Sustainable Development of Megacities

A Mega Challenge for China and the World

Chinese-German IESP Workshop on the occasion of the IFAT in Munich, 2012.

Minutes

Summary:

On the 8th of May 2012, as part of the IFAT industrial fair in Munich, the IESP held a workshop to discuss solutions, environmental impacts and the latest research regarding the issues of Megacity growth around the world. The workshop linked researchers from the IESP, the Chinese Research Academy of Environmental Sciences and the Bavarian Government.

Four key areas of research were discussed.

1. The concept of resilience was discussed as it applies to forming policy and strategy to deal with conservation and development issues. Dr. Martin Grambow presented the concept of resilience as it applies to Megacities emphasizing how resilient strategies are not necessarily optimized but rather adaptable and self correcting in reaction to significant changes. Prof. Meng Wei gave examples of some resilient strategies for waste management that have been introduced in China such a circular economy for e-waste. Prof. Mauser showed how important resilience is in the phosphorous based food chain and how, due to poor recycling and conservation standards, a phosphorous crisis may be looming.

2. The impact of Megacities on land resources as they expand and how land can be used responsibly and efficiently and how damage that has already occurred can be mediated and reversed. Prof. Li Fasheng introduced the importance of land as a resource and the ever increasing need in China to repair the damage done to its land resources by landfill, industry and intense agriculture. Prof. Mark Michaeli introduced an architectural perspective on Megacity development with regard to the more dispersed urban centres which are seen in reality but not accommodated in the traditional model. He also showed how intelligent spatial planning can make Megacities sustainable and efficient.

3. The importance of water as a resource for expanding Megacities was discussed including strategies for meeting the greater demand on limited freshwater resources. Dr. Lei Kun talked about the state of the Bohai Ring metropolis' water resources and their decreasing quality due to industrialization with special focus on conservation areas. Dr. Susanne Bieker demonstrated a new system, the semi centralized system, for water management which incorporates greywater recycling and localized processing facilities to make water and waste management resilient to city growth.

4. The issues of energy supply were discussed, including strategies to meet energy demand while still satisfying carbon emission reduction targets, as well as the problem of air pollution and how air quality improvements can be efficiently managed. Prof. Löschel presented the Nuclear phase out

plan and Germanys plans to meet energy requirements. He also discussed how the emission reductions of industries can be balanced using the Carbon Trading Initiative. Dr. Fu Jiafeng presented the Chinese equivalent to this trading scheme and the effects it will have on industry carbon reductions in China's coastal cities. Dr. Gao Jian discussed industries effects on China's air quality both with regard to environment and health. He covered the initiatives that allowed Beijing to clean up its air in the run-up to the Olympics.

The IESP brought together many perspectives on the major challenges that will be faced in the future of Megacities. It is hoped that such collaborations will form an integral part of future discussions on resilient and sustainable Megacity development in the future.

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Introduction

On the 8th of May 2012, as part of the IFAT industrial fair in Munich, the IESP held a workshop to discuss solutions, environmental impacts and the latest research regarding the issues of Megacity growth around the world. The workshop linked researchers from the IESP, the Chinese Research Academy of Environmental Sciences and the Bavarian Government. The workshop was held in three languages: English, German and Mandarin. Presentations covering energy crises, waste management, environmental conservation and resource distribution were given and discussed among an expert panel, drawing attention to the key issues that will be faced in industrialized nations as this millennium continues.

Part 1 – Sustainability, Resilience and the Development of Megacities

Breakdown of key topics.

- The role of resilience and a holistic, multi-disciplinary approach in developing strategies for sustainable development.
- The use of circular economies in meeting resource demands in a sustainable way.
- The impact of solid waste (domestic and industrial) on the environment and methods for recycling such waste effectively.
- The importance of Phosphorous and other non-renewable resources in the human economy.

1. Resilience and Development of Megacities and Land Use

Dr.–Ing. Martin Grambow – is a civil engineer and currently occupies the post of Director General of Bavarian Water Management for the Ministry of Environment and Health. His duties include the implementation of EU law regarding water management, environmental monitoring and developing strategies for water supply and waste treatment.

Since the founding of the IESP, many people have approached them with ideas pertinent to the concept of 'Environmental control'. That is, solving environmental problems through technological intervention. Many of these ideas focused on chemically altering the atmosphere in order to cause 'cloud seeding' or cooling in order to manage climate change. The IESP has found that, while climate change is a great threat for the future, there are a number of interconnected crises faced by humans that cannot be addressed in isolation.

The world population currently stands at a little over seven billion and is set to rise to nine billion in the next few decades. All these people are consuming the planets limited resources: land, metals, phosphorous etc, and simultaneously contributing to pollution of the atmosphere, sea and land.

These crises fall into four main categories:

1. Climate and Energy: As the population rises, and quality of life and industrialization rise with it, strain increases on global energy resources; be they fossil fuels, biofuels, nuclear or renewable sources. These processes all impact the environment to a greater or lesser extent and the greater energy demand becomes, the more significant our impact on our climate is set to become.
2. Water and Food: There is only a finite land area available for food production and, as the demand for food increases, arable land becomes ever more vital to our stability. Freshwater is also becoming more and more valuable and waste treatment systems are under ever greater strain to produce sanitary water for booming urban populations.
3. Equality and Social Justice: As strain on the earth's resources increases, conflict, political and economical, is on the rise. Political and economic stability is increasingly under threat.
4. Biodiversity: Efficient use of resources is leading to land clearance, monoculture farming, soil pollution and other factors that threaten the species with which we share the planet and on whom, directly or indirectly, our survival depends.

One should not underestimate the implications of these global crises but neither should one be lulled into fatalism. Humanity may well adapt to a more hostile planet but the health of our civilizations and ecosystems is under threat. The key is to interact with our environment in such a way as to be sustainable into the future. The way to achieve this, it has been suggested, is not through environmental control but by engineering systems that can successfully coexist with naturally occurring ecosystems.

Achieving sustainability must be considered in terms of real time operations which are developed and constructed progressively. Such operations must not only aspire to achieve efficiency in their use of resources but also strive for sustainability and 'resilience', which is to say they must be naturally adaptive to change. Systems that optimize efficiency tend to fail in terms of resilience as small perturbations from the conditions under which this optimization was achieved will render them less effective. Megacities represent a distinct challenge in contrast to rural or natural conservation due to the concentration of population and infrastructure that these vast systems are based on. Key factors that distinguish

Megacities, and which must be considered when trying to implement resilient systems, are traffic, food, education, living standards, income and population growth. In order to ensure approaches to managing these challenges are resilient, all these factors must be considered as dynamic and fundamentally interrelated.

The interplay of systems in such a complex environment can be considered to sit in a naturally occurring well, drawing conditions and operations back from small perturbations into a stable state. However, this is not to say that systems naturally achieve a resilient or sustainable state. By reengineering the systems we have in place, we can pass the threshold of this well and find a new stable state that is more beneficial, sustainable and resilient. The key to achieving this is to realise that no system is static but evolves constantly and co-dependently with other factors. The traditional model for such change moves through four steps. First, a resource or environment is recognized. Use of this newly recognized resource eventually leads to exploitation where humans tap resources for the benefit of their own expansion. After a period of exploitation, humans often realise that a resource or environment requires management and conservation and try to implement strategies to achieve this. Lastly, humans will relinquish control of the resource or environment. This model becomes increasingly complex when large numbers of systems interact. Each subsystem has its own cycle based on this model but affects a larger system of which it is a part. Thus, when considering Megacities, it is important not only to focus on solving a particular issue that holds a special priority, but to plan strategies that consider the system as a whole and recognize that issues that may appear to be highly localized and small scale, may be part of global changes.

In terms of Megacities and their surroundings we have three categories of environment, all of which are affected by the four crises mentioned above and all of which affect each other. These categories are urban environments, cultivated environments and wild environments. In order to form strategies that balance all these co-dependent systems and subsystems in a sustainable and resilient way, we need an interdisciplinary approach.

2. Waste recycling and sustainable development in Qingdao

Prof. Meng Wei – is the president of the Chinese Research Academy of Environmental Sciences (CRAES). He is a senior expert on water pollution control technology and a member of the Environmental Protection and Resources Conservation Committee of the 11th National People's Congress.

AS China's urban population grows, sustainable development, recycling and the development of a secure economy are high priorities. There are currently 661 main cities in China. These cities have a combined population of 0.69 billion and an average GDP of $5540 per capita. These areas of high population concentration produce a vast amount of solid waste. This waste falls into four categories:

1. Municipal solid waste.
2. Industrial waste.
3. Hazardous waste.
4. Other waste such as electronic scrap.

With vast amounts of solid waste being produced, this resource needs to be tapped through recycling in order to ensure resource consumption is sustainable. There has been an increase in the rate of waste recycling of approximately 45% in the last few years. In 2010 2.4 billion tons of solid waste were recycled across china with a yield from recycling processes of just under 70%. The majority of recycled material is used in building so as to meet the demands of china's ever expanding urban population.

As China's cities increase in economic prosperity, there is much higher rate of consumption of E-waste in cities. This consists mainly of computers, televisions, refrigerators and washing machines. Dealing with this waste has proven a problem in terms of creating a circular economy. However, some companies have recently taken on the role of storing hundreds of thousands of units of E-waste and presenting them for resale in order to meet China's demand for electronic goods without the resource cost associated with generating new units. Such projects have saved $8 million a year in Qingdao and achieve resale rates of 52% with only 17% of E-waste units lying idle.

In addition to domestic and consumer waste, China is currently in the middle of a period of extensive industrialization. Industries centred in China's expanding cities produce huge amounts of solid waste which places great strain on the environment. It has been shown that, by considering the use of resources in industry as a circular economy, much of what has been considered industrial waste can be recycled in another industry. For example, the Carbide Slag from PVC production can be reused in Alkali chemical production and the White Mud from this process can be put to use in local power plants. In order to coordinate such processes, a new information exchange has been set up to allow these resources to be effectively and efficiently tracked and allocated to useful sectors.

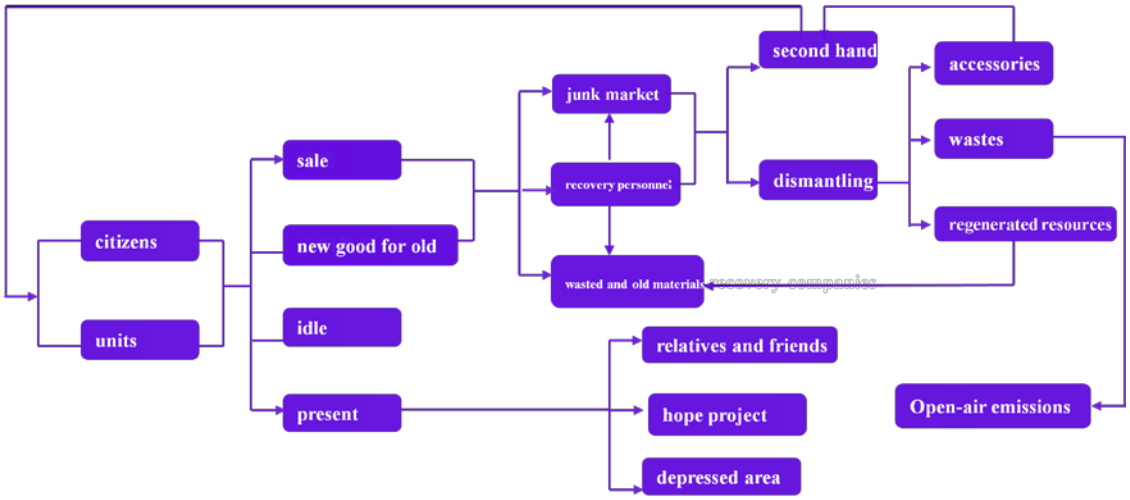

Figure 1: The circular economy for e-waste in Qingdao.

In Qingdao, energy requirements for expanding Megacities are also under consideration in order to further the development of a stable economy. It has been proposed, for example, that the thermal energy stored in the sea could be harnessed with a potential yield of 900MW. Wind energy projects have also been implemented in Huawei and Solar power demonstrations have been held in the Mo river park which are projected to reduce the coal use of local power plants by 0.45 tons per year. These energy innovations as well as the promotion of recycling are conducive to a motion towards a more stable, circular economy where increasing resource demands are met in renewable and sustainable ways. In the future, these projects will continue in the four directions mentioned above:

1. Analysis of industry structure and resourcefulness with a view to solid waste recycling.
2. Recycling of the main components of the industrial waste production of Qingdao's factories, especially carbide slag and white mud.
3. The development of the solid waste information exchange platform and E-waste recovery systems.
4. Environmental safety and security in the acquisition and recycling of resources.

3. Resilience and Development of megacities and Land Use

Prof. Wolfram Mauser, Ludwig Maximilian Universität, Munich, Geography

When trying to understand our environment, we must consider the system at work within it in a dynamic fashion. Of course, some systems have very short lifetimes and are difficult to capture in observation, but it is only by considering dynamic processes that we can form strategies to work sustainably within an environment.

A key aspect of the human environment that has changed during our evolution is our use of land with regard to food resources. The human metabolism in isolation requires 3.5GJ of energy a year. In hunter gatherer societies, this changes to 10-20GJ per year, corresponding to 2-3 tons of material. In agrarian societies, this rises to 60-80 GJ and 4-5 tons of material. In modern day industrial societies humans require about 250GJ and 20-22 tons of material per year. The results of this change with respect to human environments is a rapid increase in the use of fossil fuels in order to generate the vast amount of energy required, a rapid increase in population and a rapid increase in income.

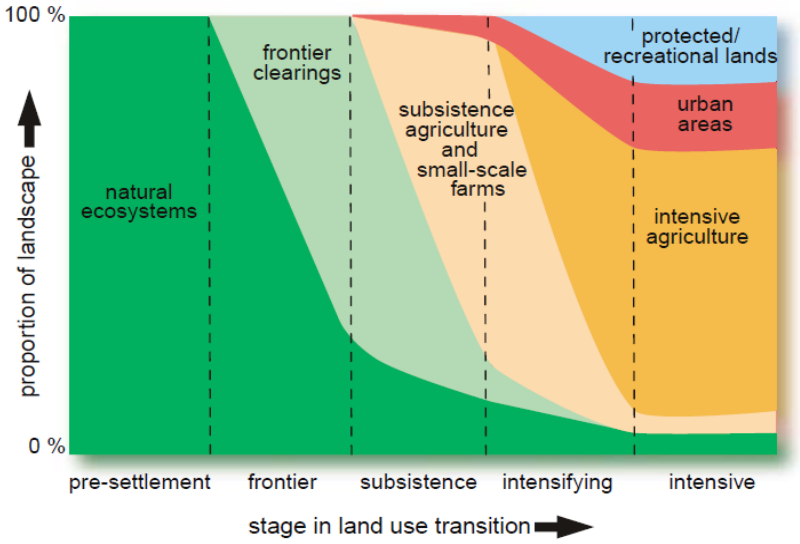

Figure 2: The use of land as human society progresses from hunter-gatherer to fully industrialized and urbanized. Note the vast reduction in natural eco-systems and the relatively small contri-bution of protected lands.

Due to these changes, humans begin to alter the land around them to fit their purpose. This progression usually takes natural land and clears it, opening it up for further use. This land is then used for subsistence farming which is relatively low yield but also does not place much strain on the resources of the environment. As population grows, this subsistence farming becomes intensified and industrial. Further increases in population and income promote the creation and growth of denser population centres and the beginnings of urbanization. It is only after urbanization has begun that areas of conservation begin to appear where a semblance of the original natural system is restored for recreation and improvement to

quality of life. The rapid increase in the population, size and requirements of urban areas results in the creation of megacities. In some cases, such as Western Europe, this growth eventually reaches a stable state. It is too early to tell if societies that are currently undergoing periods of intense industrialization, such as China and India, will also stabilize.

Megacities can be considered as a form of organism that takes in vast amounts of natural resources, processes them and outputs waste products. However, these waste products can be very damaging when disposal is uncontrolled. A key resource to consider is phosphorous which is crucial in fertilizing arable land. It is currently impossible to artificially construct a food chain that is not based on phosphorous. It is a non-renewable resource since it does not occur gaseously in the atmosphere but dissolves in the ocean and is irretrievable once it has done so. 18Mtons of phosphorous are distributed over arable land per year but only 3Mtons of this enter human food and only 1Mton then goes into excretion. The rest is lost, mainly through erosion of soil that eventually takes excess phosphorus to the sea. Some is also lost in waste management systems and water. This is particularly pertinent to western societies where higher consumption of meats means that the phosphorous requirements per capita are far higher than in less meat heavy diets. Use of bio fuels also increases phosphorous requirements.

Despite its important, there is currently no organised system to reclaim phosphorous from waste management systems or arable land. Thus, in the future, areas with high concentrations of phosphorous will become very important in the global food market. Currently, the largest known phosphorous reserves are in China and North Africa but these reserves are not readily harvestable. As the worlds phosphorous consumption increases, recycling and reclamation must be considered seriously. The majority of current losses are based in modern farming methods. By using methods that do not have such a significant accelerating effect on erosion, phosphorous in soil will not be lost so quickly. In addition, by harvesting manure and waste for phosphorous, a large portion of the phosphorous lost through consumption can be reclaimed. This must be done through technological advances. Though viable solutions do not yet exist, the problem is now known and research activity in this area is increasing. Phosphorous loss in modern infrastructure is a perfect example of why systems need to be developed to be resilient.

4. Discussion 1

To Prof. Mauser: Forty years ago there was no indication the phosphorous was limited and running out. Now we hear this horror story! How important will this problem be in the future and is there really no alternative to reclamation? Is this, in fact, the main problem humanity will face in the future?

Prof. Mauser: The fact is, we don't know and we didn't know forty years ago. It is not a renewable resource and the food chain is based on it. We will have to see what happens in the next few years.

To Prof. Meng Wei: You mentioned the influence of culture. We usually try to solve problems through technology. How will culture help us live more but need less?

Prof. Meng Wei: Perhaps we need more communication between cultures. I am from Qingdao which is a very saving conscious society, In the 60's, we would reuse water 3-5 times before disposing of it and even though we now have a regular water supply, we are still saving conscious. Conscience is very strong in China, the society is largely against luxury at the expense of natural resources. However, China has become the number one production site in the world and, thus, has consumed a lot of resources and produced a lot of pollution. We have supplied many luxuries at the expense of the environment. The way to solve this is to universally agree to live a low carbon life, both producers and consumers, and to promote, through organisations like the IESP, working together to make more sustainable contributions to the world.

To Dr. Grambow: I lived in a very beautiful rural area of Germany for many years and had a very high quality of life. I didn't want to urbanize because I found cities very crowded, as they must be in China. However, China seems to have a much lower quality of life in rural areas compared to its cities. Is the pathway to Megacity development very different in different countries?

Dr. Grambow: Fifty-five years ago in Bavaria, villages started to die as people moved to urban areas. This was a shock to the Bavarian government who understood that the stability of the region was based in rural areas. People wanted to provide similar living standards in rural and urban areas. Not the same, but similar. It was wise to promote this and to help people to work in rural areas without the need to migrate. Munich can be considered as a 'big village' with a good quality of life in the city and in the villages around it. But this is not easy to achieve and not necessarily sustainable. The battle for the world may be fought in Megacities but the battle for Megacities is fought in rural areas.

Part 2 - Sustainable Land Use in Megacities and the Supporting Land

Breakdown of Key Topics.

- The importance of land as a resource.
- The need for cooperation and planning to reclaim contaminated land.
- The effect of industry on land and atmosphere.
- China's plans for mediating pollution and contamination.
- Architectural considerations of Megacity efficiency and sustainability.
- The difference between Urban and Rural planning requirements.
- The role of infrastructure in sustainability.

5. Sustainable use of urban contaminated land in China: Problems and Countermeasures.

-Prof. Li Fasheng

Among the resources consumed in the expansion of Megacities, land is one of the most important. China possesses a significant asset in this regard but quality as well as quantity must be considered. China's population currently numbers approximately 1.3 billion inhabiting an area of 9.6 million square kilometres. However, only 18.2% of this landmass is occupied by forest, compared to the 31% global average. High quality land is under ever greater demand as Mega Cities such as Beijing and Shanghai continue to grow. The environmental pressures of atmospheric emissions, water contamination and solid waste disposal threaten what arable land remains. With the urbanization level of china rising to 50% and cities like Beijing increasing four times in size since 1984, high quality land is becoming a valuable resource. Reclaiming contaminated land and conserving the land that remains is, thus, of great importance. While many countries posses environmental databases, containing information on known contaminated areas, the severity of certain contaminants and the methods available for dealing with them, China does not yet have a comprehensive review of the state and extent of land contamination.

In order to effectively implement reclamation projects in areas of contamination, a proper assessment must be undertaken of priority sites. A key source of land contamination is industrial waste. For example, China produces 90% of the world's chromium products. Such industries leak by-products into the surrounding soil, creating harmful concentrations of toxic chemicals. By considering two major industrial cities, we can assess the level of such damage and how reclamation can be undertaken to mediate and reverse the damage.

Beijing has an extensive Mechanical industry and Chongqing is chiefly concerned with metallurgy. These cities both cause extensive contamination of the surrounding land but contamination levels peaked at different times (Beijing in 2002 and Chongqing in 2008). This is largely due to the extensive relocation of Beijing's industries during preparations for the Olympics. Beijing has shown that it is possible for large industrial cities to moderate their impact on the land.

Currently, the key factors hindering redevelopment projects are as follows:

1. A lack of sufficient data detailing the number, condition and priority of contaminated sites.
2. A lack of appropriate policy driving and directing action.
3. No risk management protocols to protect workers.
4. A lack of cost effective technology for dealing with badly contaminated areas.

The challenge to establishing a proper database is the size of china's landmass and industry. In contrast, European countries tend to have accurate and extensive data on areas of contamination (i.e. Germany has 240,000 recorded contamination sites) and the United States has established a national priority list supported by government policy. China has not even established a proper estimate of the number of contaminated sites. It is hoped that, by calling on the experience of Europe and the USA, the problems of technology and data collection can be overcome. The problem of policy is somewhat more difficult since land in China is 100% state owned whereas Europe and America is mostly privately owned thus simplifying the problems of responsibility. The problem of risk management is also highly complex since soil is a spatially heterogeneous and chemically diverse medium. One must also consider that the criteria for severity are very different for China in comparison to Europe with some contaminants shown to be 10,000 times higher in China than in Europe. This difference in scale must be factored into considerations of risk and prioritizing reclamation.

Despite these problems there has been a great deal of progress. The Department of Soil Pollution and Control have begun risk assessments and cataloguing of contaminated sites. Reclamation projects are underway for some sites in collaboration with the USA and the Netherlands. In addition, collaborations with Oxford University in 2005 and Germanys GTC in 2011 have generated new possibilities, both technologically and in terms of policy making. The continued economic growth of China means that we are likely to see an increased risk of contamination in the future. However, the increase in available resources that accompanies this growth also makes it more likely that viable solutions can be found.

6. Balancing Out Urban and Rural Development

-Prof. Mark Michaeli

When designing new projects, architects and planners must consider not only the masterplan for the project itself but the limiting factors and constraints that may affect its implementation:

1. Financial constraints.
2. Organization.
3. Agreement on designs.
4. Time constraints.

All of these factors must also be considered for the future of a development as they are all related to the sustainability of a project. So how can we design projects so that they will be stable and resilient to current and future problems? We need to be able to understand and account for the above limiting factors and speculate accurately as to how these problems will affect the future.

Such considerations are important in urban and rural planning. Current understanding separates rural and urban development and conservation of the natural environment. However, the truth is that we do not yet understand enough to accurately plan for the minutia of megacity operation and how this relates to the surrounding environment. Creating areas of isolated urban development and artificially maintained “green” areas is not productive and not sustainable. In reality, most urban developments are centred in areas of fertile land. Thus, through urban expansion, the best land is consumed.

By mapping the development of urban and rural areas together we can see that urbanization does not occur in a few isolated population centres but through a wide and diffuse network. Urban and rural areas develop in a similar fashion both demanding similar lifestyle or at least comparable living standards. This development destroys agricultural land and forests reducing the stability and resilience of the land. When planning future development, we need to focus on mitigating future problems. This would appear to be logistically simple until one considers the knock on effects from introducing new policy to a settled area. For example, if one wishes to widen a narrow waterway to reduce flooding risk, houses have to be moved. However this leads into a serious conflict of interests between private property rights and the public realm, aiming decreasing flooding risk downstream.

We can improve the sustainability of urban development by considering the efficiency of the distribution network around which a megacity is centred. A survey of US food deserts, areas where commercially available food was of poor quality or in short supply, showed that areas of high food production are the most likely to offer inadequate supplies to consumers. This is due to inadequate organization of the distribution of food which prevents the value of the goods produced in a region from contributing fully to the regions wealth. However, attempts to fully localize food production are unlikely to be successful. Such a project in New York found that the available arable land in New York could only contribute 4% of the cucumber crop consumed in the city. Industry is required since the knowledge and facilities for harvesting and processing are not all located in the same area. Thus, we must have an efficient network for the production, processing and distribution of goods.

Poor organisation of urban and rural systems is generally due to attempts to organise both areas through a common approach. Local areas must be considered individually and as part of a bigger network. An example would be the problem of noise pollution in residential areas near Zurich airport. If a system can be designed to shift housing away from the airport and shift industry and facilities closer to the airport house prices can be increased without reducing the efficiency of the facilities. However, such schemes must be very detailed and act over long time scales, this case taking approximately 30 years up to two generations. It is impossible to create a generalized model for such projects and thus it must be an interdisciplinary endeavour considered on a case by case basis. Similar projects have been planned to design districts to improve waste and water filtering systems, raising land value and living standards and reducing costs.

The key to reorganizing cities to be efficient is to approach organization on a local level while understanding that each district is part of a larger network. A great deal of theoretical effort has gone into demonstrating how redevelopment projects on a local scale can be used to slowly restructure cities to make them more efficient. Restructured cities can be planned so as to be stable to future change and to use resources efficiently. Developments can be considered on a case by case basis and adapted to the specifics of a certain land relief, environment or role in order to produce unique designs that contribute to a more sustainable megacity at its region.

7. Discussion 2

To Prof. Michaeli

In the past development has taken a centralized approach. In the future, perhaps a decentralized approach will be better. However, as this is not only a technical problem but also an educational problem, we need to educate and reorganise on a more personal level. Should we approach cities as a living organism that absorbs resources and redistributes them?

Prof. Michaeli: Yes, in general I agree. However, to make a system efficient we must integrate on a small and a large scale. For example, small farms are integrated part of a larger processing and distribution network. In energy, large-scale and small-scale production of power, e.g. by power stations on the one side and wind turbines on the other might complement each other or create redundancies which make the system less vulnerable and by this provides security of supply. Our approach to efficiency and sustainability is changing: "resilience" becomes a key factor. In logistics and retail we can observe the same development as mentioned before in the energy sector. After a period of ever growing centralized systems we know can find more sophisticated ways of organizing the flow of goods from production to the customer and by this not only raising efficiency but also giving new impulses to spatial development.

To Prof. Michaeli

What are the key differences between efficient and inefficient commercial systems?

Prof. Michaeli: One would be flexibility of range of products in retail. For example, in Germany umbrellas are available all year round. In Japan, they are only sold when rain is likely. This makes supermarkets smaller and more efficient. Here information and sales mix are coupled with a highly efficient distribution system. As well we can observe, that the location of the shop might have major impact on the flow of people in the urban space. Even train stations and the area around in that way are organized to optimize the flow of passengers.

To Prof. Michaeli

I come from Santiago, a city of 7.5 million people. There, we discuss the idea of a city made from cities and of moving the characteristics and functions of different areas about a megacity. How do we organise the different sections of cities?

Prof. Michaeli: Organization based on statistics does not work for very long. We need to continuously study how people work and move through urbanized areas, how they "make use" of the urban area. In Munich there are several areas that form natural centres but a great deal of effort went into creating a single centre resulting in transport inefficiencies we are facing today. In the future we expect to see cities develop with a variety of centres and sub centres in a polycentric metropolitan region.

To Prof. Michaeli

Can we design new cities close to existing Megacities to ease current problems?

Prof. Michaeli: This is dependent on the case. Addis Ababa attempted to do this when migration threatened to overwhelm jobs and housing. Independent and self sufficient cities are under planning and construction around it. But such success is dependent on the structure of economy. Maybe, such an endeavour would not be viable in Europe due to the costs associated with new development.

To Prof. Michaeli

What limits are there on the size of Megacities and what is the relationship between size and efficiency?

Prof. Michaeli: There are theories that suggest 500000 to 1000000 people should be the optimum population but most cities easily surpass this and keep growing. Since large cities exist, we have to organize them. There are very large cities that work very efficiently but this is due to organization not size.

To Prof. Li Fasheng

How are we learning from the wisdom of China in our strategies?

Prof. Fasheng: We want to develop our Megacities into the future but the situation in China is very different to that of Europe. We need specialized knowledge to deal with individual cities. China's population is big but Europe's population is more evenly distributed. In China, people migrate from rural to urban areas but this is not always the case in Europe. China has more experience with its own cultural traditions and can use this in the development of its own Megacities.

To Prof. Li Fasheng

You mentioned India and China's role in the disposal of waste. Is there a viable alternative location that would also be cost effective?

Prof. Fasheng: For the disposal of E-Waste we must use cheap labour as the profits are very low. Also, the economic effect of this industry is very important in China and India. We need to develop a greater awareness of the environmental impact of E-Waste and try to take on less waste and protect our environment more. Socio-economic policy should be introduced to mediate the impact of this industry.

To Prof. Li Fasheng

Are there policies in China to encourage the development of contaminated land?

Prof. Fasheng: In the last 5 years China has implemented a number of policies and directives to regulate contaminated areas and relevant technologies. However, China needs to coordinate its environmental departments better in order to pool the resources of multiple departments so as to find environmental solutions.

To Prof. Li Fasheng

What technology is required for E-Waste management?

Prof. Fasheng: More and more E-waste is being produced which contains hazardous material. Even if the number of units is not higher the contamination is worse. There is no particular solution for E-Waste management. At the moment, contaminated soil is simply removed and then buried but this is a costly approach. We need to coordinate with German technology companies to find better solutions.

To Prof. Li Fasheng

You mentioned the idea of a life cycle for land use. Isn't this just a theory for analysis? How does it apply to disposal of products?

Prof. Fasheng: The theory is true for E-Products with short life cycles. We should be adapting products so that they have longer lifetimes and are not so harmful when disposed of. The life cycle idea shows us that a potential solution to waste management problems is to design them to be used for longer.

Part 3 - Sustainable and Integrated Water Management in Megacities

Breakdown of Key Topics.

- State of water pollution in the Bohai region of China.
- The role of assessment in environmental protection.
- Balancing industrial development and environmental conservation.
- New systems for water recycling.
- The use of systems that promote recycling without impacting on lifestyle.
- The semi central approach and plans to implement this approach in Qingdao.

8. Water Pollution Control and Management in Bohai Ring Megacities.

Dr. Lei Kun – served as a professor of the Chinese Research Academy of Environmental Sciences (CRAES). Her main research fields are material flux from watersheds to coastal zones, environmental quality evaluation, environmental evolution trends and mechanisms with a focus on human activity. Recently, she has served as a project leader for "Techniques for Control Unit Water quality target managements" and "The 12th five year plan for coastal environmental pollution prevention and control."

There are eleven coastal provinces in China and a total of fifty two coastal cities. These coastal regions constitute just 13.34% of China's total landmass and yet hold 42% of the national population and 56% of GDP. Three of these provinces are located on the Bohai sea. The cities of the Bohai ring are highly industrialized with oil, steel and shipping as the main industries. The steel industry in Bohai accounts for a seventh of the national industry and oil production for a third of national production. However, alongside this heavy industry is a valuable coastal ecosystem and National Marine Reserve.

The state of Bohai's ecosystem can be assessed in part by looking at the water quality of the three river basins that drain into the Bohai sea. Water quality is divided into five categories. Only 40% of the rivers in the Bohai area fulfil the criteria for the lowest of these categories. This shows how severe the environmental situation is in Bohai. The water table is contaminated with phosphorous, nitrogen compounds and waste from oil production. This has resulted in polluted waters in Liadong, Bohai and Laizhou bay. Of six environmental monitoring areas, five have been shown to be sub healthy and one is in a state of ill-health. Protected wetlands near Tianjing have also declined over the last fifty years as land use has shifted towards heavy industry and intensive agriculture.

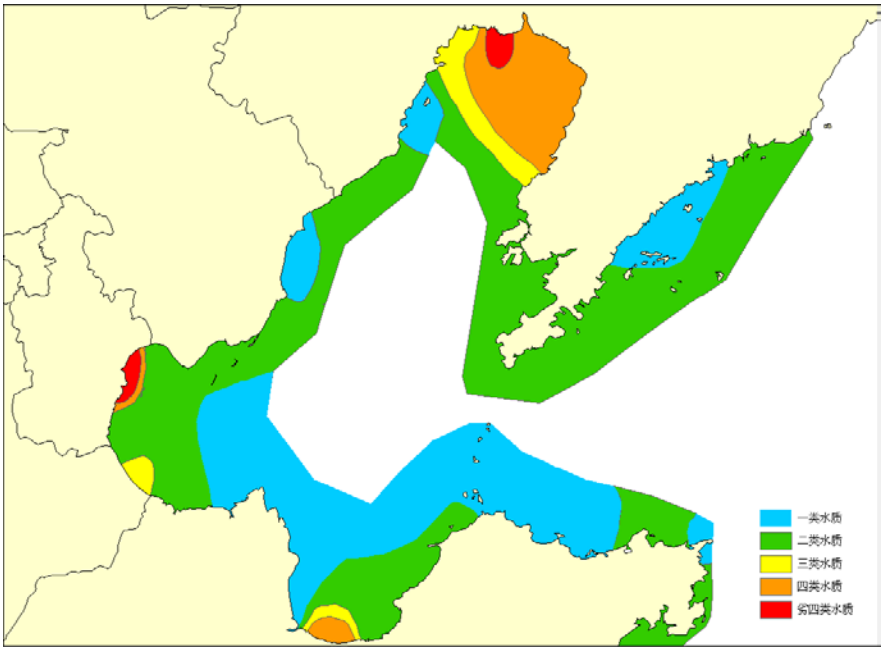

Figure 3: Map of the Bohai bay showing the levels of contamination in different regions. Note, the central region is largely unaffected but the three smaller bays have been heavily contaminated by industrial activity.

The cities of the Bohai region vary in the spectrum of pollutants they produce but the highest overall contributions come from Dalian and Tianjin. There are seven core industries that contribute to pollution. Some have been shown to run quite efficiently such as the chemical industry while others, such as the paper making industry, produce far more pollution in Bohai than the national average for these industries.

In recent years, there has a drive to develop the key economic areas of China. Since 2007, the central government has pushed through 14 regional development plans five of which are specific to developing the north east and Bohai as a key industrial area. These directives are focused on accommodating the rapid growth of Bohai's megacities. There are plans to reclaim 3370 km^2 of land around coastal regions to allow industries to expand. Economically, this is a viable endeavour as the cost of reclamation will be 220-520 Yuan per m^3 while the land value will be 2000 – 3000 Yuan per m^3. However, these expansion plans further threaten the damaged coastal ecosystems. Thus, there is a pressing need to find a solution to the dichotomy between conservation of Bohai's ecosystems and expansion of its industries.

So how can conservation and expansion be achievable? Firstly, Bohai's ecosystem needs to be stabilized, if it is allowed to continue to decline the damage may become irreparable. In order to do this, an environmental monitoring and conservation system needs to be applied over the entire bay to measure and control contaminant levels. Once this is achieved, dependence on heavy chemical industries can be reduced by upgrading industrial

technology and rethinking industry models. In addition, by identifying key industries and focusing on their development, management and control can be simplified. By introducing circular economics and ecologically minded industrial parks, the environmental impact of further industrial development can be minimized. With these strategies in place, we can begin restoring damaged ecosystems by increasing the flow of freshwater from the surrounding river basins and improving water quality as well as minimizing artificial land reclamation along the coastline.

9. Integrated water infrastructure for megacities – needs and strategies for sustainable development.

Dr. Ing Susanne Bieker and Prof. Peter Cornel – Dr Susanne Bieker studied spatial planning and worked a consultancy, focusing on spatial and organizational effects of demographic changes. She then worked as part of the Environmental and Spatial Planning group at TUD. Her main research fields are the integration of different infrastructure sectors and their implementation in organizational and operational structures. She is an elected member of the DWA working group (German Association for Water, Wastewater and Waste.)

Here we will present the benefits of the semi centralized approach to waste management in Megacities. This approach allows the facilities that allow a city to function to expand along with the city without the need for extensive reengineering.

The main challenge faced in Megacities is population growth. By 2050 we expect to see the global population rise to nine billion people and almost all of this will be in the form of urban expansion. Currently 50% of the world's population live in megacities and this is expected to rise to 70%. As the population grows, we need to be able to able to deal with the resultant waste and water requirements. However, there exist only a finite amount of resources for these systems and water of sufficient quality is in short supply.

One of the main problems is that the industrialized world focuses on centralized industrial sectors in its planning, a tradition that began in Europe and has now spread to China. This system is outdated and produces infrastructures that do not take advantage of modern technology. The fact is that it is no longer sustainable not to recycle the resources we have available. For non renewable resources such as phosphorous, we need to start implementing circular economies. In order to do this we need a system that can grow along with urban expansion unlike, for example, underground sewage networks that take years to build and cannot be modified after construction.

In terms of water management we need to maximise reuse as much as is safe and also minimize the need for pumping and transport in order to conserve energy and cost. However, we do not want to move away from centralized approaches entirely as we still need professional, high quality water processing systems to ensure water is of sufficient quality and waste is safely dealt with. This is the basis for a semi centralized approach that integrates professional management but maximized reuse and adaptability. A semi centralized approach is primarily an issue of planning and organization.

The semi centralized approach focuses on smaller, compact systems. Small treatment centres can be constructed for individual city sectors and as the city expands, new treatment centres can be added at minimal cost. Qingdao is a prime example of why this approach is needed. The city currently hosts a population of 8 million people and is expected to grow by 5 million by 2020. The current infrastructure and water supply cannot support this additional population. Current plans aim to solve this by desalinization of seawater but this is very costly in terms of energy. The costs for this process are ten times that required for implementing a semi centralized approach to reduce water demand and processing. The aim of the semi centralized approach is to make people aware of the scarcity of water and use it responsibly without reducing comfort or living standards. Of the 109 Litres per capita per day used in an average household, 41 litres goes to grey water processing centres. This grey water can be reused for purposes that do not require a high level of sterilization. The idea of reuse can be extended to solid waste as well. Of the average 1kg of solid waste produced per capita per day, 250g can be recycled and reused. Implementing these systems reduces the demand placed on water resources and on processing. We can also remove the problems of bio waste disposal by intruding anaerobic treatment methods that allow bio waste to be reused as fertilizer.

The semi centralized system presents a leap forward in planning security since significant investment will not be required to adapt the system to cope with future demand. In addition, when expansion is necessary, the smaller scale of the local treatment facilities means they can be operational in a far shorter timescales. The semi central approach has been shown to be theoretically sound and the technology required to create efficient local treatment centres does exist. The first semi centralized system will be implemented in Qingdao in order to supply the world horticultural exhibition. The system will remain in place as a proof of concept for the hotels, exhibits and worker villages that accompany the exhibition. This implementation will be relatively small scale, serving 12000 people but the semi central approach is defined by its ability to adapt to different demand. Construction of this system will begin in October.

10. Discussion 3

To Dr. Bieker

Will the Semi central system be implemented in residential areas of Qingdao?

Dr. Bieker: We are working on two development areas. One for a small population of 6000 people and another servicing two hotels and the workers village. There will be additional developments on the site after the World Horticultural Exhibition when the land will be sold.

To Dr. Bieker

What is the reaction of residents to this system? In Beijing, similar systems resulted in concerns regarding hygiene during the SARS outbreak.

Dr Bieker: We know about the problems Beijing faced with using grey water. We will be open with citizens regarding this endeavour. It will be a fundamentally open process. We have not taken public questions yet but we will later on during the implementation process.

To Dr. Bieker

Which disciplines are working together on this project?

Dr. Bieker: We started with four research departments: waste management, waste water processing, supply and spatial management. We now have partners in architecture and energy supply and others to help with planning and operation. The work group is now very large and multidisciplinary involving 20 groups and 6 companies.

Addendum from Peter Cornel

We are not only collaborating on the German side but also with Chinese research groups such as Qingdao technical University. We need a large group to manage the system, not only in a scientific capacity but also in an administrative one. We are constantly adding new people to the team as the project grows.

To Dr. Kun Lei

What changes do you expect to see in Bohai in the future? What do you expect the situation to be in twenty years and what might have been done to reach conservation goals?

Dr. Kun Lei: We have not yet optimized our strategies for dealing with future problems in coastal and urban areas. New industrial parks are being constructed and a great deal of land is being consumed by industrial expansion. It would appear that, currently, things are only getting worse.

I feared this would be the case. It would appear that the ocean is the most important subsystem in terms of conservation. If we can't protect it, things will get much worse.

Dr. Kun Lei: We are now planning to prioritize protection of our coastlines and our research group has submitted proposals to the government to ensure a line is drawn against the destruction of protected ecosystems. We must hope that these proposals we be accepted and implemented soon.

To Dr. Bieker

How do you go about separating the different categories of waste water?

Dr. Bieker: Our concept is not to influence the living habits of households. We will use separate sewers to collect grey and black waste water. People living in a flat who live with the semi central system should not notice a difference in their lives. In terms of cost, there will be an initial investment to get the system operational or to implement it in new construction. This system is generally intended to be implemented in areas of new development where this set up cost will constitute only a small fraction of the construction cost.

To Dr. Bieker

How do we expand a system that has only been implemented for 6000 people for a global population that is growing at a rate of 11 million per year?

Dr. Bieker: We have been working with Qingdao for three years. The challenge is not the scale but getting a developer to take the risk of being the first to use this system. We need to demonstrate that it works in a controlled way. Then we can start applying it to larger projects.

To Dr. Lei Kun

Can we continue to base future predictions on past numbers? What will happen in Bohai if there is a sudden and dramatic change in the situation, for example if the oil supply runs out?

Dr. Kun Lei: The issue of energy is very important for development and Bohai's oil production continues to constitute a third of national production. If the oil runs out in Bohai, the energy department may move to deep sea oil drilling or move the industry to another part of China.

To Dr. Lei Kun

At the moment there is a trend of using artificially reclaimed land. Is this positive or negative?

Dr. Kun Lei: The coastal ecosystem is very important in the development of coastal cities. With current economic trends we can imagine that future expansion will take place along the coastline. This development is very important in terms of the country's economy and thus cannot be derailed. The government will, hopefully, take the initiative to protect coastal ecosystems. Ultimately, it is a question of balance between development and conservation. I think artificial land use can be positive if done responsibly.

To Dr. Bieker

If we are running out of phosphorous as has been suggested, would it not be possible to harvest it from waste?

Dr. Bieker: We do not want to challenge perceptions or comfort too much. As prosperity increases, people's expectations in terms of living standards also increase. We want people to accept the system during its implementation and that means not causing significant changes in people's lifestyles.

To Dr. Bieker

How will your system be a tempting prospect for investors?

Dr. Bieker: We will accompany this first implementation with a detailed research project to accurately track the benefits of the system and encourage future funding. It should appeal

from a costs perspective due to the savings associated with efficient water reuse and processing. Promotion and new projects will be our focus over the next few years.

Part 4 - Energy Supply and Air Quality

Breakdown of Key Topics.

- The effects, both economic and environmental, of the Nuclear Phase out.
- The state of the Carbon Trading Scheme.
- Expected future changes in the energy generation structure of Germany.
- Balancing carbon targets across provinces in China in order to meet emission standards.
- The effects of Urban Pollution on air quality.
- Future strategies for improving air quality and examples of their success in Beijing.

11. Transformation of the German Energy system.

Prof. Dr. Andreas Löschel is head of the Research Department "Environmental and Resource Economics, Environmental Management" at the Centre for European Economic Research (ZEW) and Professor of Economics at the University of Heidelberg. Since 2011, he chairs the government's Energy Expert Commission to monitor the energy transformation in Germany. He serves as Lead Author in the Working Group III contribution to the IPCC Fifth Assessment Report (2010-2014).

This presentation will cover three key topics:

1. Ideas regarding energy currently held by the German Government.
2. The European Emission Trading System.
3. Suitable indicators with regard to the progress of sustainability directives.

Current energy policy is based on two year old predictions that model the long term vision of viable ecological energy production over the next century which includes a reduction in Nuclear power; a process that was brought into policy before the Fukashima disaster. To monitor the progress of this model, the government has set up scientific monitoring protocols. The Fukashima disaster prompted an immediate shutdown of 40% of Germanys Nuclear facilities. However, long term plans had already aimed to phase out nuclear power

by 2022, a process which had been planned as long ago as 2002. In 2011, policy was altered to allow an extension of the lifetime of currently active nuclear power stations, a plan which has since been reversed.

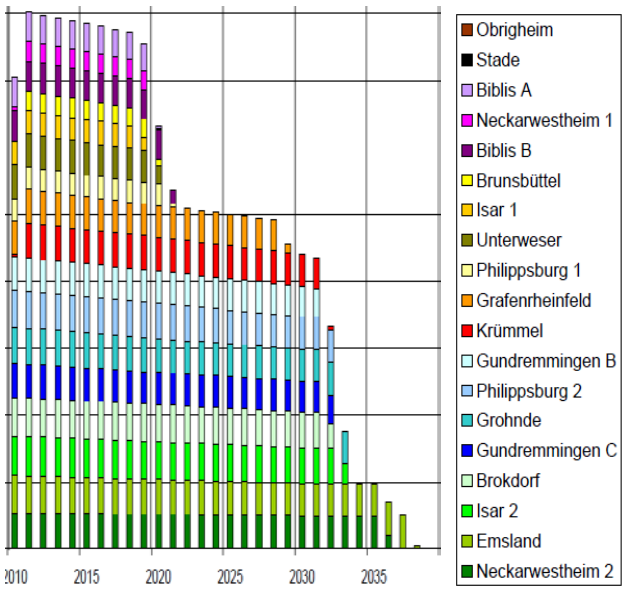

Figure 4: The Nuclear Phase out plan as proposed in 2011 showing the major power plants that are intended to be active each year.

A number of projections have been prepared accounting for a number of different future scenarios. These models can be applied to predict what will occur over the course of, and after, the nuclear phase out. These models can be applied not only to Nuclear energy but to a range of different components of the energy problem. Current energy targets in Germany are very ambitious and maintaining these targets is of great importance. Current energy targets still stand after the Fukashima disaster with 30-35% of Germanys energy expected to come from renewable resources by 2020.

So what do we expect to see, given these models, in both Nuclear phase out and extended nuclear lifetime scenarios? It has been found that neither scenario can support a 40% CO_2 reduction since 50% of CO_2 production in Germany is beyond government control being produced by private and personal emission sources. Extended lifetime scenarios are expected to result in a slight reduction in overall CO_2 reduction since the energy produced via nuclear power will not have to be replaced with other sources. However, the reality is that we do not expect to meet renewable energy targets in either scenario. Nuclear power does not appear to significantly affect the development of renewable energy sources as Renewable Energy markets are driven by subsidy programs and promotions and are, therefore, not dependant on the energy market. In order to meet renewable energy targets we would need to double our renewable energy production by 2020 and, according to current predictions, this will be missed by a wide margin. With extended nuclear lifetimes

the margin will be even wider since energy prices will be cheaper and there will be less of a drive to move to renewable sources.

In order to make up the energy deficit created by the nuclear phase out we will have to expand energy generation in other sectors. So how will these sectors be affected according to projections? Coal power stations are not expected to change much as they will remain a core component of European energy generation. Renewable and gas generation are set to increase. The gap left by nuclear power is expected to be filled primarily by these sectors. However, gas power stations are generally not economically sound and are unlikely to attract investment, thus making them unstable as an energy generation resource. Ultimately, we expect to see overall energy generation increase but restructure to favour different sectors. Since we do not expect to see significant improvements in the efficiency of energy generation, we expect to see an increase in energy imports in the future from France and other parts of Europe.

Energiewende has been law for ten years but little change has occurred in that time. This is largely because it has not been taken seriously, but this attitude is now changing. In order to successfully phase out nuclear power we need to secure investment for future expansion as energy demand increases. Renewable resources offer very inefficient generation compared to other energy sources and, thus, are unlikely to secure this investment.

In terms of meeting CO_2 targets, the EU carbon trading scheme may offer a solution. This system allows industries to trade EU emission allowances in order to meet their own targets and ensure the necessary reduction in emission is met elsewhere. The system of trade behind the scheme is currently being remodelled and is moving toward auction based trade. A key question is whether this scheme actually works in terms of reducing overall CO_2 production.

Research has found that many of the companies involved in the scheme have introduced emission abatement measures but the motives behind these measures are typically motivated by efficiency and not ecological conscientiousness. Part of the problem may be that there is currently an excess of EU allowances available for trade. It has already been seen in Phase one of the Emission Trading Scheme, in which a certain number of free allowances were given, that low cost and numerous allowances resulted in no reduction in emissions from major companies. This kind of stockpiling of allowances has negative repercussions both environmentally and economically, since the trade opportunities offered by free allowance allocation are not being exploited. The result is that only a few of the major companies involved in the trading scheme are currently meeting emission targets.

It is noteworthy that we are only discussing the effect of CO_2, however, there are a number of other pollutants that must be considered as well. We must construct a comprehensive system of trade that fully documents the risks, price, demand and environmental concerns of the emissions trading scheme if we are to optimize this system. These issues encompass a broad range of complex socio-economic factors. For some of these factors, appropriate models already exist but for some, new databases must be constructed. It is only with such a comprehensive review in hand that we can accurately model the effects of the transformation of the energy system into the future.

12. The Low Carbon Index Development and Application

Dr Fu Jiafeng – is mainly engaged in the study of energy and climate change. Dr Fu Jiafeng worked with the Chinese Research Academy of Environmental Sciences and has been involved in a number of research projects. At present, he is involved in an environmental protection commonwealth projects "Development of a Low Carbon Economy Model and its Applications in Slowing Climate Change."

With increasing world population the issues of resource consumption, emission and climate change become ever more pressing. We need to protect the world against climate change by living a low carbon life. China has not currently made a CO_2 reduction commitment but has indicated a target of 40 – 45 % emission reduction by 2020. In order to achieve this we must set local reduction targets and ensure that each province meets its reduction targets in order to contribute to an overall, national reduction. In order to organise the allocation of reduction targets a zero sum gain model has been applied. This is based on a remodelling of previous models which assumed input output independence. That is, that an input into one particular part of a process does not affect the output of the other parts of the process.

In our model, emission is viewed as an undesirable output which can be allocated to certain sectors along with emission reductions. The goal of the resulting process is to assign emission and emission reduction such that the net undesirable output is zero. This is achieved by appropriate allocation of emission reduction targets and allowances. Currently, only nine of China's provinces achieve the required individual reduction targets. Ultimately we would like to see 100% of provinces achieving the required efficiency. Seven provinces have shown negative CO_2 reductions, net increase in CO_2 emission. Thus, in order to meet CO_2 targets, a reallocation process must be constructed to balance areas that are not able to achieve the necessary emission reductions against those who are showing good progress in terms of emission reductions. Using this model, we can see how much some provinces must reduce emission in order to balance out emission increases in other areas.

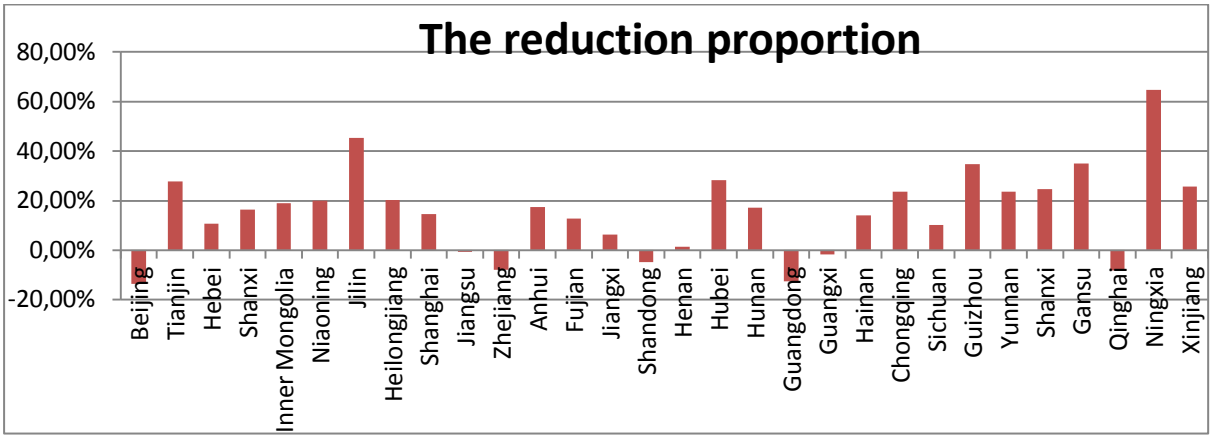

Figure 5: Reductions for the carbon emissions of major cities in China. The aim is to produce a system where the sum of all emission reductions is positive.

This allocation plan is not yet perfected as it still produces some unrealistic emission reduction targets in certain provinces. Fairness is an important factor to consider in order to ensure the burden of CO_2 reduction is not laid upon only a few provinces while others are given significant allowances. The ultimate focus should be to provide reduction targets that are feasible and which are environmentally beneficial with regard to the zero sum gain model. There are two key expansions which must be included in future models:

1. We must include other greenhouse gases since CO_2 is not the only contributor to climate change and many other pollutants are far more destructive.
2. We must include proper weighting to take account of relevant and important factors which affect emission i.e. Population and GDP.

13. Urban Air Pollution Control Strategies and Demonstration in China

Dr Gao Jian – is an associate professor of the Chinese Research Academy of Environmental Sciences. His main foci are atmospheric chemistry, instrument development, field measurement, air pollution management and control. In the past ten years his group have collected extensive data on fine atmospheric particles.

This presentation summarizes research undertaken since 2005 in support of the ministry of environmental protection in China.

China is characterized by a very high population and this translates to very high emission rates. Particulate emissions, such as organic carbon and ammonia, can enter clouds and return to the ground in precipitation causing chemical contamination and acid rain. Our research group studies these emissions to try to find ways to reduce them and their impact.

China may be the engine of the world, but is not adequately controlled. We must find ways of controlling its emission output and reducing the damaging effects it has on the environment. If this cannot be done, and indeed the effect of emission can be seen in China today, we face atmospheric issues such as haze, O3 reduction and acid rain.

Particulate emission components, including toxic components such as sulphites, are very problematic in terms of the atmosphere and are unusually high in China. This has also lead to an increase in secondary pollutants such as ozone and nitrous oxide. These pollutants not only lead to poor air quality but also severe haze effects over China's cities. These cities comprise a tenth of China's land but hold 30% of the population and 50% of the GDP and urbanization is only increasing, expected to rise to 70% in 2050. The pollution spectrum that arises from such a population is very complex and includes industrial by-products, coal burning emissions, car exhaust and others.

Measures have been taken to improve China's air quality. Limitations have been placed on coal burning and controls have been implemented to regulate the resulting emissions and similar controls have been placed on dust in urban areas. Key to progress in improving China's air quality has been an upgrade in the standards assumed for emission. China is now far less tolerant of high emission activities, especially in Beijing. This has lead to a reduction in primary pollutants. Air quality standards have been implemented for China's major cities; though at the moment 20% of these cities have been unable to meet air quality standards. This may be due, in part, to the new quality standards inclusion of a broader spectrum of pollutants which, while encouraging a more conscientious attitude towards pollution, presents new challenges for cities seeking to improve air quality to required standards. However, it is now recognized that air quality has a profound impact on environmental and human health.

So how can we improve policy to encourage better air quality standards? Firstly, due to the complexity of urban pollution, a proper inventory of pollution components needs to be compiled, one that is specific to the situation of individual cities. In addition, we need to encourage cooperation between different cities and provinces and combine their resources in search of more efficient solutions. In terms of policy, environmental strategies must be optimized and supervision enforced to ensure emission standards are met. In essence, the benefit of lowering pollution should be maximized and the cost of implementation minimized. The responsibility for meeting standards needs to be shared among different departments and levels of government to ensure a cooperative effort and equal opportunities to contribute.

There are four steps to implementing an effective strategy for dealing with atmospheric pollution:

1. Compile an inventory of emission components.
2. Diagnose the specific problems faced by a certain city or province.
3. Find the key sources of pollution.
4. Indentify an improvement that can be made to reduce the impact of this source.

Such strategies require extensive organization, finance and policy to promote action, financially or otherwise. In order to monitor progress, we must also set up proper evaluation systems to assess the progress of a particular initiative. Self examination processes can go a long way to monitoring the air quality of cities and this data can be fed back to relevant authorities. It has been shown that such mechanisms can be successful. The best example is Beijing's preparations for the Olympics in which a network of environmental agencies pushed through pollution reduction strategies and implemented them successfully through effective planning and monitoring. All main pollutants that had caused problems in Beijing were significantly reduced; though it should be noted that these improvements did not show much longevity. By 2009, pollution in Beijing was back on the rise. However, such a demonstration shows that, with more effective long term strategy, significant improvements can be made to the air quality of China's cities.

14. Discussion 4

To All

Is it really possible for us to achieve our targets given the data presented? Or, do we need revolutionary new ideas to change the way we generate energy? Are there people in China working on viable, revolutionary energy systems?

Dr Gao Jian: I think we can achieve our goals. We have shown that through efficiency and control we can improve our atmosphere and environment. We still have a long way to go before we can meet our targets but it is not impossible.

Dr. Fu Jianfeng: In the ministry of environmental protection there are a number of specialist climate change experts and they have not yet reached a consensus regarding our future. Some think things are likely to go badly but others are hopeful.

Dr. Löschel: As an economist I believe in ideas and that ideas are out there which may present a long term solution. However, for the time being we have to work with what is available. There is a great deal of uncertainty as to whether revolutionary technology will appear as and when we need it. Thus we must make plans assuming that it will not and form projections for future risks. New ideas are acceptable and can work so long as they are able to move from conception to reality. Germany, for example, has very strict guidelines on what technology can be subsidised.

Dr. Gao Jian: I don't know if or who is doing this type of research but it is not the right time. China needs to optimize its industry and current energy production before we consider revolutionizing.

To All

In Beijing, environmental collaborations reduced emissions in the short term but emissions rose again after the games. Can these strategies be effective in the long term? Also, in terms of technology, is there a gap to be bridged between research and society in China? Finally, we know of the key pollutants in urban areas but what are the main pollutants in rural areas?

Dr. Fu Jiafeng: China is still a developing country and we must think about how to resolve its emerging crises. While doing this, we must develop a new environmental program for the future. China is making progress in terms of efficient policy to manage environmental problems. So, we must continue to study and research but must also continue to put policy in place to guide our actions.

Dr. Gao Jian: In Beijing in 2008 we improved emission by shutting down and removing factories. After the games, emission rose again but in 2011 it is still much lower than it was in 2008. This proves that we are capable of improving the air quality of Beijing and the reductions achieved in the run up to 2008 make a good beginning.

Dr. Fu Jiafeng: In terms of CO_2*, China has to make some major decisions in forming the* 12^{th} *5 year plan. They planned a 30% decrease in 2010 but by 2012 40-45% was being called for. In the* 11^{th} *5 year plan, emission is expected to decrease by 20% so China must make strong policy decisions in order to reach its goals. In the future, China will invest more in research and engineering to find technological solutions to some of the problems faced. There is a great pressure on the government to do more in terms of environmental policy.*

To Prof. Löschel

You mentioned the idea that phasing out nuclear power will not affect renewable energy. How will we make up the difference in energy production? Do you know about China's policy on renewable and nuclear energy?

Prof. Löschel: Renewable energy is promoted through subsidy programs and is not in direct competition with the rest of the energy market. Renewable energy is not expected to change because there are no plans to change these promotion programs. We need to find ways to integrate renewable energy with the rest of the grid in order to make it a more significant part of our energy generation program.

Dr. Gao Jian on Nuclear Energy in China: I am not an expert on Nuclear power but China is generally very careful about promoting it. Nuclear power is very clean and China needs more clean sources of energy. However, we do need to be aware of the public image of nuclear power especially after Fukashima. I believe Nuclear power is a good path forward. We are in a situation now where there are more cars than bicycles in Beijing and we need to offset this with clean energy sources.

Conclusion

The IESP discussion brought together a range of different perspectives on a variety of important issues both in Germany and in China. The key problems faced such as Megacity sustainability, energy production and industrial pollution were discussed in detail and a number of solutions proposed such as circular economies, carbon trading, infrastructure efficiency and research into proper cataloguing of threats. The conference brought together researchers, students and key advisors and academics. It is hoped that the ideas presented here will form an integral part of future discussions both in Germany with regard to its changing energy policies and in the 12th 5 year plan in China.