complex only includes six squares of the Ming t'ang structure, the three others being owned by the neighbouring house.

4.5.2.2. Interpretation with respect to the climate (Figs. 13, 19 and 25). The reason for the asymmetry of the volumes could be the climate; if the south-facing building were the tallest, it could well shelter the courtyard against the winter north and northwest winds but it would obstruct the south winds which are welcome in summer.

The share of the Ming t'ang structure could be a solution to limit the built mass and to help a better air circulation in summer.

The courtyard is surrounded by galleries on the three built sides, whose floor is 26 cm higher than the central space which is to collect rainwater, and it is planted with a deciduous tree on the south side. The large overhangs of the roofs above the clay brickwork walls on stone footings protect them from rain and provide shade during summertime.

In winter, the courtyard is protected from the cold winds, and the low sun can enter the galleries of the southern-facing building through the branches of the tree which still has its leaves in autumn.

In summer, the galleries provide shelter from rain and sun. The air movement from the south can be distributed everywhere through the courtyards and the galleries.

A comment can be formulated about the volumes of this house, which repeat the same principle in all the houses of the quarter:

- if the south-facing building was the main and the highest, the wind protection of the courtyard and the sun radiation of the main rooms would be better in winter;
- in this case, the shading of the main rooms would be easier and more efficient, but the wind from the south would not enter the courtyard so easily if the adjoining house repeats the same structure on the southern side of the courtyard, which is the present case. This is the disadvantage of this solution, and maybe the reason of the present choice.

#### 4.6. Du Jia, Yunnan province

4.6.1. Climatic question, bioclimatic analysis (Fig. 8) (Givoni, 1978; Szokolay, 1987)

Also situated in Yunnan, but in the southern area of the province, the Du Jia village is situated in a little valley with a lower altitude 1121 m, and latitude 23°55'.

Compared with San Yuan, if the temperature range is about the same, the annual average temperature is 4 °C higher at 17.9 °C; the rainfall is not as large with 912 mm and more concentrated in summer.

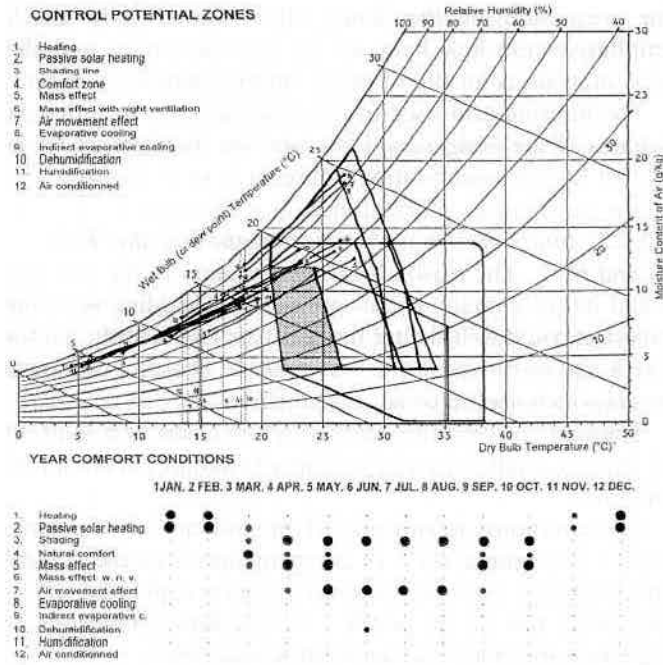


Fig. 8. Du Jia, Yunnan: latitude, 23°55'; alt., 1 121 m; sea, 540 km; temp. mean, 17.9°C; rain, 912 mm.

In winter, the dry wind blows from the north and the northeast and the temperature minima do not fall below 5°C.

In summer, the rainy winds blow from the south and the southwest and temperatures can reach 30°C.

The bioclimatic requirements approach the classical tropical ones with a shorter winter period:

- in winter, shelter from north and northeast winds, solar gains and very few heating and
- in summer, shelter from the rain, ventilation with south and southwest winds and shading.

#### 4.6.2. Building responses

**4.6.2.1. Interpretation with respect to the Ming t'ang structure (Fig. 14).** Like in San Yuan, the interpretation is partial and the orientation is dictated by the slope of the mountain.

The courtyard occupies the centre (5) square and it is open to the view and on the east/southeast; three buildings are built on the other sides.

The main building turns its back to the mountain and faces the east/southeast, and it is in dominant position. It is divided into three rooms with the main hall in the centre; it occupies squares (4, 9, 2).

The two other side wings close the courtyard and contain the kitchen and the farming functions.

The slope effect and the farming village structure prevents the use of the complete Kunming classical plan but this remains the basic model for the main hall, especially for the timberwork.

The whole plan is symmetric and composed of a main east–west axis which links the mountain to the valley,

crossed by the main hall, the front gallery, the courtyard, the open gate, the path and the view.

Thus, the plan is not north–south facing and particularly because of the orientation of the mountain slope; in a certain way the mountain figures the north and it is also a back protection facing the view and the light.

**4.6.2.2. Interpretation with respect to the topography and the climate (Fig. 14, 20 and 26).** The slope position of the house was a major constraint regarding the *pisé* materials which are used in the building.

Indeed, the buildings could not be buried or set at ground level, because of the summer rains running on the surface, first a platform has been created. The back of the main hall is detached from the cutting and the *pisé* walls are built on stone foundations which can resist the flows of the rainwater. The important overhangs of the roofs protect the *pisé* walls from the rainwater like umbrellas.

These umbrellas are completely detached from the wall structure and supported by timber poles to allow a constant ventilation of the roof garners which are used for the farming works.

The slope has another consequence on the house structure: it has a split-level arrangement the high level with the main hall and its front gallery, the clean, elegant and pleasant human habitation; and the 1.5m lower secondary and rustic level, the farming one with the kitchen, animals, stores, lofts and garners.

In winter, the courtyard is correctly sheltered from the north/northeast winds, the low sun warms the *pisé* walls, reach the lofts, the front gallery receiving sun only in the morning through the porch and the two side-awnings.

In summer, the wind from the south and southwest crosses the garners, the high sun casts the shadows of the roofs on the walls maintaining them at a medium temperature and the large overhangs protect the buildings from rains, waters from the low farming courtyard flowing down the slope to the path and the river outside.

If this house were built on a south-facing slope, the climatic operation would be better with respect to the sun and the winds, and the living conditions inside would be better.

## 5. Comments

It is truly remarkable that the climates of these six regions of China have the same basic structure, and that confirms China's identity, and probably with other factors, it is responsible and determining of the rich Chinese culture and knowledge.

### 5.1. About the interpretation of the Ming t'ang structure

If the *Ming t'ang* structure can be correctly identified in most of the cases studied in this paper, one can observe an increasing deviation from the north to the south:

- the closed courtyards observed in Bei Suzha, Chi Qiao and Xiao Qi, are the standard *Ming t'ang* structure; the

courtyards of Xia Futou, San Yuan and Du Jia change to an open and oriented system which is partial by respect to this structure;

- all the plans have an axis of symmetry with variants in Xia Futou and San Yuan: in the first case, the plan is organic and adapted to the sloping site, in the second one, the main hall is not on the axis of symmetry and it imposes a second axis which unifies the main components of the site which are east-west; and
- in the two last cases in Yunnan Province, and to a certain measure in Xiao Qi, the north–south orientation of the plan is forgotten, the mountain forming the site being considered as the north, the dominant element.

### 5.2. About the climatic integration

Considering the climatic integration and working of these six housing case studies, one can observe that some work better than others:

- the houses of Chi Qiao, Bei Suzha and Xia Futou are probably the best designed and operating of the six, the north–south orientation determining this success;
- the house of Xiao Qi is probably the best-designed and most interesting of all, but the orientation of the plan is not the best mainly with respect to the local winds;
- in Xia Futou, San Yuan and Du Jia houses where the plan is incomplete and incorrectly oriented, although the climatic effects of the building are not affected and the seasonal working remains correct, the south wind influence being maximised by the south opening;
- the houses of San Yuan and Du Jia would work better if the main hall of the first one was facing south and if the whole plan of the second one was facing the southern sector.

### 5.3. About the courtyard

This overview, let us observe the evolution of the courtyard(s) from the north to the south with respect to the different climates.

The distortion of the proportions from the north to the south is revealed in the plans (Figs. 9–14), isometric views (Figs. 15–20) and sections (Figs. 21–26):

- the elongated, narrow and low courtyards of Bei Suzha and Chi Qiao are suitable for the best protection against the winter cold winds, and the height dimension is as high as the climate is cold like in the second case (Fig. 22); the annexed side micro-courtyards (Figs. 9 and 10) are useful to daylight the main hall in winter and to help the best air circulation in summer;
- the square and south-facing open courtyard of Xia Futou (Figs. 11, 17 and 23) is well wind protected and sunlit during winter and takes the best winds influence during summer thanks to the tall south-facing main hall and the bank on the west hilly side;

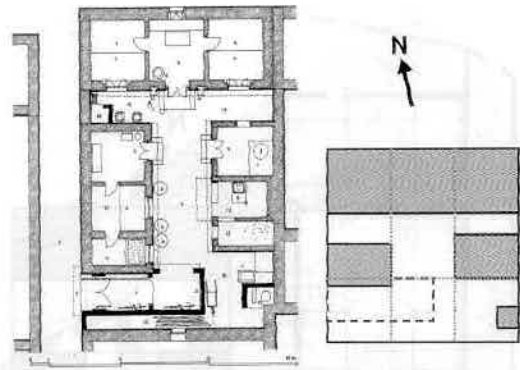


Fig. 9. Bei Suzha, Hebei.

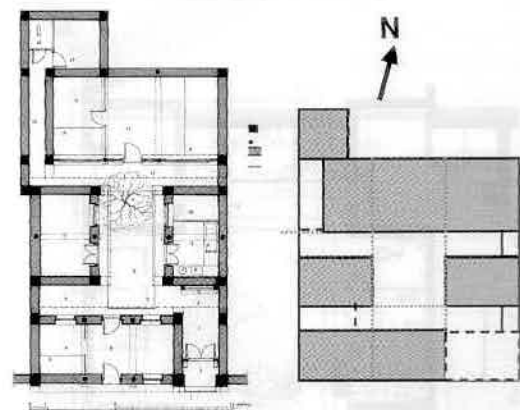


Fig. 10. Chi Qiao, Shanxi.

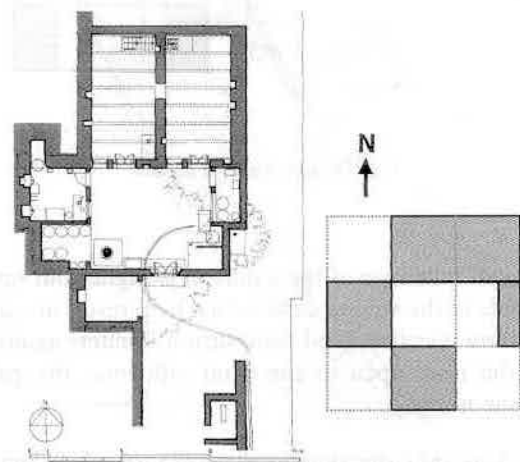


Fig. 11. Xia Futou, Henan.

- this square plan proportion is distinct in Xiao Qi (Figs. 12, 18 and 24). It becomes cubic and quasi-closed so as to master the influences of the sun, rains and air movements separately and together;
- the square proportion still exists in the south in San Yuan (Figs. 13, 19 and 25) and Du Jia (Figs. 14, 20 and 26) with variants: the height proportion is low and closed on the four sides in the first case, which promotes

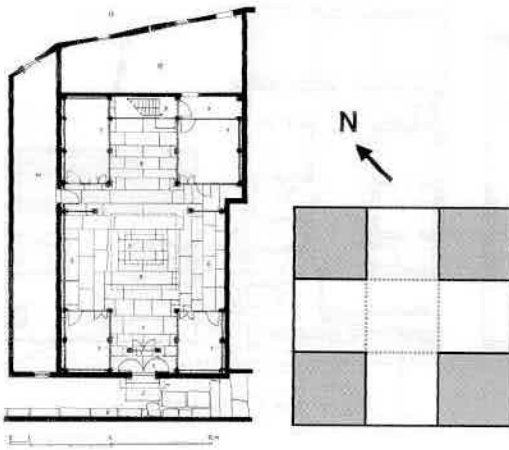


Fig. 12. Xiao Qi, Jiangxi.

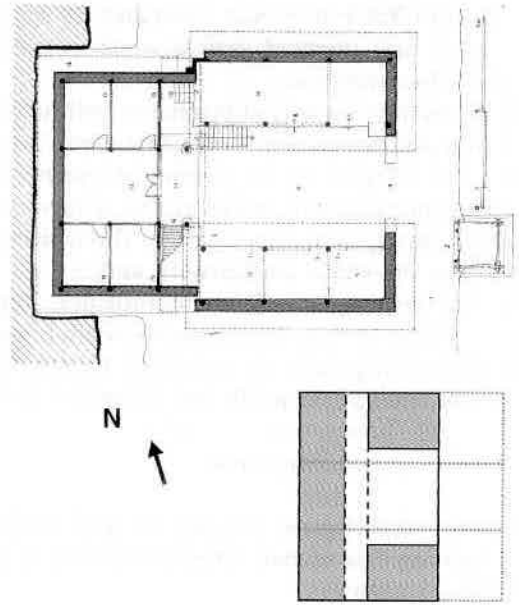


Fig. 14. Du Jia, Yunnan; isometric views.

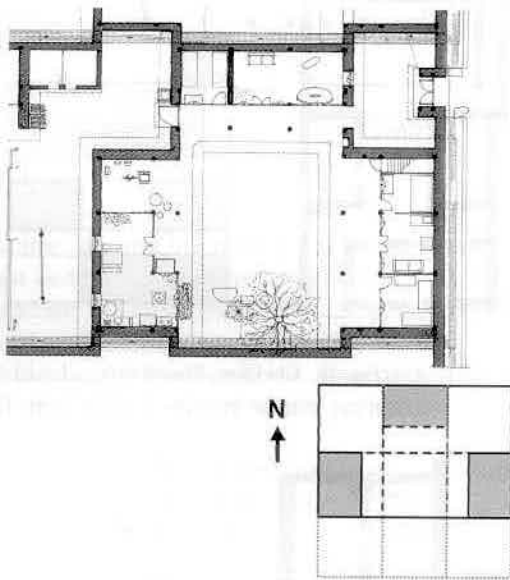


Fig. 13. San Yuan, Yunnan.

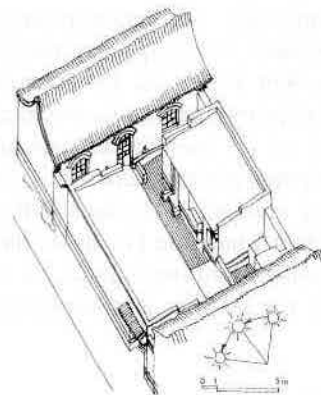


Fig. 15. Bei Suzha, Hebei.

a limited influence of the winds; it is higher but open on one side in the second case, which help result in a greater but more selective wind penetration; shelters against sun and the rain, open to the wind influence, the galleries become normal.

It is clear that the shelter against coldness is the main challenge in the north where the outdoor free space is limited, but among the potential solutions some can solve also the summer conditions.

In the south, the problem is more in summer with the sun in zenith. Even in high altitude like in San Yuan, the winter conditions are not so hard as in the north and the gallery system solves the orientation question in summer.

The case of Xiao Qi does not quite fit this pattern, the very much more elaborate design is the result of the strong constraint of the rains that which fall all year long with the

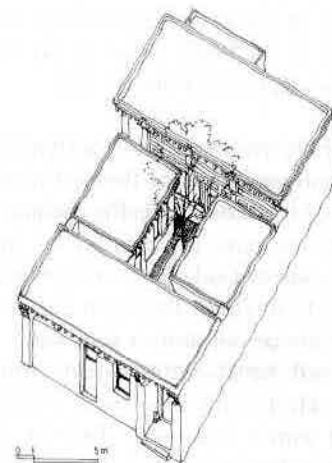


Fig. 16. Chi Qiao, Shanxi.

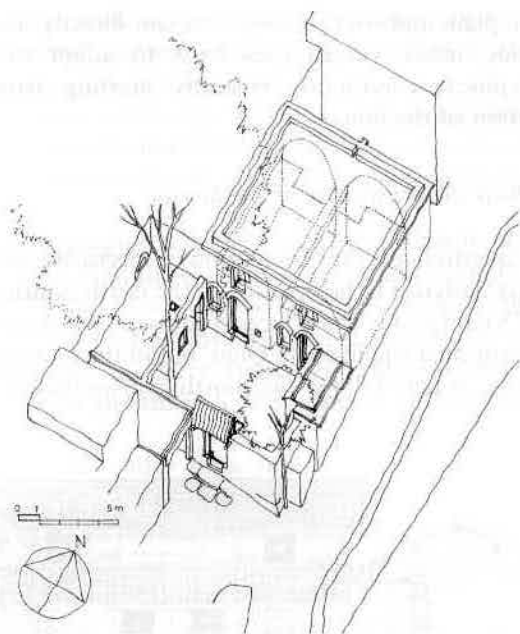


Fig. 17. Xia Futou, Henan.

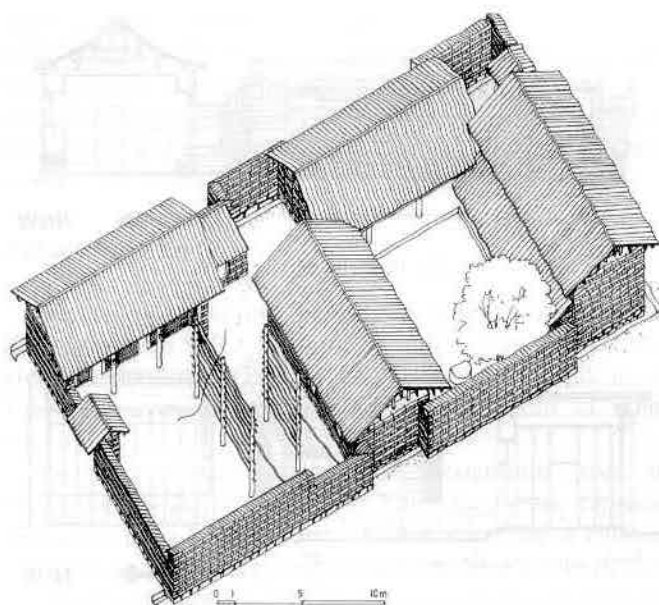


Fig. 19. San Yuan, Yunnan.

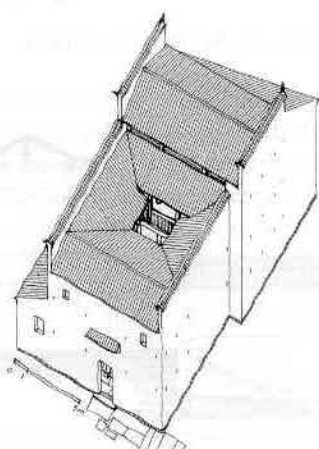


Fig. 18. Xiao Qi, Jiangxi.

consequent humidity; the concept is to re-create inside that which is lacking outside, using all the positive aspects from the sun (light, warmth, shade), the rain (water) and the wind (ventilation, shelter).

#### 5.4. About the topography influence

From these observations, it appears that the topographical considerations are stronger determinants than the climate and the strictly north–south orientation requirement, which is realistic so far as the microclimate is often determined by topography, especially concerning the winds.

However, it remains certain that the integral observance of the *Ming t'ang* structure and orientation, combined with an adequate choice of the site is a guarantee of positive

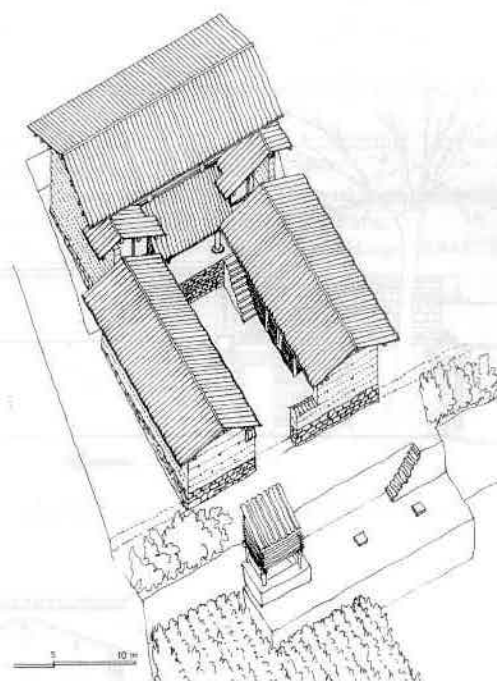


Fig. 20. Du Jia, Yunnan; house longitudinal Sections I.

results concerning the bioclimatic behaviour of the house, because one of the main roots of the *Ming t'ang* theory is the climate and especially the Chinese one, so it is not just a theory in the superstitious meaning.

The highly sophisticated Fengshui practices have integrated the topographic values for time immemorial so as to design and produce human living spaces starting from a cosmic structure of the world.

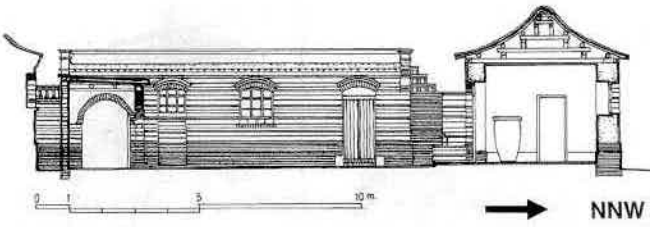


Fig. 21. Beisuzha, Hebei; NNW.

If the plain and south-facing sites can directly use these principles, many village sites have to adapt to other topographical conditions, basically starting from the orientation of the house.

5.5. About the orientation of the houses

The question of the orientation is decisive—all these plans are designed to be oriented to the north–south; in the case of Xiao Qi, the house faces southwest, which could be convenient on a site like Chi Qiao; but in the first case, the prevailing winds follow the northwest/southeast valley

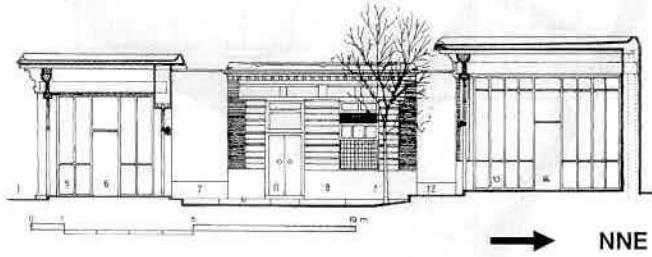


Fig. 22. Chi Qiao, Shanxi; NNE.

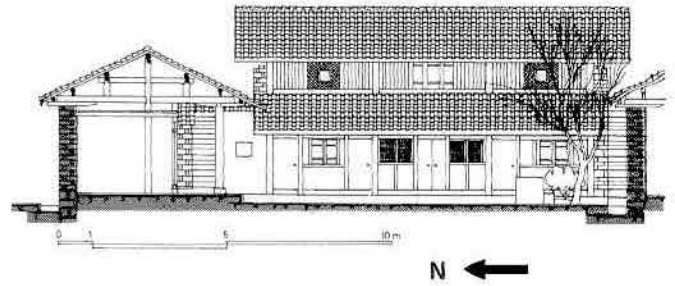


Fig. 25. San Juan, Yunnan; N.

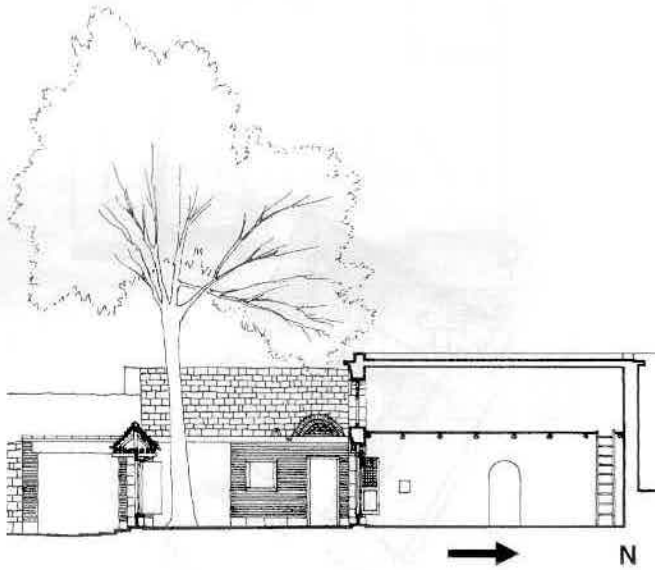


Fig. 23. Xia Futou, Henan; N house longitudinal Sections I.

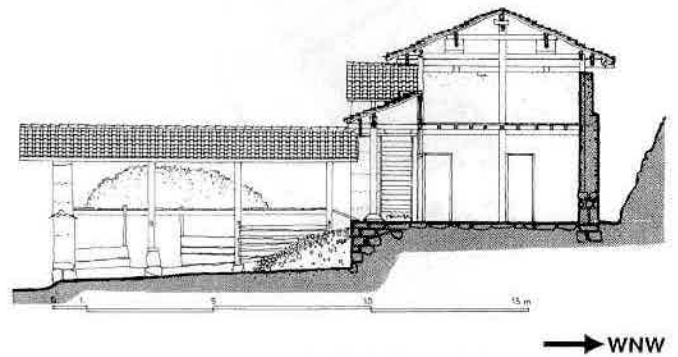


Fig. 26. Du Jia, Yunnan; WNW Surveys.

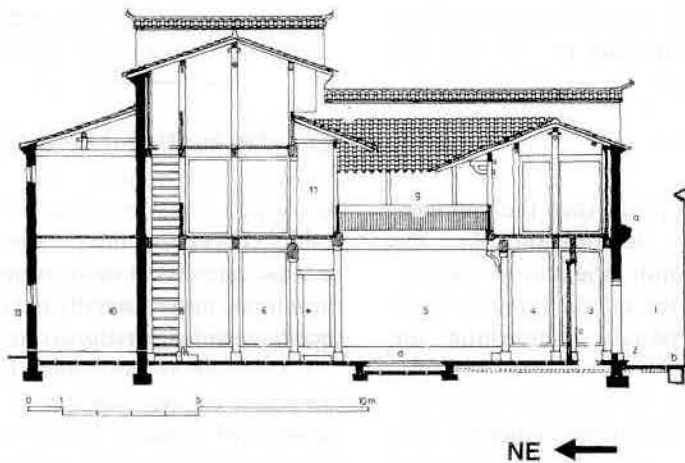


Fig. 24. Xiao Qi, Jiangxi; NE.

orientations and as well the winter protections as the summer wind catchers do not work as well as if the house was facing south or even southeast.

In the cases of Xiao Qi, San Yuan and Du Jia, situated in mild climates, the main halls of the houses face southwest, west and east southeast, all of them turning back to the mountain.

The topography and consequent local winds' influence are stronger than the classical north–south option.

Indeed, the turn back to the mountain is the best position to shelter against the cool air breeze falling from the mountain in the evening, and to take the breeze blowing from the valley to the summits in the morning.

#### 5.6. About the choice of the site

The choice of the site is not so restrictive as illustrated by the case of the Xia Futou house which faces south though it is built on an west–east slope.

The site of Du Jia shows that it is possible to find suitable plots with respect to the local winds and that the orientation of the slope is still a dominant element for the choice of the site.

## 6. Conclusion

The main result of this study is the realization that Chinese vernacular housing has integrated on a grand scale the cultural link between the people and climatic demands with the help of local building materials, so as to produce “classical-vernacular” buildings.

The challenge of designing new buildings taking great care of environment protection, energy savings, economic

considerations, care for the health of people and comfortable living conditions, persuades us to build with respect for natural conditions where the climate takes an important place, especially in China, where past builders have found the key of the local problematic, which can be a key for the future.

## Acknowledgements

This study could not have been possible without the Sino-European SUCCESS project initiated and led by Mrs Heidi Dumreicher, Director of Oikodrom Stadtplane in Vienna, Austria, who opened to me the door of inner China.

My sincere and posthumous recognition goes to Professor Marcel Granet whose book *La Pensée Chinoise* opened to me a large window towards the Chinese culture.

The inter-disciplinary approach in the SUCCESS project has been a chance to develop cross-questions, discussions and results between the participants, particularly with Nigel Mortimer about energy and climatic design, Lutz Katschner about climate interpretation and Lu Hongyi about Fengshui and housing.

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# Xia Futou's public bathhouse—A sustainable urbanization experiment in a Chinese village<sup>☆</sup>

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## Abstract

Xia Futou, a small Chinese village with a unique cultural landscape, consists of two unbalanced parts, an old village up the hill and a new one down the hill. In order to upgrade and preserve the unique cultural landscape of the older village and rebalance the dislocation of the two parts, a small public bathhouse project has been carried out according to sustainable architecture principles. Based on the current cultural landscape of the bathhouse and its surroundings, this approach is attempting to localize an informed, balance-seeking, design process in the village and in so doing develop a series of diverse possibilities and beneficial paths.

The experiment of the public bathhouse's design and construction led to two key conceptual questions that need to be examined, the one is to research a village with a dynamic system conception instead of a static one; the other is to research a village with a self-organizing system conception<sup>1</sup> instead of an organized one. Furthermore, we can give the sustainable path for the future that such naturally evolved Chinese villages evolve into sustainable towns and cities.

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**Keywords:** Sustainable village-urbanization; Public bathhouse; Dynamic/static system; Self-organized/organized system

## 1. Introduction

The village pattern of Xia Futou, a small village located in the Tai Hang Mountains in central China, is typical of traditional villages based on Feng Shui principles. Surrounded by nearby mountains, with a river passing through the village to its east, the position of the village is

auspicious according to Feng Shui. Xia Futou, through a long and natural evolution, developed its own cultural landscape and vernacular architecture of stone houses based on the local carrying capacity of the environment.

Today, the village consists of two parts: an old village up the hill and a new one down the hill. The old village has retained its vernacular architectural pattern of diverse public and semi-public spaces and has maintained a balance of socio-cultural, ecological, and economic concerns. The pattern of the new village, which attempts to emulate modern towns patterns of the West, is based on function and uniformity. Villagers, as a result of poor and outdated infrastructure in the older part of the village, increasingly abandon their old homes to migrate down the hill to the new settlement. Thus, Xia Futou is in danger of losing its unique cultural landscape as the old village up the hill increasingly falls into decline.

In order to revitalize the settlement up the hill and rebalance the two parts of Xia Futou, the SUCCESS research team tried to upgrade the vernacular houses in the

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<sup>1</sup>The essence of self-organization or self-organizing system is that system structure often appears without explicit pressure or involvement from outside the system. In other words, the constraints on form (i.e. organization) of interest to us are internal to the system, resulting from the interactions among the components and usually independent of the physical nature of those components. The organization can evolve in either time or space, maintain a stable form or show transient phenomena. General resource flows within self-organized systems are expected (dissipation), although not critical to the concept itself (Wu, 2001).

old village and the nearby environment through a comprehensive consideration of the balance of socio-culture, ecology and economy that engaged the participation of the local farmers. Building a public bathhouse in an abandoned house up the hill was one of the small projects that the SUCCESS team considered an “Acupuncture Point”—an important point of change that would have the potential to catalyze and rebalance the distribution of power in the village as a whole.

## 2. Experimental methods

### 2.1. Finding “Acupuncture Points” in the village

First, we tried to identify the “Acupuncture Points” in the village and analyze their relationship and their influence on the village as a whole. Acupuncture Points represent key points in the village that have embedded in them a connects of information about ecology, economy, social-culture and reflect the built environment. These points are the most lively parts of an organic village pattern. At the same time, these points have the potential to influence the redistribution of energy and information in the village as a whole if their vitality and relationships are regulated properly.

From our analysis, the poorest relationship of “Acupuncture Points” in Xia Futou was between the river and the old village up the hill. This relationship was the most important nexus in the local landscape and potentially a site for future sustainable development of the village. Therefore, reconnecting the river and the old village up the hill was a key to re-establishing the dynamic village system in Xia Futou as a whole.

A potential connection between the river and the old village up the hill is the establishment of water flow between the sites and along with it the feedback of information and energy (ecology, economy and social-culture, etc.). In this scenario water would flow down the hill into the ground and river, while other information and energy (such as economy and socio-cultural interests) would flow back. This proposal was the impetus and inspiration for building a public bathhouse up the hill.

### 2.2. Sustainable approach to public bathhouse up the hill

The methodologies applied in the SUCCESS project in designing and constructing the public bathhouse shared a common understanding of the definition of sustainability as follows: “Sustainability is a local, informed, participatory, balance-seeking process that operates within its sustainable area budget and in so doing exports no negative imbalances beyond its territory or into the future, thus opening spaces of opportunity and possibility” (Dumericher and Levine, 2002).

#### 2.2.1. Local

Localizing the process, from a sustainability point of view, was an important step in upgrading the current cultural landscape up the hill as it related to water—a regional resource and economic means for the village. Therefore, localization of the process aimed at extending the village’s natural evolution of decision-making within ecological and cultural means.

First, working with the local farmers, we surveyed the old village up the hill and chose an ideal old house for the new bathhouse, where the oldest family in the village, the Dong family, lived for many years. The building has an outstanding entrance with fine stonework and is located on a small street that could be used as public space in the future.

Second, the SUCCESS team emphasized using local materials and local building techniques. Using participatory methods, we found that the local materials used in Xia Futou include stone, bamboo, and cobblestone among others. Also, the design of the public bathhouse used materials that required little transportation from the town which resulted in less pollution and less embodied energy in the materials.

Third, the research team emphasized having local craftsmen upgrade the old house. Compared to a typical worker in the town, the local craftsmen are much more familiar with the vernacular of the old houses in the village. Utilizing their knowledge helps to keep the local building techniques flowing from one generation to another generation.

#### 2.2.2. Informed

In general, there are two levels where the “informed” element of the definition of sustainability is a significant part of the process in the Chinese village. The first is a well-informed cycle inside the village in which it is easy to recognize the effects of anything that happens within the village. While the second is an overarching or encompassing information cycle that recognizes how village decisions affect national and global cycles. The first cycle is a bottom-up cycle, while the second one is a top-down cycle with few overlaps.

Rather than choosing one of these cycles, the public bathhouse project instead aimed to build a reciprocal bridge not only between the bottom-up and top-down decision-making cycles but also between the upper and lower parts of the village in Xia Futou.

In order to do so the research team first needed to set up a feedback loop between the top-down cycle (the knowledge and information from the “experts pool”) and the bottom-up cycle (the local knowledge from the farmers and critical reference group in the village). For example, there were four alternative scenarios for how to heat the water for bathing: with coal, with wood, with solar energy or with biogas. Working with the participation of the farmers, several scenarios were made, shown to the villagers and discussed with them. Before taking any actual step, each

scenario was evaluated as to how it would affect a variety of different aspects (i.e. ecology, economy, socio-culture, local architectural patterns, etc.) of the village system under the criterion of sustainability. After several discussions it was decided to utilize solar energy in order to heat the water in the bathhouse. Thus, a “decision-making” process became a scenario building process in the bathhouse project, in which the best characteristics of a top-down technocratic approach were combined with those of a bottom-up participatory approach.

Second, the SUCCESS researchers set up a lively communication loop shared by the two parts of the village. Usually, in a small and “familiar” community like a Chinese village, everyone knows one another and it is very easy to build up a lively socio-cultural system in the village as a whole. But because of the large dislocation and unbalanced settlement situation in the village (not only in geography but in socio-cultural and economic status), people in the two different parts were unwilling at first to communicate with each other. Moreover, many villagers who live up the hill even felt inferior to the villagers down the hill. The new changes and new image of the village up the hill not only brought new information and energy into the village, but it physically brought people up the hill out of curiosity and social and economic interests. This in turn created more conversation and space for a lively communicative atmosphere between the people up the hill and people down the hill.

### 2.2.3. Participatory

In the natural evolutionary process of a traditional Chinese village, participation can be regarded as inherent because the farmers are involved in its building process step-by-step, generation-by-generation, in a process that creates its specific cultural character. Therefore, the success of the public bathhouse project depended on whether the villagers treated it as “their bathhouse”. So, we regarded the public bathhouse project as an ongoing process with the involvement of the farmers in every step. In other words, participatory here is not only a method and approach to achieving sustainability-oriented development, but an aim and natural characteristic of a sustainable civil society.

First, meetings were held with the farmers up the hill and down the hill to talk about the future scenarios of the bathhouse and its surroundings. Posters were placed outside the village community and a small exhibition was held in the upper village to show the design of the bathhouse and to discuss it with all of the villagers.

Second, the farmers installed solar-powered lights along the street to the bathhouse, which we called the “Hope Light” project. It was meant to be a demonstration of both solar energy and of community participation.

Third, the researchers called for volunteers to help build the bathhouse. Many farmers cleared the street to the bathhouse for free and many children helped to collect the

cobblestones from the river for the future construction of the bathhouse. The volunteer effort was helpful in building a common identity among the villagers and generating, as Dr. Heidi Dumreicher calls it “emotional co-ownership” (Dumericher and Kolb, 1999) of the bathhouse.

Finally, the experts and design team worked closely with local craftsmen to renovate the old house into a modern bathhouse. In this way, high technology and local techniques were able to find a way to synergistically combine and enrich one another.

### 2.2.4. Balance-seeking within the sustainable area budget

Balance-seeking here means to model alternative future scenarios by taking into account the classical triad of sustainability: economy, ecology, socio-culture, and acting within the context of the built environment (Levine, 2004).

Therefore, a participatory balance-seeking process, is a comprehensive negotiation method within the limits of the local sustainable area budget of the village. “Sustainable area budget” means the whole regional sustainable carrying capacity in the area, including its natural resources and human cultural resources that are shared in a fair and reasonable way, continuously through all generations.

Based on this understanding, the public bathhouse project in Xia Futou, as stated previously, started to rebalance the dislocation of the two parts of the village and import new energy and information to the old village up the hill. However, as soon as the new project started, more unbalancing factors arose from it. The new function introduced to the current settlement up the hill resulted in a great amount of energy consumption, water consumption and a need for grey-water management. It was very possible that the new function and economic interests could have replaced the currently well-balanced ecological and socio-cultural aspects of the old village up the hill. So, a new round of the balance-seeking process started on the basis of the imbalances introduced in the former step. The rebalancing process continued in a sort of spiral cycle toward equilibrium. Closely working with the informed participatory process described above, the research team along with the villagers developed the future scenario of a new “village center” up the hill, which included a small village park, an open theater, a village square, and a tea house all around the public bathhouse. In this way, a series of diverse possibilities and beneficial paths within the current cultural landscape were developed up the hill, each of which allowed for negotiation space for the farmers to develop their ideal village in a sustainable way in the future.

## 3. Results and discussion

As the bathhouse project progressed, more and more farmers began to show interest and joined in the building process. At first, only a few villagers up the hill were interested in talking about the location of the solar-

powered lights on the street to the bathhouse but the interest grew with time. Gradually, more villagers began to ask about the time schedule of the bathhouse and gave more suggestions about the design. Now many villagers down the hill have begun to go up to see what is going on with the bathhouse. One woman even told the researchers that her recent trip up the hill was the first time she had gone up since she was married there 20 years ago. Though the villagers in Xia Futou have many doubts, concerns and much curiosity about the bathhouse and its future scenarios, they have begun to regard it as their own bathhouse, something that belongs to all the villagers in Xia Futou. Thus, a cycle of energy and information is starting to flow again between the two dislocated parts of Xia Futou and the previously stagnant state of the old village pattern (with its good cultural landscape) has been revitalized and re-energized by the acupuncture-like impact of the bathhouse.

The experiment of designing and constructing the public bathhouse in Xia Futou led to two key questions that need to be examined before such naturally evolved proto-sustainable Chinese villages can be further evolved into sustainable towns and cities.

### 3.1. Should a village be regarded as a dynamic system or a static, mechanistic one?

The first question is how is one to judge the current village pattern? Should it be regarded as a dynamic system or a static, mechanistic one? A function-oriented approach tends to regard the current village as a static, mechanistic pattern, where elements are added or erased without concern for their influence on the other parts of the village, much less the carrying capacity of the village. The damage brought by function-oriented urbanization is devastating to the fragile cultural landscape at the scale of a rural village, which leads to the quick disappearance of the diverse vernacular architectural pattern and village pattern in China.

A sustainability-oriented approach, on the contrary, always regards a village as a continuous and dynamic system and respects the cultural landscape that has developed naturally and spontaneously, and takes into account local carrying capacity in planning for the future. It takes the village as it is and tries to understand the current pattern that is full of information about the ecology, economy, socio-culture and local architectural language. And it tries to very carefully import new functions and urbanistic qualities into the current cultural landscape to create more potential for future development. Using an informed, participatory approach operating within a sustainable area budget a sustainability-oriented approach tries to localize a balance-seeking process in a village and explores alternative sustainable scenarios for the village system as a whole.

### 3.2. Should a naturally evolving village be regarded as a self-organizing village or an organized one?

The second question is more concerned with the relationship of bottom-up and top-down methodologies applied to village planning. If a village is regarded as an organized entity in which all problems can be solved with good planning and management from top-down channels, then the role of the users is neglected. This conception disregards the role of the local farmers in the evolution of their own village. The new village down the hill in Xia Futou is an example of great concern for infrastructure and other functional aspects but little care or consideration for the original settlement pattern, a self-organized pattern, which slowly and naturally developed and evolved. The only place the villagers down the hill love and use frequently is a square with a large tree in it. This preference relates back to the village's naturally evolved traditional settlement pattern.

A sustainability process instead, tends to regard a naturally evolving village as a self-organized system that has developed from bottom-up channels with the richly integrated thoughts of ecology, economy and socio-culture. This approach, therefore, tries to clear and unblock the "Acupuncture Points" that influence the self-organization and self-evolution process of a village. It sets up a proper integration channel between the top-down cycle and bottom-up cycle, making possible a sustainable civil society process in these villages.

## 4. Conclusion

In summary, the sustainable urbanization experiment in Xia Futou village offers a new view to "development" and "urbanization" in the village and in general, at the same time, it creates possible and potential spaces in the current culture landscape in a village and provides diverse possibilities and various choices for the future to the local stakeholders and with them as well. In the long term, it has the potential of evolving into a full sustainability process and developing in as a self-organizing system. Personally, I think that what we have done in the Chinese villages like Xia Futou can be a good vehicle for pursuing and exploring sustainability-oriented urbanization not only at the village scale, but in any larger coherent urban scale as well.

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## Generating sustainable towns from Chinese villages: A system modeling approach

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### Abstract

The great majority of China's developing towns will be extensions of already existing villages. With the prospect of hundreds of millions of Chinese farmers projected to leave their villages to become industrial workers in new and expanded towns within the next few years, new challenges will be faced. As expansion and modernization progress, this development moves from the traditional village model that operates not far from resource sustainability to increasingly unsustainable patterns of commerce, urban development, and modern life. With such an unprecedented mass migration and transformation, how can Chinese culture survive? What is to become of the existing million plus agricultural villages? How can these massively unsustainable new industrial towns survive? In the European Commission sponsored research program SUCCESS, researchers worked from the scale of the Chinese village to find viable answers to these questions.

To address these issues, the Center for Sustainable Cities, one of the SUCCESS teams, studied the metabolism of several small villages. In these studies, system dynamics models of a village's metabolism were created and then modified so that inherently unsustainable means were eliminated from the model (fossil fuels, harmful agricultural chemicals, etc.) and replaced by sustainability-oriented means. Small Chinese farming villages are unlikely to survive in anything like their present form or scale, not least because they are too small to provide the range of life opportunities to which the young generation of educated Chinese aspires. As a response to this realization as well as to the many other threats to the Chinese village and its rural way of life, it was proposed that one viable path into the future would be to enlarge the villages to become full service towns with sufficient diversity of opportunity to be able to attract and keep many of the best and brightest young people who are now migrating to the larger cities. Starting with the village in its sustainability-oriented model form, the village model would be enlarged both quantitatively and qualitatively through many trial iterations. A research program is described whereby an operational definition of the sustainable city is developed as a means of creating these enlarged models through citizen participation assisted by outside experts using software under development called the Sustainability Engine™ to guide the process and provide feedback as to the consequences of various proposals that are brought to the table. As this process is continued, the village would be incrementally enlarged and made more diverse and more complex through a variety of scenarios until it would emerge as a modern, sustainable town or city. In this way, through a participatory, balance-seeking civil society process involving villagers and scientists in what the Center for Sustainable Cities calls the Sustainable City Game, the villages can become the DNA for generating future sustainable Chinese towns and cities. As an extension of this discussion, a new urban model, the Sustainable City-as-a-Hill, is presented that responds to both the qualities of the traditional Chinese village as well as to the modern demands of industrial and post-industrial economies and, in particular, to the need for sustainable urban patterns. In addition a new concept, the Sustainable Area Budget (SAB) is introduced which definitively creates the boundary condition for both modeling the sustainable city and presenting the quest for the sustainable city-region as a coherent, scientific design process.

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## 1. Introduction

### 1.1. The traditional Chinese village and new industrial cities

The traditional Chinese village, having slowly evolved over thousands of years, has had a long history of maintaining a balanced relationship with its landscape and its resources. In recent years, some of the unsustainable trappings of modern life and economics have begun to enter the realm of the traditional villages, but the overall rhythms of life in the villages, along with their architecture and urban forms, still essentially read as a continuation of patterns from generations past. Modern forces and policies of education, industrialization, mechanization, electrification and urbanization have conspired to draw people away from these villages. In particular, the youth are attracted to the life in the newly emerging industrial towns and cities. The new type of industrial city that is appearing all over China has a massively unsustainable character and so threatens not only the continued existence of the Chinese village, but also China's culture and environment.

Structural conditions in China are leading toward the depopulation of its villages as younger villagers are leaving their homes in search of a salary and a chance at the consumerist lifestyle that is incessantly touted on their television screens. In the towns and cities, this middle generation lives packed in small apartments or dormitories, for the first time in their lives earning a small wage, but without any of the social or cultural supports that were taken for granted in the villages. They leave their children back in the villages in the care of grandparents who still pursue the farming life. After elementary school, the children too leave the villages to live in dormitories in the towns, where they attend middle school and high school. Having obtained a level of education that their parents and grandparents lack, the children will not be returning to the villages as farmers, but will be seeking the sort of work in the towns and cities for which their education has prepared them. For 5 days during the annual Spring Festival, the city-dwelling parents return to the villages bringing clothes for the children and TVs and DVD players for their farmer parents thus supporting the attraction to the consumerist lifestyle of the cities.

Because the multi-tiered structure of the Chinese government does not currently include these small farming villages within its scope of recognition and legislation, former villagers lack the documents that would permit them to legally live in the cities and therefore have no rights to social services, medical care, or—should their children be living with them—the right to schooling. Increasing education, TV programming promoting modern consumerist lifestyles, negative depictions of the old fashioned village way of life, and the lack of opportunity and long and tiring regimen of manual labor in the villages, all conspire to remove the best and the brightest and everyone else able to escape. And yet there is much that the SUCCESS research team has learned from the villagers

that demonstrate their abiding love for many of the customs, traditions and ways of life into which they have been born and which constitute a good part of Chinese culture. In spite of all of the seemingly beneficial opportunities in the towns, a move from the village to the town is invariably accompanied by much regret and the new town-dwellers often look for excuses and opportunities to return to their villages. Increasingly, there are those who seek to return with new economic endeavors that can be practiced in the villages.

### 1.2. What to maintain and what to change?

One of the central research questions of the SUCCESS project posed to the villagers in different ways and through different techniques was, "what to maintain and what to change?" What sorts of structures are central to their identity and valued in their way of life, and what aspects of their villages and culture are merely encumbrances that they could well do without? These are not easy questions to answer as even harmful conditions may well be essential links within overall favorable patterns and their removal can precipitate the movement down a slippery slope that threatens the favorable patterns. For example, there is a strong temptation among modern experts to seek improvement of some of the ancient farming techniques—the stoop labor and use of slow draft animals—with modern techniques in the name of health, time and efficiency. But the free time that is earned by modern means is not a part of their culture and if it is spent sitting in front of the TV, then arguably, a new and potentially damaging alien cultural pattern will have been established.

As it has become clear that the villages are not to continue in anything like their current or historical patterns the question becomes, "What sorts of changes could be made that would make the villages worth coming back to for the children and worth staying in for the middle generation?" "What sort of diversity of opportunity would be sufficient to make the villages attractive to farmers who are now attracted to the towns and cities?" "How large would the villages have to grow in order to support the diversity of services and opportunities that would make life there a viable alternative to urban life?" And finally, "Is it worth it to try to save the villages, or to work from the villages as the beginning point? Would it be better to put the available resources into new and enlarged industrial cities and just let the villages wither away?" Through the SUCCESS project, the Center for Sustainable Cities has come to believe that the villages are a good place to start—at least if the question is to be, "How can the quality of life improve for the Chinese people while living within the limits of nature?"

Because the villages are much smaller in scale than existing towns or cities, they are much easier to model and understand as a whole. The villages are also the repository of generations of collective wisdom that reflect a culture and a design that has never been far from balance

with local resources and still today is very close to this balanced way of life. It is for these reasons that the “SUCCESS” project has identified the traditional Chinese village as an appropriate place to begin the implementation of sustainability processes to generate future sustainable towns and cities.

### 1.3. The sustainability process

The Center for Sustainable Cities together with Oikodrom has contributed an operational definition to the sustainability discourse:

Sustainability is a local, informed, participatory balance-seeking process, operating within a Sustainable Area Budget, exporting no harmful imbalances beyond its territory or into the future, thus opening the spaces of opportunity and possibility.<sup>1</sup>

Much of this definition has been adopted for inclusion in the European Charter of Cities and Towns Towards Sustainability—the so-called Aalborg Charter<sup>2</sup> (1994), which has become a major vehicle for the implementation of sustainability programs in Europe, and as such it represents a degree of consensus about the character of the sustainability process. Elsewhere, the Center has presented an extensive explication of the definition (Dumreicher et al., 2000) so that here we will rather focus more on the functional aspects of the process. The Center’s work has described the local nature of sustainability (i.e. the city-region) and the necessity for a participatory sustainable civil society process. The Center has also formulated the Sustainable Area Budget (SAB) as the aggregated “fair earth share” of the city-region interpreted as land area (Levine et al., 2000). In this formulation, the citizens of a city-region are each entitled to the use or stewardship of one six-billionth of the earth’s bounty taken as land area on a regenerative basis. In principle, citizens are free to negotiate amongst themselves how they will afford to live within their SAB as long as they do not export any harmful imbalances outside their aggregated land budget or into the future.

As the overarching concept for the SUCCESS project, the operational definition of sustainability was seen as a multiple scenario-building negotiation process where parallel competing models of the structure and metabolism of the future of the villages could be assembled that represent diverse interests and ideas brought to the table<sup>3</sup> by the villagers as well as by scientific experts. Through such a process, researchers were able to construct models repre-

senting the metabolism of the village-system and ask “what if” questions about the future of the village. These models were constructed using system dynamics modeling techniques and software. SUCCESS researchers adjusted the existing village-system models so as to eliminate all unsustainable materials and processes and to replace them with sustainability-oriented methods, so that at an energy and material flow level, the village model operated on a sustainable basis. With this normalized model, the SUCCESS researchers were poised to be able to work with the villagers to determine “what to maintain and what to change” and to improve and enlarge the village model, all the while using sustainability-oriented means in order to stay within the village’s Sustainable Area Budget. By working through an iterative, multiple scenario-building process, it is projected that the process would evolve a robust sustainable town, with a sufficiently diverse economy to be more than competitive with the grossly unsustainable towns being developed all over China.

## 2. System dynamics modeling of a Chinese village

System dynamics modeling is one component of a feedback software under development by the Center for Sustainable Cities called the Sustainability Engine<sup>TM</sup> that will provide the alternative scenario-building design process of negotiating a sustainable city with systemic feedback in reference to the limits of a town’s Sustainable Area Budget (SAB). The negotiation process in combination with the feedback of the Engine provides the operational framework to evolve future Chinese sustainable towns and cities from proto-sustainable traditional villages.

In creating a design model for the transformation of an existing village into a new sustainable town, the current material, economic and energetic metabolism was researched and embedded within a working systems model. Modeling was focused on a small village named Dujia, in South-Western Yunnan province. Dujia is made up of 38 households with a total of 165 people. Each household is centered around a courtyard where most family activities occur and where livestock is billeted.<sup>4</sup> Each of Dujia’s households represents, in microcosm, the metabolism of the entire village. While each household could be modeled as a largely closed system, a series of relationships that related each household to the village was built into the systems model to acknowledge connections at the next larger scale.

The system models were constructed using software that employs four basic types of “intelligent” icons to typify the relationships among the different parts of the village system: stocks, flows (in-flows and out-flows), converters, and connectors (Fig. 1). Stocks are accumulations. They

<sup>1</sup>Definition: Dumreicher, Heidi, Richard S. Levine, and Ernest J. Yanarella. (©Oikodrom The Institute for Urban Sustainability, Vienna, Austria and Center for Sustainable Cities, Lexington, KY). 1998–2001.

<sup>2</sup>The Charter of European Cities and Towns Towards Sustainability (Aalborg Charter) can be accessed online at: <[http://ec.europa.eu/environment/urban/pdf/aalborg\\_charter.pdf](http://ec.europa.eu/environment/urban/pdf/aalborg_charter.pdf)> 10/19/2006.

<sup>3</sup>SUCCESS researchers used the traditional Chinese metaphor “under the tree” instead of “to the table.”

<sup>4</sup>For modeling purposes, the household farmland allotment was also considered contiguous with the courtyard although in the actual village the courtyard and the allotment were not adjacent to one another.

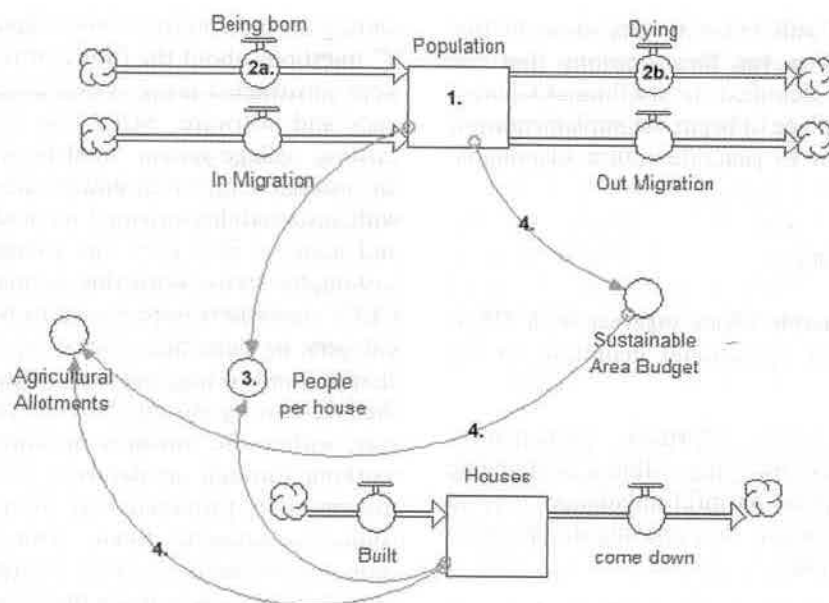


Fig. 1. From the *Population* section of our Dujia model you can see the basic “intelligent” icons used for systems dynamics modeling in STELLA<sup>®</sup>: (1) stock, (2a) inflow, (2b) outflow, (3) converter, (4) connectors.

represent the net of what flows into them and out of them—they are symbolized by squares. Flows fill and drain stocks—they are represented by circles with valves. Converters serve a utilitarian role in the software, providing numerical values for constants, defining external inputs to the model, and calculating algebraic relationships. In this way, the converters translate inputs into outputs through the functions they contain—they are represented by circles. Connectors create the mathematical relationships and interconnections among stocks, flows and converters—they are represented by curved lines with arrows.

The modeling process began with an extensive data set describing the structure and the metabolism of Dujia assembled by Huang Jian Sheng—one of the Chinese SUCCESS partners who had both lived in and studied many aspects of day to day life in the village. These data were organized into 10 categories: income and expenditures, population, village calculations, land allotments, crops, labor, animals, energy, water, and agricultural waste. At first, each of these categories was modeled separately to begin the construction of the village system and later more data and complexity of relationships were added as the village model was extended. The final model represented Dujia in its existing unsustainable (yet nearly sustainable) state (Fig. 2). Because the mathematically based graphic systems icons used in constructing the model represented the metabolism, that is, the energy, time, and material flows of the village, it was possible to add or subtract functions from the village-system and to change their relative quantities. This enables the asking of “what if” questions of the model in order to receive systemic feedback to alternative future scenarios.

There are three cash crops grown in Dujia, sugar cane, maize, and rice. The systems model revealed that the agricultural chemical costs and the labor hours for growing sugar cane were quite a bit higher than for the other crops. This led to the first “what if” question: “What if the villagers stopped growing sugar cane?” In conducting this simple “what if” experiment, an unexpected discovery was made. Sugar cane, although it brought in a substantial percentage of the yearly income of the village, was discovered to have an associated negative net cash flow. The villagers would actually be able to eliminate almost half of their annual labor and still have more cash on hand than if no sugar cane were planted at all. The villagers did not realize that their hard work in producing sugar cane was not paying off because the sum of money generated when they took the sugar cane harvest to market gave the illusion of profit, when actually, the expenses associated with sugar cane production accumulated gradually throughout the year and were lumped together with all the other agricultural expenses, effectively masking the net loss of money.

From this point, however, the villagers had much more to gain than increased profit from ceasing to grow sugar cane as a commodity crop. There was also land (5 mu of agricultural allotment per household per year) and time (6943 labor hours per household per year) previously devoted to sugar cane production that were now available to be used for another purpose. This opened a space of possibilities within the model which led to more “what if” questions: “What if the available land and time were used for increased maize production?” “What if the villagers were to save the money earned by growing more maize to buy photovoltaic panels?” “What if instead of selling the

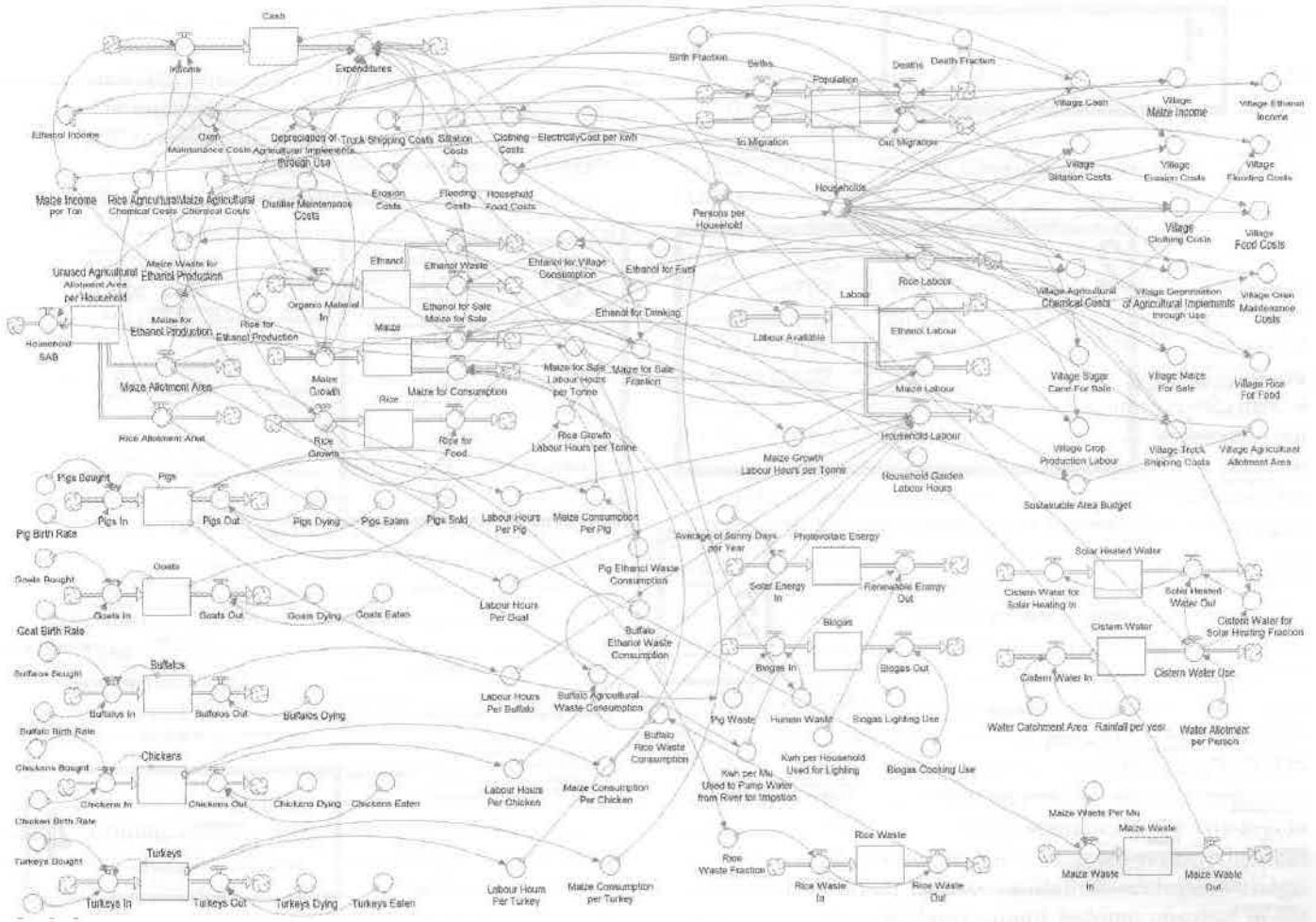


Fig. 2. This systems model represents an abstraction of the existing metabolism of the village based on the best information available.

sugar cane the villagers used it to make ethanol?" And even: "What if the villagers used their extra time for relaxation—to play basketball or watch television?" To follow just one of these scenarios, that of substituting maize production in place of the land and time used for sugar cane production, the systems model revealed that a net increase in income of 5496 yuan per household would result. All of the maize, in this "what if" scenario could have been sold at the market, but instead through further "what if" runs of the model, it was proposed that a value added product, ethanol, be made from the additional 5 mu of maize and the agricultural waste produced from the maize and rice harvesting (Fig. 3). The labor once used for sugar cane was now split between maize and ethanol production.

Experimenting further with the model, the waste from the ethanol production was used to feed the oxen. Some ethanol was sold at the market, some was for human consumption and some was used as a fuel for vehicles, a non-cash item that would be a renewable substitute for the petrol currently used. With the addition of ethanol into the village-system, fossil fuels, and the economic, ecological, and social costs associated with them, could be eliminated.

With the added income from the production of ethanol, the village would also have more opportunity to further explore renewable energy resources. For example, photovoltaic panels could be purchased to eliminate the need in the village for imported electricity from fossil fuel sources. At the end of this chain of "what if" scenarios, the village was no longer dependent on fossil fuels, the economy was more diverse, and the overall village system had made great strides toward sustainability, at least from a resource point of view.

Starting "what if" scenarios at different points yielded very different but equally compelling synergies. For example, in other villages cooking fuel was needed for each household which necessitated that each woman spend several hours each day collecting firewood. Also, lighting was needed in the houses, which required electricity that the villagers had to pay for from their very limited amount of cash generated from selling crops at the market. It seemed that the villagers would benefit if a way could be found to cook food and illuminate their homes that was more efficient in terms of time and money. So the question was asked, "What if biogas digesters were introduced to each household?" Biogas could be produced from human

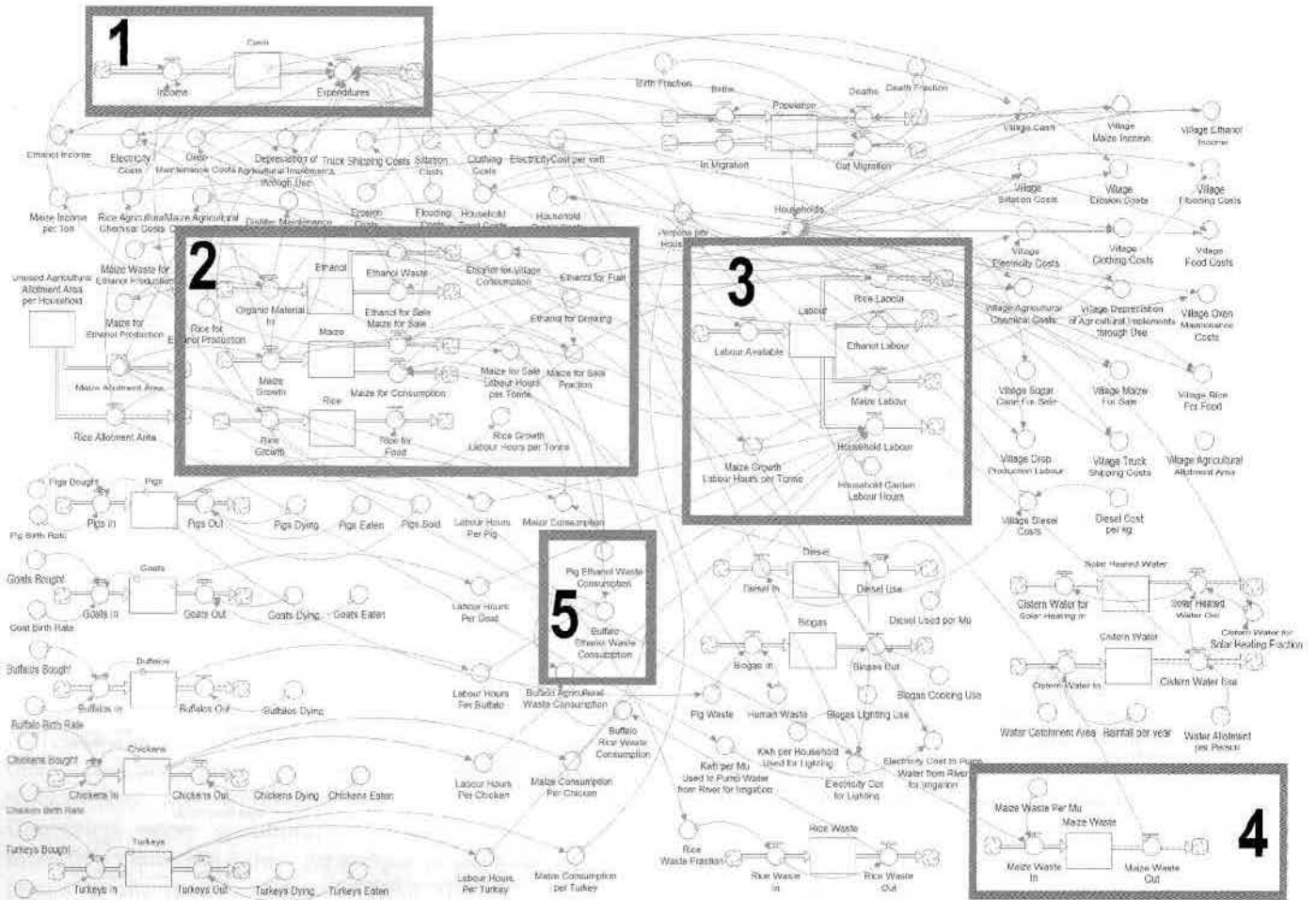


Fig. 3. The metabolism of a household in the village represents, on a smaller scale, the life of the entire village, so most changes can be made at the household level to achieve a balance in the village. For example, the income of the household (1) could be positively affected if a crop were used to manufacture a value added product (2). The labor hours will have to be redistributed to take into account the production of the value added product (3). Depending on what each household has the ability to make, it could take more or less labor hours to merely grow another crop, instead of getting involved in a manufacturing process. Something that would otherwise be seen as waste (4) could be used in the manufacture of a value added product. Even the waste from the value added product (5) could be used elsewhere in the system. Eventually, as the system starts to come into balance, synergistic energy loops are created, which serve to strengthen the system.

waste and pig waste and could be used both as a cooking fuel as well as a fuel for lanterns. Following this sub-scenario would afford the women 5 more hours a day, and eliminate the cost of electricity associated with lighting. With more money and 5 more available hours per day, the question was asked, "What if more pigs were bought and tended to?" The increased pig population would increase the production of biogas. The surplus biogas could be used for other purposes: value added food production, more lights, domestic hot water heating,<sup>5</sup> eliminating coal costs and pollution (instead of wood, coal was the cooking fuel in some villages), thus improving the life quality of the villagers. "What if instead of merely selling the pigs, a value added product was made?" The extra pigs could be

used to make ham, which could be sold at a higher price at the market. The result would be that the villagers would have an increased income that could be reentered into the scenario-building process in an ongoing quest to increase their quality of life.

These types of "what-if" questions, receiving feedback through the systems model, are at the core of the alternative sustainable scenario-building design process. This presentation followed only two scenarios out of the many played out to bring Dujia toward sustainability by both balancing the village metabolism and opening new spaces of possibility. These scenarios presented above may not be amenable to all of the families, or they may not balance out within the village system, but through the sustainable scenario-building process, the villagers, working with scientific and modeling experts, could construct many scenarios and choose the ones that create preferable synergies working according to the villagers' desires and

<sup>5</sup>In other scenarios that produced greater cash flows, purchasing solar hot water heaters proved to be a better alternative for providing domestic hot water.

within the Sustainable Area Budget. In the SUCCESS project, systems dynamics modeling allowed the researchers to view the different parts of the village-system in isolation to understand local effects, but more importantly, it instantly revealed the many effects that a small change would have as its influence reverberated through the entire system. Thus, the systems dynamics model was able to quickly and easily provide village-system feedback as to the effects of any proposed future scenario and thereby was poised to be used to facilitate a sustainable alternative scenario-building civil society planning process in the village.

At this point, if the research project had the resources to continue, the village systems model would have been able to be used as a gaming tool for extensive experimentation by the villagers, experts, technicians, government officials, entrepreneurs, etc. Such a process would be bound only by the ecological limits designated by the Sustainable Area Budget and the creativity and imagination of the stakeholders. In spite of this, the results of the systems scenario-building studies of Dujia have not yet been communicated back to the villagers, because there was neither time nor resources in the project to implement a full and working understanding of the balance-seeking sustainability process into the village's culture before the research ended. Therefore, any scenarios that would have emerged had the dangerous potential of being implemented at face value, without having an ongoing civil society process to take them into the future. It should also be noted that although our research team had a great deal of data about Dujia, no data set can be complete and indeed a living village is continually generating new and often unexpected data. Our initial models are undoubtedly too simplistic and contain both qualitative and quantitative inaccuracies. If the model were to be used in the village's civil society process, its inaccuracies would be weeded out, as the model's workings would be modified to more closely parallel the actual workings of the village.

Although we could take some comfort that through the modeling process it is possible to develop an environmental, economic, and, to an extent, a socially sustainable village, the emerging village would still not be sustainable because the now educated young people would still leave, because they would be attracted to the diverse activities and way of life promised in the towns and cities. With this realization, we propose that the sustainability-oriented village and its sustainable civil society scenario-building process, be enlarged and extended to become the process that transforms the village into a sustainable town or city. With the opportunity to develop the model over time within the framework of the lived-in reality of Dujia and through a sustainable civil society process, the operation would gain the confidence of the villagers. In this way, the successful co-evolution of village society with the sustainable systems modeling process, could become a means of evolving the Chinese village as it is today into the sustainable Chinese town or city of the near future.

### 3. From proto-sustainable villages to sustainable towns

If the future Chinese town, as an evolved village, were to incorporate many of the widely published sustainability practices and, as a result, create scattered individual "green" projects, this in itself would not be a sufficient demonstration of sustainability. It is not possible through an incremental approach to establish fixed standards that in the aggregate would constitute sustainability (Levine and Yanarella, 1994) because sustainability is an ongoing urban process of rebalancing that functions only when developed as a whole system. For example, it is not useful in a sustainability regime to try to establish the criteria for maximum CO<sub>2</sub> emissions for a given industry. Rather, a whole sustainable town-region would have to balance out its CO<sub>2</sub> emissions at the scale of the region. If it chose to allocate a particular factory with a large part of that budget due to its great importance in the metabolism of the town-system, this would be perfectly acceptable as long as the total budget of the town-system were not exceeded; that is to say, as long as, on a net basis, excess CO<sub>2</sub> was not exported beyond the SAB of the town-region. It would be most unfortunate if the industrialization of the proto-sustainable villages proceeded based upon the "best environmental practices" of the present. While many of the best practices of the present may be sustainability-oriented, to be acceptable they must still be integrated within an overall sustainability scenario at the city-region scale operating within its SAB. A town-region that has negotiated its urban balances within its ecological budget (Sustainable Area Budget) cannot become obsolete in the future.

#### 3.1. The sustainable city game

In order to advance from best practices and sustainability-oriented means into full sustainability, it will require the use of an effective civil society design and governance process and a feedback tool to guide that process. The Center for Sustainable Cities is calling that process the Sustainable City Game and its tool the Sustainability Engine<sup>TM</sup>. The future sustainable city will be a "learning ecology". That is to say, the Sustainability Engine<sup>TM</sup>, the Sustainable City Game, the people that play it, and the city that emerges through their ongoing process will all develop in content and intelligence the more times it is played. The Sustainability Engine<sup>TM</sup> is not intended to replace architects, city planners or any other professionals needed to sustain a healthy city. Instead, it is intended to be a tool to manage and bring to light the many tangled and sometimes overlooked interconnected relationships that exist in every city, but are neither understood nor controlled. In the sustainable city, the modeling and monitoring of these interacting influences and flows would occur simultaneously. When it is fully developed, the Engine will be an essential technical means and public policy tool for facilitating a democratic participatory stakeholder process.

The Game is played when local stakeholders—citizens, business owners, industrialists, environmentalists, government officials, etc.—sit down at a table and reveal their interests, ideas, proposals, and goals for the city. Placing a proposal on the table does not insure that it will be adopted. First, it must be incorporated into one or more of the competing emerging scenarios (the more scenarios into which it is integrated, the better chance it has of being adopted). Numerous “what if” scenarios are constructed and the Sustainability Engine™ provides feedback as to the state of balance of the proposed scenarios. In order to persist through multiple rounds of play, the out-of-balance scenarios must be modified in order to remain competitive. Through this process, the stakeholders’ conflicting interests are seen as opportunities for creativity and are used to synthesize synergistic solutions in an ongoing balance-seeking sustainability design process that can often have positive, counterintuitive results on the system.

In the early iterations of Sustainable City Game, it is to be expected that many aspects of these scenarios will be far from their balance points. Equilibrium will never be reached, because in balance-seeking civil society process, it is the ongoing striving toward equilibrium that fuels the system. Since the main criterion for sustainability is that a sustainable town-region be operating near the balance points of the system or approaching its balance points, its imbalances become the stimuli and focus of attention in the next iteration of this scenario-building sustainability game. New ideas and suggestions can come from any quarter. From the range of scenarios in play, it also becomes clear to the participants that each of the scenarios has strengths as well as weaknesses. The playing of the Sustainable City Game through multiple iterations becomes a process of trying to incorporate the various strengths of the competing scenarios while at the same time trying to eliminate their weaknesses. An important goal is to both balance and maximize the performance of the town system within the sustainability definition and the Sustainable Area Budget™ by seeking out synergies within system.

After a number of iterations of this process, each of the surviving scenarios becomes more complex and comprehensive and have likely responded in some productive way to each of the diverse stakeholder interests. Through this process, each of the participants gains a sense of ownership of both the process as well as each of the emergent scenarios. The sustainable town, first as it develops through the Game, and later as an actual town to be constructed and managed through a continuation of this stakeholder process, gains the confidence, support, and emotional co-ownership of all of the participants.

### 3.2. The Sustainability Engine™

The Sustainability Engine™ is seen as a powerful software system that integrates the capabilities of, BIM, facility management, and GIS software with the sort of system dynamics modeling software already utilized in the

SUCCESS project. The system dynamics software<sup>6</sup> that was utilized in the Dujia model represents the sort of functionality that would be at the heart of the Engine—a mathematical model into which data from the alternative “what if” questions are plotted on a systems diagram of each scenario. An advantage of using the Engine to run these scenarios is that very quickly a number of scenarios may be run to search for positive, self-reinforcing feedback loops within the system.

Building block modules would be constructed in the Engine to formulate a virtual three-dimensional version of each city scenario. These modules would function as plug-in, “free body” objects that provide inputs and outputs when attached to a larger sustainable city scenario model. The embedded information in each module would include libraries of local architectural pattern languages and industry standards, embodied energy, distance from source of materials, cost, availability within the region, labor requirements, recyclability, insulation value, land use implications, energy and material flow connections to other regenerative systems and other inputs and outputs to and from the larger city-system (Levine et al., 2003). Changes made in material, size, energy performance, and cost would be automatically projected through the model and its database. In turn, the effects of those changes as they reverberate through the city-system would be displayed almost instantly. Digitized information from a variety of scientific and other disciplines and information sources would also be entered into the Engine’s database to create an increasingly detailed picture of the city. In this way, as the Chinese village model is expanded into a town or city model so too is the complexity of the model. The more complex the model becomes, the more robust the possibilities are for future scenarios even as the model’s data set and feedback become more accurate.

### 4. The sustainable City-as-a-Hill, a new urban prototype

Thus far, a process has been outlined for negotiating the sustainable city, but a sustainable city is a place and needs a specific place to happen. There is little reason to believe that the form and character of the modern city, as it manifests all over the globe, is of a suitable form and structure to be that place where sustainability can happen. The modern city, or even the modernized historic city, is dependent upon too many of the unsustainable structures that have driven us far from any balance with nature’s capacities. In response to such a realization, many descriptors have been advanced as to what a sustainable city might look like if one should ever appear. Some of them include: a city without private cars, a pedestrian city, a human-scaled city, a self-sufficient city, a diverse city, a city that provides for all its food, material, energy, and other resources (on a net basis), a city with strong civil

<sup>6</sup>STELLA<sup>®</sup> (Systems Thinking Experimental Learning Laboratory with Animation).

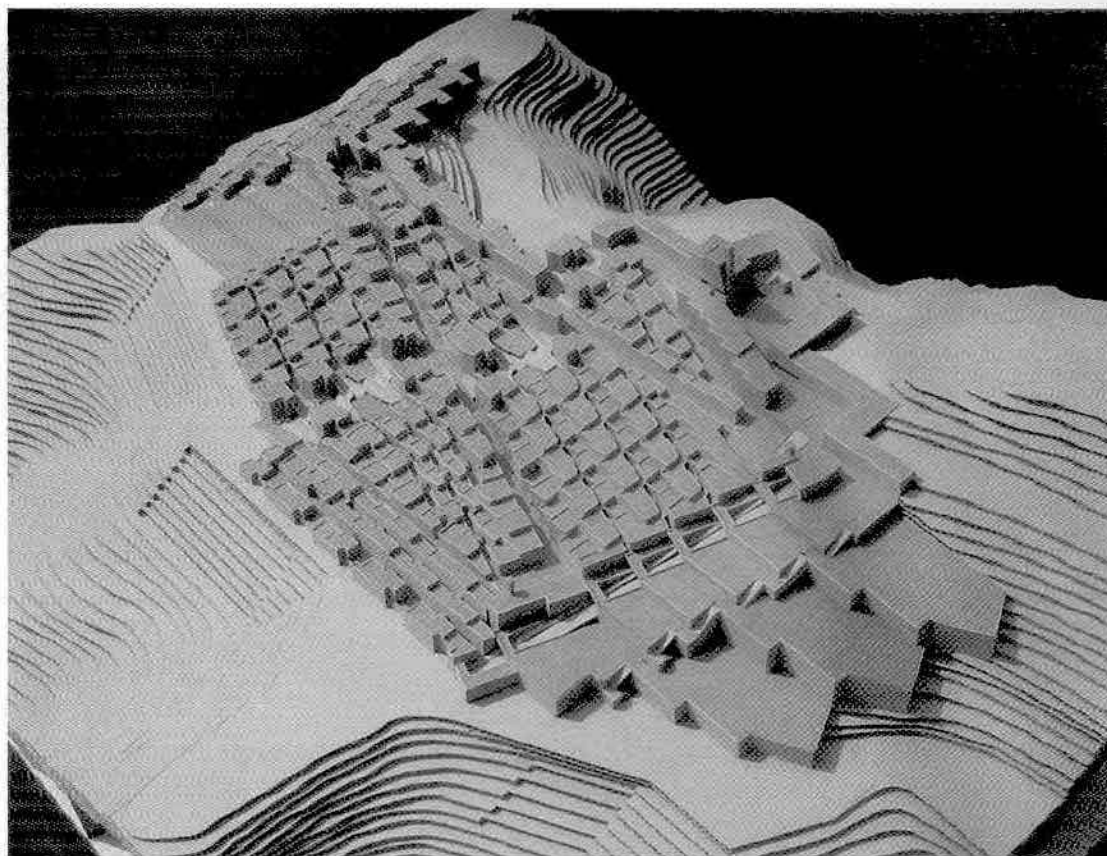


Fig. 4. This City-as-a-Hill project was designed by Michael T. Hughes for a reclaimed strip mining site in Whitesburg, KY.

society participatory governance processes, an equitable city, a resilient city, a city that operates within its fair earth share (or its Sustainable Area Budget), a beautiful city.<sup>7</sup> Many of these characteristics can be found separately in cities around the planet, but they have not yet found their way to come together in the first modern sustainable city. For several decades, the Center for Sustainable Cities has experimented with the conceptualization of physical models that would satisfy all these criteria. Taking clues from history as well as from more modern successes and projecting how sustainable city processes as described above might be reflected in urban form, the Center has synthesized a new family of urban forms called Sustainable Urban Implantations. These Implantations have been inspired by the medieval European hill town as found in profusion in Italy and other European countries. Although these “Cittè d’arte” are quite resilient and quite beautiful, being visited by millions of tourists each year who are attracted by the life affirming qualities projected by the ambience of these ancient places, they are not suitable models for modern industrial or post-industrial cities.

<sup>7</sup>Many of these qualities are explicated in Register (2002). *Ecocities: Building Cities in Balance with Nature*. Berkeley Hills Books, Berkeley, CA.

The Center has developed a family of urban forms that based upon the concept of a “City-as-a-Hill” (Fig. 4). Whereas its medieval counterpart was a city built upon a hill, the new urban model becomes a city built *as* a hill, with the inner “hill” being comprised of the many large scale industrial buildings, mass transportation and other necessary infrastructure that is needed for the operation of a modern city (Fig. 5). The construction of the hill is made possible by a flexible structural system, the Coupled Pan Space Frame, a post-tensioned concrete structure developed by Richard S. Levine at the University of Kentucky (Fig. 6). This space frame spans large distances and at the same time allows for systems infrastructure to be interwoven within the depth of the structure. The space frame system also easily accommodates future expansion and modification of the city, allowing the surface to evolve and increase in complexity. The City-as-a-Hill is organized around slightly sloping main streets that cut through a human-scaled, mixed-use urban fabric and lead to public spaces at a variety of levels. Several level streets and pathways are connected to the sloping main streets and lead to terraced urban fabric usually arranged around courtyards—which is also typical in the Chinese context (Fig. 7). The interior of the “hill” is arranged along day-lit gallerias and accommodates large “big box” functions that generally are scattered on the outskirts of modern towns, as

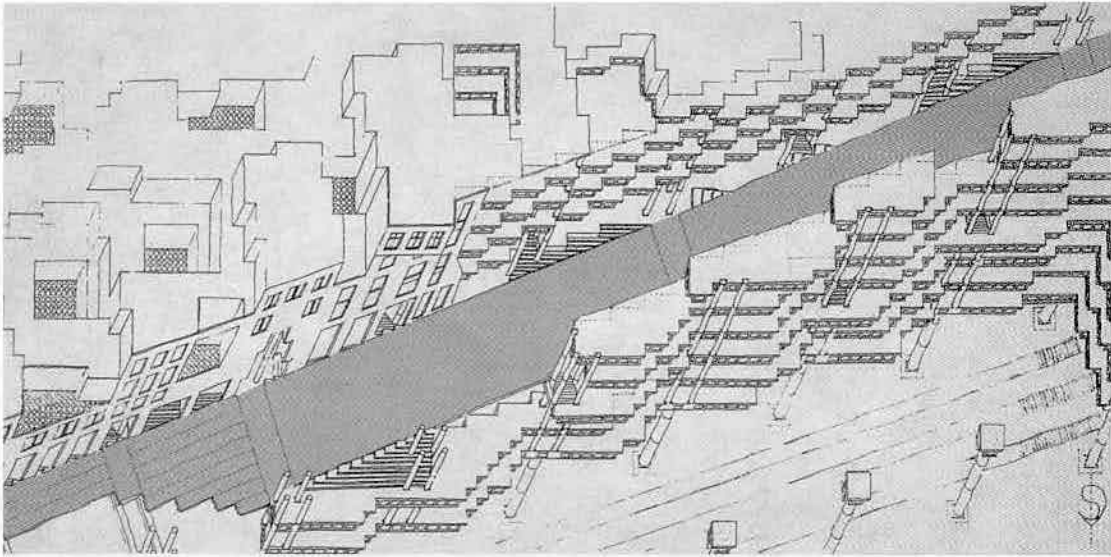


Fig. 5. Axonometric cut-away of one of the Westbahnhof Sustainable Urban Implantation's sloped streets showing space frame and train tracks on lowest level, with larger spaces in the interior of the hill.

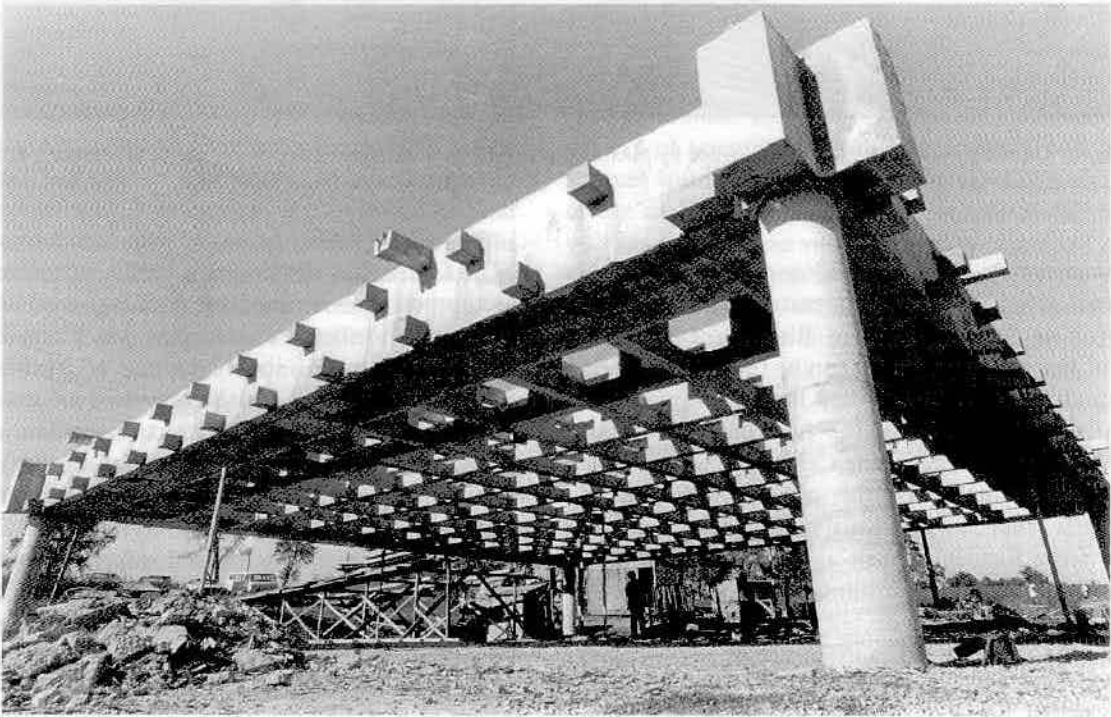


Fig. 6. Coupled Pan Space Frame test structure.

well as parking for a car-sharing program, mass transit stations, and elevators that lead to any level of the walkable town above.

There are a number of reasons why the Sustainable City-as-a-Hill model is particularly appropriate in the Chinese development context. Included among these is that the Sustainable Urban Implantation (SUI) is sized to a walkable, human scale and therefore no private cars are

required or even desired within its boundaries. While its density rivals the density of some of the largest new Chinese cities, this occurs without the liability of losing human scale. In a country where farmland is becoming increasingly precious, the SUI creates a clear boundary between city and landscape and can be built on otherwise unbuildable terrain. The Implantation is surrounded by the agricultural and natural territory that constitutes its

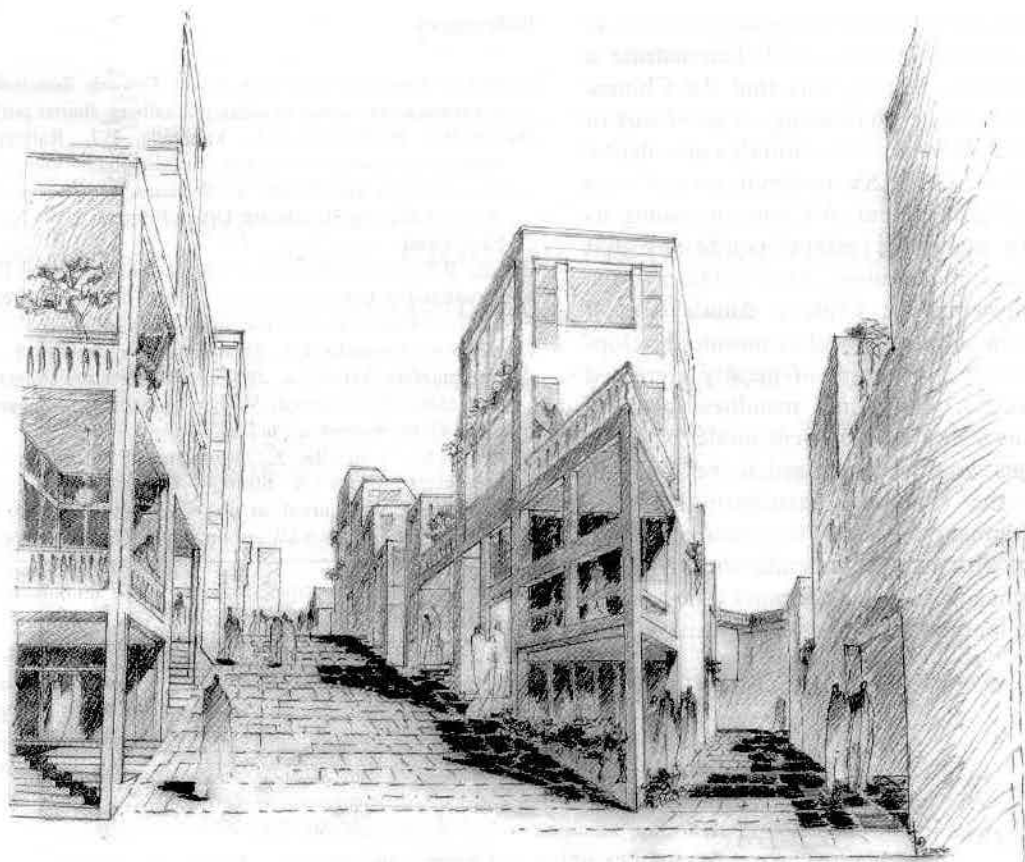


Fig. 7. An intersection between a sloping street and a smaller level path in a Sustainable Urban Implantation.

Sustainable Area Budget and from which it gains its sustenance. As the SUI concept is verified and acknowledged, expansion happens in the form of additional Implantations built nearby and linked to one another by public transportation. The tendency toward sprawl is thus eliminated. Similarly, the pressure to move toward private automobiles that is already beginning to overwhelm China is completely eliminated, at least from a functional or convenience point of view. We would hope that other city concepts would be developed that would support and encourage the emergence of sustainable cities through their inherent structure. Hopefully, the Sustainable City-as-a-Hill concept will be provocation for the conceptualization of equally supportive models.

## 5. Conclusion

With a consistent annual growth rate exceeding 9%, the recent trajectory of Chinese urban, industrial, and economic development has been nothing short of phenomenal. However, its current path is clearly running up against environmental limits, social and cultural limits, and even economic limits. It will be necessary to modify the path such that it adjusts to the limits as well as the strengths of the Chinese context and the carrying capacity of the land and resources of China. Although this situation can be

represented as a problem, in actuality it represents an enormous opportunity if China is willing to act on it. This is because China is in the position of being able to develop a new kind of urban-industrial development based on traditional Chinese patterns as well as on China's natural budget. Only in towns based on such a balanced approach can a durable future be assured. While it is not so difficult to imagine and project what a sustainable town or city might look like, it is a good deal more difficult to describe how to get there from here. The proposal herein is to begin with the nearly sustainable but underdeveloped villages in which most Chinese people now live as farmers and in these villages institute a Sustainable Civil Society Process, playing the Sustainable City Game, and generating alternative "what if" scenarios with feedback provided by the Sustainability Engine<sup>TM</sup>. To support these emerging scenarios, the Sustainable-City-as-a-Hill provides a supportive urban form that avoids the many slippery slopes toward unsustainability inherent in other urban models. These sustainability-oriented scenarios and models would slowly be enlarged until they would reach the size and diversity that would support a modern way of life while operating within their Sustainable Area Budget. Any period of rapid expansion carries the risk of creating an economic "bubble" which has no other possibility but to eventually burst. Fortunately, the resources and the

technology now exist to develop sustainable towns in China. These new sustainable towns will demonstrate a better way and ultimately the only way that the Chinese economy can expand to create Zhao Kang—a good way of life—in the years ahead. It may not be entirely coincidental that a year after the SUCCESS research project was completed the central government of China in issuing its eleventh 5-year plan mandated several conditions that mirror this team's recommendations. As a reaction to the rapidly growing unrest in the Chinese countryside, it changed its focus from urban to rural economic development. It mandated both a program of greatly increased environmental protection with harsh penalties for non-compliance, as well as a new development model whereby administrative villages would be enlarged to become full service towns with the voluntary participation of the farmers in the development process. These new mandates are entirely consistent with our recommendations and if the two were to be brought together it could mark a new era of sustainability for the land and the people of China.

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# Place as a social space: Fields of encounter relating to the local sustainability process

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## Abstract

The paper shows how sustainability questions relate to the local space. The local place is not a static entity, but a dynamic one, undergoing constant changes, and it is the rapid social and material processes within the given local situation that is a challenge for the Chinese villages and their integrity.

The following article considers the cohesion between the dwellers' emotional co-ownership of their local space and the sustainability process as a driving force in social, economic and ecological development. We bring together the classification of the seven fields of encounter, which were developed out of the empirical data of the Chinese case study villages, and sustainability oriented management considerations for all levels of this concept. We do not pretend to know the solutions, but describe a set of interrelated fields that can be anchor points for placing the solutions and show in which fields action and intervention is possible.

In our concept of sustainability, every spatial field has its special meaning, needs special measures and policies and has different connotations to concepts like responsibility, family values or communication systems.

We see the social sustainability process as a support for the empowerment of the local dwellers, and the SUCCESS research has encouraged the villages to find suitable sustainability oriented solutions for their natural and societal situation.

Before entering the discussion about the chances and potential of a sustainability approach for the Chinese villages, it is first necessary to accept the fact that rural villages play a primordial role in Chinese society and that their potential can strengthen future pathways for China.

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*Keywords:* Sustainability; Spatial and social interrelationships

## 1. Introduction

The SUCCESS project—Sustainable Users Concepts for China Engaging Scientific Scenarios—carried out seven case-studies of peri-urban and rural settlements in six different provinces in China, developing future scenarios of sustainability for these settlements (see Heidi Dumreicher, Introduction: Chinese Villages and their Sustainable Future: The EU-China-Research Project “SUCCESS” in this volume). Within this framework, the sociological team put forward the spatial development in the rural and peri-urban countryside within its socio-economic processes. The

research is organised along four steps: empirical data collection and analysis in each case study site, synopsis of findings from the seven case studies, conceptualisation leading to the concept of seven fields of spatial encounter, and last but not least discussing these findings in relation to sustainability.

The sociological team considers the interference between the spatial possibilities and their social representation as a counter form of societal development, containing two main time related components: the dynamic and the static usage of space. Human interaction in the space produces the dynamic movement of persons and goods, but it also involves static spaces for staying, resting and living. During the modernisation and urbanisation process, and with increasing motorisation and traffic, the public space tends to loose importance—in the villages as well as in the towns

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and cities. In the confrontation between different interests promoted during the modernisation process, space often represents the local resource where contradictions become tangible and this is true in Europe as well as in China. In the SUCCESS project, the team of social scientists studied the life quality in the given settlements, taking the community as a whole into account, respecting the inner community relations and the social interactions within the corpus of people living on a specific place. In the studied villages, we were able to discover and to show the social dimension and its spatial equivalent.

## 2. Methods and material

The sociological team in the SUCCESS project worked with the specific methodology of the photo interview (Harper, 1987, Wuggenig, 1990) in order to investigate the local life patterns.

The photo interview is one of the rare sociological methods able to create a relationship between spatial and societal realms. Selected people in the village take photos of their view of their own home village and give an interview where they make a narrative about the sites which they photograph. The photo interview as an active participatory process in visual sociology, generating empirical data for the photo and text analyses (Oevermann, 1993), is the basis for our interpretation that figures manifest as well as latent aspects and creates the scientific hypothesis building process that involves scientists from different disciplines and different socio cultural background. In the interdisciplinary research design carried out in the project, these findings also supported the emergence of sustainable future scenarios for the rural spaces. This chapter presents results based on 28 photo interviews undertaken in the Chinese case study villages and several iterative interpretation loops with the technique of objective hermeneutics (Photo 1).

In this interpretation process we found out that social activities are related to a specific space of the village. With

the photos, the interviewees guided the researchers in the interviews to meaningful places for village life and pointed out the social relevancies to their personal life. In the synopsis of the empirical data from the seven case study villages, the connection between physical space and social encounters became evident as a perception of the dwellers. Out of this mosaic of the insider's view, a series of interrelated adjacencies between physical and social emerged in the interpretation loops. From this empirical basis, we proceeded to a conceptualisation phase that led to a differentiated picture of fields of encounter, structured along seven fields (Dumreicher and Kolb, 2006b). These results are summarised in the following table. The column "empirical basis" represents the quotations from the interviews in the English translation. The "spatial field" shows the tangible place that carries the "spatial codes" as well as the "social relations" (Table 1).

This classification is summarising the outcome of our empirical data from photo interview and interpretation loops (see above) and according to the theory of objective hermeneutics, these results represent a latent layer of common description by the dwellers and should apply to rural settlements throughout China. The present article is a next step of interpretation that relates this theoretical concept to the realm of sustainability and how local sustainability scenarios should take into account the differentiated potential of each of these fields.

## 3. Sustainability theory as a framework

### 3.1. The local process of sustainability

The following definition of sustainability was used in the SUCCESS project and gives the frame for this article.

"Sustainability is a local, informed, participatory balance-seeking process, operating within a Sustainable Area Budget, exporting no nocuous imbalances beyond its territory or into the future, thus opening the spaces of opportunity and possibility."

- *Local*: It happens at a specific place—the living environment of a settlement within its region, including living patterns and creativity of the tenants.
- *Informed*: It benefits from the tools of the global scientific community and requires an interdisciplinary approach which provides cause and effect feedback as well as systemic loops.
- *Participatory*: It needs informed, empowered, gender sensitive human actors who are the stakeholders in the sustainability negotiation process.
- *A balance-seeking process*: It models alternative future scenarios, taking into account the classical triad of sustainability: economy, ecology, socioculture, complemented by the context of built environment.
- *Sustainable area budget*: It operates within people's fair earth share.



Photo 1. Procedure of photointerview in San Yuan, Yunnan Province. Photo by Huang Jiansheng.

Table 1  
Seven fields of spatial and social encounter (Dumreicher and Kolb, 2006b)

Empirical basis	Spatial field	Spatial codes	Social relation
“If you are happy, I am happy” Village: San Yuan	The human body—the individual “ME”	The body, its nutrition goods and its clothes constitute the personal space for privacy and intimacy. Food, clean water, clean environment mark the environmental and material frame	The individual ME and its basic needs for personal well-being and good health depend on the social network. This specially concerns specific age stages in one’s life—childhood and old age. Disabled persons, even if temporary, and their ME have specific needs that need attention in this field as well as in field 2 (the house), 3 (the street)
“This is my lovely home and this is my darling wife” Village: Xia Futou	The house with the inner courtyard	Furniture and personal equipment guarantee the frame for privacy of the ME. House, roof, courtyard with its furniture and specific architecture represents the family’s identity	The relationship with the family and the relatives as a reliable relationship with other human beings, reliving hope, trust, security and happiness
“This is on our street” Village: Xia Futou	The street, the house and the neighbouring buildings	The street as the place for “emotional co-ownership” of the person to a space with its space for informal information and exchange between people or changing of goods	Place of encounter within a community for the neighbours, representing the integration into a peer group and closer community
“After all, I live here and grew up here. How to say here is my own native home. No matter how good or how bad it is, I feel nice. I feel satisfied.” Village, Bei Suzha	“The village” and the spatial “in-between” at the village border—the village as a built environment with its streets, shops, public spaces, school, temples, meeting squares, family trees and the edge of the village with its loosely defined spaces	The pattern of built environment and the village public space as a space for exchange, the village border for village related experiments and a space of transition	Dwellers’ community and its representation in the different village groupings and committees  Borderline for formalized community relationships, participation in village activities, forming the commonly agreed identity of the village
“Outside, there are no relatives, there are no friends. and staying in a strange place, it is really not easy.” Village, Bei Suzha	The village and the region -  Neighbouring villages and towns	Borderline for the “emotional co-ownership”, space for exchange and regional markets	Space for comparing one’s own situation with other entities concerning an informal common value system. Outside working relations, social affiliation with specific tokens: dialect, collective memory, cultural identity
“Look, these are his students, one was thinking, one was writing something. We can feel Liu Dapeng’s spirit. This is excellent tradition of China.” Village: Chi Qiao	National territory of China  A unity beyond the province reaching every village	Dimension for common historic and socio-cultural background	Citizens, nation as a whole, national policies and resources for the village, communication with the public information systems, regulation about common value systems
“If the villagers have a telephone, this is very convenient, if there is television, they get a lot of information.” Village: San Yuan	The Globe  A new challenge for China: its role in the global community	The earth as a global material cycle including its space less electronic information system	World society, trans Atlantic and trans Pacific new alliances and networks, global development, world governance

– *Spaces of possibilities*: Sustainability considers the future as an open space where socio cultural life quality, economic equity, and ecological needs converge towards balance (definition slightly renewed after Levine et al., 1999).

This definition binds the sustainability approach to a local place within its actual or abstract territory. By focusing on local identities and their social reception, we were able to bring up diversified specific characteristics that can furthermore serve as examples for larger

sustainability oriented activities, in the same place or somewhere else.

### 3.2. *Local identity, emotional co-ownership related to sustainability*

The daily life practice makes a strong impact on the usage of space. The little piazza, the wall next to a lion's statue, the space under a family tree, the village washing place, the streets, the spaces under the roof of the house entrance doors, all of the spatial surroundings create the possibility for social life practice. The existence of the place contributes to the development of social life (Dumreicher and Kolb, 2001). So if there is a possibility to live in an existing spatial environment this affects the feelings and relationship of dwellers to a specific place. "Emotional Co-ownership—a strong attachment to a place that results in an interest from local citizens in the perpetuation of the valued qualities of the place. Most often this attribute is found in an empowered citizen who is involved in the decision making process of her or his locality" (Dumreicher and Kolb, 2003, p. 246). With the interviews in the seven Chinese case study villages we found out that "emotional co ownership" plays an important role in all observed local conditions. In a sustainability approach, the local actors are the representatives and carriers of the changing societal situation, thereby being also the carriers and promoters of the material changes in the environment produced by the urbanisation and modernisation processes. It is these actors who develop the new surroundings for their present and future life, and their interventions are based on a strong foundation of their own insights, the local tradition and a deep emotional connection with the place: the emotional co-ownership. This co-ownership is generated via a process of appropriation in daily life: "In the context of sustainability, the local identity is the starting point for future scenarios: the local potential in its singularity will be the glue that holds together the integrity of the village" (Dumreicher and Kolb, 2005, p. 922).

Besides the theoretical findings, this sociological approach also specially supported a sustainability process in the case study sites by providing specific results that supported the building up of spaces of possibilities within the village groups.

In the SUCCESS project, in every case study a group of stakeholders developed specific future scenarios for the villages (for details of the local participation process, see also ilse Marschalek, "The Concept of Participatory Local Sustainability Projects in Seven Chinese Villages", in this volume). This "sustainability group" in the village followed the specific task of assuring the integrity of the village in the present and into the future. In this participatory way, the SUCCESS project opened new spaces of possibilities. The people proved to be the one important power that can create new local places or new local actions.

In all selected case study villages, there was a similar devotion to the place, whereas the material form of this

sense of ownership differed from place to place. In one village, the local element that served as a focal point for the feeling of emotional co ownership was a deteriorated temple, in another village, it was the traditional way of water organisation, in yet another a common history of funeral and marriage ceremonies. The local qualities became significant under specific conditions, especially when the past was kept alive in the place, partly willingly, partly as an underlying, ever present historical flow. This was the case in SUCCESS case study villages where the memory of the dramatic events during the Cultural Revolution was still working. People had developed social strategies to explain their past, including their actual life and decisions, in order to come to terms with the past. These strategies still have an impact on changing social situations, concerning the present but even more on the capacity of imagining a future. So the past experience acts as an important force for future practices, the possibilities people can intend. In the definition of sustainability this aspect also includes the power to manage and push societal change: "spaces of possibilities : sustainability considers the future as an open space where socio cultural life quality, economic equity, and ecological needs converge towards balance" (Levine et al., 1999). The local identity and the local emotional co-ownership of dwellers influences the capacity of societal change in managing future developments as spaces of possibilities.

### 4. Chances for a sustainability oriented policy in China

China has to improve the social situation in the countryside and also has to protect nature against devastation. The rural Chinese villages will have a central role in this task and will have a strong impact on China's social and economical development. China's obvious quest for an accepted place and role in the world community provides a basis for the integration of global aspects into the national and local future scenarios. In the rising uncertainty of the global community, the international high tech knowledge of today's science is necessary even for a Chinese remote village as the concept of sustainability is part of the modern and post-modern global discussion and its repercussions reach far. The concept of sustainability has good chances to be considered in the Chinese governmental decision making structures. In a discussion over several years, the draft 5 year plan from October 11, 2005, states that "a prediction can be made that in the next five years, China will pursue growth in a fair, balanced and sustainable way"(New Five Year Plan to see revolutionary changes, 12.10.2005) and presents this challenge. "We will effectively strengthen the environmental protection. We will continue to promote clean production and formulate evaluation criteria for clean production in major industries." (Reports on China's economic and social development plan 2005). China's new 11th five year plan, under implementation since February 2006, puts an emphasis on rural development and points out that social disparity as

well as environmental challenges are to be dealt with in the next five years (Major policies pointing way to sustained growth, 2006).

#### 4.1. Sustainability in the process of the SUCCESS project

Through the SUCCESS study, the global discussion about a sustainable future has reached the dwellers in the selected Chinese villages. The awareness raising process conducted by the SUCCESS project supported the modernisation process on the one hand, but it also introduced the joint European-American critique of the concept of modernity. Through the participatory standards, the project also formulated its critique of a concept of development that is only oriented from a Western world view with its standards. In this context, the experience of the SUCCESS project with its more than 50 researchers, taking the idea of sustainability as a new concept to the villages, showed that the farmers actually want to find new ways to conduct their lives that would combine the accepted value of balance with nature with the need for a better quality of life in the rural areas. The challenge of combining global and individual aspects is a well-discussed topic in sustainability theory: from Hazel Henderson's "think globally—act locally" to the hope that individual lifestyle, when seen in its global dimension, might be able to bring about a sustainability change. In our view, these approaches are too general; we offer a new concept that will give a basis for more differentiated discussions. We show the interfaces between spatial and societal approaches—the interfaces where, when taken into account, change may happen. The newly developed concept of spatial fields that carry the potential for social encounter can serve as a theoretical framework for any sustainability effort regarding operational approaches.

This article makes the bridge between the empirical case study findings, the conceptualisation of fields of encounter and the pre-existing concepts of sustainability. We propose this concept as a tool for serving expert discussions concerning possible operationalisation of sustainability.

It is a scientific concept supporting the precise context, spatially and socially, for actions that are understood as steps towards sustainability. Finding future scenarios that give the villages a chance for survival, therefore, is the first challenge in a changing world. The necessity for new ideas and for change is present in the interviews—even if they come about with a quotation from the past: "Just like Mao said: We need animals, services, agriculture, factories. Just being a maize farmer is not enough. We need new idea" (Interview film maker 3, Bei Suzha 9/2002).

New scenarios, in a best case scenario a sustainability oriented approach, therefore might have a chance to get support in Chinese rural areas. Some results of the SUCCESS project have shown local practical scenarios and the concept of Seven fields of social encounters may contribute to a generalisation of these results.

#### 5. Place and society: encounter fields in the local space

This article demonstrates the conjunction between the physical places and the social interactions within a community. Each built environment, each part of a public space represents the social status of its user, be it individuals or groups differentiated according to their internal hierarchy and corresponding to their societal position and economic background. It is the outcome of a societal negotiation process by which space is attributed to each social entity. Architecture, urban planning, policy making and other decision making processes have their effect on the local places and make these processes visible and tangible.

The results of the socio-cultural team show that the horizon for the spatial and social experience is present in seven spatial interconnections, all perceived and having special meanings for the local village dwellers, all of them being interrelated open systems. The studied Chinese village represents a system of correspondences between social relationships (family, neighbours, village committee, village council and village government) and village spaces (house, courtyard, street, region). The social interactions in the families or between the dwellers have their specific choice of physical places where these interactions take place. The spatial context supports the social interactions within the community, with the family, the relatives, the neighbours, the village community and up to the national or global level. Every one of these fields constitutes an entity that relates the social to the physical and vice versa. The material realm is a counter form for the economic and social power relations and potentials.

##### 5.1. The first field of encounter: the body and the me

In China, by all evidence, the individual perspective is integrated in the community, but refers to personal health and safety and respects personal feelings. The sustainability process works with the potential of individuals as spaces of possibilities within their field of action, based on a concept of the "ME". On a pathway to a sustainable living in the community, the individual person is the first anchor point and the first agent for supporting this endeavour. One of the aims of SUCCESS was to support the village dwellers as well as the representatives of the governmental agencies in experimenting with their own fields of action: what lies within the field of the "ME"? How can I enlarge the field of action and influence within the community?

For a rising sustainable society, the participation of the "ME" is the *conditio sine qua non*. The body and the ME are an anchor point for two concepts that have much in common: sustainability and a preventive health approach. Both need participation of the concerned person, both are prevention oriented, both combine present and future, both need an individual as well as a societal approach. The role of the individual consists in commenting and estimating the impact on the real life situation and to discuss it within the social setting—the human community. In China, the place of the "ME" within the society is about to be newly defined.

Neither the Confucian nor the Maoist concept with their idealistic image of man are helpful for the village dwellers when looking for their place in the upcoming consumerist society. From the European point of view, the individual is the driving force that moves and defines all other societal fields. According to this view, those norms and values that a human being takes for granted, those roles that humans integrate in the social system are the carrying forces in the social interactions with other individuals. Our research shows that the Chinese village is an entity where the changes are discussed and valued in a collective way; the accomplishments and attainments of modernity like the commodities, the income generation or the moral and ethical changes are discussed, and the village people, together, look for a balance between advantage and disadvantage. This can make a difference to the state-of-the-art in the European research area that is over evaluating the potential and possibilities of the individual. Chinese people are used to knowing that the radius of action for the individual is limited—be it under Confucian, under communist or under neo-capitalist rules.

Within the SUCCESS project, the dwellers of all the selected villages were surprised by the fact that they had more decision space than they had expected; series of changes occurred during the study period on different levels: cadres were removed, buildings built, roads improved, ethnic groups encouraged, new societal relations established, new future images developed.

In Europe, the contradictory “Ecological dilemma” is largely discussed: public-opinion polls show that the consciousness for ecological questions is relatively high, but the willingness to change the individual lifestyle does not at all correspond to these results. In China, especially in the rural area, the challenge for the sustainability approach consists in the question: can sustainability be achieved while respecting the legitimate desire for more individual life quality on an ideal as well as a material level? The nearest field of action for the ME, where there is no discussion about responsibility, is one’s own body. To a large extent, decisions about the body can be taken at the individual level. At the same time, the body is the space that can serve as an indicator for life quality and life expectancy. Water quality, health care, food safety and food security, electro smog, technical achievements, housing quality—they all influence the “ME” in its most basic condition, the body and its state of health. Sustainability management considering social aspects needs to make the bridge between this first field that we describe as the “ME” and the body and the other fields described below. The quality of life is involved with the feeling of individual safety in the community and the integrity and specific value of the individual person, including his or her self-respect.

### *5.2. The second field of encounter: the house and the inner courtyard*

The starting point for the village life is “my house”, including the persons who live here—the family members.

“This is my house”—is the answer of a village dweller when the foreigners asked for the most significant place in his village. Some photos from the photo interview showed the typical inner courtyard in a farmer’s house in the case study villages: this is the place where, for centuries, Chinese people have been living their Chinese family life. The house and the courtyard is seen as a unit in the Chinese traditional architecture: “a courtyard represents Yin, where a building represents Yang in a house series” (Lü, 2005, p. 356).

The place and space for the individual within her social network and encounters is the house, where a basic social life between very strongly related actors takes place. In this field of encounters, modernisation enters the dweller’s life, with new technology and new societal tasks. In sustainability concepts, the house is considered as an anchor point for sustainability oriented activities: The house is a unit that seems entirely under the control of the owner. Technologically, especially in Europe, energy measures regarding buildings have reached a high level of performance in the realm of renewable resources, of building material and of energy storage. Zero emission houses, low energy houses are state of the art new ecological architecture and building concepts, which when adopted by the broad housing construction community could lead to a sustainability oriented housing structure. The house, or more precisely the house and the household, is the smallest unit for social, economic, ecologic and architectural activities. The house is the place for technical improvement on an individual level and the centre for the upraising of life quality concerning the human body: access to water—and if possible a hot shower; access to modern cooking devices, and for all other improvements in manual activities. In sum, the house, thereby, is a place for CO<sub>2</sub> emissions reduction and waste pollution and changes could be source for improvements (see also N.D. Mortimer, J.F. Grant, “Analysis of Energy Use in a Sample of Chinese Villages” in this volume.) The house is the place where technological innovations can raise the life quality of all family members within the community. The house plays also a role regarding health. The material used, the bio climatic quality as well as cooking, heating and cooling systems contribute to the comfort of the dwellers and thereby to their health. In similar ways, the courtyard—which at the same time serves as a production and free time space—contributes to the body and mental health of the dwellers. In the societal realm the social networks, people living and belonging to a house, are the economic and social manpower that contribute to survival. On this scale, the traditional Chinese farmer’s household provides inter-generational balance. Still the grandparent’s generation brings up the children and works in the fields, when parents have left the village for menial migrant work in the cities. Still the young care for their old family members, still the young come back to celebrate new year or to work at harvesting time together with the elderly. These mutual support duties are still the main social security system in

China's rural regions. So far the house is still a place for the intergenerational family and can supply the necessary mutual support for all generations and all family members. This intergenerational balance is under stress through the ongoing urbanisation and migration process and tends to put an overload on both generations. The urbanisation process with its migration patterns will sooner or later put an end to this well-working system. Therefore the necessity to organise health care will come up at village level, just as unemployment and insecure life situations will need solutions through a public and organisational approach.

In these ways, the house, in China, can be considered as a valuable anchor point for all sustainability oriented approaches. Yet, the house with its courtyard cannot be overloaded with too many challenges—it is a part of the larger entity: the street, the village etc.

### 5.3. *The third field of encounter: the street*

The village street, the space in front or to the left and right of the door, is an extended living room in the Chinese village and elongates the Chinese courtyard into a semi-public space. When describing the village in the photo interviews, "the street" becomes "our street" and the Huai Shu tree growing there achieves the quality of a landmark on the street, demarcating specific spatial spots. In your own street, you know every face, you know the name that belongs to every face, and any person from outside is immediately recognised. The street constitutes a narrow system of spatial and social interrelationships, including the exchange of neighbour services. The public space in the street has its special furniture, supporting the presence here. Stones are set to the right and left of the house, the door itself often carries a roof so that village small talk can be done even under rain or heavy sunshine, tree trunks sit on the sunny side of the street for winter days and in the shaded side for summer.

The street is a first public instance for common ethical or normative agreements where the closed system of the house meets an open societal space. The street acts as mirror for the good or bad governance in the village: it is an organisation level beyond merely individual encounter. The street (with its small squares and family trees) is a space for social control where a commonly agreed pattern of behaviour is openly shown (Dumreicher and Kolb, 2003). It is on the street that the neighbours see what a person has purchased, whether one carries fertiliser to the field, whether one has a washing machine or crosses the street with loads of laundry. Other members of the community can see how an individual deals with waste and with resources.

The street is also the first field for good governance and transparency which is a precondition for a sustainability process and for participation: the neighbours meet under the door or in front of the door, under family trees, next to lion statues or water wells, the street is the public realm where people get the latest news and exchange their views

about open and hidden activities happening in the village. The street is also a thermometer for the democratisation process: today, since the period of "opening the door" in China, people meet and have an informal information exchange that takes place on the street.

The way in which the streets in the village are modernised also reflects the ecological aspect. There is a sensible difference between a concrete street, and a paved one that allows for the rain water to flow in the earth, between using local technology and material or outside ones that produce transport with its ecological burden.

### 5.4. *The fourth field of encounter: the village and its borderline*

In the Chinese rural area, the native village with its complex social system of the family and neighbours shows the dwellers as active parts of the whole village community, including the communicative and interactive qualities of the village environment. The village with its streets, shops, public spaces, school, temples, meeting squares, and family trees is the material foundation for emotional and social life in rural China. Dwellers are positioning and living in a given community with the chance for primary education, information and cultural identity. The Chinese village is the place to assume responsibilities for other people, family members, friends and neighbours. In the case study villages, dwellers consider the village as their community. If they have a problem in the village, they solve this problem in a common way, with common effort.

Relating to sustainability, an advantage is the fact that for many topics, the whole village is the owner of the problem, and there is mostly no disturbing segregation of different local groups or clans. The question of social justice, the distribution of natural and human resources and other sustainability related issues are discussed and decided within the community, including the official representatives of the village governance like the teacher, the head women's federation, the village or the party leader.

The perception of the dwellers that they are living in a safe environment for their personal life and personal goods, is part of a future image of sustainability. The better the service in the settlement, the higher the emotional co ownership and the higher the identification with the village. We understand service in the broad sense: the community establishes the tangible as well as the intangible infrastructure for the settlement. It guarantees water, roads and electricity, but also the infrastructure for socio cultural life: kindergarten and schools for education, an assisted living facility for the elderly, and entertainment and meeting places. In an approach of social sustainability, these items of public life quality are justified requests. The villages are used to a high degree of self-organisation, self-financing and voluntary work, and under the new decisions in the actual five years plan, the government has recognised its responsibility to strengthen its support for the rural

areas. More and more, the dwellers ask for their part of modern life style with restaurants and shops, with badminton, jogging, fitness gymnastics and basketball in addition to the traditional dancing groups that you find in nearly every Chinese village—the dragon dancers, for instance. The communal perspective is represented in the organisation of the local village governance that goes far beyond an informal exchange of thoughts: the village committee, the cadres, the village leader, the women's organisation, the party members—these entities have a regular exchange of views and a organisational structure—certainly not as formalised as at provincial or national level, but they are places for repercussions of the national laws and rules. The villagers participate in the governance of the village, a fact that supports the social quality in the community. The village meetings are the place for reflection of social and spatial issues, they are the place for discussing and implementing procedures that aim at the integrity of the settlement, including the delicate question of social disparity. So far, there is very little organisational support for a possible inbuilt redistribution system or other approaches that provide social security. This grass roots system in the Chinese village is a local potential, but also a big challenge in case the common stakes of the dwellers are endangered.

This local governance system also has a large potential impact for the implementation of a sustainability process on the village level. Individuals or even street committees are too low a level to deal with the dump problem; it is at the community level that sustainability can lead to ecological interventions like waste water management systems and irrigation tools, waste recycling or re usage systems. The village is also the scale for economic interventions that enhance the local economy, the local weekly market for example.

Relating to ecological questions, the smallest scale—the house and street—are the places where people avoid dumping waste—they have a need to keep their own spaces clean because these are the spaces for their daily social activities. This is a demonstrative example for an occasion where emotional co ownership leads directly to individual ecological behaviour (see 3.2). At the scale of the village, we observed, that the local government has not yet found a way to deal with the waste that comes along with modernity. Several years ago, rural industry had a cyclical character, using organic material that did not produce any permanent waste; today's dumping on the contrary is not biodegradable. The modern commodities, the cans, the nylon bags, the bottles, in one word today's waste is filling the rare village spaces that are not under social control, such as the creeks, the empty spaces between abandoned houses, and the tiny spaces at the side of the streets. In some concerns, it is the village level where the non-degradable waste problem can find a solution, in a combined effort of money and education. For problems going beyond the village border, where the social control ends, there is no independent jurisdiction in China that could intervene with specific sanctions.



Photo 2. Photo taken in photo interview in Chi Qiao (YM, 10/2003), Shaanxi province.

In the SUCCSESS villages, the research team found a basic acceptance of these new ideas and policies. In the village Chi Qiao, young people want to get rid of the polluting daily usage of coal. But they get into a conflict of aims: as the coal is very cheap, the dwellers use it abundantly for heating and cooking. "This is the coal that we need for whole year." (YM, 10/2003) the young man explained showing a picture of his own house that he had taken for the photo-interview (Photo 2).

"I think this kind of use is too wasteful. I hope that we have an environmental protection way. I don't like to see this, I hope to see the development and change". (YM, 10/2003) The young people in Chi Qiao welcome new technological development that supports environmental protection, but the organisational framework for waste management at the community level is still missing.

In a time of rapid change, the village dwellers need to find a balance between their old rural life and their modern, urban one. New technologies, as mentioned in the policies, can support a societal change so that the village, adopting an ecological pathway that raises life quality, can compete with the modern town's pollution, which the young especially have experienced through migrant work. Although they find better chances for money making in the towns, they also experience the shortcomings of the town-be it the pollution, the traffic jams or the societal threats.

#### 5.4.1. *The edge of the village*

The village as a space of built environment has a different meaning for the Chinese dwellers than the surrounding fields where people do their agriculture work. This border is the edge of a social space and can be experienced at specific occasions. In times of harvest, the farmers come back from the fields until they reach this border when the time for a meal has come—at the edge of the village, families and working groups sit together for a break. The children in their free time respect the borderline, too: their behaviour changes from within the village where

they show a great deal of traditional good behaviour as opposed to the outside area where they act much more freely.

The village is the field for organisational and societal learning for community-oriented tasks and thereby a vehicle for change in the sense of sustainability.

Many new activities find their place at the edge of the studied villages—the new pig farm in Xia Futou, a cultural centre in Jiang Jiazhai, a parking structure for tourist-buses in Xiao Qi. This part of the village is not yet occupied by specific interests, therefore it is a place for negotiation of sustainability oriented solutions.

### 5.5. *The fifth field of encounter: the region*

The village is conceived as a spatial and societal unit by the dwellers, but it is also seen in its broader context, the region. Similar to the city, the village, too, is embedded in a larger context which influences the claims and expectations of the dwellers for their present and future life “the life quality in a town depends on a good balance between the near and the far away, between the well known and the unknown” (Dumreicher and Kolb, 2003, p. 253). The village is part of the surrounding landscape with other settlements and scenery, offering social and economic opportunities and support for sustainability action in a broader context. In many aspects the village can be seen as a part of the broader regional community: for the realm of mobility with the challenge of offering public transport systems, for the economic relationship with a nearby city which would establish chances for an urban-rural partnership in the sense of sustainability. The roads into a settlement and the close distance to other villages work as communication tools for material, for information and for knowledge.

The region is a space for comparing the life quality, the governance and transparency of your own social environment within a naturally given broader context—a tangible as well as an intangible context. The region constitutes a specific social network with its specific dialect, collective memory, religious and cultural identity and value system.

For ecological aspects, SUCCESS pointed out that a whole set of issues needs solutions at a level that goes beyond the village. Like many other issues, the provision of water as an essential resource may only be resolved at a larger scale than that of the village. Whether the water from a river is used for the newly built city, as opposed to the irrigation of the fields of the village, is not within the decision space of the village, but depends on provincial or regional impact.

In the official central Chinese administrative system, several levels are interposed between the village as the micro-unit and the nation as the largest unit. At the central level, many official documents support the concept of sustainability (see 5.6), but the in-between-levels are hard to work with; they are difficult to understand for the

scientific experts, as well as for the farmers and village cadres themselves.

Without regional governance strategies, sustainability cannot be established: several targets can only be reached when a concept of regions is developed. Developing “a clear concept of regional development” (Heilig et al., 2005) is necessary and should include resettlement and upgrading programmes for disadvantaged regions that are listed in the new Chinese five years plan. Under a sustainability concept, there is a need for combining the concept of a quasi autarkic mode of operation without drawing on outside resources with the need of integrating outside fields of encounter as well (see below) in order to guarantee a decent level of economic livelihood.

The village governance itself cannot solve this problem without the political power and support from the provincial government. One of the aims of the SUCCESS project was to give the village dwellers an occasion where they could experience and check out how far the village self-management relates to upper political and administrative structures and how big a say villagers have in these upper echelon levels of decision making. In several cases, the villages would relate to regional governmental entities during the three year period of SUCCESS—sometimes in order to get a new village party leader, sometimes to get funding for a project, sometimes in order to get more respect from the authorities for the village activities.

### 5.6. *The sixth field of encounter: the nation*

In the Chinese tradition, the village has a specific standing and is respected as an entity of its own, an attitude that finds its expression in the Chinese saying “Shan da, Huandi yuan”—“The mountains are high and the emperor is far away”.

Not that far away. There is a whole tradition of oppression in China where the rural regions have been despised throughout centuries, beginning with the low status of farmers in the feudal power structures and continuing in recent history when urban dwellers were sent to the rural settlements as a punishment for bad behaviour towards the party and its rules. The nation constitutes the basis for a comprehensive collective memory and establishes a common awareness of rules that concern all other spaces of encounter. Model villages and other experiments, in China, have the potential for influencing the nation wide policies, thereby creating a national framework that promotes the successful models.

One instrument, extremely welcome and well established, that makes a direct link between nation and village is the national TV programme with its regional and local stations. In the year 2000, out of 100 rural households, 53% were provided with a Black-and-White TV and 49% with a Colour TV; this means practically a 100% coverage (China, Fakten und Zahlen, 2001). Today, the TV programmes as well as many official documents often show the rural area as a problem area that needs help, neglecting its

potentially positive role for the future of China. A sustainability policy should be embedded in an overall policy that gives the village the right of access to information beyond the government controlled information. Telephone and email are still at very low level in the rural settlements, and the state owned TV programmes could contribute to establishing a more positive image of rural life throughout the whole nation. A first step in this direction is the official new five years plan that aims at directing more attention to rural China.

At the national level, China has the choice between a merely economic growth or else a sustainable national policy. China's government is aware of the big challenge to balance the economical and societal gap between the towns and cities on the one hand, and the rural society with its human potential for industrial production on the other. Besides the provincial support, a sustainable future needs a national strategy as the background for action—especially in the Chinese situation where national rules play a primordial role. The nationwide discussion about the implementation of a better life quality by the year 2010—“Xiao Kang”—in the rural area could create space for the topic of sustainability, as several points are compatible. In the meeting of the Tenth National People's Congress March 2005, a set of strategies and guidelines were promoted to build a “harmonious socialist society” (The Yin and Yang of a Harmonious Society, 2005). Beside fiscal and monetary policies to keep prices basically stable and support transfer payments, China's government focuses on the environmental challenges for economic growth. “We will formulate and publish a policy outline for developing energy and water-efficient technologies, to support the development and application of new technologies, processes and equipment that help conserve energy, reduce consumption of materials, and make comprehensive use of resources...” . [We will work out policies for developing energy-efficient, environment-friendly automobiles, new wall materials and energy-efficient housing” (Report on China's Economic and Social Development Plan, 2005).] Whether these expressed future strategies will find their way from the proclamation to an implemented programme is the question for the next five years. The many riots in rural settlements in the last months show that the urgency of action becomes more and more obvious—for the foreign observer as well as for the Chinese government.

For balancing the income disparity, the Chinese central government promotes the monitoring of employment problems and “will accelerate the establishment of a social security system in line with the level of economic development” (Report on China's Economic and Social Development Plan, 2005). The social structure is highly influenced by larger nation-wide guidelines, policies, rules and worldviews. When Chinese policies make a big difference between rural and urban areas, the action field for a local initiative depends highly on the status assigned to this place by the authorities—if the village is considered

as belonging to a rural area, it needs to conform to the respective rules even if the village is on its way to becoming a suburban satellite. When the aim is to preserve the integrity of the village—a basic condition for its sustainability—one main question is whether it has an existing social security and health system and if not, is there at least a desire or understanding to establish it. China will decide whether this is a topic of primordial importance and how she can distribute the financial resources in an equitable way. Providing the situation of the place gives enough support for health and medical care, a well-working social security system can establish a continuity of safe life conditions for dwellers in the rural area in a similar way that it is provided for people in the towns. A healthy environment and healthy personal situation for the dwellers in the villages can only be achieved if it is considered a national endeavour.

### 5.7. *The seventh field of encounter: the globe*

Global developments reach the village mostly through the space-less information system, the World Wide Web, providing a somewhat skewed vision of the outside world, especially the global one. But this space-less communication still needs physical support. During the SUCCESS project, the village Bei Suzha established a first Internet café supporting the exchange between town, village and even a European partner. In another village the expert team made the first real-time-internet-link on the village square during the field work. In this way, the project, at the symbolic level, represented the global world for the SUCCESS case study villages: whatever is new, whatever represents the new urban life makes a difference to the farmer: “The foreigner has the same value like the motorcycle” (Photo interview, men group, Xia Futou, paragraph courtyard, 04/2003).

Technology and knowledge are both global contributions of the global society to the remote Chinese village, and assuming that there is a good governance in the village, the new knowledge can empower the farmer to establish new levels of future agricultural production (details about a sustainability oriented agriculture, see Veronika Prändl-Zika, “From Subsistence Farming towards a Multifunctional Agriculture: Sustainability in the Chinese Rural Reality” in this volume).

In a rural village with its dirt roads, with a lack of heating or cooling, with only one employment opportunity (namely agriculture), without access to the information society (besides the official programs of Radio and TV), the need for better public service is evident to any observer. The SUCCESS project gave evidence that a sustainability process taking these needs into account is welcome. It strengthens the self-confidence of persons in the local and regional realm who up to now have felt like outsiders. Being part of a sustainability project shows them that their own views can fit into an international trend. A combination of the inner communication in the village with the

world outside can be a basis on which modernity and more life quality in the village can emerge. The dwellers have an eye on the life quality inside the village just as well as on the world outside. Both, the near and the far way, have their necessity and eligibility (Dumreicher and Kolb, 2003).

In a shift toward sustainability, information plays a crucial role. Availability and non-availability of information is at stake when discussing winners and losers in the digital age—in the western neo-liberal situation as well as in the era of transformation in China. In all studied case study villages there are several issues where people indicated the need for more information on different levels. The lack of transparency is obvious to many of our interviewees, even at the village level (Dumreicher and Kolb, 2004). Sometimes the whole village is not informed about their future development and the government plans concerning their region.

If the concept of a sustainability process for the rural area in China as proposed by the new five years plan is to be taken seriously, it will be the task of such a sustainability process to take into account both dimensions of communication, the global wireless one and the face to face communication, in order to support an integrative village community.

The welcoming of foreigners delivered a special kind of sustainability indicator for the rural dwellers: the interest that the foreign experts showed was a supplied evidence for the village that the place contains hidden qualities and treasures that can be ferreted out. The approach of SUCCESS that aims at recognising and detecting and activating the existing potentials is a counter form of this challenge.

In a threshold country like China, sustainability as a concept can only work if the critique on modernity and its excesses becomes an inherent part of a development concept.

The combination of high touch and high tech information systems is a possible way to support the potential for a sustainable post modernisation era in China. Global and local village in one: the “glocal” sustainable village as a possible future option.

## 6. Discussion

The presented theory of fields of encounter shows an interrelated system between space and social encounters as a basis for a sustainability oriented agent for change. There is, of course, a relationship of recursivity between all these fields—the “ME” relates to itself, to the family, but also to the nation or the globe. In similar ways, the neighbourhood recursively relates to the family as well as to the region, and so forth. The authors expect that this theory will be helpful within theoretical approaches to sustainability and within attempts to operationalise this normative future concept. It allows for a sophisticated access to sustainability management questions, relating them to the convenient choice of

one or more of the seven spatial and societal fields. The study in the Chinese villages shows that, from a social point of view, “spaces of possibilities” represent chances for new human activities within the society, apart from the so called objectively definable future targets. Imagining spaces of possibilities is in itself a social action that showed the participants in the process what their possibilities are—at first independently of the actual situation and its direct implications. In a second step, the stakeholder group saw whether the far away sustainability oriented future that they imagine for themselves can be bound back to the present. When discussing and balancing the spaces of possibilities, the social group that was undertaking the herein described sustainability process defined its own potential and its own field of action and experimented with its own power of transformation—at first in thought, later also in more practical terms. “Sustainability research is based on the idea that human beings dispose of spaces of action and that, by trying out their possibilities, they can further develop their radius of influence (Dumreicher and Kolb, 2006a). The existing social patterns present in the local place have a general character and are not specific to a certain place; they rather show similar qualities in different villages. Any local action needs to relate to these existing local social parameters, but it also needs to respect and adapt to the larger context that plays an overwhelming role. By doing so, local initiatives will find ways to better define their fields of action.

A remaining research question for the future is the role of agents of change, for instance the women and children—the carriers of the next generation—who play a substantial role. The sustainability management only has chances for implementation when it takes into account the tangible as well as the intangible aspects of the village patterns and when the future scenarios concern all population groups and take into account all described levels of encounter from the ME to the globe.

## 7. Conclusion

The paper discusses the interference between the spatial possibilities and their social representation as a counter form of societal development, containing two main time related components: the dynamic and the static usage of space. Human interaction in the space produces the dynamic movement of persons and goods, but it also involves static spaces for staying, resting and living. During the modernisation and urbanisation process, and with increasing motorisation and traffic, the public space tends to loose importance—in the villages as well as in the towns and cities. The results of the Chinese case study villages bring together the classification of the seven fields of encounter, which were developed out of the empirical data, as well as sustainability oriented management considerations for all levels of this concept. The concept shows that every spatial field has its special meaning, needs special measures and policies and has different connotations to

concepts like responsibility, family values or communication systems. The theory should be helpful within theoretical approaches to sustainability and allows a sophisticated access to sustainability management questions.

Any local action needs to relate to the existing local social parameters, but it also needs to respect and adapt to the larger context that plays an overwhelming role. The concept differentiates between the following spatial fields and describes the tangible place and its spatial qualities, as well as the social relations, which take place in this specific surrounding:

1. The human body—the individual “ME”.
2. The house with the inner courtyard.
3. The street, the house and the neighbouring buildings.
4. “The village” and the spatial “in-between” at the village border—the village as a built environment with its streets, shops, public spaces, school, temples, meeting squares, family trees and the edge of the village with its loosely defined spaces.
5. The village and the region—Neighbouring villages and towns.
6. National territory of China, A unity beyond the province reaching every village.
7. The Globe, A new challenge for China: its role in the global community.

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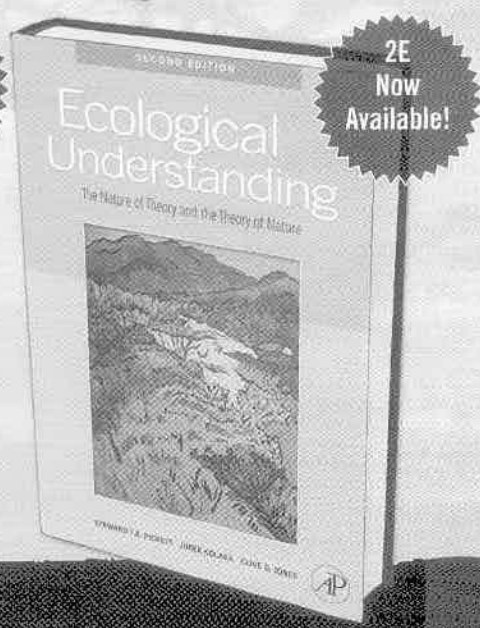
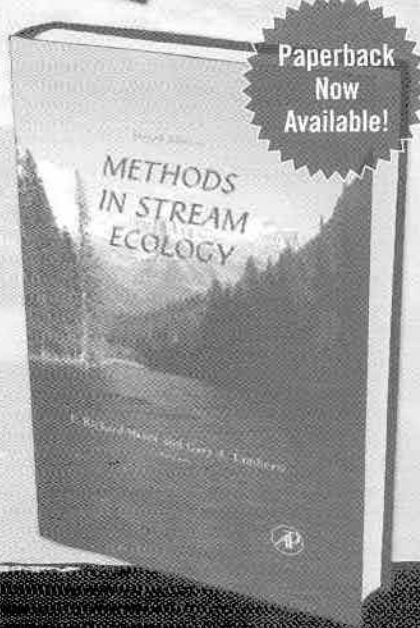
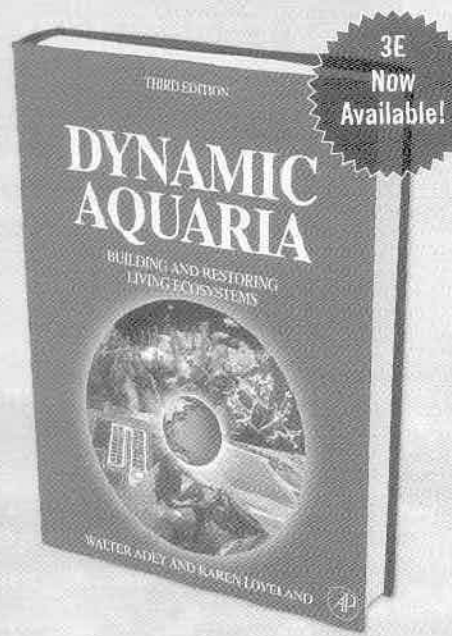
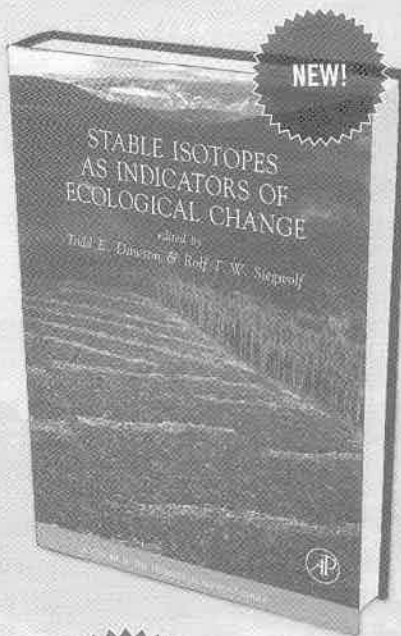
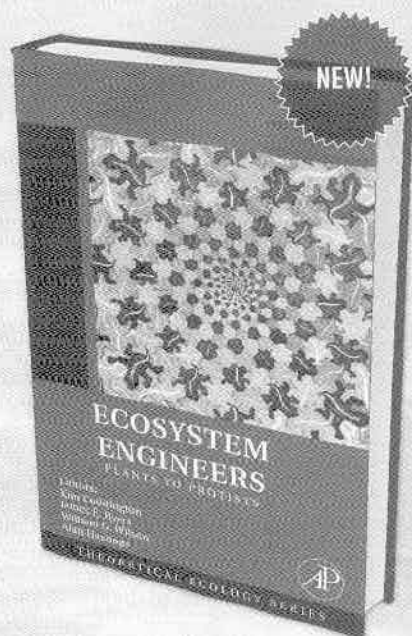
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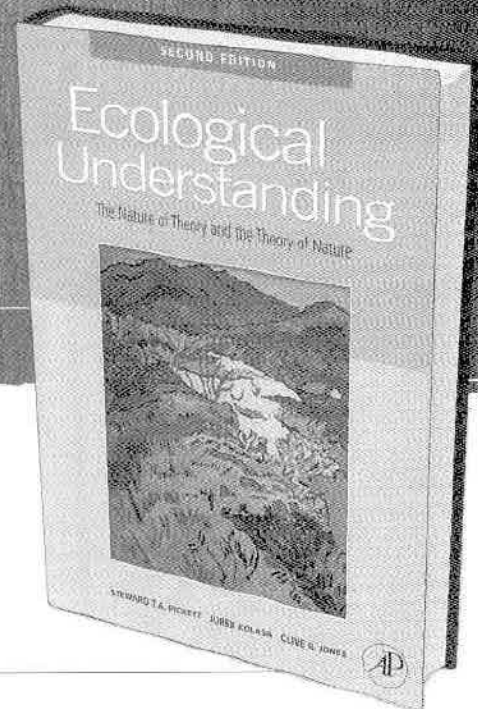
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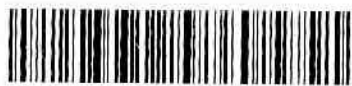
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