China Council for International Cooperation on Environment and Development

INTEGRATION OF CLIMATE INFORMATION INTO EXISTING ECOSYSTEM MANAGEMENT PROCESSES

Background Paper

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Executive Summary

For its Annual General Meeting (AGM) 2010, the China Council for International Cooperation on Environment and Development (CCICED) is focusing on the theme of "Ecosystem Service and Green Development". This annual meeting will discuss the main issues of ecosystem protection in China. According to the topic of the AGM, this report will provide options and policy support on how to integrate climate information into existing ecosystem management processes, emphasising the major ecosystem management tools Environmental Impact Assessment (EIA), planning EIA, and Strategic Environmental Assessment (SEA).

Changing climate, increasing weather extremes, population development, and economic development cause challenges for ecosystem management. Climate information should be integrated into existing ecosystem management processes, in particular the tools EIA and planning EIA or SEA, in order to enhance ecosystems' capacity to adapt to changing economic and climatic conditions and to improve the management of ecosystems. At present, climate information products are already available from relevant institutions such as the National Climate Center of the China Meteorological Administration but are not formally used in the existing ecosystem management processes and tools. It is therefore important to know how many and what kind of climate information can serve for efficient ecosystem management within EIA, planning EIA, or SEA. The needs for climate information at project level, regional level, and strategic level have not been assessed yet.

This study was undertaken by GTZ on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The purpose of the study is to provide a Policy Background Paper with options on how to integrate climate information into the existing ecosystem management tools for EIA, planning EIA, and SEA. The study will supplement the work of the CCICED Task Force (TF) on Ecosystem Service and Management Strategies. The Policy Background Paper screens international experience as well as local examples in two pilot areas: Xiamen Municipal City (urban ecosystem) and Poyang Lake Basin Area (fresh water ecosystem). Questionnaires and interviews were used to identify the needs for and the current status of climate information delivery in ecosystem management, the institutions involved in ecosystem management and the current mechanisms. Shortcomings and gaps in the integration of climate information into ecosystem management and major tools are identified and several policy recommendations relevant for China are drawn.

The experience by EU countries in integrating climate information into ecosystem management delivers five conclusions that are relevant for China:

1) In Europe, climate change adaptation is a major aspect under the umbrella of sustainable development. At the SEA level, integration of climate change impacts is

more prevalent than on local level (EIA). EIAs require data at a very local level and are quite detailed. Climate information in EIA is not only used but accompanied by additional processes (e.g. studies and surveys) or tools such as flood protection planning or fire prevention planning. Primary surveys and studies are carried out to determine climate impacts. For SEA, more general projections are used.

2) The legal basis for mandatory enforcement is adopted through legislation which makes the use of climate information a requirement and describes the kind and level of climate information to be used in EIA and SEA.

3) Information updating is conducted continuously, including the research and development of climate change scenario forecasts and the strengthening of the research on specific impacts of climate change. The best available climate information is provided.

4) The barriers to information access are reduced. For example, relevant results of the assessment for climate change scenarios are posted on the website of the UK Climate Impacts Partnership (UKCIP), which allows administrators and project planners to access the information in a timely and convenient way.

5) Capacity building to support the integration of climate information into regional spatial strategies and local development plans. The 'SEA Directive' in Europe requires that the assessment addresses 'Climatic Factors'. However, there is a lack of specific guidance on how to make use of climate information at the local level. UKCIP, which is mainly funded by the UK Department for Environment, Food and Rural Affairs, supports learning and capacity building around these initiatives, and produces 'best practice' tool boxes and guidelines.

In Xiamen municipal city, a complex human managed ecosystem, the challenges are the balance between urban expansion (accompanied by traffic and domestic/industrial/agricultural waste water) and the preservation of the ecosystem. The latter is projected to be influenced by weather and climate related changes and the main concerns are sea level rise (urban flooding and waterlogging, intrusion of sea water into freshwater ecosystems), weather extremes (urban flooding and water logging), as well as surface water quality. Although Xiamen has a municipal development (master) plan, the stakeholders are in need of more scientific, accurate, timely, and comprehensive climate information to be provided in user-defined ways. The experience of EU countries has been screened in this regard and the following shortcomings and gaps in the application of climate information for ecosystem management in Xiamen have been identified:

1) Standards: The climate parameters and formulas or equations used in urban infrastructure construction planning have remained the same for decades without any change. There are no requirements to use updated data and there is no policy for setting new standards. Therefore, the data used may be out of date.

2) Data sources: Multiple government departments have their own climate, or climate-related information, with neither a mechanism in place for information communication or information sharing, nor for information release.

3) Capacity: The government departments have not operationalized climate change in their routine work. Although climate information is used in operational tasks for ecosystem management, the possible impacts of climate change are not taken into consideration.
4) Information sharing: Communication between climate information providers and users is limited. There is need for agreeing on data formats and technical specifications. For example, some climate data are only available in formats that cannot be directly accessed by the users and processing the data requires additional funding.
5) Legal basis: No legal basis is provided for the application of climate proofing (observed data), climate predictions and projections. Therefore, there are no clear arrangements for the tasks of supervision, inspection, and reporting on the use of climate proofing, predictions and projections.

In the Poyang Lake area, the central pillar for ecosystem management is the balance between the mountain environment and surface water resources. At the end of 2009, the State Council approved the Poyang lake area as a national strategic economic region. Climate influences the ecosystems of forests, grasslands and other types (or species). The main concern regarding projected impacts due to climate change for the Poyang Lake area are floods, droughts and weather-related diseases, as well as temperature changes which may affect the freshwater ecosystem. For Poyang Lake the study shows that in general the available climate products are satisfactory, especially for flood and drought prevention, forest fire early warning, solar and wind energy development. However, based on the feedback obtained by local stakeholders as well as the European experience, several shortcomings and gaps have been identified. Aspects that need to be improved regarding the integration of climate information into ecosystem management at Poyang Lake are as follows:

1) Low frequency of data dissemination: The Jiangxi Climate Center (JCC) offers monthly, seasonal and annual climate information products, but the Environmental Protection Department and other government departments require daily data and even real-time data for their routine work. According to the meteorological law, data can be released after quality control which takes more than one week and real-time data cannot be delivered timely to the water resources bureau, agricultural department forest department, or environmental protection bureau.
2) Lack of accurate data products: When using climate predictions, the estimated data is about 1°×1° (about 100km x 100km). The agriculture, forest and water resource departments would like to use predictions in their operational work and in SEA but on a higher resolution to make it effective for ecosystem management.
3) Lack of climate proofing: There is no mandatory requirement for climate proofing. For the Poyang Lake Ecology and Economy Regional Master Plan future climate predictions have been considered, but not systematically. Stakeholders are interested to investigate possible future impacts, but indicators or assessment criteria for climate proofing have not been established. The need for climate projections and their

assessment criteria was raised as it strengthens the resilience and adaptive capacity of the lake water capacity, wetland protection (bird protection) and biodiversity conservation, and therefore can improve ecosystem management.

Based on the evaluation of the pilots and the international experiences, the following policy recommendations have been elaborated on the integration of climate data into existing ecosystem management and in EIA, planning EIA and SEA:

1) Climate proofing should be integrated in the Environmental Impact Assessment process: A legal standard for the use of climate information in EIA, planning EIA, and SEA should be established. A legal standard requiring the use of climate projections in EIA and SEA should be established. It is commonly understood that climate change will have impacts on the four parameters air, water, waste and noise. Consequently, it is necessary to integrate climate projections into EIA, planning EIA and SEA to take these impacts into consideration. We recommend introducing and implementing relevant policy instruments such as climate proofing. Climate proofing will deliver a formalized legal approach on the use of standardized observed climate data accompanying climate impact studies for each EIA and climate predictions in EIA, planning EIA and SEA, including the sharing of responsibilities and tasks such as supervision and reporting mechanisms. Other tools should be developed to improve public understanding of climate change, and to improve sectoral studies on climate impacts which will enhance ecosystem management.

2) Mechanism or policy platform for exchange of climate information and increasing participation of decision-makers in ecosystem management: Stakeholders in ecosystem management must be strengthened in their awareness of climate information and the impacts of climate change. This involves tasks on the demand and supply side of climate projections. Capacity building should be developed at the local level, to increase the knowledge of local agencies on how to integrate climate information into their planning. A specific agency similar to UKCIP whose role would be to support the local planners in this regard could be established. For the demand side, a variety of mechanisms could be adopted including propaganda, education and training to make administrators/stakeholders aware of the importance of integrating climate information and projections into their planning. On the supply side, coordinating institutions or coordination mechanisms should be established among government departments. Communication between the providers and users of climate information should be improved. The authority of the Climate Change Monitoring and Assessment Centers (such as Xiamen and Jiangxi) in EIA, planning EIA and SEA should be formalized as these institutions could be made responsible for coordinating the mechanisms on the supply and demand side.

3) Basic collection of climate and climate change information and communication between providers and users should be improved: The provision of basic monitoring data needs to be improved. In addition to conventional monitoring

of climate data, information should also be collected for a variety of climate change impacts. This further requires providing guidance on how to process the data in climate impact studies. Ecological data needs to be accumulated to serve protection strategies for ecology and wildlife. While assessing the vulnerability of ecosystems, metadata on ecological systems should be developed to store the historical and current records about the distribution of plants and animals, and to provide data for carrying out climate simulations, assessment and implementation of protection strategies.

There should be special regulations on the use of data, especially on the ownership, property rights, costs, and data frequency: A) The frequency of providing observational data has to be increased. This requires computer systems and methods for fast quality control. B) Easy access to data should be set up. A web-based distribution system or electronic document sharing platform should be established. C) The spatial extent of climate projections should be improved in order to enhance data accuracy and to limit uncertainty. D) Formalities for information sharing should be settled.

CMA requires a legal framework that depicts how to provide service based on the requirements that EIA, planning EIA and SEA have.

4) Topic/sector and region focused impact and vulnerability assessments should be improved: Based on the observed and monitored data, climate change scenarios should be improved to study the impacts of climate change and assess vulnerability of key sectors (agriculture, water resources, forests) and key regions (coastal regions and vulnerable eco-regions in the West). Climate change scenarios and projections have to be used in SEA and regional planning.

Key words: Climate Information, Ecosystem Management, Environmental Impact Assessment, Strategic Environmental Assessment.

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1 BACKGROUND, CHALLENGES, OBJECTIVES AND SCREENING METHODOLOGY

1.1 Background

The overall goal of the China Council for International Cooperation on Environment and Development (CCICED) is to foster cooperation between China and the international community in the field of environment and development. For its Annual General Meeting 2010, CCICED is focusing on the theme of "Ecosystem Service and Green Development". This annual meeting will discuss the main issues of ecosystem protection in China. Policy recommendations will focus on policy measures to enhance ecosystem management and environmental protection in order to meet the challenges posed by China's economic transformation. Within CCICED, a Task Force (TF) on Ecosystem Service and Management Strategy was set up. This TF develops recommendations and carries out studies on ecosystem management in China.

This policy background paper will be adapted by the TF and supplement its current activities which focus on cross-sector coordination for ecological restoration at provincial level in Poyang Lake Basin. The TF also gathered experiences and lessons from WWF China for wetland conservation and restoration in the Central and Lower Yangtze. The TF works closely with the EU-China Biodiversity Programme on biodiversity assessment and conservation and, in particular to find the best suitable biodiversity protection case study on implementing adaptation to climate change at regional level and within that framework contributing to the UNFCCC work on climate change adaptation.

1.2 Challenges

At present, Environmental Impact Assessment (EIA), planning EIA and Strategic Environmental Assessment (SEA) are the predominant tools to assess ecosystems and their management. These are, however, just the major tools among a series of measures that might be used to address ecosystem management. Climate information (such as observed and projected temperature and precipitation) is not integrated into existing ecosystem management or the tools EIA, planning EIA, or SEA. This, however, would enhance ecosystems' capacities to adapt to changing economic and climatic conditions. Changing climate, weather extremes, population development, and economic development pressure cause challenges for ecosystem management. Ecosystems are at risk and constant pressure as they are frequently hit by climate and weather extremes such as drought, heavy rainfall, heat and cold waves, snowstorms, typhoons, etc. Investigating these challenges in this paper supplements the existing work of the CCICED task force on Ecosystem Services and Management Strategy.

Climate information products are available from relevant institutions such as the

National Climate Center of the China Meteorological Administration. They provide monitoring and forecast for East and South-East Asia, including China. Monthly and annual climate impact reports for air quality, fresh water, flood, drought, typhoon impacts, water logging, monsoon, El Niño/Southern Oscillation, etc. are available, and in total, the reports add up to 26 monthly and annual products. However, this climate information is not formally used in the existing ecosystem management or EIA and planning EIA as it is often available in a format, resolution, or frequency that cannot be easily understood and used by the institutions involved. It is important to know how many and what kind of climate information can serve for efficient and sustainable ecosystem management, EIA, planning EIA, or SEA. In turn, EIA or planning EIA or SEA need to have climate information at project level or regional level and strategic level.

Xiamen municipal city, a complex human managing ecosystem, has been chosen as a first pilot area as it represents a high-income area with an urban ecosystem. Challenges are the balance between urban expansion (traffic and domestic/industrial/agricultural waste water challenges) while preserving the urban ecosystem. The latter is projected to be influenced by weather and climate related changes and main concerns are sea level rise (water logging, urban flooding and intrusion of sea water into freshwater ecosystems), urban flooding and water logging caused by weather extremes, as well as surface water conditions. Xiamen has a municipal development (master) plan and offers various opportunities to investigate ecosystem management processes and test the integration of climate information.

In the Poyang Lake area, the central pillar for ecosystem management is the balance between the mountain environment and surface water resources. The Poyang lake area was approved by the State Council as a national strategic economic region at the end of 2009. Climatic factors are important in determining the distribution of the ecosystem of forests, grasslands and other types (or species). Changes in temperature and precipitation directly affect characteristics and distribution of water ecosystem in the Poyang Lake Basin. The projected impacts due to climate change for the Poyang Lake area are floods, droughts and weather-related disasters, as well as temperature changes which may affect the freshwater ecosystem. When analyzing climate change impacts in the area, it is found that the number of flood events has increased towards the end of the last century. This has caused major losses of water infrastructure, such as destroyed levees and dykes, and damaged reservoirs. The area is also severely affected by drought. In the last 50 years, Jiangxi has had drought events every year. Zhang et al (2008) have analyzed future trends in extreme precipitation. For the middle and lower Yangtze River basin, an increasing tendency is projected before 2025, after which the increasing tendency will become insignificant. It is suggested that this may imply both more floods and droughts in the coming decades. Considering that, it will be of utmost importance to make use of climate information in the planning of the area.

In ecosystem management, the needs for climate information are closely related to the type and distribution of local ecological systems. Getting a better understanding about the impacts of climate change on ecosystem management and using the necessary climate information will also be essential to promote the sustainable management of local ecosystems.

1.3 Objectives

The purpose of this study undertaken by GTZ on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) is to provide a Policy Background Paper to show options on how to integrate climate information into existing ecosystem management including tools of EIA, planning EIA and SEA. The study will supplement the work of the CCICED TF on Ecosystem Service and Management Strategy. The paper is based on the screening of international experiences as well as the Chinese experiences with the application in the two pilot areas: Xiamen Municipal City (human induced and managed ecosystem) and Poyang Lake Basin Area (fresh water ecosystems). The screening results are presented successively for the international experience and for the two local sites. Policy recommendations regarding the integration of climate information and proofing into existing ecosystem management and corresponding planning tools like EIA, planning EIA, and SEA including needs, approaches, processes and institutional requirements are summed up.

1.4 Screening methodology

Besides the investigation of the current situation in China, international experiences have been screened and summed up. This study has been undertaken by a group of international experts from Scott Wilson Ltd. (UK). It provides examples of international best practices on the integration of climate information into EIA, SEA and ecosystem management.

Internet and literature reviews on the listing and mapping of the institutions in the existing ecosystem management and the processes of planning EIA and SEA in each of the pilot areas (Xiamen City and Poyang Lake Basin Area) were conducted. Questionnaires were sent out by email to different stakeholder agencies in Xiamen and Poyang Lake Area in order to identify their needs for climate information and to draw a collection of feedback. Interviews were conducted with key stakeholders who showed interest to participate in the study. Finally, the results of the questionnaires and the interviews were analyzed in order to identify the needs, the status quo and the existing shortcomings and gaps to the integration of climate information into ecosystem management, EIA and SEA.

Based on a comparison and an analysis of the two Chinese case studies and the international experience, policy recommendations were drawn.

2 INTERNATIONAL EXPERIENCE AND CHINESE CURRENT STATUS

2.1 International experience

The report of the international experts provides real cases of some EU countries where climate information is applied in the tools Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA) and ecosystem management in general. These cases provided a reference from Europe.

The EU is an active promoter of international climate processes and has gone ahead of many other countries concerning climate policies. The EU stresses that the current projects under construction and plans under implementation will exist for a long time in the future. Therefore, the impact of future climate change shall be taken into consideration at the beginning of planning, so as to adapt to the challenges that arise. As an important policy tool, Environmental Impact Assessment (EIA) is used for construction projects, while Strategic Environmental Assessment (SEA) is used for evaluation of policy, planning and programs. EIA and SEA are related to both mitigation and adaptation by considering climate change. The future baseline scenario is an important parameter used for evaluation process; the EU and many member states have all developed detailed guidelines on how to consider climate change in the EIA and SEA, such as flood hazards, sea level rises, heat resistance, water resources, energy, and so on.

The EU member states UK, France, The Netherlands and Germany are most advanced in applying these guidelines. At the same time, some countries have published estimated future results for various climate change scenarios, so as to guide the implementation of construction and planning. In order to better apply climate change scenarios at the project level, more detailed studies and analysis have been conducted for some specific issues related to impacts of climate change, such as water resources. The UK, for instance, has pushed forward Flood Risk Assessments and Water Cycle Studies which estimate the impact of climate change on flood risks and water resources. The UK Climate Impacts Partnership (UKCIP) has developed a simple tool to help organisations and authorities to assess their exposure to weather and climate and the impacts on transport, buildings, and health. In Hungary, an indicator system for the environment-economy-society interactions in response to climate change was developed for the Lake Balaton Resort Area. In Andalusia, Southern Spain, where one of the driest ecosystems in Europe and unique habitats and species are located, the impacts on ecosystems under different scenarios were assessed.

The use of climate information in Europe is guided by different regulations. The processes for SEA and EIA are intimately linked with the planning and development process, therefore it is important to differentiate between what is required by the SEA legislation, and what is required by planning and development law. EIA requires the

use of climate data on local level and SEA on a regional level.

The experience by EU countries in integrating climate information into ecosystem management delivers five conclusions that are relevant for China:

1) In Europe, climate change adaptation is a major aspect under the umbrella of sustainable development. At the SEA level, integration of climate change impacts is more prevalent than on local level (EIA). EIAs require data at a very local level and are quite detailed and primary surveys and studies are carried out to determine impacts. For SEA, more general projections are used. This means that climate information in EIA is not only used but accompanied by additional processes (e.g. studies and surveys) or tools such as flood protection planning or fire prevention planning.

2) The legal basis for mandatory enforcement is adopted through legislation which makes the use of climate information a requirement and describes the kind and level of climate information to be used in EIA and SEA.

3) Information updating is conducted continuously, including the research and development of climate change scenario forecasts and the strengthening of research on specific impacts of climate change. The best available climate information is provided.

4) The barriers to information access are reduced. For example, relevant results of the assessment for climate change scenarios are posted on the website in the UK, which allows administrators and project planners to access the information in a timely and convenient way.

5) Capacity building to support the integration of climate information into regional spatial strategies and local development plans. The 'SEA Directive' in Europe requires that the assessment addresses 'Climatic Factors'. However, there is a lack of specific guidance on how to make use of climate information at the local level. The example of the UK agency, UKCIP, which is mainly funded by the UK Department for Environment, Food and Rural Affairs, is interesting in this regard. UKCIP works on the boundary between the science community and users of information, such as local authorities that are required to consider climate impacts on their regional plans. For example, UKCIP has one staff responsible for supporting the work of each of the regions. These regions may hire consultants to do special topic studies (e.g. flood vulnerability assessment), or may write their own reports (e.g. climate proofing of a particular plan). UKCIP supports learning and capacity building around these initiatives, and produces 'best practice' tool boxes and guidelines.

Based on this international report, the Chinese cases were analyzed and considered in the policy recommendations.

2.2 Related legislation and present status of Environmental Impact Assessment in China

2.2.1 Related legislation

EIA assesses the environmental impact that might be caused by basic construction development plans and projects. EIA includes the analysis, forecast, and assessment of this impact and has to deliver countermeasures or measures to prevent or reduce the negative environmental impact. The EIA system was introduced to China in the 1970s. In more than 30 years of economic development, this system has become the most important tool in environmental protection and ecosystem management. It has manifested the primary principle of preventing negative environmental impacts of new constructions. In 2003, China adopted the “Environmental Impact Assessment Law" in order to implement a sustainable development strategy, which was seen as an important milestone. The law regulates the implementation, responsibility of government departments and legal liability in EIA. However, the law failed to consider resources constraints and the overall cumulative effects. Basic construction projects for instance are the last step in the entire policy-making chain (strategy - policy plan - program - project), but potential environmental pressure arises when drafting the development plans. Following the regional aggravation of environmental deterioration, the Strategic Environmental Assessment (SEA) was introduced in China. SEA is a process that systematically assesses the possible environmental effect of regional policy decisions, the super-regional or regional planning and local construction plans. The results of the assessment are supposed to be adopted in the decision-making process, but this is still a concept. SEA has complemented the gaps in EIA, as it considers cumulative impacts of projects against the natural resources available. In China, SEA is still at an initial stage, constrained by many factors, such as organizational barriers and methodology deficiencies. Planning EIA is more important than SEA. Although it is still at a lower hierarchical level than SEA, it is developing. In 2006, the "Provisional Method for Public Participation in Environmental Impact Assessment" started to be issued and in 2009 the "Planning Environmental Impact Assessment Regulations" were adopted. Different rules and regulations were released and further consolidated the environmental impact assessment laws and regulations system, which is a milestone in the environmental protection and in the ecosystem service management. It also promoted planning EIA. Climate information has to be involved, but under constraints as is analyzed in this background paper.

2.2.2 Present status

EIA is organized, approved and supervised by the environmental protection bureau in the respective province where the project to be approved is located. Accordingly, the environmental protection bureau is the main control institution of EIA. The environmental protection bureau has the final decision-making power over the

environmental impact assessment.

In the planning EIA process, the public participates at many levels and in many ways. According to the public participation principle, besides the local environmental protection bureau, other departments may also participate in this process (for example the urban planning bureau, water conservancy bureau or forestry bureau). The departments, the local residents and the experts are all important participants.

2.3 Present status of climate proofing at regional and project levels in China

On January 1, 2000, the enacted "Meteorological Law" stipulated that all levels of meteorological bureaus must organize themselves to carry out climate proofing for urban planning, national key construction projects, significant regional economy developmental objects, large-scale solar energy projects, wind energy projects and all development projects using climate resources. When the qualified units carry out the atmospheric environmental impact assessment for construction projects, they should use the meteorological observational data from the meteorological administrative agencies. However, no projections are used.

Large-scale infrastructure projects, such as construction of highways, bridges, nuclear power plants, large-scale water conservancy facilities and so on, need to use and understand conventional climate parameters. Local climate conditions and the impact on the regional atmospheric environment that can be caused by the project must be included. For example, climate proofing (on its own initiative) was carried out by the department in charge for the construction of the Three Gorges Dam, the Hangzhou bay ocean bridge, and the Beijing overall construction plan. Some departments have released standards, like "Highway and Bridge Wind Design Standard", "Building Climate Demarcation", or "Nuclear Power Plant and Meteorological Events". Some departments and enterprises do not pay enough attention to this work, for instance when developing wind power plants without climate feasibility studies which led to wrong technical design.

In 2009, the China Meteorological Administration promulgated the "Climate Proofing Management Regulation". It contains standards for climate proofing, measures to develop climate resources and to assess climate risks which may affect the basic construction, such as meteorological disasters, climate change impacts, or the potential regional climate impact caused by the project. This regulation could play an important role in support of meteorological disaster prevention, dealing positively with climate change. It is as yet, however, only valid within the hierarchy of the CMA. Climate proofing in Chinese terms refers to the use of observed climate data and not, like in Europe, to the use of climate projections. Climate proofing is conducted by the meteorological department, focusing on climate feasibility, while EIA is conducted in the environmental protection department, focusing on environmental feasibility.

3 XIAMEN CITY: BACKGROUND AND SCREENING RESULTS

3.1 Background information

3.1.1 Urbanization process, urban ecosystem, climate

3.1.1.1 Urbanization process in China

The world has stepped into the phase of urbanization. China, as a big developing country, enjoys incomparable urbanization development in terms of either scale or speed. Statistics indicate that in the 60 years after the founding of the PRC, the level of urbanization in the country increased from 7.3% in 1949 to 46.6%[1] in 2009 and urban population accounted for 622 million. With an urbanization rate gradually closing to the level of middle-income countries; China is still stepping up in this process, and shall soon elevate the rate to over 50%. Furthermore, this trend shall last for a long time. It is expected that there will be 350 million more people living in cities in the coming 15-20 years, making the total urban population more than 1 billon. Studies forecast[2] that 75% of Chinese population shall live in urban areas by 2050, a level close to developed countries. However, the rapid development of urbanization accompanied by industrialization not only consumes a large amount of resources and energy, but also imposes huge pressure on the ecological environment. China's coal-based energy structure contributes to urban air pollution and acid rain. In addition, cities are also confronted with such severe environmental problems as water scarcity, water pollution, urban waste, noise pollution and photochemical smog. Therefore, it is of urgency to strengthen the management of urban ecosystems for the sake of sustainable urban development.

3.1.1.2 Urban ecosystem

Urban ecosystem is a unified whole formed with the interaction between urban residents and the environment, but also a special artificial ecosystem built up by humans based on adaptation to and modification of the natural environment. The main characteristics of urban ecosystem are: human-centred, strong dependence on external inputs and intensive population flows, logistics, energy flows, information flows, capital flows and so on. The urban ecosystem is composed of an economic system, social system and natural system. As shown in Figure 1, the systems are interdependent and influenced by each other, forming complex circular and feedback relations. The natural system consists of water, land, air, plants, as well as other ecological and energy subsystems.

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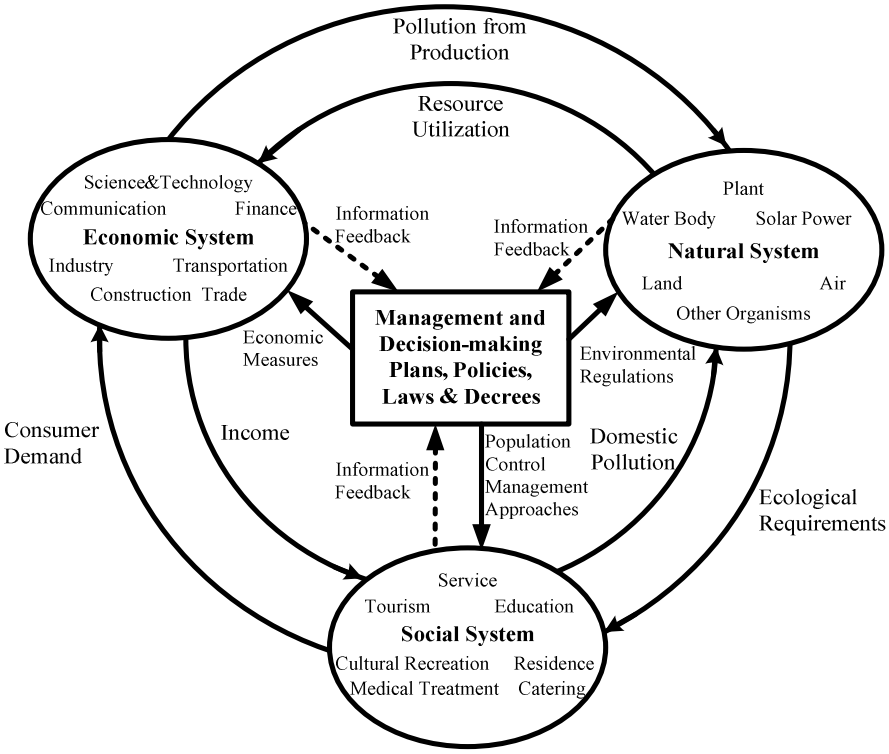
[1] News Center—China.com, http://www.china.com.cn/news/2010-03/29/content_19709680.htm.

[2] China Urban Development Report 2009 published on May 11th, 2010, hosted by China Association of Mayors, undertaken by the China Science Center of International Eurasian Academy of Sciences (IEAS).

Figure 1. Composition of the urban ecosystem



3.1.1.3 The "climate" factor and benefits of integrating climate information

Climate is a part of the natural system, and closely related to other subsystems. A series of adverse impacts caused by climate, including temperature, precipitation, extreme weather events and rising sea levels impose a real threat to the urban ecosystem. Under the joint impacts of natural and human activities, the Earth's climate system is going through global climate change featuring global warming, as a consequence of which the sea level rise, glacial retreat, and frequent weather extremes have threatened the environment for human survival. As the home to human society and material wealth, the city and all the economic activities it supports are typically vulnerable to the impact of climate change. Frequent extreme weather events such as typhoons, local storm, high temperature, heat waves and cold damage, intertwined with urban environmental conditions and urban residential activities, evoke a series of secondary disasters and the consequent events in the disaster chain, significantly jeopardizing urban operation security[3]. The water logging as a result of heavy rainfall in large cities during the summer of 2010, caused great losses of life and property. Impacts on urban ecosystems mainly appear in the following areas: extreme weather events, water resources, coastal zone, forest and human health.

Urban ecosystems are vulnerable to changing climate, and the role of climate information should be brought into play in the division of industry, urban planning,

[3] Zheng Guoguang, http://news.xinhuanet.com/mrdx/2010-07/05/content_13810258.htm.

energy planning, industrial layout, and environmental protection[4]. In urban construction, effort should be made to specify planned adaptations to climate and to fully tap climate resources. In project planning, properly predicted scenarios and participation corresponding to climate shall boost economic development and provide significant economic benefits. Otherwise, any breach of the law of climate or improper estimation of climate indices will incur huge economic losses. Only by scientific management of the urban ecosystem, coordinating economic, social and natural systems and integrating climate information into urban ecosystem management, the healthy circulation and pattern of coordinated development of urban ecosystem can possibly be maintained.

3.1.2 Xiamen characteristics: geography, economy, climate challenges

3.1.2.1 Geography

Xiamen municipal city is situated on the southeast coast of Fujian Province at the estuary of Jiulong River, across the Taiwan Strait from Taiwan and Penghu islands. Xiamen city has six districts. Two are on Xiamen island (including the small island of Gulangyu), and the other four are on the mainland. Xiamen has a land area of around 1,565 km² and a sea area of 300 km². Xiamen Island covers an area of 128 km². Most of Xiamen island is at very low elevation (<5 m asl). Xiamen Harbour is an international natural ice-free deep water seaport.

3.1.2.2 Economy

Xiamen City is one of the four Special Economic Zones (SEZ) established in 1980 by China's State Council as China 'opened up' to international trade. At the end of 2007, there were a total of 2.43 million permanent residents in Xiamen and population increase in recent years has been rapid (ca 55,000 per year). In 1988, the central government listed Xiamen as a municipality enjoying independent status in state economic planning, and executing economic administration with a provincial capacity. In May 1989, two districts were designated as Investment Areas for Business from Taiwan, and also began to implement the SEZ policies. In 2009, Xiamen's GDP was 1,623 billion RMB, which represented an increase of 8% over the previous year. The per-capita GDP was 64,413 RMB in 2009. Xiamen's primary economic activities include fishing, shipbuilding, food processing, tanning, textiles, machine tool manufacturing, chemical industries, telecommunications, and financial services. The city benefits particularly from investment capital from Hong Kong, Macau and Taiwan.

Xiamen is a traditional trading port. In 1979, the year before establishing the SEZ, the total export value was around US$100 million. In 2007, it was US$255 hundred

[4] Li Weijing, *Climate and Cities-Make Better Services of Climate to Humans*, http://gb.cri.cn/14404/2007/06/22/1245@1645747.htm.

million. Xiamen is highly trade dependent (in 2007, value of trade/GDP=202%, second only to Shenzhen). Xiamen's 1,126 joint enterprises with foreign companies or foreign invested Chinese companies create almost 80% of Xiamen's industrial output value. Within industrial output value, 40% came from industrial export trade. Growth in exports has become the main driver of economic growth in Xiamen.

In order to facilitate this economic growth, major investments in urban infrastructure have been made, including the airport, harbour, advanced communication systems, highway networks and several major bridges, power plants and transformer substations, water-drawing projects, sewage system, and gas pipelines.

3.1.2.3 Climate challenges

Xiamen has a subtropical climate, with an average annual temperature of 21°C and an average annual rainfall of about 1,200 mm, mainly occurring from May to August. Because of the air currents resulting from the difference in temperature in the Pacific, Xiamen is affected by typhoons three to four times annually on average, mainly from July to September. Owing to population growth, urban development and climate change, Xiamen suffers from degradation of wetlands, red tides, increased haze days and higher frequency of acid rain occurrence[5]. Meanwhile, urban heat island of Xiamen has extended into winter after 2003 and 2004.[6]. Under the influence of climate change, Xiamen also confronts the threats of flood events due to extreme precipitation (mostly related to typhoons), direct effects of typhoons, and potential risks due to sea-level rises and other extreme weather events.

3.2 Results of the Screening in Xiamen

3.2.1 Results of the Screening methodology

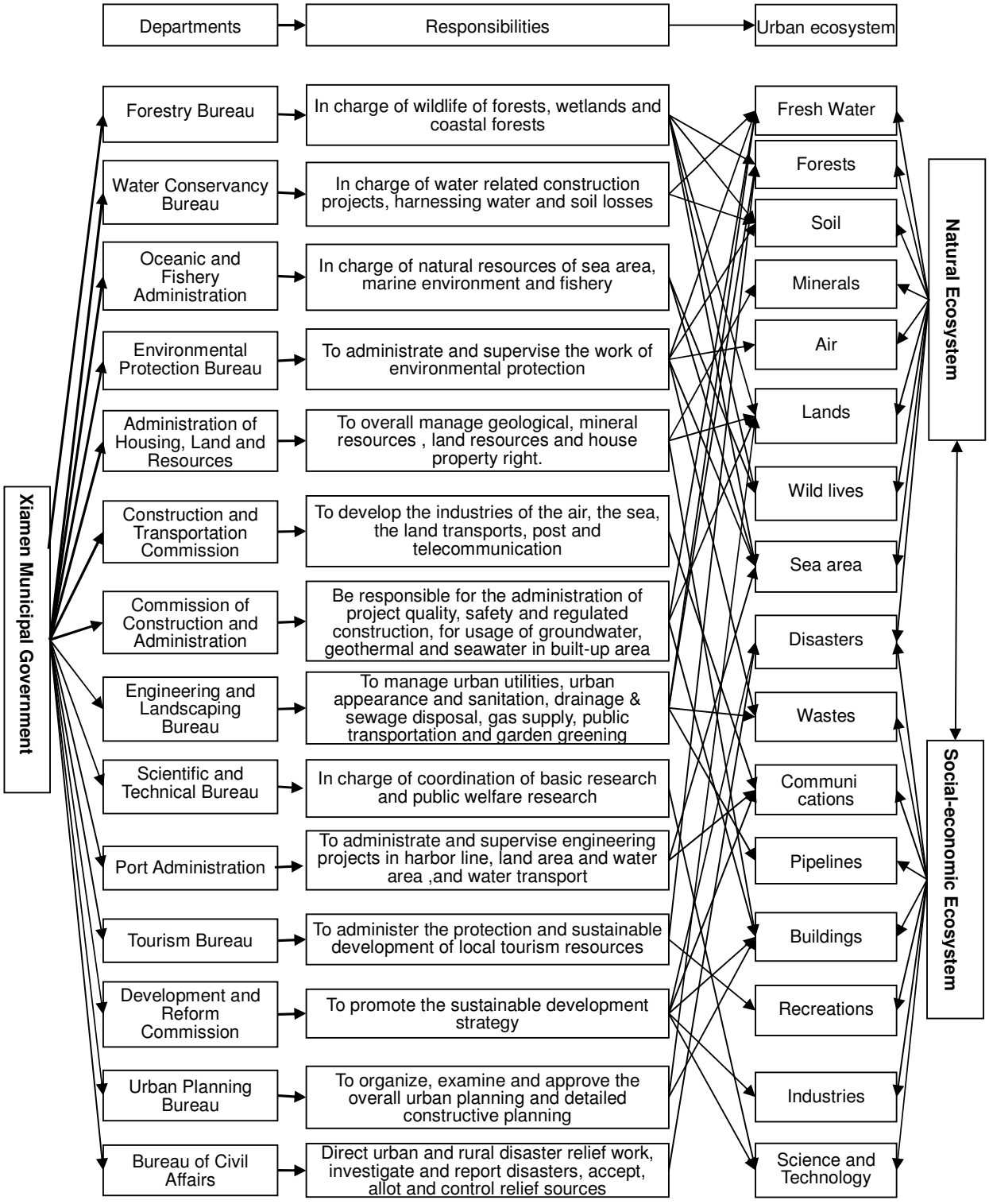
An internet and literature review regarding the listing and mapping of the institutions in the existing ecosystem management and the processes of planning EIA and SEA in Xiamen City was conducted. 30 questionnaires were sent out to local stakeholders in Xiamen in order to identify their needs for climate information and to collect feedback. 17 answers were received from 11 agencies. In addition to the analysis of the answers to the questionnaires, interviews were conducted to get more information from several key stakeholders regarding their needs for climate information and the current situation. Based on the results of the screening as well as the review of the international experts, several shortcomings and gaps regarding the use of climate information in ecosystem management, EIA and SEA were identified. Eventually, policy recommendations were defined for Xiamen. The results of this screening work are presented below.

[5] Xiamen City Environmental Quality Bulletin 2009.
[6] Zhao Xiaofeng et al., Remote Sensing Monitoring of the Seasonal Dynamics of Heat Island effect with the Evolution of Urbanization Process, Journal of Ecological Environment, Volume 5, 2009.

3.2.1.1 Listing and mapping of existing urban ecosystem management processes

The figure below shows the listing and mapping of the existing urban ecosystem management processes in Xiamen.

Figure 2. Listing and mapping of the existing ecosystem management in Xiamen

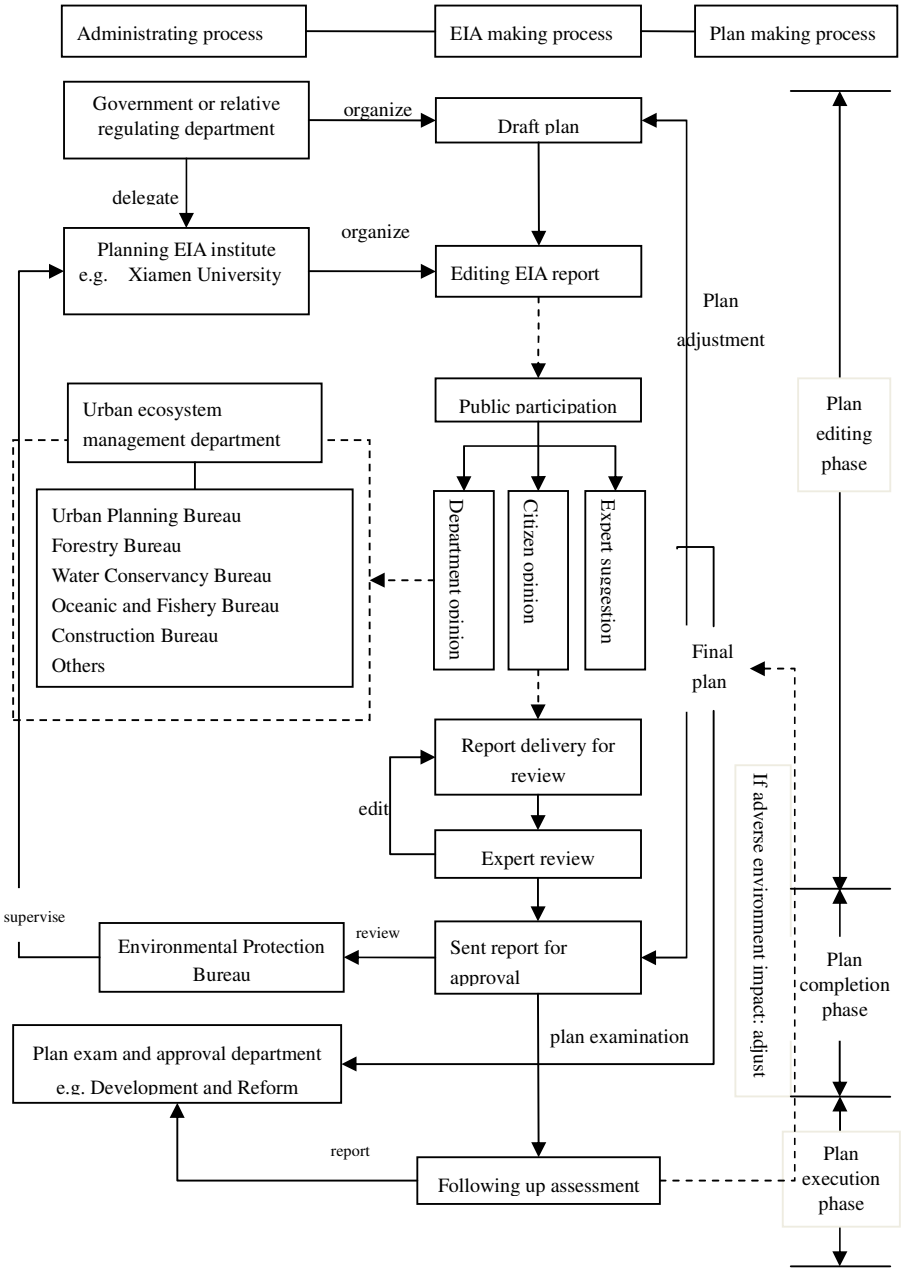


Various government agencies are involved in the ecosystem management process in Xiamen. The most prominent tools that are used to protect ecosystems are EIA, planning EIA, and SEA. However, as can be seen from Figure 2, some functions that can support ecosystem management (such as fire prevention, algae control), are not covered by the traditional tools. The needs for climate information of the stakeholders to protect ecosystems are screened in the following.

3.2.1.2 EIA, planning EIA and SEA

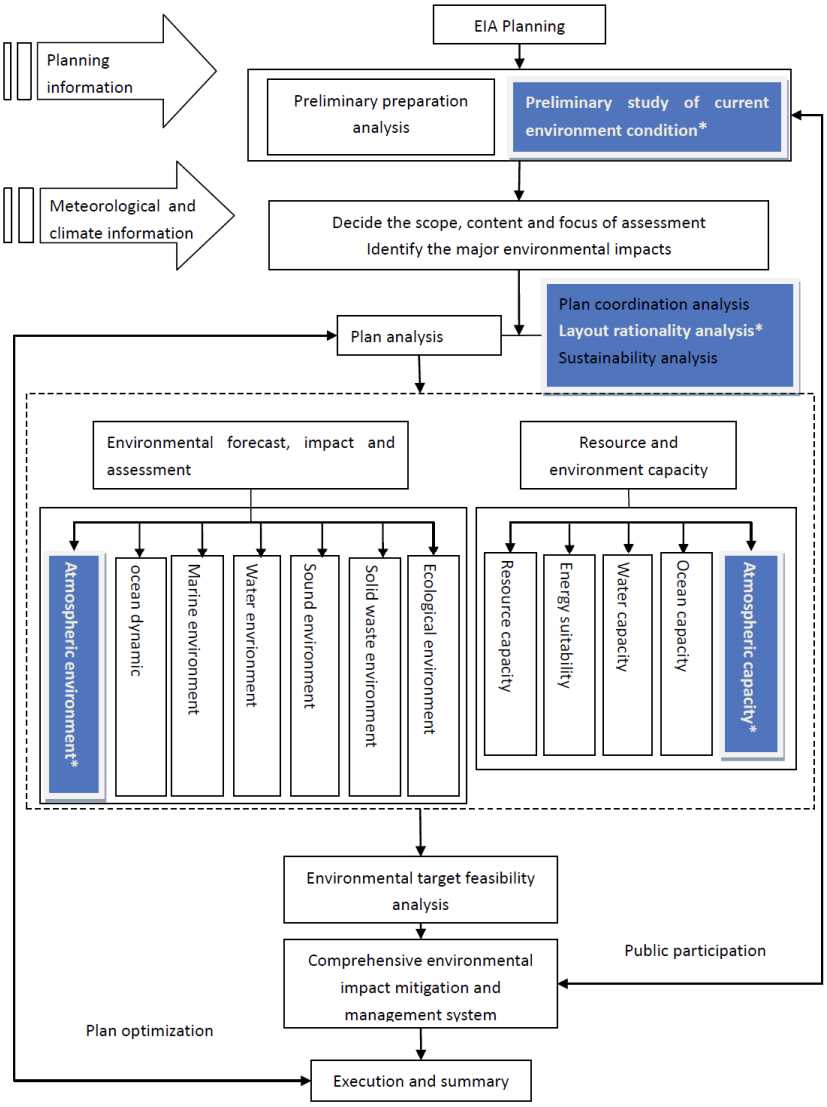
The EIA process is shown in Figure 3. This depiction is relevant for the whole of China.

Figure 3. The EIA process in Xiamen



The EIA plays a major role in prevention of adverse environmental impact. The conclusion of an EIA report is considered when the draft plan is examined and approved. During the execution phase, a following-up assessment has to verify the accuracy of the predicted impacts and evaluate the effect of the countermeasures. According to the Technical Guidelines for Atmospheric Environmental Impact Assessment (HJ2.2-2008) released by the Ministry of Environmental Protection, climate information is needed in each EIA and SEA process. The framework of planning EIA is shown in Figure 4 below. This planning usually appears in the first chapter of an EIA report and it covers the major content of the planning EIA. The meteorological and climate information demands, based on the technical guidelines, of the interviewed stakeholders are indicated in the figure.

Figure 4. Framework of planning EIA



In the initial stage of planning EIA, a preliminary study of the current environmental conditions calls for observed meteorological and climate information including climate parameters, annual average wind speed, dominant wind direction, annual average temperature, maximum and minimum temperature, annual average relative humidity, annual average precipitation quantity, number of rainy days, sunshine, heavy rains, typhoon, hail and cold wave. However, there is no standard for the quality of climate information, i.e. an EIA can be conducted with a time series of climate information covering 1950-1960.

The projected impact of planning (e.g. regional economic planning or water resources planning) on the environment is the core content in a planning EIA. The Ministry of Environmental Protection of China recommends 3 kinds of atmospheric models, including ADMS-EIA, AERMOD, CALPUFF, which are suitable to analyze the impact of a project or plan on different levels and scales (e.g. air pollution before and after project or plan). Atmospheric pollutant diffusion is closely related to meteorological conditions. Meteorological parameters are prerequisites to atmosphere prediction models. The atmospheric impact assessment contains two levels based on pollutants and natural characters. Level one needs meteorological observation data day by day in at least three consecutive years during five recent years. Level two needs meteorological observation data day by day in at least 1 consecutive year during 3 recent years. For level two, ground meteorological observation data and upper meteorological sounding data are required.

In a completed planning EIA, a basic meteorological analysis figure is required, while a general meteorological analysis figure is optional. However, the planning EIA report is conducted with observed data only. Projected changes (e.g. of temperature, wind directions, rainfall) are not considered. The stakeholders have addressed that climate projections would be important to make the planning more sustainable, thus integrating climate projections in the process of planning EIA. Climate proofing in this term is different from EIA.

3.2.1.3 The functions of ecosystem management departments in EIA and SEA

Similar to other cities in China, EIA is delegated, approved and supervised by the Environmental Protection Bureau in Xiamen. It gives the final approval of EIA. The EIA or steps of the EIA (e.g. noise impact assessment) can be conducted by different authorized and qualified institutions with a specific certificate. The documents are then collected and submitted to the EPB for approval. These authorized and qualified institutions with a specific certificate can be for instance Xiamen University and the Third Institute of Oceanography of the State Oceanic Administration. From January to August 2009, Xiamen Environmental Protection Bureau inspected 505 EIA reports. The results showed that 52 reports were well organized and assessed, 332 reports were qualified with ordinary level, while the 121 reports were not qualified.

Public participation runs throughout the whole planning EIA process in multiple levels and ways. A complex planning relates to varieties of ecosystem and may encounter implementation difficulties. So it requires a higher level and broader range of public participation. According to the public participation principle, ecosystem management departments, local citizens and experts are all important stakeholders. Besides the local Environmental Protection Bureau, other ecosystem management departments are also involved in the process. All the related ecosystem management departments, including Urban Planning Bureau, Construction and Administration Bureau, Engineering and Landscaping Bureau, Water Conservancy Bureau, Forestry Bureau, Environmental Protection Bureau, Oceanic and Fishery Bureau, Forestry Bureau, Municipal Tourism Bureau, Construction and Transportation Commission, are invited to a meeting to give advice and suggestions on both the planning and the EIA report. The representatives of the departments are free to convey their concern over the planning according to their ecosystem management function. The character of each ecosystem shall be demonstrated in detailed and the adverse impact on the ecosystem shall be avoided or alleviated. Their professional and pertinent advices are always considered in the final EIA report and the planning draft should be adjusted. In case the public's or agencies' opinions are not accepted, the reason should be explained in the EIA report.

3.2.2 Assessment of climate information needs

3.2.2.1 Climate information needs of stakeholders in ecosystem management based on the questionnaires and interviews

Based on the answers to the questionnaires and also the interviews that were conducted with several key stakeholders, the needs of these stakeholders in climate information as well as some deficiencies of what is actually available were identified. The needs assessment made clear that different kinds of climate information are requested by stakeholders. These needs do not only fall within the instruments EIA, planning EIA, and SEA for ecosystem management, but also into the operational services of the government agencies (such as fire prevention, disaster management, and algae control).

According to the results of the survey (questionnaires), the climate information needs were divided into two types of ecosystem management: climate information in planning EIA and SEA (Table 1), and climate information in operational ecosystem management (Table 2).

Table 1. Climate Information Needs in planning EIA and SEA (Xiamen)

Department	Climate Information Need	Use of information	Advise & Demand
Urban Planning Bureau	Average temperature, Annual precipitation quantity, Wind direction, Daily average sunshine	Drainage planning, urban layout, general layout	Climate information is very important. Information on climate and weather extremes could be useful to develop precautionary measures to prevent disasters. For instance, it could be useful to be warned in case of heavy rainfall for landfill design management. This is not done yet in EIA or any other strategic planning instrument such as planning EIA.
Municipal Commission of Construction and Administration	Maximum temperature, Daily precipitation quantity, Wind direction typhoon information, Daily average sunshine	Direction and spacing of buildings, Energy consumption and comfort of the buildings	Differ the weather information between rural and urban area, provide more details about the heat island effect and wind information related to buildings. City buildings have some influence on urban climate (heat island effect for example). Information on sunshine or wind could be relevant. There is a link between climate and energy consumption and use of solar energy, requires information about solar radiation. More data on wind (wind speed, wind direction) supports decisions on building high constructions on the coast line: building must not block sea wind blowing into the city. This is not foreseen in EIA and SEA.

Table 2. Climate Information Needs in operational ecosystem management (Xiamen)

Department	Climate Information Need	Use of information	Advise & Demand
Municipal Forestry Bureau	Number of rain days	Fire prevention	It focuses mainly on fire prevention (forest covers 42.8% of Xiamen area), so they need climate data from the Meteorological Bureau. However they recently raised the idea that forests should be managed by the farmers in a more straight, efficient and scientific way (so that they can get more economic benefits). But for that, the Forestry Bureau would need easily available, precise and updated climate data in order to delegate the farmers' behaviour. This is still to be arranged and organized.

Department	Climate Information Need	Use of information	Advise & Demand
Oceanic and Fishery Administration	Accumulated temperature, Precipitation, Wind, Air Pressure	To forecast algal blooms disaster To warn and monitor the risks of marine environment	
Water Conservancy Bureau	Annual precipitation quantity, Typhoon	To monitor and control flood and drought	It is in close cooperation with the Meteorological Bureau regarding typhoon prevention. The emergency office within the Water Conservancy Bureau organises some prevention measures and therefore needs climate information. But it appears that they have difficulties to get heavy rainfall data. Moreover, discrepancies are found between data on water quality that is monitored at the same time by the EPB and by the Water Conservancy Bureau. As a consequence, there is no unified data on water: the quality of information is different, as the index used is different, and/or water assessment is different. The issue of relative reliability of data can be raised here.
Municipal Engineering and Landscaping Bureau	Maximum temperature, Relative humidity, Typhoon, Daily average sunshine, Precipitation	To control water supply and drainage To prevent water logging and safe guard plants	Improve the accuracy of the forecast of special weather.
Environmental Protection Bureau	Precipitation, Wind direction, Number of rainy days	To assess and forecast the influence of water pollution and air pollution	They showed interest in developing a climate information yearbook. Such a book doesn't exist yet and could be developed by the meteorological bureau. Collaboration started in the early 1990s between the EPB and the Meteorological Bureau concerning acid rain, the EPB wanted to know the causes of acid rain. But collaboration on this topic is still at an early stage.
Port Administration	Typhoon, Low air pressure, Precipitation	To control vessels entering or leaving ports and shelter scheduling	Improve the precision and frequency of extreme weather reports, such as typhoon and fog
Municipal Public Security Bureau	Precipitation, Wind	For international shipping and flights, flood-fighting and disaster relief	It has daily information about the city population (how many people travel to the city, how many people stay temporarily, etc.). Interesting phenomena were mentioned regarding the link climate and criminal rate. It was found that in summer, the criminal rate is relatively high. Therefore this administration is also interested in receiving updated climate information.

Department	Climate Information Need	Use of information	Advise & Demand
Economic Development Bureau	Temperature, Precipitation		
Development and Reform Commission	Average temperature, Monthly precipitation quantity, Daily average sunshine, Typhoon information		
Municipal Government (Mayor)	Impacts of Climate Change on Xiamen City (precipitation extremes and economic impacts)	Climate change impact assessment	Set-up climate change monitoring office; provide information on projected impacts for economic sectors and ecosystems

As can be seen, the highest share of climate information needs is outside the tools EIA, planning EIA, and SEA. For most agencies, their operational tasks are impacted directly by meteorological conditions. They expect to get more accurate, timely, and scientific meteorological information, especially about the forecasts of special and extreme weather events (such as typhoons, haze, and torrential rains, fire, etc).

Because the departments in Table 1 keep a close contact with the urban infrastructure construction, what they require mainly focuses on climate change information for the city system on the long term, so that they can build up a stronger adaptability at the beginning of urban planning. They mostly pay attention to the perennial mean temperature and precipitation and winds. Many agencies indicated that there is a real need for updated climate information. However, regularly updated information is either not always available, for example wind direction for city planning, or it is not provided and/or updated regularly.

Concerning environmental protection areas, SO_2, NO_2, PM_{10} (and soon O_3) are forecasted on a weekly basis. Time is required to process data and there is always a delay. It was also said that ultra violet intensity is not provided for forecasting (human health-related) though it could be useful (currently only temperature data is used).

Generally, there are needs for more scientific, accurate, timely and comprehensive climate information to be provided in user-defined ways. Depending on the department concerned the needs differ but more regularly updated data are needed. The stakeholders' feedback is that there is a need for climate information. The examples of the Xiamen Environmental Protection Bureau mention the development

of a climate information yearbook and of the Xiamen Forestry Bureau willing to develop an efficient way to provide climate data to farmers show that climate information is required in ecosystem management. Therefore, we distinguish the needs within the ecosystem management tools and operational needs

3.2.3 Existing climate products and their availability and suitability

For the description of the current environmental conditions, some observed parameters of meteorological information are sufficient. The information can be accessed from the internet or in some publications for free. Predicting and assessing the atmosphere quality and emissions, precise data and strict format are required. The institutes that prepare the EIA reports have to pay for meteorological information. If the existing information does not satisfy with the prediction demands, a field observation is supplemented and additional charges occur. All the services are provided by the meteorological department. Due to the advanced technical requirement, the field observation is always the task of the meteorological departments at provincial level.

According to a report from the Meteorological Bureau of Fujian province, meteorological services are of different characteristics in the regions. The meteorological requirements of coastal cities are higher than that in hinterland cities. As a coastal city, Xiamen suffers from typhoons, torrential rains and floods. Thick fog is a frequent phenomenon in the city in spring. Therefore, transportation and agriculture sectors are sensitive to meteorological conditions.

In some key projects, such as nuclear power plants, cogeneration power plants, coal-fired power plant and transportation infrastructure construction, the provincial bureau is the only bureau competent to undertake the work due to some services featuring higher technology.

The Xiamen Climate Center distributes a large part of its products to the Climate Center of Fujian province and on the intranet. Only four products are distributed to the municipal government in the form of reports. These reports, produced by the Climate Center, are assessment reports on different topics, such as weather forecasting. The format of the assessment report might not always meet the needs of the receiving department. Climate data as such are not distributed. The shortest time scale presented in the assessment reports is one month, while the longest is one year. Without time-series data, the meteorological and climate trends cannot be detected. Xiamen faces the challenges of climate change, such as sea level rise. The condensed construction and rapid urbanization causes a series of slight wind direction changes. However, updated information is not made available to the ecosystem management departments. Without a smaller time scale, such as daily data, the forecast of the pollutants is not accurate and precise as was mentioned by an official from the Environmental Protection Bureau during his interview. The Environmental Protection

Bureau also stressed that if they got data more frequently and with higher temporal resolution, they would be able to use them in order to improve forecasting.

Furthermore, longer-term projections could also benefit urban planning and therefore avoid large financial losses due to inappropriate planning. For example, change of wind direction needs to be integrated into urban planning as it influences the distribution of pollutants. If urban planners want to build a new urban area upstream of an industrial park, they need to know the current and also the future change of wind direction. They will also need storm surge data (how intensive, how high) if they want to build the infrastructure of a sea harbour. Integrating climate projections into urban planning can bring huge benefits as it can improve people living conditions, it can avoid catastrophes and strengthen the protection of infrastructures.

3.2.4 Shortcomings and gaps

There are several shortcomings and gaps between the needs for climate information and their availability in EIA, planning EIA and SEA. In contrast to the experience of EU countries, Xiamen has shortcomings and gaps in applying climate information and projections to improve the management of urban ecosystems. The shortcomings and gaps are mainly related to the requirements of which data to use and how to use them. These are as follows (order does not reflect importance):

1) Standards: The climate parameters and formulas or equations used in urban infrastructure construction planning have remained the same for decades without any change. There are no requirements to use updated data and no policy for setting new standards. Therefore, data used may be out of date and lead to incorrect evaluation of projects.

2) Data sources: Multiple government departments have their own climate, or climate-related information, with neither a mechanism in place for information communication or information sharing, nor for information release. The different data sources provide different standards and spatio-temporal resolutions.

3) Capacity: The government departments have not operationalized climate change in their routine work. Although climate information is used in operational tasks for ecosystem management, the possible impacts of climate change are not taken into consideration.

4) Information sharing: Communication between climate information providers and users is limited. There is a need for agreeing on data formats and technical specifications. For example, some climate data is only available in formats that cannot be directly accessed by the users. Processing the data for the needs of the user requires additional funding. There is no agreement between the users and providers of climate information on the formalities such as payments, delivery, or timelines.

5) Legal basis: No legal basis is provided for the application of climate proofing (observed data), climate predictions and projections. Therefore, there is no clear arrangement for the tasks of supervision, inspection, and reporting on the use of climate proofing, predictions and projections.

The shortcomings and gaps in the integration of climate change data in Xiamen are prevalent and are very likely to be applicable to the urban ecosystem management systems in other Chinese cities.

3.2.5 Policy recommendations for Xiamen

In summary, the common challenges in urban ecosystem management include: the lack of disclosure and sharing of climate information, the scarcity of basic climate information, the insufficiency of climate-change scenarios, inadequate understanding of climate change, etc. Many government agencies require climate information for ecosystem management (e.g. forest fire prevention), whether it is within EIA, planning EIA or other operational tasks of the specific department. The following measures on the use of climate information should be adopted to strengthen urban ecological management. First, raise the awareness of administrators on the use of updated climate information, and strengthen coordination among different government departments to provide and share climate information for their tasks in urban ecosystem management. Second, find practical approaches and feasible policy tools related to the two aspects of information provision and information use as presented below.

3.2.5.1 Improve the management awareness of urban ecosystem

Awareness

It is essential that administrators should have the awareness of how to use updated climate information for urban ecosystem management. A variety of means should be adopted including formal awareness raising, education and training, to let urban ecosystem administrators clearly understand that China is in the process of rapid urbanization. Lack of climate information and inadequate response to climate change problems have occurred at the same time, which has put ecosystems under stress, e.g. by increasing weather extremes while also water consumption increased. These entail the importance of integrating climate impacts into the macro strategies and planning of urban areas, so as to ensure its healthy development and ecological security.

Coordination among government departments

Coordination mechanisms should be established among government departments on the use of climate information in EIA, planning EIA, SEA, and their operational tasks for ecosystem management. The relationships between the departments in formal urban ecosystem management (EIA, planning EIA, and SEA) should be adjusted and streamlined in order to achieve a rational division of responsibilities. It is important to

form the governance structure of sharing -- deciding -- commanding -- interacting – implementing the use of climate information in EIA and SEA processes. Currently master planning (coordinated by different city governmental agencies) does not require SEA or climate proofing although the agencies need climate information for ecosystem management. Therefore, SEA should be implemented in city-level master planning to make use of climate proofing in order to harmonize master planning with ecosystem management tools (EIA, planning EIA) and services of the government agencies.

3.2.5.2 Strengthen climate monitoring

Provision of basic monitoring data

As accurate climate prediction and assessment depend on systematic and long-term monitoring data, the systematic and long-term climate monitoring must be strengthened. In addition to the conventional monitoring of temperature, humidity, and wind direction, information should also be collected for a variety of phenomena resulting from climate change, such as sea-level rises, extension of growing seasons, river runoff, increasing frequency of rainstorms, early melting of snow and ice, extension of ice-free period of ports, outbreak of human diseases.

Analysis on climate change scenarios

The urban ecological system is an integration of environmental, social, and economic systems. By conducting climate change analysis from the perspective of integrated sociology and ecology, the uncertainty and dynamic mechanism of the system can be analyzed to construct a future scenario using a kind of structural framework, in order to better guide the decision-making mechanism of the ecological system.

The accumulation of ecological metadata

The ecosystem is very sensitive to the changes in climate conditions. Even the most minor changes may push a species into the dangers of extinction. Due to global warming and climate-related changes affecting the Earth, all animals, plants and their habitats, from the sky, the land, the ocean to the glacier areas, are facing risks. Climate information is needed to identify the areas and wildlife facing risks, so as to develop protection strategies. While assessing the vulnerability of ecosystems, metadata based on ecological system should be developed to store the historical and current records about distribution of plants and animals, and to provide data for carrying out climate simulations, assessment and implementation of protection strategies[7].

[7] World Meteorological Organization and United Nations Environment Programme, Climate Information Used to Create a Healthy Environment, Reports (No. 6).

3.2.5.3 The introduction and implementation of relevant policy instruments

Climate Proofing Research could be a step before the EIA and formalised in feasibility studies. Since 2009, China adopted Management Measures on Climate Proofing Research, which requires that analysis and feasibility studies should be conducted on the climate suitability, risks, and impacts on local climate by the planning and construction projects closely related to climatic conditions. The planning and construction projects closely related to climatic conditions include: urban and rural planning, development and construction planning for key industries or regions; major infrastructure, public works and large construction projects; major regional economic development, structural adjustment projects in regional agriculture (livestock farming) construction; large solar, wind and other weather resources development and utilization projects; other planning and construction projects of which climate proofing study should be conducted according to laws. However, climate projections are not foreseen in current climate proofing studies.

The role of climate proofing study as an integrated decision-making tool for evaluating climate impacts should be strengthened, primarily through the following aspects:

Enhance the status of climate proofing study

Compared to the Environmental Impact Assessment Law adopted in 2003, climate proofing studies still lack significant legal effects or mandatory requirements. With regard to the international application of EIA and SEA, the use of climate information in China is lagging behind and therefore cannot improve ecosystem management. Climate impacts should be considered in the environmental assessment process, but also future climate change scenarios should be analyzed, and an assessment should be conducted for sectors such as the water cycle or disasters. The implementation of climate proofing study can be regulated in the form of a law at a higher level.

Strengthen the research on forecasts for climate change scenarios and publish related results

The comprehensive impacts of climate change on ecosystems, economy, and society change the baseline of observed impacts. It is necessary to use basic climate information, to strengthen the research on forecasts for climate change scenarios in order to use them in ecosystem management. First, predictions and projections for climate change scenarios should be developed to limit the uncertainty related to them, based on the needs of stakeholders involved in ecosystem management. Moreover, as there are no standards for the use of forecast, it is necessary to build a high level of regulation to use forecasts that serve ecosystem management. We are facing more and more climate extremes. The research results should be published in an appropriate manner to inform stakeholders in ecosystem management about the importance of using climate information.

Strengthen the special assessment services for climate change effects

The municipal government has stressed its need for climate change impact assessment studies, mostly focusing on weather and climate extremes and ecological impacts. Climate change scenarios are measured by large scales, and construction projects are measured by small scales, which do not converge with each other. From the perspective of time scale, climate scenarios usually project 20 years or even longer terms, but project investments are concerned about the payback period, which is short and does not converge with the former. Therefore, it is necessary to strengthen the special assessment services for climate change effects according to different needs. For example, the comprehensive assessment of water resources, and the assessment and early warning of extreme weather events, as these are most closely related to urban development. More open and accessible data should be made available for the public. Data privacy should be regulated by the policy side. Modern tools and techniques such as software, internet, newspapers, books, etc. should be used.

4 POYANG LAKE: BACKGROUND AND SCREENING RESULTS

4.1 Background information

4.1.1 Geography

Poyang Lake with an area of about 5,000 km² is the largest freshwater lake in China. The Poyang Lake watershed area covers 162,000 km². The size of the Poyang Lake surface area fluctuates greatly throughout the year, between 3,000 and 4,000 km² in the winter (dry) and summer (wet) seasons. Poyang Lake drains through a narrow outlet into the Changjiang (Yangtze) to the north. Inflow to the lake comes from 5 major rivers (Xiushui, Ganjiang, Fuhe, Xinjiang, and Raohe) that flow from the surrounding mountains. The watershed therefore covers almost all (97%) of Jiangxi Province. The lower sections of the Jiangxi Rivers meander through broad alluvial valleys and sediment deposition (especially from the Ganjiang and the Fuhe) has created a large delta plain on the southern and western shores of Poyang Lake. The Ganjiang is the largest river in the region extending 750 km. It contributes 55% of the total discharge into the Poyang Lake and carries by far the greatest sediment load. Long-term annual average precipitation in the basin is 1,878 mm and mean temperature 18 ℃, with some variation in different areas of the watershed.

The water level of Poyang Lake is determined by the water surface elevation of the Changjiang, and by the discharge from the Jiangxi Rivers. Usually in mid-July, the direction of water flow from the lake into the Changjiang reverses and water begins to flow from the Changjiang into the Poyang Lake. High discharge in the Changjiang typically occurs during the mid to late summer months. The most severe floods in the Poyang Lake region occur when high discharge from the Jiangxi Rivers occurs later than normal in summer while the level of the Changjiang is also high.

The river deltas surrounding Poyang Lake and the broad alluvial valleys of tributary streams support intensive cultivation of rice and a high population density (400–800 persons/km^2). An extensive levee system to protect low-lying areas from floods has been in place for centuries. Before 1950, the total length of levees in Jiangxi was about 3,100 km. Since the 1950s, major levee construction projects have increased the levee heights and the area of flood protection. There are now about 6,400 km of levees that afford protection to 10,000 km^2 of farmland and to a population of about 10 million people who live in the low-lying areas at the margins of Poyang Lake and in the alluvial valleys along the large rivers in this region.

Historically, the forest coverage of the Poyang watershed was relatively high (ca. 60%), but it was reduced to 31% in the early 1980s. The result was an increase in soil erosion, silt inflow to Poyang Lake and the increased occurrence of flood events. In the 1980s, pollution of water resources from urban and industrial sources increased. With support from central government, in 1985 Jiangxi established the Mountain

River Lake Development Commission which since 1991 has been implementing a range of activities within the framework of an integrated watershed management plan. These activities have included scientific studies, pilot demonstrations, and participatory catchment planning, as well as implementation of a range of water management infrastructure projects, including levees, reservoirs, irrigation facilities and so on. Since 1991 this programme has increased forest coverage to 57%, increased the area of Poyang Lake and its water quality, and also brought economic benefits to millions of farmers in the region. Jiangxi now has 30 national ecological demonstration sites (eco-agriculture zones), six ecological services conservation zones (two on the lake and four on major rivers), 30 national and provincial nature reserves (including eight on Poyang lake, and the remainder in upstream watersheds), and Poyang Lake is now a Ramsar (UN Wetland World Conservation Right) registered wetland. Following the floods of 1998, large areas of farmland have been abandoned and returned to lake, which has increased the potential water holding capacity of the lake.

4.1.2 Economy

Jiangxi has a large manufacturing and industrial sector. In 2007, of a total GDP of 5,500 Million RMB, agriculture contributed 16%, secondary industries 51% and services 31%. The main industries are energy (coal), metals, machinery, light industry (tobacco, cloth and medicines). Of Jiangxi's total population of 43.7 million, 26 million (60%) are rural, and 17 million (40%) are urban. Overall, the province is relatively poor, having had a net fiscal budget deficit in all recent years. In particular, rural Jiangxi contains large pockets of poverty. Average rural net per capita income in recent years have been around the national average (4,098 RMB in 2007), but between 2001 and 2005, 1200 villages were targeted for poverty alleviation. Ganzhou, Nanchang, Shangrao, Pingxiang and Ji'an city account for 70% of the total of 660,000 poor people in the province (2007 figures). Within agriculture, most of output value comes from farming (43.5%), livestock (30.5%), and fisheries (12.8%). Jiangxi is a main production area for grains, cotton, oil crops as well as tea, tobacco, fruits, bamboo and medicinal plants.

4.1.3 Climate and water resources challenges

Climate and more particularly climate change represents a challenge in Poyang Lake area. It has caused over the past years severe impacts on:

- water resources: runoff and flooding in summer has increased, decreasing precipitation and increase in drought events
- agriculture: drought impacts and other extreme climate events (wind, hail, snow disasters)
- forestry: winter freeze, drought, hail.

In the context of climate change, getting a better understanding about the impacts of

climate change on ecosystem management, and having the necessary climate information will be essential to promote the sustainable development of local ecosystems under current climatic conditions.

Water resources challenge is probably the most prevailing challenge in Poyang Lake. Between 2002 and 2009, the water level in the lake fell to historical lows (2007), and drought has become more frequent, with impacts on the vegetation and wetland ecosystems and their services. Water quality continues to be a problem, with only 80% of monitoring points reaching quality grade III (on a scale of I-V) compared to 97% in the late 1990s. Flooding continues to be a problem, with the frequency of severe floods increasing in the 1990s. In 2010 floods happened again and caused severe losses, partially because of increasing precipitation and increases in runoff from the major tributary rivers. In part, it is also because changes in the Yangtze River level caused that the Yangtze water level has a blocking effect to prevent drainage from Poyang Lake. At the same time, drought events have increased because rainfall is more concentrated in the summer months. Parts of Jiangxi are affected by drought every year, but since 2003 droughts have become more frequent, and drinking water supplies have become problematic in some counties, despite the region's overall wealth of water resources.

At end of 2009, the State Council approved the Poyang Lake Ecology and Economy Regional Master Plan as a national strategy. This includes a major plan to divide the lake from the Yangtze and use sluice gates to control water flows between these two bodies to minimize flood and drought impacts in Jiangxi as well as interventions in water management in the main tributary rivers. Many tasks have been conducted for this master plan, like planning EIA and SEA, including climate proofing. This climate proofing refers to the observed climate conditions and took climate projections into account. Therefore, the Poyang Lake Ecology and Economy Regional Master Plan is until now the only national strategy which considers climate change projections.

4.2 Results of the screening in Poyang Lake area

4.2.1 Results of the screening methodology

First an internet and literature review for the listing and mapping of the institutions in the existing ecosystem management and the processes of planning EIA and SEA in Poyang Lake was conducted. 100 questionnaires on the needs and present use of climate information were sent out. 50 people from 30 agencies related to SEA sent back their answers. Among them: 24 people from universities, 14 people from other institutions and 13 people from the government (the total being 51 as one person belongs to an institution and a university at the same time). Those people were mainly researchers, senior engineers and professors.

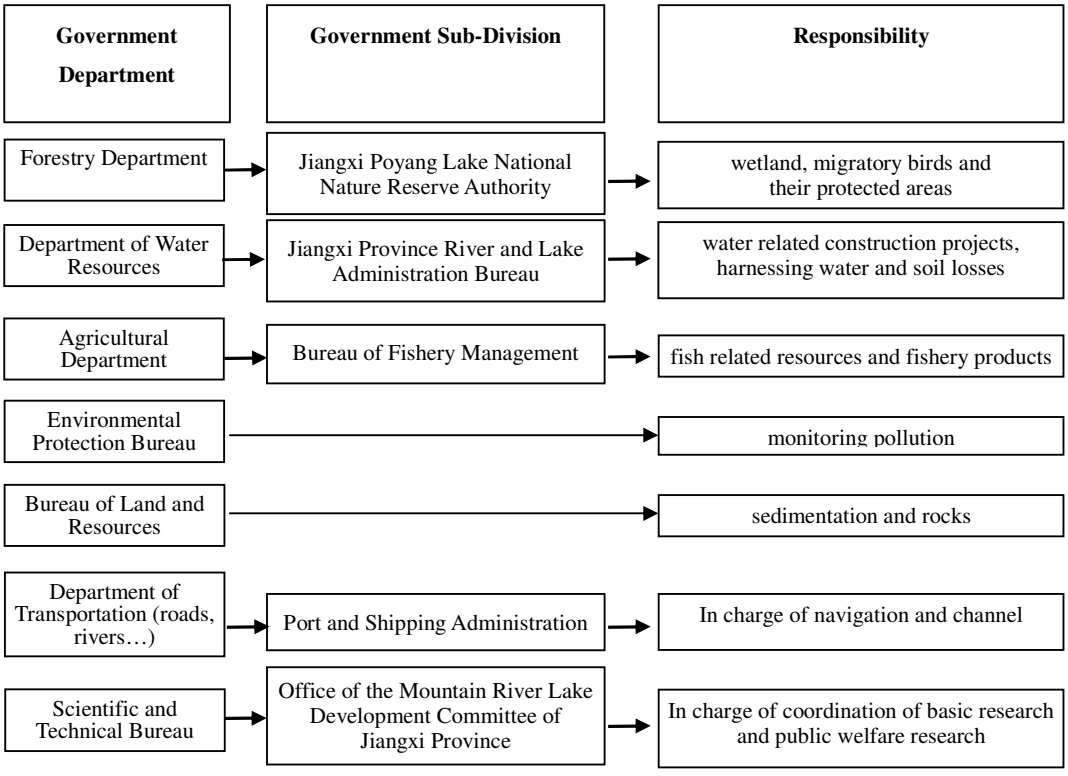
Based on the results of the screening as well as the review of the international experts,

several shortcomings and gaps regarding the use of climate information in ecosystem management with specific focus on EIA and SEA in Poyang Lake area were identified. The results of the screening in Poyang Lake are presented below.

4.2.2 Listing and mapping of the existing ecosystem management, planning EIA and SEA in terms of institutions and processes

Following the Environmental Protection Law, the Poyang Economic Master Plan is the guiding instrument for ecosystem management in the area and sets it a requirement for projects to do EIA. The figure below presents the different departments of the Jiangxi provincial government dealing with ecosystem management and some exemplary responsibilities that are implemented by the departments of lower hierarchy.

Figure 5. Agencies dealing with ecosystem management and exemplary responsibilities (Poyang)



In January 2009, Jiangxi Province established the Jiangxi Province Climate Change Monitoring and Assessment Center, housed within the Jiangxi Province Disaster Prevention Technology Office, which is overseen by Jiangxi CMA. The stated purpose of the center is to monitor climate change and extreme climate events, analyze the causes of climate change in the province, and undertake assessment of impacts on agriculture, forestry, water resources, energy, transport, tourism and

construction. The tasks of this Center are: providing monitoring, analysis and forecasting and early-warning information on natural disasters in the province, and specific functions include collating and sharing information between different departments.

4.2.3 Assessment of stakeholders' needs for climate information based on the questionnaires and interviews

The response of the stakeholders in the Poyang area shows that climate information in ecosystem management is required for their operational tasks and planning EIA. A great majority of the stakeholders (90%) put heavy rains and floods as the most influential meteorological hazards in Jiangxi Province. Most of them (66%) acknowledge that climate and climate change impacts mostly affect reservoirs and lakes and 51% of them feel concerned about the climate impacts on Poyang Lake wetlands and biodiversity. The meteorological departments prepare and provide routine climatic data including temperature, precipitation, wind, sunshine duration and air pressure. According to the needs identified by the investigators, there are needs for average temperature, daily precipitation and 17 other detailed factors. The respondents of the questionnaires are most concerned about precipitation. The daily precipitation information is of most concern among the five detailed factors for precipitation.

The second important climate element concern is temperature. Among four detailed factors (average temperature, maximum temperature, minimum temperature, accumulative temperature), the maximum temperature is of highest concern; needs of Wind and sunshine cause less concern, and detailed factors like the UV radiation intensity, maximum wind speed, typhoons and other information are slightly more often required. Some researchers are very concerned about the impact of climatic factors on traffic or health. The questionnaire did not focus on these detailed indicators. In addition, some departments are more concerned about the relevant data and information for air pressure, acid rain, atmospheric conditions such as suspended solids and particulates.

Table 3. Climate Information needs in planning EIA and SEA (Poyang)

Department	Information Need	Accessibility
Forestry Department, Agricultural Department, Department of Transportation, Jiangxi Provincial Power Company	Weather disaster monitoring data	Normal
Department of Water Resources, Forestry Department, Agricultural Department, Department of Transportation, Scientific and Technical Bureau, Jiangxi Provincial Power Company	Extreme weather and Climate events monitoring	Easy
Department of Water Resources, Forestry Department, Agricultural Department	Meteorological drought monitoring	Normal

Table 4. Climate information needs in operational ecosystem management (Poyang)

Department	Information Need	Accessibility	Advise
Department of Water Resources Forestry Department Agricultural Department Environmental Protection Bureau Bureau of Land and Resources Department of Transportation Scientific and Technical Bureau Jiangxi Provincial Power Company	The climate impact assessment of Jiangxi Province	Easy	
Forestry Department Agricultural Department	The Climate disaster impact assessment	Easy	
Forestry Department Agricultural Department	Continuous cold and rain days	Difficult	
Department of Water Resources	Flood monitoring	Normal	
Jiangxi Provincial Power Company	Heat wave monitoring during summer	Easy	Improve the frequency
Forestry Department Agricultural Department	The frozen disaster monitoring during winter	Easy	
Forestry Department, Agricultural Department	Climate Prediction every month	Normal	
Agricultural Department	The specially prediction for the spring sowing season	Easy	Add the release platform
Department of Water Resources Agricultural Department	The forecast during flood season	Easy	Improve the frequency
Department of Water Resources Agricultural Department	The forecast during June to August	Difficult	
Forestry Department Agricultural Department	The prediction for the summer and autumn drought	Easy	
Agricultural Department	The forecast of cold wind during autumn	Normal	
Agricultural Department	Forecast damage from cold air in winter	Normal	
Department of Water Resources Forestry Department Agricultural Department	The forecasting for the next year	Normal	
Department of Water Resources Agricultural Department	Forecasting from March to September	Difficult	Improve the accuracy of the prediction
Agricultural Department Environmental Protection Bureau	Rolling forecast every month	Difficult	Timely release
Agricultural Department Environmental Protection Bureau	Rolling forecast every season	Difficult	Timely release

As can be seen, most of the climate information that is required by government agencies in the Poyang lake area represents the operational tasks of the departments that fall under ecosystem management. Some information is overlapping regarding the use for operational tasks or planning tools: the monitoring of drought for instance belongs to both processes: the departmental operational tasks and the SEA. The climate information for planning EIA and SEA in the Poyang area can easily be accessed by the departments. Other information for operational use, however, is very difficult to obtain. The seasonal climate forecast that is required for instance by the water resources department is an important information for ecosystem management and can help to prevent negative impacts on the ecosystem, e.g. algae bloom.

The requests and comments from the different agencies interviewed were gathered into four groups. These are reported below:

1) Agriculture (fishing) and forestry products related agencies (Provisioning services management departments)

These agencies are in management or related to the goods or products obtained from ecosystems, for example, the Academy of Agricultural Sciences, Agricultural University, Fishery Bureau, Academy of Forestry, Forest Inventory and Planning Institute and other agricultural (including Fisheries Service) forestry sector. This sector's climate information needs mainly focus on temperature elements: minimum temperature and accumulative temperature, and precipitation elements of annual precipitation and relative humidity. During the interview, Jiangxi Academy of Agricultural Sciences (JAAS) raised a number of questions and said it would be good if data were available on future prediction on impacts. The complex factors affecting agriculture and the diversity of agriculture in the province make it difficult to undertake impact assessments on ecosystems without precise climate information. From available publications and the JAAS internet, it appears that no researchers at JAAS are involved in climate impact assessment at present, and most agro-meteorology assessments in Jiangxi are done by Jiangxi CMA and Jiangxi Meteorological Sciences institute. None use predictions.

2) Biological diversity, environmental protection, ecological regulation related agencies (Regulating services management departments)

Jiangxi Academy of Sciences Research Center / Biological Resources Institute, Wildlife Conservation Board, Lushan Botanical Garden and other agencies are related to "production and maintenance of biological diversity" services in Poyang Lake; Environmental Protection Sciences, Environmental and Chemical Engineering and other related units (e.g. the Office of Mountain River Lake Development Committee) are related to environmental protection departments. Temperature, precipitation and sunshine are relevant factors for this sector, the main concerns of temperature elements are on maximum temperature, minimum temperature and accumulative temperature; precipitation elements requirement is on daily precipitation and precipitation days.

3) Water supply, economy, decision-maker and related research and support departments

This group includes the Development and Reform Commission, Water Resources Department, Central Committee of the NPC capital, power, mining and water resources planning agencies and other relevant agencies. Climate information needs in this sector focus on temperature and precipitation, the main concerns are average and maximum temperature, and daily and annual precipitation. During the interview, Jiangxi water resources bureau said they do not currently use climate predictions because they have no access to the required data, and also because there are no procedures and standards for including future scenario assessment into the design of water infrastructure. However, they said they would be interested to have access to predicted data so that they can make a quantitative estimate of the likely implications of future scenarios.

4) Tourism, culture, scientific research and other relevant departments of non-material products

This sector includes Nanchang University, Jiangxi University of Finance, Jiangxi Normal University, Jiangxi Science Association, Ganjiang hotels and other universities. Climate information needs of this sector are more diverse, and closely related to the research areas of the respondents. For the tourism research agencies, the maximum temperature, minimum temperature, UV intensity and average daily sunshine are the factors the most often mentioned.

4.2.4 Existing climate products and their availability and suitability

Climate products are independently developed by the Jiangxi Climate Center according to internal regulations of CMA and NCC and the particular needs of Jiangxi province. The climate data comes from the 87 meteorological stations of Jiangxi province and the satellite images come from the National Satellite Center. These products are released on the web-page of CMA, Meteorological bureau of Jiangxi Province and the Jiangxi Climate Center according to the regulation. The public and the institutions can get the climate products for free. Some special predictions such as the prediction during flood season will be submitted to the province governor and relevant government departments.

Climate products are used by commercial departments and government departments. Among the commercial departments, there are: the electric power sector, the city construction sector and the agriculture sector. The electric power sector includes wind farm industry, nuclear power industry, solar energy industry and Electric Power Planning and Designing Institute. The city construction sector includes Advertisement Company and Construction Company and other enterprises. The agriculture sector includes Seed Company and Agricultural Technology Promotion Corporation Company. The government departments include: the Department of Water Resources, Forestry Department, Agricultural Department, Environmental Protection Bureau,

Bureau of Land and Resources, Department of Transportation, Scientific and Technical Bureau and others. As can be seen from the tables above, there are shortcomings and gaps in the provision and demand of climate information.

4.2.5 Shortcomings and gaps

In general the assessment showed that the climate products available are quite satisfactory for planning EIA and SEA, but also for the operational service such as flood and drought prevention, forest fire early warning, solar and wind energy development which all support ecosystem management. However, based on the feedback obtained from the stakeholders as well as the European experience, several shortcomings and gaps are noted that need to be addressed on the integration of climate information into ecosystem management in Poyang Lake area. These include:

1) Low frequency of data dissemination. The Jiangxi Climate Center (JCC) only offers the monthly, seasonal and annual climate information products (including evaluation of observed events and monthly and seasonal predictions), but the environmental protection department and other departments need daily data and even real-time data for their routine work. It appears to be difficult for the JCC to provide daily data. According to the Meteorological law, data can only be released after quality control, which takes more than one week to be done. Therefore, the real-time data cannot be delivered in time as requested by the government departments such as water resources bureau, agricultural department, forest department, or environmental protection bureau.

2) Lack of accurate data products. When using climate predictions, the estimated data is about 1°×1° (about 100km × 100km). The agriculture, forest and water resource departments would like to use predictions in their operational work and in SEA but require a higher resolution to make it effective for ecosystem management.

3) Lack of climate proofing. At the moment climate feasibility studies or climate proofing is just an option. There is no mandatory requirement for these. The Poyang Lake Ecology and Economy Regional Master Plan includes planning of water infrastructure, which has been done on the basis of historical data on water flows. Future climate predictions have been considered but are not used systematically. Some stakeholders are interested to investigate possible future impacts, but there are no established indicators or assessment criteria with regard to climate proofing procedures. The need for climate projections and their assessment criteria was raised as it strengthens the resilience and adaptive capacity of the lake water capacity, wetland protection (bird protection) and biodiversity conservation, and thus clearly influences the ecosystem management in the region. Until today, there is no legal requirement to use observed climate data in SEA or other instruments that serve ecosystem management. Optional usage is not processed well due to 1) lack of awareness regarding climate information and also 2) lack of accessibility of climate

data. The different departments dealing with ecosystem services in Poyang Lake area do not systematically use updated climate information and weather forecasts which would support ecosystem management.

Most of the challenges mentioned above could also be relevant for other areas in China. It makes the Poyang Lake case study more significant as the recommendations drawn out from it can be applied in other parts or for other cases in China.

4.2.6 Policy recommendations for Poyang Lake area

Based on the shortcomings and gaps identified above, some policy recommendations regarding the integration of climate data into existing ecosystem management and in EIA, planning EIA and SEA including needs, approaches, processes and institutional requirements were drawn from the Poyang study and are summed up below.

1) Climate proofing should be supported by legislation (e.g. environmental, planning, water, land-use). Currently EIA, planning EIA, and SEA include air quality, water/waste water, solid waste and noise and the strategic planning (SEA) includes impact analyses. Up to now there is no part addressing climate proofing in EIA and SEA. There is currently no legal or administrative requirement for climate proofing. It is commonly agreed that climate will have impacts on the four parameters air, water, waste and noise. Knowing this, it is necessary to integrate climate information into EIA, planning EIA and SEA. Climate proofing therefore needs to be supported by law to make its application compulsory. Thus, climate change impacts will be taken into consideration and planning mistakes can be reduced. This requirement is in line with the common practise in the EU, which asks to integrate climate information and even climate predictions into EIA and SEA.

2) Improve projections and public perception. Ecosystems are facing heavy losses and damage of ecosystem services due to extreme climate events, planning and construction. In order to manage ecosystems, climate information and projections should be mainstreamed into all planning processes, especially EIA and SEA. The public should be well informed about climate projections in their area and stakeholders should be provided with higher resolution projections for sectors to utilize the data provided. The use of regional climate models or downscaling methods should be systematically formalized to improve data accuracy.

3) Specific and Sectoral Impact Assessment. Climate data quality, accuracy, frequency and accessibility must be improved to allow a proper use. Systematic updates and forecasts should be conducted with direct integration into the needs of the departments that support ecosystem management. This includes tailor-made specific and sectoral impact assessment which goes beyond climate information but into other applications.

5 CONCLUSIONS FOR TWO PILOT STUDIES

Policy recommendations for the two pilot areas (Xiamen City and Poyang Lake area) were developed and it appears that the current situation and the findings obtained from the study are very relevant and applicable for other regions or areas of China. Xiamen as an urban ecosystem faces challenges in the integration of climate information that are also relevant for other urban ecosystems in other cities in China. Poyang Lake area as a freshwater ecosystem facing more and more water resources challenges gives an example that can be duplicated in other parts of China. The major gaps that were identified for the two areas are the following: lack of updated standards in climate information provision, multiple data sources for different government departments, lack of capacity on understanding the impacts of climate change, lack of information sharing between providers and users of climate information, lack of climate proofing studies, lack of accuracy of climate predictions, low frequency of data dissemination, lack of authority in the system of providing and demanding climate information and predictions, lack of legal basis for a mandatory integration of climate information, the latter being the biggest challenge.

Apart from these two examples, it was also of great importance to base the study on the experience of other countries such as countries of the European Union. Climate challenges are not only faced by China and to further develop options and integrate in a more efficient way climate information into ecosystem management, planning EIA and SEA, good examples and models can be taken from Europe. This was done in this study.

The main finding is that ecosystem management is carried out by government agencies using major tools such as EIA or planning EIA. However, ecosystem management is also based on operational tasks by these agencies. It becomes clear that the agencies have addressed needs for more accurate and tailor-made climate information to use within the major tools of ecosystem management and outside these tools. The main challenge is to gain legislative support and standardization on the use of climate information. Collecting the stakeholders' feedback about their use in climate information is of utmost importance for such a study as they are the first users most concerned about climate information.

6 OVERALL POLICY RECOMMENDATIONS

The needs of the users (government agencies) of climate information in ecosystem management, EIA, planning EIA and SEA and the current provision of climate information have been identified. The gaps between the provision and desired use of climate information come from the technical side (data formats) and mechanisms (obligation to use updated climate information). International experience from Europe was used to identify that the use of climate information has to be required by policy and regulations. Most of the challenges are similar for the pilot areas Xiamen City and Poyang Lake area. Five overall policy recommendations can be drawn:

1) Climate proofing should be integrated in the Environmental Impact Assessment Process

A legal standard for the use of climate information in EIA, planning EIA, and SEA should be established. This should also include a legal standard requiring the use of climate projections in EIA and SEA. It is commonly understood that climate change will have impacts on the four parameters air, water, waste and noise. Consequently, it is necessary to integrate climate projections into EIA, planning EIA and SEA to take these impacts into consideration. We recommend introducing and implementing relevant policy instruments such as climate proofing. Climate proofing will deliver a formalized legal approach on the use of standardized observed climate data accompanying climate impact studies for each EIA and climate predictions in EIA, planning EIA and SEA, including the sharing of responsibilities and tasks such as supervision and reporting mechanism. Other tools should be developed to improve public perception of climate change, and to improve sectoral studies on climate impacts which will all enhance proper ecosystem management.

2) Mechanism or Policy Platform for Exchange Climate Information and increase Participation of Decision-Makers in Ecosystem Management

Stakeholders in ecosystem management must be strengthened in the awareness about climate information and the impacts of climate change. This evolves tasks on the demand and supply side of climate projections. Capacity building should be developed at local level, to increase the knowledge of local agencies on how to integrate climate information into their planning. A specific agency similar to UKCIP whose role would be to support the local planners in this regard could be established. For the demand side, a variety of mechanisms could be adopted including structured awareness raising, education and training to make administrators/stakeholders aware of the importance of integrating climate information and projections into their planning. On the supply side, coordinating institutions or coordination mechanisms should be established among different government departments. Communication between the providers and users of climate information should be improved. The authority of the climate change monitoring and assessment centers (such as Xiamen and Jiangxi) in EIA, planning EIA and SEA should be formalized as these institutions could be made responsible for coordinating the mechanisms on the supply and

demand side and enhance the required use of climate information in ecosystem management.

3) Basic collection of climate and climate change information and Communication between providers and users should be improved: The provision of basic monitoring data needs to be improved. In addition to conventional monitoring of climate data, information should also be collected for a variety of climate change impacts. This also requires providing guidance on how to further process the data in climate impact studies. Ecological data needs to be accumulated to serve protection strategies for ecology and wildlife. While assessing the vulnerability of ecosystems, metadata on ecological system should be developed to store the historical and current records about distribution of plants and animals, and to provide data for carrying out climate simulations, assessment and implementation of protection strategies.

There should be special regulations on the use of the data, especially on the ownership, property rights, costs, and data frequency: A) The frequency of providing observational data has to be increased. This requires computer systems and methods for fast quality control. B) Easy access to data should be set up. A web-based distribution system or electronic document sharing platform should be established. C) The spatial extend of climate projections should be improved in order to enhance data accuracy and to limit uncertainty. D) Formalities for information sharing should be settled.

CMA requires a legal framework that depicts how to provide service based on the requirements that EIA, planning EIA and SEA have.

4) Topic/sector and region focused impact and vulnerability assessments should be improved: Based on observed and monitored data, climate change scenarios should be improved to study the impacts of climate change and assess vulnerability of key sectors (agriculture, water resources, forests) and key regions (coastal regions and vulnerable eco-regions in the West). Climate change scenarios and projections have to be used in SEA and regional planning.

The challenge of ecosystem management in Xiamen City and the Poyang Lake area can be found in other regions of China. Our overall policy recommendations can be used in other regions of China. The theoretical and practical experience collected in both pilot studies can serve as demonstration for integrating climate information into existing ecosystem management.

ATTACHMENT

GLOSSARY

Climate

The climate is the general or average weather conditions of a certain region in a long-term, is each kind of weather process synthesis performance at this time interval. The climate is the average or statistical condition of meteorological elements and weather phenomena in a long-term, the time criterion ranges from month, season, year, several years to several hundred years. The climate is weighed by cold, warm, dry, wet and so on, it's usually shown by the mean value and the differential value in a certain time. Each kind of statistics value (average value, extreme value, probability and so on) of meteorological element (temperature, precipitation, wind and so on) is a climatic basic indicator.

Climate change

'Trends or other systematic changes in either the average state of the climate, or its variability (including extreme events), with these changes persisting for an extended period, typically decades or longer (i.e., longer term)'. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between "climate change" attributable to human activities altering the atmospheric composition and "climate variability" attributable to natural causes.'[8]

Climate proofing

In China, climate proofing refers to the construction of large infrastructure projects, such as highway construction, bridge construction, nuclear power station construction, large-scale water conservancy facilities, regional framework plans and so on. It is necessary to use and understand the conventional climate parameter, consider carefully the local climatic conditions and the impact on the regional atmospheric environment probably caused by the project. Based on the European Commission's green paper on climate change "Adapting to climate change in Europe – options for EU action" (2007), ensuring the sustainability of investments over their entire lifetime taking explicit account of a changing climate is often referred to as 'climate proofing'. 'Climate proofing is a shorthand term for identifying risks to a development project,

[8] Asian Development Bank (2005): Pacific Studies Series: Climate Proofing. A Risk-based Approach to Adaptation

or any other specified natural or human asset, as a consequence of climate variability and change, and ensuring that those risks are reduced to acceptable levels through long-lasting and environmentally sound, economically viable, and socially acceptable changes implemented at one or more of the following stages in the project cycle: planning, design, construction, operation, and decommissioning'[9].

Ecosystem

An ecosystem consists of all the organisms living in a particular area, as well as all the nonliving, physical components of the environment with which the organisms interact, such as air, soil, water, and sunlight. Ecosystem's scope may be possible to be small or greatly, interlocks mutually, the biggest ecosystem is biosphere. Humankind mainly lives in the artificial ecosystem which primarily consists of urban ecosystems and farmland.

Ecosystem assessment

It's a social process that meets decision-making's needs through providing the reason of ecosystem change, impact of ecosystem change on human blessing, as well as the management and policy aspect's countermeasure and so on scientific research achievements for the policy-maker.

Ecosystem management

An approach to natural resource management, which aims to sustain ecosystem to meet both ecological and human needs in the future. It is based on an adaptive, collaboratively developed vision of desired future conditions that integrate ecological, socioeconomic, and institutional perspectives, applied within a geographic framework, and defined primarily by natural ecological boundaries

Ecosystem service

Humankind benefits from a multitude of resources and processes that are supplied by natural ecosystems, many functions are unable to buy or sell in the market and each kind of service has important value to human mankind, including provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycle that maintain the conditions for life on Earth.

Ecosystem service function

Ecosystem may provide many kinds of benefits for the humanity, including provisioning services, regulating services, cultural services and supporting services.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.
Regulating services: The benefits obtained from the regulation of ecosystem processes,

[9] Asian Development Bank (2005): Pacific Studies Series: Climate Proofing. A Risk-based Approach to Adaptation

including, for example, the regulation of climate, water, and some human diseases.
Cultural services: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.
Supporting services: Ecosystem service is necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Urban ecosystem

The urban ecosystem is a unified whole, formed by the interaction between city, people and its environment, is also a special artificial ecosystem, constructed by human from the natural environment through adapting, processing and transforming. The urban ecosystem is one kind of typical artificial ecosystem which founds according to humanity's wish. Its main characteristic is that putting human as the core of the system, intense dependence to the exterior and crowded stream of people, physical distribution, energy flow, information flow, capital flow and so on.

Most of the urban ecosystem’s demand in energy and material are put in artificially from other ecosystems (for example field ecosystem, forest ecosystem, prairie ecosystem, lake ecosystem, marine ecosystems); At the same time, most of waste cannot be decomposed completely or recycled in this system and thus must be transported to other ecosystems.

The scientific urban ecology plan and design can make the urban ecosystem maintain the positive cycles and present the coordinated development patterns in urban construction, economic development and environmental construction.

Environmental impact assessment

The environmental impact assessment (EIA) refers to the environment impact probably caused by the plans and projects of basic construction to carry on the analysis, forecast, assess, propose the countermeasure and measure in prevention or reduce the adverse environmental impact, and carry on the method and system in the track monitor.

Generally, it analyzes the possible environmental impact caused by the project, and proposes the countermeasures to reduce these impacts. According to the environmental factor which it influences, it can be divided into atmospheric environmental impact assessment, water environmental impact assessment, noise environmental impact assessment, solid waste environmental impact assessment and so on; According to the object, it can be divided into Items of basic construction environmental impact assessment (EIA), plan environmental impact assessment (planning EIA), strategic environmental impact assessment (SEA)..

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