Comparative study of Models and approaches of "Eco-provinces and Eco-cities"

Chinese Research Academy of Environmental Sciences

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1 Introduction

In recent years, China's urbanization process is at an unprecedented pace. However, during this process, it will inevitably leads to a series of urban problems, such as environmental pollution, resource depletion, transportation congestion and land tensions. At present, implementing eco-city is a globally optimal way to solve urban problems and provide a harmony residential pattern between nature and human.

As a result, China Research Academy of Environmental Sciences and Germany Federal Agency for Nature Conservation (BFN) decided to organize the experts from both side to hold a seminar on the subject of "China-German sustainable planning and management of eco-province " from 21st to 23rd October 2009 at Shenzhen. This seminar will discuss the related technologies, methods, policies, laws and implementation of eco-city and carry out experience exchanging activities.

In order to facilitate the mutual understanding of both side, under Germany BFN and China Research Academy of Environmental Sciences commission, the Study Group analyze and summarize other eco-city constructions and related case studies, which provide background information for this seminar.

1.1 Current Situation of China's urbanization

1.1.1 The rapid pace of urbanization, the urban population increasing rapidly.

In 1985, there were 297 cities in China, while there have been formed 655 cities by the 2007. In 20 years, the number of city increased more than double, the urban population also increased more than double from 17.92 percent in 1978 to 44.94 percent in 2007. The population increased three times from 170 million to more than 590 million. There are only 50 cities with population of more than one million in 1984 while the number has increased to 118 cities in 2007, and the cities with population of four million are over 13. Although the family planning policy has been carried out, the cardinal number is too large in China's population. Besides, due to the fast rate of population growth, coupled with reform and opening, the rapid urban development, the scale expansion, the urban population increased dramatically.
1.1.2 The urban spatial patterns shift from single development to groups

Since the reform and opening, the central region of southeast coast and western regions have their own urban development, which formed different city groups. Beijing and Tianjin are the central city in the area of JingJinJi. Shanghai and Nanjing are the center of the Yangtze River Delta city group. Guangzhou and Shenzhen are the center for the Pearl River Delta city group, as well as Chengdu-Chongqing as the center for Chengyu city group. In the Central Plain, Zhengzhou, Luoyang as the center city group and so on. These cities concentrated, such as the Yangtze River Delta city group include Shanghai, Nanjing, Hangzhou, Ningbo, Suzhou, Wuxi, Taizhou and other 16 cities. In addition to these five groups, there are many other cities in the composition of large urban groups. All the city groups has a closed relationship, both competition and cooperation, and put forward the whole city groups.
Table 1. The cities in Five cities groups.

<table>
<thead>
<tr>
<th>area</th>
<th>The number of cities</th>
<th>cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jingjinji urban group</td>
<td>10</td>
<td>Beijing, Tianjin, Shijiazhuang, Langfang, Tangshan, Qinhuangdao, Baoding, Zhangjiakou, Chengde, Cangzhou</td>
</tr>
<tr>
<td>Yangtze River Delta city group</td>
<td>16</td>
<td>Shanghai, Nanjing, Hangzhou, Ningbo, Suzhou, Wuxi, Changzhou, Zhenjiang, Yangzhou, Taizhou, Nantong, Jiaxing, Huzhou, Shaoxing, Zhoushan, Taizhou</td>
</tr>
<tr>
<td>Pearl River Delta city group</td>
<td>9</td>
<td>Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Zhongshan, Dongguan, Huizhou, Zhaqing</td>
</tr>
<tr>
<td>Chengdu-Chongqing Urban group</td>
<td>15</td>
<td>Chengdu, Chongqing, Mianyang, Deyang, Neijiang and Ziyang, Suining, Zigong, Luzhou, Yibin, Nanchong, Guang'an, Florida, Meishan and Leshan</td>
</tr>
<tr>
<td>Central China city group</td>
<td>9</td>
<td>Zhengzhou, Luoyang, Kaifeng, Xinxiang, Jiaozuo, Xuchang, Pingdingshan, Luohe, Jiyuan</td>
</tr>
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1.1.3 urban development Dependent on the supply of in rural areas

At the end of 70 decade, China's economic rapid developed in rural areas, population growth, limited arable land, a large number of rural surplus labor move out from the traditional agriculture. Then these labors engaged in the non-agricultural industries in the city and the city's basic infrastructure facilities were completed by the migrant workers who played more and more important role in promoting the urban development. Moreover, the entire urban food was supplied by the rural. This urbanization development and prosperity is built on the rural economic which is a major characteristic of urbanization and the result of the coordinated development of urban and rural areas.

1.2 Current Situation of China Eco-city construction

Yichun City proposed the goal of building the ecological city in 1986, and started the construction of eco-city pilot project in 1988 which is the China's first eco-city construction practices. Subsequently, Guangzhou, Shanghai, Ningbo, Kunming,
Chengdu, Guiyang, Changsha, Yangzhou, Weihai, Shenzhen, Xiamen and other cities have put forward the goal of building eco-city. Hainan carried out the construction of the first ecological province approved by the country in 1999. Jilin and Heilongjiang was approved of building of the ecological province in 2001. Shaanxi, Fujian, Shandong and Sichuan have proposed the building of ecological province one after another.

The cities were not only actively exploring eco-city construction methods and practicing, but also discovering their own characteristics in practice. In 2003, the Minister of Environmental Protection of the People's Republic of China awarded the planning and construction of ecological zones, ecological city and ecological province on the basis of the practice of eco-demonstration region, which provide an important guiding role in regulating the standard of planning and construction the pilot eco-province.

1.2.1 China's eco-city construction is from a systematic, holistic thinking point, formed a complete theoretical framework of the system.

China's eco-city construction through the continuous efforts in recent years has already formed a complete theoretical framework system, which involves the ecology, urban ecology, social ecology and all aspects of industrial economy. The determination of specific implementation plan is through various ecological analyses.

The theoretical framework of China Eco-city planning system generally include natural system, eco-industrial system (mainly including ecological industry, ecological agriculture and ecological tourism etc.), resources and energy security system (mainly including water resources, land resources and energy etc.), environmental support system (mainly including the water environment and water ecology control, air pollution control and environmental improvement with solid waste processing and resource utilization etc.), the building of ecological culture and ecological communities accordingly with specific projects and security planning goals.

Moreover, most of the planning of the proposed project funds were estimated, and proposed a wide range of possible funding sources to guarantee the smooth development of the project. In addition, planning used remote sensing technology as a source of ecological information. GIS was used as a basis for the planning platform to get the latest and most accurate basic data, while through GIS software to draw beautiful graphics (such as the green heart of the city and the design of ecological corridor etc.) to visually show the effect of planning and design and give a visual impact which is a major bright spot in China's eco-city construction plan.
1.2.2 the clearly explanation of Eco-city construction planning character and the legal status

On the basis of accurate characterization of Eco-city construction plan and their legal status, the smooth implementation can be ensured. At present, the compiled Eco-city plan in China has all made clear the nature of planning and legal status. In generally, the Planning Qualitative is characterized as ecological city planning programmatic document to guide the construction of ecological city, planning and set targets, measures and capital budget to include in the city's budget. Each district and county (city), departments, township and corporate development plans which provide guidance for specific urban planning and basis for individual planning.

A clear legal status is put forward by the local municipal government and proposed by the Municipal People's Congress for deliberation and approval, the municipal people's government responsible for the implementation, and the municipal people's congresses and their standing committees oversee the implementation, reflects the construction of the eco-city authority and seriousness. Eco-city construction planning through accurate qualitative and clear legal status created a favorable external conditions for the specific implementation.

1.2.3 Chinese eco-city construction is a difficult task

The majority of the urban cities have weak economic foundation, so economic development is the city's primary task, improving the people's material standard of living is a priority. Because of geographical location, traffic, weather and other factors, the city has to introduce the high-energy consuming and high polluting enterprises to promote the local economic development and sustainable development will be temporarily shelved, when the city has come back after a certain economic base to
build the ecological environment, many cities have produced adverse effects, as a result, the ecological construction is an arduous task.

### 1.2.4 Eco-city construction is mainly distributed in the central and eastern economy developed region

From the proposed eco-city construction target characteristics of the urban geographical distribution point of view, the eco-cities are mainly in central and eastern economy developed areas, and mainly distributed within the eco-province construction regions. Furthermore, eco-cities also distributed at economically and culturally developed areas rather than the less developed economic and cultural areas; coastal areas rather than inland areas; the high level urbanization area rather than the lower lever area. From Figure 3, we can visually see that in the 114 has been established and prepared eco-city construction cities, the highest proportion is in East China, up 36%; the west (including the Northwest and Southwest) economically underdeveloped areas, the Eco-city construction of cities is at least, accounting for only 5%.

![Fig3: the distribution of eco-city construction](image-url)
2 The main elements of eco-city planning

2.1 Ecological Function Zoning

Ecological function zoning is the basis for eco-city construction plan. To demonstrate the idea of the ecosystem approach, Eco-city construction planning took into account the ecological state of the environment, the diversity of ecosystem services, ecosystem processes and future trends and other factors, analyze the characteristics of different regions, functional requirements and the linkages between the regions. Moreover, Eco-city construction planning focused on proposing protected areas, development control and developed construction of regional and urban areas. From the bio-diversity conservation, urban ecological security pattern and urban construction and development needs point of view, this paper proposes a clear control programs.

Clearly what the region must take strict measures to protect, which areas can be appropriately developed and which areas can be developed to use as well as the scope and the extent of use. Reveal the integrated potential development, the advantages and disadvantages of the utilize resources and scientific and rational development and utilization, as well as the ecological environment improvement and means so as to provide a scientific basis for policy formulation on regional economic development and environmental protection.

2.2 Analysis of ecological carrying capacity

Human life depends on healthy ecosystems which provide the resources to maintain life and absorption, decomposition of the waste. Ecological carrying capacity analysis is mainly used to assess the urban ecosystem can provide the total resources used for guiding the human development approach and level of development. Based on China's status quo, to carry out the evaluation process includes analysis of the ecological carrying capacity of water resources carrying capacity, land resources carrying capacity and ecological footprint analysis to determine the maximum population load.

2.3 Natural ecological system

The natural ecological system mainly includes three aspects: ecological security patterns in the planning, ecosystem recovery, eco-Habitat suitability planning, in which the ecological security pattern mainly depend on landscape ecology theory. In order to maintain of natural ecosystem in Shenzhen, the connectivity of important ecological function areas, and basic ecological control lines, based on building by large plaques, ecological corridors and key nodes of the natural ecological patterns,
so that the natural area between the inland city is separated from the city's goal of achieving a natural melting.

Restore and enhance ecosystem function primarily through the adjustment of the natural ecosystem within the system configuration and component composition, improve the zonal type of area ratio of forest ecosystems and restore natural ecosystems, native species composition, to achieve ecological land to protect from quantity to quality control to enhance changes. Habitat Ecosystem planning mainly aim at the suitability of human activities, and other land in green space planning, as well as the protection of biological diversity.

2. 4  **Resources and energy development planning**

The principle of "resource conservation, utilize efficiency", the use of resources and energy to carry out planning, this part of the content is often combined with industrial planning. Resource planning aimed at carrying out land and water resources.

2. 5  **Environmental Support System Planning**

For the environmental issues in planning studies, including: water environment, atmospheric environment, solid waste disposal and noise control, etc. Because of the content of this seminar focuses on natural eco-system planning section, this report does not make too much explanation.

2. 6  **Industry Development Planning**

In order to plan the overall strategic thinking of social and economic development and aim at win-win on both industrial development and environmental protection as well as focus on adjusting the industrial structure then put forward the general concept of the development of industrial system.

This section mainly based on ecological principles and the cycle of economic theory, market-oriented, through government guidance and planning, the establishment of industrial coordination, rational layout, production and eco-efficient industrial system, which display fully ecological protection and construction of socio-economic development. The eco-industry are dominant in the national economy.

3  **Case Study**

This study has collected and sorted out some successful ecological province / city planning in China, and ultimately selected different scale of following case studies, respectively.
Pearl River Delta: urban agglomeration,
Shenzhen: China's economy developed cities
Longhua district: county-level cities

3. 1 ShenZhen

3.1.1 Basic Information
Shenzhen, Guangdong Province, located in the south coast, south of the Tropic. The land area is 1952.84km², a coastline of 229.36km and the population is approximate 700 million. Shenzhen is a southern sub-tropical monsoon forest, forest coverage rate is 55.5% and the natural vegetation includes: sub-evergreen monsoon forest, evergreen broad-leaved forest, mangrove forests, bamboo groves, shrubs, irrigation bushes, thorn shrubs, bushes and so on. The total number of national and provincial wildlife is 20 species of rare and endangered plants, including two kinds of protected plants at the national level, 11 species of protected plants at the second national level, six kinds of protected plants at the third national level and one plant species at the provincial level.

3.1.2 the conditions for analysis of ecological construction, Shenzhen
3.1.2.1 Excellent natural and economic conditions is the basis of building ecological and environmental protection.

Shenzhen is located in the subtropical rain forest area, natural conditions are unique, good natural conditions, in particular, great water, heat and adequate light to enable the construction or restoration of vegetation easier to restore the destroyed ecological system. As China's first general plan of development and construction city, Shenzhen has a high level of urban planning and construction; also have a high level of urban management. After 20 years of rapid development, Shenzhen has laid a sound economic foundation, its comprehensive economic strength among the best in the country, a good economic foundation for Shenzhen to increase investment in environmental protection and environmental infrastructure provides an important guarantee.
3. 1. 2. 2 **the main constraints**

- **Land resource constraints**

To maintain good ecological conditions need to retain at least 50% of the land area as ecological space, subject to landscape topography, geological conditions, the remaining available land for construction in Shenzhen is 239 square kilometers. Construction land in accordance with the 2003-2005 annual growth rate of 51 square kilometers, the remaining land can be used up in the "Eleventh Five-Year" period.

- **Water Resources Constraint**

Constrained by natural conditions, the local water resources utilization rate is only 19.65% in Shenzhen. Urban water supply mainly depend on induce water source. In the same premise of supply capacity, the existing water supply capacity is difficult to support the sustainable development of economy.

- **Energy Constraint**

The shortage of local energy sources is obvious in Shenzhen, all the primary energy and the major secondary energy dependence on external inputs. According to GDP energy consumption by 2010, suppose 10% less compared with 2005, calculated the total energy demand in 2010 will be more than 40 million tons of standard coal.

- **Population pressure**

The resident population of 2004 as the base, even if the population growth rate reduced to 3% after 2010, in the year 2020 the resident population will reach 12.31 million. To meet the ecological city requirements, to protect the habitat comfort and integrated considering the resources, energy, environmental capacity constraints and other conditions, the population should be controlled within 10 million in Shenzhen.
Fig 4  distribution of ecological footprint

- Ecological Footprint

It can be found out that the spatial distribution of the ecological footprint present higher in the South than in the north, higher in the west than east, the ecological deficit was primarily concentrated at the special region, which means that within special region the ecological pressure is much larger than outsider, is about four times larger. The reason is that the socio-economic activities are concentrated within the region, population density and ecological demand.

3.1.3 mainly measures
3.1.3.1 carry out ecological function zoning

According to the ecological function zoning, Shenzhen divided terrestrial area into key protected areas, control zones and optimize the development zone three area, the first class is focused on protected areas which is divided into 19 the second areas; the second-class area is control the zone which is divided into five second areas; the third-class areas is optimize development zone which is divided into five second areas.

3.1.3.2 Construction of ecological security pattern

In order to maintain connectivity of natural ecosystems and to prevent the spread of urban sprawl in Shenzhen. The important ecological function zones and basic
ecological control lines based on build by the “four horizontal,” "Six vertical" natural ecological network structure in which the inland city intervals between the natural areas to achieve a natural melting city.

3.1.3.3 **to restore the ecological functions of natural ecosystems**

- the strict conservation of biodiversity-rich areas

  The establishment of area of not less than square kilometers of provincial nature reserves and seven municipal forest parks and to develop appropriate protection and management regulations. At the same time the establishment of different levels of rare plant communities conservation district to rescue and protect the critical habitats and rare plant species resources.

- according to the law to return fruit, returning farmland to forest

  The restoration zone of forest ecosystem, increase the proportion size of enclosure management. When it comes to the poor condition site which need for artificial modification of the pure forest, using areas of natural forests, dominant species and construction of species of afforestation. Further strengthen the protection and management of rare trees.

3.1.3.4 **Protection of the ecological environment of the Habitat**

- a balance distribution of public green space, the protection of public resources for equitable access to public green space

  In a large public green blind area, carried out green construction and balanced distribution of public green space. An additional area set up of more than 30,000 square meter of large blocks public green space or of medium-sized area of more than 10,000 square meter of public green space.

- **adjust the structure of the medium and large public green space to enhance the ecological functions**

  In larger than 30,000 square meters of public green space, selected a certain proportion of the regional training functional areas of biological diversity. Hills and wetlands biodiversity conservation also need protection.
3.1.3.5 Protection of Land Resources

➢ Control of land development speed to achieve land development by the extension type to the content.

Strictly control the scale of land development, the recent development of the scale will be controlled at 8 ~ 9 square kilometers / year, and long-term control is 2 ~ 3 square kilometers / year, so that the city’s ecological land area is not less than 50% of the city’s land area, and retain the basic 56 square kilometers of agricultural land protection.

➢ the implementation of land development and sub-control strategies to enhance ecological and economic benefits of land resources

In accordance with the ecological function zoning regulation requirements, implementation of land development sub-control strategies to enhance ecological and economic benefits of land resources. Focus on protected areas, strictly control the development of new projects or which do not meet the requirements of the ecological function of land use approach; strictly control the total land development, reasonable control the land development and intensity and optimize land use structure and layout, clean inefficient land use, intensive, scale of development of land resources, improve the ecological functions;

Optimizing land replacement in the development zone, take into account the ecological and economic benefits. Combined villages and the transformation of old industrial areas, adjust the built-up areas economic function and improve the economic efficiency of land use. In densely populated areas, especially in the blind spot of large public green space services, through land replacement to carry out the habitat ecological environment, improve ecological benefits.

➢ development and utilization of underground space, expanding space for urban development

The preparation of underground space in Shenzhen, the overall development of construction, underground public facilities such as underground civil air defense systems to reduce land use intensity on the ground.
3.1.3.6 Measures for sustainable use of energy

- adjust the energy structure

  The establishment of eco-energy structure. Reduce primary energy ratio (coal, oil), increased proportion of gas, nuclear, solar energy and other clean energy and renewable energy, increase in proportion of purchased power.

- to improve energy efficiency

  Strengthen the management of industry energy conservation. The electricity production industry to promote the use of new technologies and new processes to improve energy conversion efficiency; for other industries, according to the total energy consumption per unit of output indicators for energy consumption and energy-intensive industries classified as high, moderate, and energy-saving three types of industries, the implementation of category energy conservation management.

3.2 The Pearl River Delta

3.2.1 Basic Information

The Pearl River Delta is located in south-central of Guangdong Province, downstream of the Pearl River, and the brink of the South China Sea, and is not only China's largest alluvial plain in south subtropical, but also the most developed region of China. The Pearl River Delta includes 23 cities and 3 counties which are Guangzhou, Shenzhen, Zuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou, Huizhang, Huidong, Boluo, Zhaoqing, Gaoyao and Sihui. The area of the Pearl River Delta is 41698km², which accounts for 23.4% of the province. The populations of this region are more than 26 millions. The zonal vegetation of the Pearl River Delta is subtropical monsoon evergreen broad-leaved forest. Due to frequent human activities, the native vegetation within this region is almost completely destroyed, natural secondary broad-leaved forest is also scarcely saved; mostly single-species dominant plantations such as pine, slash pine, fir, eucalyptus, or Acacia.

3.2.2 Main Problems

3.2.2.1 Sharp reduction of arable land

  From 1990 to 2000, the Pearl River Delta region's arable land reduced from 1058367hm² to 753789 hm², that is a total reduction of 304578 hm², accounting for 28.78% of all arable land of this region. Per capita arable land area fell from 0.1 hm² of the 50's to 0.0185 hm² of now.
3.2.2.2 Vegetation area reduced, net production decline

Besides the reduction of arable land, from 1990 to 2000, Woodland, shrub woodland and grassland decreased by 77093 hm² and 604 hm², which accounts 30.15% and 38.57% of its area in 1990. The Pearl River Delta regional vegetation (including arable land, forest, woodland, shrub woodland and grassland) areas also decreased 206845 hm², which accounted 8% of the vegetation area of 1990. Net production decreased 2424303 t/a. In some high-speed urbanization areas in The Pearl River Delta, such as Dongguan City, vegetation area fell 25.35%, biomass fell 24.69%, net production and carbon sequestration and release oxygen fell 26.76%, decline of ecosystem function is very obvious.

3.2.2.3 Forest biomass, net production and forest ecological benefits is low

Per unit area forest biomass and net production in the Pearl River Delta forest are 56.57 t/hm² and 10.41 t/hm²·a, only accounts 14.89% and 44.87% of these in well-grown subtropical evergreen broad-leaved forest in Dinghu mountain (biomass 380 t/hm², net production 23.2 t/hm²·a), and also below the average level of forest biomass of China (84.09 t/hm²).

3.2.2.4 Natural vegetation is constantly replaced by artificial vegetation, species diversity reduce

As the urbanization of the Pearl River Delta region, urban area expanded. There are more and more artificial vegetation in city, which result in an increasing proportion of artificial vegetation. During the planting of artificial vegetation, due to inadequate consideration of species diversity and the impact of alien species, resulting in a lacking of species diversity in urban vegetation and degradation of ecosystem’s self-regulation capacity. Meanwhile, as the economic interests driving, certain areas are ignoring the ecological benefits. In these areas, hills and mountains are planted with a large-scale plantation of fast growing plants, resulting in decreasing of the proportion of natural forests.

3.2.2.5 Typical ocean ecosystem is severely damaged, coastal waters ecological deterioration becomes worse

The reckless exploitation of coastal zone, shallow, and island resources resulting in severely damage of typical high productive ecosystems such as coral reefs, mangrove, and also resulting in the drastically decline of marine habitats and rare plant and animal numbers. The mangrove, which has important regulatory function of regional eco-balance, has reduced more than half from the end
of the 1970’s to now. The Chinese White Dolphins, which is one of the level 1 national protected animal, is now only 400 to 1000 at Pearl River Estuary.

3.2.2.6 Ecological security system is imperfect

The coastal plain and coastal ecosystem protection system are fairly complete, but they lack coastal shelter belt and plain forest protection networks, therefore coastal plain and coastal ecosystem have low resilience to natural disasters. Cities lack of controlled eco-protection systems; ecological safety structural systems such as ecological protection zone and ecological segregation are incomplete. The lacking of the necessary separation between urban and rural ecological zone leads to an inadequate control of the disorderly development of cities and the extension of pollution. There is a serious shortage of ecological security protection system in the river network system of plain region. The natural process of land-water ecotone was damaged by human. Water pollution is serious.

Key ecological transition zone, corridor, and the node has not been properly maintained. The land-water ecotone, also known as coastal belt, accounted for a very critical position in the integrative ecosystem of Pearl River Delta. The land-water ecotone plays an important role in protecting the safety of habitant and raise bio-diversity of the delta plain. However, as for a long time, people only focus on the protective function of the dam, and overlook the ecological environment construction, the ecological landscape at the Pearl River Delta Estuarine and Coastal is inferior, the ecosystem lack of diversity, sparse vegetation along the coastal forest, lack of systematical windbreak belt. Mountain edge ecotone is destroyed by man-made destruction and truncation. Some important river corridor is not well maintained and utilized. The land-water ecotones on both banks are damaged. Most coastal lines haven’t set appropriate ecological buffer zone; and some important bank lines have been occupied by polluting industrial clusters; and some other eco-node have been destroyed, such as Sixianyao region at Liantong West River and North River, which is the eco-intersection of these three rivers. Because of the ecosystem of the Sixianyao hasn’t been appropriately protected, therefore it has a significant impact to the downstream delta plain.

3.2.3 Main Measures

3.2.3.1 Ecological function zone planning

Through geographic space-partitioning to eco-environmental sensitivity, importance of ecological services, and eco-environmental characteristics’ similarities and differences, regional socio-economic development directions in the Pearl River Delta region, it can be divided into 3 level one ecological function zones and 8 level two ecological function zones. Based on further analysis of function of level two ecological function zone, main eco-environmental problems, land
use patterns and resource developing situation, there are 67 level three ecological function zones. With each level three zone, there are different ecological protection and construction program.

3.2.3.2 Construction of a complete eco-system

Using landscape ecology methods, propose an eco-system construction program in the Pearl River Delta region. This program consists of structural control region, ecological channel and key node. The structural control region is the reserve area of regional natural ecosystems, habitant of species; it has the source function of regional ecosystem. The eco-channel is used to enhance the ecological connections of patch-to-patch and patch-to-source, such as river channels, mountains channels, and external transport and economic radiation channels. The key node is the point which has significant importance to the stability and connectivity of the regional natural ecosystems. The key nodes including species spreading and animal migration cross points (or vulnerable points).

3.2.3.3 Important and sensitive eco-zone protection planning

Through expansion and upgrading of existing forest ecosystems and marine protected areas, enhance the construction of wetland ecosystems and marine coastal ecosystems protected areas. In short term, 9 newly constructed, 4 expanded and 3 upgraded natural reserving areas are planned in typical ecosystem region in the Pearl River Delta. During the increasing of forest parks, we should pay particular attention to improving their quality. The total area of these natural reserving areas is 171000 hm².

3.2.3.4 Soil and Water Conservation

Zoning management: according to the Pearl River Delta Soil and Water Conservation districts, including prevention areas, monitoring areas, and control areas, carry out targeted preventive measures respectively.

Prevention and Monitoring of man-made soil erosion: targeted to earth quarrying, development zone construction, traffic road construction, sloping land and steep slope land reclamation, carry out operation programs and management systems.

3.2.3.5 Ecological protection control planning

According to the requirements of eco-environmental protection, reasonable exploitation of resources and socio-economy sustainable development of the Pearl River Delta region, it can be divided into “important ecological functions strictly protected areas”, “ecological quality strictly
controlled areas”, “ecological protection control using areas”, “introductive resource exploitation areas” and “city construction developing areas”. In each areas, the importance of ecosystem function and key eco-environmental problems will be taken full considerations.

### 3.2.3.6 Rural areas

(1) Eco-agricultural construction based on ecological protection

(2) Eco-agricultural construction based on ecological cultivation

(3) Eco-agricultural construction based on ecological barrier function

### 3.2.3.7 Important ecological projects


(2) Plain Economic Area ecological protecting and ecological industry construction projects: including “Ecological Agriculture construction project”, “Farmland protection forest system construction project”, “Green-Channel construction project”, “City Mountain Green Island Forest Ecological Park construction project, “Ecological Industrial Park construction project”, “Eco-town construction project”, “River-Lake-Ocean Water Ecological Safety construction project”.

(3) Important river system ecological protection projects: including “Man-made Fish Shelter construction project”, “Estuary Remediation project”, “Fish Migration Channels Restoration project”.

### 3.3 Longhua

#### 3.3.1 Basic Information

Longhua County is located in the central of Chengde city. Geographical coordinates of latitude 41°08'49" to 41°50'10", longitude of 116°47'44" to 118°18'46". Land area is 5497km², and population is more than 40 thousands. There are many low hills and few plains within Longhua County. There are many biological resources and forests in Longhua. The area of forest is 2.95 million mu, with an 45.9% forest cover rate. Main tree species are Poplar, birch, pine and oak. Total forest accumulation is 3.681 million m³, with an annual logging of 50 thousands m³. Grazing area
is 4.2 million mu, rich in all kinds of land delicacies and Chinese herbal medicines. Rich in mineral resources, 48 kinds of mineral materials have already been discovered in this region.

3.3.2 Situation Analysis

3.3.2.1 Obvious Advantage in Environmental Resources

Longhua has abundant environmental resources, such as well preserved Maojin Forest Park, which has significant importance in bio-diversity protection. There are many mountains and sloping fields, which have abundant forests and grass lands and many precious wild animals. Therefore, there are obvious advantages for Natural scenery, history and culture, historical sites tourisms, natural reservation, ecological agriculture education, Ecological Demonstration Area construction.

3.3.2.2 Poor Geographical and Topographical Conditions

Since Longhua is located in mountainous region in northern Hebei Province, and has high elevations, it is isolated with other regions. Therefore, the economy growth of Longhua is relatively slow. Besides, there is large regional difference of economy developing level within the county, which results in a considerable portion of regions and populations are under poverty.

3.3.2.3 Uneven spatial-temporal distribution of water resources, low degree of development and utilization

Water resources in Longhua are relatively rich, however, precipitation during June to September accounted for 78.9% of that of annual precipitation. Precipitation variability is large; the precipitation variability during crop growth stage is reach up to 39%. Moreover, the precipitation decreases from southeast to northwest. Meanwhile, there is large elevation difference between river and land in Longhua and no control project to utilize the rain and flood, therefore, dry period and the dry areas still exist. Degree of water resources development and utilization is low; water supply is 247 million m³ under 75% guarantee rate, which only accounts for 27.4% of total water resources.

3.3.2.4 High forest cover rate but unreasonable stand structure

Longhua's forest cover rate is 45.9%, far more than the average level in Middle East China. However, forest accounting result in 2000 shows that compare to 1982, the natural forest reduced 12.2%, artificial forest increased 23.7%. Artificial forest has higher ecological vulnerability than natural forest. Forest age structure is unreasonable, young forest accounts for 48.6%, middle-aged forest accounts for 34.9%, near-mature forest, mature forest and over-mature forest only account for 16.5%.
3.3.2.5 Existence of soil erosion
Longhua’s area of soil erosion is 2636 km², accounts for 47.91% of its total area. Slight erosion area is 1223.25 km², strong erosion area is 100.46 km². The more severe soil erosion is, the lower crop production is, and the more cultivation will need. The more cultivation, the more severe soil erosion will be, and this will form a vicious cycle. Therefore, control and prevention of soil erosion should be paid more attention.

3.3.2.6 Poor soil quality
Because Longhua County has many sloping arable land and dry field, along with soil erosion, the soil quality is poor. Low-yield farmland accounts for 40% of the total farmland area. With the soil erosion, a certain amount of organic matter, nitrogen and available phosphorus will loss. Moreover, with the impact of agriculture pollution (chemical fertilizers and pesticides), soil quality declines more quickly.

3.3.2.7 Frequent natural disasters
The main natural disasters in Longhua County are drought, frost, hurricane, pest and rodent infestation. Drought is the largest natural disaster for Longhua County’s economy. Since its continental monsoon climate in this region, the annual evaporation is approximately 3.2 times of the annual precipitation. Days before and after the later spring are the times with the highest evaporation of the year. There were 5 consecutive years with drought from 1999 to 2003, which brought adverse effects to the production and living of Longhua County.

3.3.3 Primary Measures
3.3.3.1 Implementing ecological function zoning
According to the ecological function zoning, Longhua County is divided into 3 first-degree ecological function zones, namely Luan River Basin District for Water Source Protection as well as Soil and Water Conservation, Yixun River Valley Economic Zone for Soil and Water Conservation together Dale Agricultural, Wulie River Basin Region for Biological Diversity Conservation and Water Source Protection. Among them, Luan River Basin District for Water Source Protection as well as Soil and Water Conservation, which is located in the west of Longhua County, includes 4 second-degree ecological function zones and 27 third-degree ecological function zones, being the ecologic and economic area of combination of forestry and agriculture. Yixun River Valley Economic Zone for Soil and Water Conservation together Dale Agricultural, which is located in the middle of Longhua County, comprises 5 second-degree ecological function zones and 56 third-degree ecological function zones, being the ecologic and economic area of combination of agriculture and animal husbandry. Wulie River Basin Region for Biodiversity Conservation and Water Source Protection, which is located in the east of Longhua County, consists of 3 second-degree ecological function zones and 15 third-degree ecological function zones, being the ecologic
and economic area of combination of agriculture, forestry and industry.

The administrative borders of towns within the County are mainly based on the watersheds in the mountains. Therefore, from the first-degree ecological function zoning of Longhua County, we can see, the borders of the three first-level functional areas coincide with the administrative boundaries of various towns. Hence, the zoning scheme is not only beneficial to the valley management of ecological environment and natural resources, but also convenient for Longhua County to carry out the management of ecological protection and construction works, and the rational distribution of ecological projects.

3.3.3.2 Layout of protecting biological diversity and vegetation

0 - Ecological forest protection and development

Ecological forest consists of protection forest and special use forests, mainly including water forest, water and soil conservation forest, farmland shelterbelts, sand-fixation forest, revetment forest and road retaining forest. Ecological forest is protected and fostered by enclosure. Per 1000 - 3000 acres of ecological forest is partitioned to be a district of responsibility for integrated management, with designated personnel for management and protection. Logging ecological forest is banned. Logging, grazing, hunting, tree tapping, playing the branches, cutting the grass and plants of earth surface, mining, building tombs, building cemetery, land reclamation, quarrying, dredging and excavation of earth are all prohibited within the land of ecological forest. The economic losses of operators or owners of the ecological forest, which are resulted from construction, management, and protection of the ecological forest, should be compensated.

The construction of ecological forest in mountains mainly exploits the implementation of natural forest protection project, which comprises updating and reconstructing the nondense forest and coniferous woodland within the areas of ecological forest, afforestation in bare lands, and implementing standard construction and protection of natural forest to 70 percent of the total area of state-owned and local-owned natural forest in the west and middle-east regions. Namely, in Longhua County, the public welfare forest will be built by update, closing hillsides to facilitate afforestation, and other means.

0 - The development of commercial forest

Forests besides ecological forests are commercial forests, consisting of forests of timber, charcoal, fruit tree, woody flowers, and other forests and trees which are principally intended to be industrial raw materials. For the lands suitable for afforestation, being combined with anti-desertification projects, fast growing and fertile tree species are introduced to build fruit and timber base according to the principles of matching the lands and fitting the trees; for the nondense woodland, considering its features of low quality and small accumulationl, rebuilding and introducing fast growing and fertile coniferous forest tree species, as well as developing mixed forest of broad-leaved and coniferous timber are implemented in order to improve forest quality.
Ø - Biological diversity conservation planning

Establishing nature reserves is an important means for conservation of biological diversity, natural landscapes and other natural and history remains. During the plan period, places where deserve nature reserves within plans should formally build nature reserves, so that nature reserves in Longhua County will form a network. The plan mainly includes projects on standardized construction of infrastructures in all kinds of nature reserves at all levels, construction of effective management of protected areas, protection and breeding of rare and endangered species. Recent emphasis should be placed on the National Nature Reserve building of Maqjingba Nature Reserve and the construction of proposed Longxi mountain nature reserve or forest park.

3.3.3.3 Conserving water resource

Ø - Building water source protection zones

In Longhua County, reserves are erected, along both banks of four major rivers, Luan River, Mayitu River, Yixun River and Wulie River, also the catchment areas of the existing Miaogong reservoir, Erdaowan Reservoir and other reservoirs. Following measures are carried out within reserves:

1. Restraining the exploiting activities rigorously, prohibiting all activities destructing vegetation.
2. Curing soil erosion energetically, improving forest cover within the region.
3. In the reservoir area, fish farming should adopt free-range way, prohibiting running bait and the development of cage fish culture.
4. Controlling the total amount of pesticides, fertilizers, and film used in reserves, limiting the development of scaled aquaculture industry.
5. Checking the population in the reserves rigidly, reining in their scale of construction of the existing settlements.
6. Accelerating the building of ecological forest. Public welfare forests and economic forests should be distinguished sharply. Classified managements should be implemented to forests. Proportion of ecological forest and protection efforts should be increased gradually.
7. Making great efforts to elevate the level of management. Natural forests covering large areas and constructed soil and water conservation district should be protected effectively as per the law to consolidate achievements.

Ø - Construction of water storage and transfer projects

The maintenance and management of existed projects of transfer and storage for water should be enhanced. The transfer and storage functions of damaged works should be restored as soon as possible. While building Xiaoduishan reservoir, a number of small-scale water storages, such as pools, water vaults, and paddy lanes, fish-scale pits and so on, should be constructed. Also, the study of the potential of constructing transfer and storage works for water in Longhua County should be carried out vigorously. Specific planning and design works should be developed as early as possible.

Ø - Setting up water-saving society

By constituting the water resources planning of specific valleys and region, the initial employment rights of water would be clarified. The macro-control and micro-scale indicators of water resources
would be determined. The using right of water of all regions and sectors, departments and even each unit would be definite. The scientific water quota of manufacturing products or services should be fixed. Legal, administrative, engineering, economic, technological and other measures should be employed synthetically to ensure the implementation of water control targets. Special attention should be paid on exploiting economic instruments to play the price leverage to promote water conservation. Through the establishment of rules, water rights trading market would be built. As a result, the compensatory convey of water rights would be implemented to achieve a optimal allocation with the water saving and effectiveness as targets.

3.3.3.4 Safeguarding farmland

0. Controlling the alteration of land use strictly
The license system of agricultural lands should be executed strictly. The use of farmland land for national energy, transportation, water conservancy, national defense and other key projects, which cannot be avoided after repeated argumentation, should be subject to statutory procedures for planning modifications. If it involves the basic farmland, the use of land should strictly follow the "Basic Farmland Protection Regulations".

0. Treating quantity and quality equally to achieve equilibrium of employment and compensation of arable land
"The Land Management Law of People's Republic of China" should be carried out rigidly. The size of the townsships of the area should be controlled strictly. Which have been approved to occupy cultivated land be implemented the balance system of ‘used size amounts to complemented size’ according to the law. The balance should be achieved in quality and quantity respectively. Briefly compensating the occupation of farmlands of high throughput with the same area of low-quality arable land to do so-called balance should be resisted. If there really are no cultivated land resources with the same quality, the compensation should be made by farmland which produces the same amount of food as the standards for employment and compensation equilibrium.

0. Establishing a special fund to increase investment in efforts to protect farmland
Instituting and establishing related policies and mechanisms to encourage the inputs to the farmland resources protection. Special funds for the protection of farmland should be established. Efforts in farmland protection should be enhanced. High-quality arable land and basic farmland construction projects should be developed actively. Substantial improvements in land production conditions should be made. Aiming at the reasons for the low-yielding, engineering, biotechnology, agricultural technologies should be combined to adjust a comprehensive improvement measures for renovating the low-yield fields and improving the productive capacity of arable land to local conditions

0. Strengthening management to fulfill the protection of farmland
A series of policies, which are constituted by the central government, on the protection of
cultivated land should be implemented earnestly. Taking the protection and remediation of arable land as a strategic task, it would be stuck to perennially. To strengthen the legal management of basic farmland protected areas, the relevant provisions of "Criminal Law" and "Land Management Law", as well as "Basic Farmland Protection Regulations" should be implemented strictly. The supervision and inspection to cultivated land protection works should be strengthened. Accountabilities of leaders as per their prefectures at all levels of government should be clarified. County and township (town) people's governments should practice the three-target management responsibility system with land management and environmental protection departments, signing responsibility books to protect basic farmland. Governments of higher levels and relevant departments should actively perform their administrative supervisory functions to direct governments of lower levels to fully achieve their targets.

- Stepping up publicity to encourage public participation in the protection of farmland

Carrying out a wide range of warning education for farmland protection by exploiting radio, television, newspapers and other media would improve people's crisis sense of farmland, and strengthen the leadership and the majority's awareness of protecting cultivated land resources. Also, the ideas, that the protection of arable land is to protect its own lifeline and the development of various undertakings should be under the premise of protecting arable land, would be firmly established. Phenomenon and behavior of illegal occupation of farmland should be exposed to inspire conscience and awaken consciousness. At the same time, measures should be taken to encourage public participation in farmland protection. Means which protect public participation also should be constituted. The local governments should ensure the public participation in decision-making process of the projects, which develop and occupy cultivated land resources, with the form of local laws. Economic measures should be taken to give spiritual and material rewards to organizations and individuals. These organizations and individuals should make significant contribution in the law enforcement, monitoring, scientific research, publicity and education, personnel training, decision-making and consulting of use and protection of arable land.

3.3.3.5 Preserving mines

- Controlling the gross of resource exploitation, and introducing green mining technologies

Basing on resource conditions and development status of Longhua County, strict control should be put over the exploitive amount of major mineral resources. Advanced technologies and equipments should be introduced to benefit the eco-environmental protection of the mining areas.

- Resource development to adjust the layout, optimize the mining structure

Gradually, the layout of mining development should be adjusted and optimized. Also, mining, selection, and processing capacities of mineral resources should be allocated rationally: the mining, selection, processing structures should be optimized; the traditional industries should be transformed to extend the industrial chain and enhance the deep processing capacity; the organizational structure of mining should be optimized by greatly reducing the number of mining
enterprises, restructuring and transforming the existing small mines, as well as actively founding enormous and medium-sized enterprise groups.

-Tightening access system for mining enterprises, and implementing recovery while mining

The examination and approval of mining sites and eco-environmental protection should be held tightly. New mining enterprises must provide serious argument and identified documents, such as the environmental impact assessment report, soil report, land reclamation reports, of approved mine construction projects. Symbiotic and associated mines that can be used must have corresponding comprehensive utilizing schemes and charters. Those mines which are temporarily unable to be used should have the effective protection measures. The approval of projects and issuance of mining charts in no-take zones are prohibited. The mining caused environmental pollution and ecological damage should be strictly restrained. Mining companies are demanded to institute recovery plans, and report them to Environmental Protection Agency of Longhua County for approval. The companies are asked to gradually realize the cure and refreshment of mines, while they are mining.

- Ecological restoration measures in the old mine site

Longhua's main forms of mineral development are mountain explosion and ground excavation. Different ecological restorations measures are developed according to the topography and the form of eco-damage in different mine sites:

(1) Residual hill and stone cave: based on the topography, build retaining wall outside the basal workspace to interception loss of soil, so the wall gradually silts up to a basal face for plants to grow. Then use natural processes and artificial measures to restore vegetation. For steep face, use engineering measures to reduce the risk of avalanches and landslides.

(2) Quarry Hill residue: feasible method is enhanced extraction. Bulldoze the residual hill and planting trees and grass. The enhanced extraction should be strictly limited in certain area. Surrounding areas’ eco-environmental protection need to be carefully considered to prevent the expansion of eco-environmental damage.

(3) Low-lying land such as Dust pit and stone pit

In principle of local conditions and make full use, type of land use, such as constructive lands, water pool and farmland, should be planed in advance. Develop proper eco-restoration plans. Some traffic convenient locations can be stacking place for engineering wastes.

For old abandoned mining sites, the eco-restoration work should be founded by local governments. The planning and implement of eco-restoration should be organized by local environmental protection bureau. Corresponding companies and towns should be economically responsible for the eco-restoration on those shut-down mining sites. The eco-restoration planning should be implemented after the approval of local environmental protection bureau.

4 Discussions
This report analyzed the ecological construction plan in three different scales of region. It shows that China's ecological construction plan has formed a complete system. Meanwhile, still need to continue our efforts in following contents.

- **There is still some misunderstanding about the concept of the“eco-city”, confusing of titles and meanings**

In recent years, the step of eco-city construction in China was accelerating. But there are still some misunderstandings about the concept of “eco-city” during the progress of eco-city construction, such as the compares between eco-city and garden-city, forest-city, healthy city, green city. Some mayors even mentioned “garden major”, “green mayor”, and wanted to move out downtown neighborhoods and instead by large area of green land. It is far not enough to build an eco-city by simply planting trees and grass. The construction of eco-city includes every aspect of economy, society and eco-environment. In addition, based on the concept of “eco-city”, some cities proposed landscape city, sustainable development city, ecological garden city, garden city, forest city, healthy city, circular economy city. This confusing of titles and meanings need to be straighten out gradually during future studies.

- **Ecosystem's ability to withstand natural disasters is seldom considered in planning**

Urban ecosystem is one of the most vulnerable ecosystems, it always seems powerless in the face of global climate change, as well as typhoons, floods, earthquakes, mudslides, snowstorms and other natural disasters. In recent years as global climate change, there are frequent natural disasters. Once the disasters came, the largest loss always happened in large cities. By reviewing several large regional natural disasters happened in last few years in China, the response to the disaster were mostly post-disaster relief instead of disaster prevention. Therefore, there is necessity of strengthening the capacity of the city's disaster prevention and mitigation. According to various regions’ natural environment, there should establish natural disaster defense systems. Make the greatest efforts to reduce the losses caused by natural disasters.

- **Lack of awareness of public participation**

Ecological construction and environmental protection not only need government’s efforts, but also need the participation of all the people. It’s is completely wrong for one to think that construction of city has nothing to do with oneself. City is everyone’s city, which needs everyone to involve in. The people has responsibility and duty to make plans for city construction, to correct improper decisions, and to avoid waste of resource. Only the interaction between the Government and the people can promote the modernization of the city. The role of government is organizing, publicity, implementation, correcting people's false consciousness and guiding people participate into the construction of urbanization with proper methods.

During the past 20 years’ eco-province and eco-city construction in China, it formed eco-city development paradigm with Chinese characteristics, obtained extraordinary achievements. Although there must be some unsatisfactory place, it is undeniable that it has great significance of the ecological wave in China in the 21st century, and it will bring real effect---economy growth and
eco-environmental quality improvement happens at the same time. As important carrier of sustainable development of China, the establishment of eco-province, eco-city and eco-county will certainly bring about the regional sustainable development into a higher and update stage. Meanwhile, the experiences and lessons gained during the establishment of eco-city in China will be an excellent reference for other countries. In the future eco-city construction practice in China, the eco-city construction index system should be improved by strengthening the theory and basic technology research. Through the strengthening of supervision, unifying types of title and objectives, and having a clear distinction between the objectives of the various title, to make the theoretical research and practical work of Chinese eco-city gradually be improved and perfected.
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