

Research on Ecological Protection and Restoration in Ecotourism Area-a Perspective of Ecological Infrastructure

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Abstract

Ecological Infrastructure (EI) is a sustainable idea and methodology and its application in China is a new field. It is a creative attempt in the practical work in eco-tourism area especially to eco-environmental protection and restoration under development. The authors first sorts out the researches of the eco-environmental protection home and abroad; then it analyzes the connotation of EI, its functions and practical application; and at last, under the guidance of the related theories of landscape ecology, it takes Shenzhen East Overseas Chinese Town (OCT East), the first national eco-tourism demonstration plot, as an example, and probes into a further inductive study of designs of micro EI systems, including its distribution, types and connotation. On this basis, the authors attempt to build up a network system of eco-environmental protection and restoration which could develop coordinately in accordance with the EI theory. Being aided with the garden management scheme system, it expects to reach an all-in-one managing and operating goal which covers scenic spots, communities and tourists, and to offer similar experience of eco-environmental protection and restoration all over China.

Keywords: ecological infrastructure; eco-environmental protection and restoration; eco-tourism area; Overseas Chinese Town East

Introduction

A good natural eco-environment is the base on which scenic spots develop and maintains its sustainability. It is also true of eco-tourism areas. The two have a close relationship and mutual influence to each other. Experts both home and abroad have put forward quite a few ways and methods to protect eco-environment in natural reservation areas, national parks, forest parks, etc., such as the view point

of "aggregate-with-outlier pattern" and "indispensable pattern" (Richard Forman,1995) and the Chinese scholar opinion about the "ecological security patterns in landscape" (Yu Kongjian, 1995). But their research mostly focuses on the scenic spots of original natural environmental resource, such as natural reservation areas, national parks, wetlands, natural heritage areas etc. However, as the natural environments are easily to be affected due to the frequent mankind activities, fewer research was done before on the tourism areas under man-made influences, although the carrier of these areas is also natural environmental resource. Through the fieldwork of Shenzhen East Overseas Chinese Town, the first national eco-tourism demonstration plot, this essay probes into eco-environmental protection and restoration of the tourism areas with frequent mankind activities in consideration.

Ecological Infrastructure is a popular idea of ecological protection over the world, and it is an interdisciplinary study of a new perspective and strategy. Currently in Europe and North America, this idea still interacts with others and new related thoughts and ideas are coming into being (Liu Hailong et al, 2005). During the process of tourism areas planning, constructing and managing, OCT east has set up a parallel system of eco-environmental protection and restoration with the guidance of EI theory. And it is just because of this unique approach that makes Oct East stands out to be prominent as the first national eco-tourism demonstration plot.

Review on Eco-Protection and Restoration

Eco-protection is to prevent anything harmful to ecology and promote social harmonious development based on human-centered scientific development outlook.

Eco-restoration can trace back to the 1830s, however, The Recovery Process in Damaged Ecosystems edited by Cairns (1980) started to carry on the systemic research on eco restoration, taking it as a branch of ecology. Eco-restoration mainly depends on self-organization and self-control within eco-system itself and external artificial control. In the recent 30 years, experts from home and abroad have different understandings and have made many achievements in physical, chemical and biological restoration(Zhou Qixing & Song Yufang, 2001; Burger J, et al?2004). They have explored many ways of eco-environmental restoration, such as phytoremediation for soil environment, artificial wetland remediation for water body,

technology of pollution-free energy and afforestation for atmosphere purification etc (Cui Xuang & Zhou Qixing, 2008). It is obvious that researches of ecological protection and restoration have gone deep in many aspects, fields and technical applications, which bear these characteristics: diversification of research objects, laying stress on theoretical and experimental research (Liu Qing & Liu Zhaoguang, 2001).

In 1980s, in some countries, well-developed tourism caused some ecological and environmental problems, so many researchers began to study the effects of scenic spots on eco-environments, then furthered to do more research on eco-environmental protection and restoration; they tried to consider the development of tourism in the view of ecology in order to solve the problems that tourism had caused. Researches on eco-environmental protection and restoration in abroad have reached to a high level. In 1916, the USA passed a bill about founding the National Park Service, beginning to protect the eco-environments through legislation. In 1970, Streeter, an ecologist, warned the world to pay attention to the protection of the atmosphere of tourist environments and wild animals. Some experts use the concept of carrying capacity of nature protection areas to put forward the management paradigm of maximizing the output of recreation and minimizing the influence on wild animals and local residents. Mercado and Lassoie stated that people should not only protect natural resources of scenic spots, but also emphasize on assessments of tourist behaviors, tourist program and process control (Leida Mercado & James P. Lassoie, 2002). The National Park Service of the US put forward a framework of a set of working processes, called VERP mode, i.e., Visitor Experience and Resource Protection, which offers exercisable working processes and technical approaches for planners and administrators. Roberto R et al (2010) analyzed the influences of tourist behaviors in road traffic of Lanzarote Island of Spain on ecological environment through ecological footprints analyzing.

In contrast to the above, research on this in China progressed slower. Before 1978, Mr. Chen Chuankang, Professor of Peking University, performed deep research on influences of atmospheric environment pollution on white marble stone carvings. Since 1980s, with the development of tourism, eco-environmental protection and restoration in tourist areas has been given more attention to, and more essays and articles have been published, such as *Tourism and Environments*, by China Environmental Science Press, 1986, Wang Guoxia and Tong Lianjun (2002) study the sustainable development of tourism in Xianghai Nature Reservation Area. Chen Baoping and Ying Pengfei (2003) research the Eco-tourism development problems in Jiuhua Mount. In 1990s, the research ways and methods are expanded further.

Wujiang (1998) discussed the relationship between tourist resource exploitation and coordination of landscape ecology. Huang Xiaoting (2009) put forward a so-called "tourist behaviors" method, which met the needs of the coordination of tourism, nature reserve and community development, and he called it the "coordination of time and space difference", which is a Chinese Visitor Experience and Resource Protection (VERP) model. Wang Yanglin and Yang Xinjun (1999) stated the problems of sustainable development principles in general plan of scenic spots. In the 21st century, works and textbooks related to eco-tourist environment have come out, such as *Introduction of Tourist Environmental Protection* compiled by Lin Yueying's (2001), which did much research on tourist environments. *Tourist Environmentology* compiled by Wang Xiang (2001) probed into tourism development and problems between resources and environments through ecological theory and the angle of sustainable development. *Tourist Environmental Protection Science* by Zhang Jianping (2003) expounds systematically tourist environmental protection and sustainable development. *Tourist Circular Economy* by Li Qinglei and Ming Qingzhong (2007) first put forward the strategic idea of developing tourist circular economy to protect environments based on environmental economics and landscape ecology, etc., which lifted the ecological environment protection to an economical and practical level.

From all the above, there is much research on ecological environment protection in scenic spots in the academic world, however, there is less on environmental restoration after developing the scenic spots and the effective strategies of eco-protection. In order to meet the needs, the essay, taking OCT East as an example, explores ecological protection and restoration in scenic areas based on the EI theory.

3. Empirical Research

3.1 General situation of research areas

The national eco-tourism demonstration plot Shenzhen East Overseas Chinese Town locates in Three Chau Tin, Yantian District of Shenzhen. It is a demonstration plot with the permission of National Tourism Administration. It takes eco-tourism, holiday tour, sports and recreation as its theme, "letting urbanite return to nature" as its aim, and cultural tourism as its feature. It covers nearly 9 square kilometers and the total investment is 3,500 million RMB. During the planning and building, the EI theory was involved and applied.

The Three Chau Tin of Yantian District, eastern Shenzhen has the best eco-environment in Shenzhen. There is Yanba Expressway in the south with two entrances in its southeast and southwest corner with Yansan Road in the north. The elevation ranges from 11 meters to 136 meters; high in the north part and low in the south part; the south is the catchment area. Most of the slopes are steep, while those in valley areas of the middle part are less steep. Most areas under the grade of 25 are suitable for development. Roads are not affected much by slopes, and the directions of the slopes are mainly east and south. Dameisha and the bay may be seen vaguely. The vegetation here consists mostly of arbor and fruit trees. The arbor is in fact mixed-growth of arbor and shrub; and the fruits trees are mainly litchi forests; and there are plenty of man-made slope protections. The water source of the south is mainly the Shangping Reservoir in the upper stream, and the Three Chau Tin Reservoir provides drinking water for the residence. With the advantages of original natural resources and environment, and the detailed planning and designing, it was titled the First National Eco-tourism Demonstration Plot. It and the big and small Meisha Beach Parks, Sea World and some other scenic plots compose Dapeng Peninsula Tourist Area of East Shenzhen, which faces directly Taiwan, Hong Kong, Macao and the whole Pearl River Delta.

3.2 Suitable Theories and Methods for Eco-environmental Protection and Restoration

3.2.1 Ideas and Application of Eco-environmental Protection and Restoration based on EI

The term EI was early seen in a report, Man and Biosphere (MAB) of UNESCO, 1984. This report proposed 5 principles of ecological city planning: means strategy of eco-protection, ecological infrastructures, citizen living standards, protection of culture and history, bringing nature into city. Ecological infrastructures mainly refer to persistent substance of natural landscapes and hinterland to a city. In the following 10 years, Selin (1988), Jongman (1995), Sanderson and Harries (2000) have done multilevel and multi-scale researches on EI theory. EI theory in original natural environmental protection and restoration is different from the protection and restoration in the tourism areas under man-made influences. The application is different between macroscopic areas and microcosmic areas (Ding, S. & Li, Z, 2007). At present, researches on EI theory home and abroad mainly focus on the eco-system in macroscopic huge-sized areas, such as forests, grassland, bushes, water body etc., and also on systems and ecological process which deteriorate and

restore naturally under the influences of mining, road construction, airport construction, grazing, felling, mountain disaster, industrial atmosphere and heavy metal pollution.

With 20 years of reform and opening-up, Shenzhen's economy has developed rapidly, but the gradual shortage of land resources and the saturation of environmental capacity urge to shift the economic growth pattern and strengthen eco-environmental protection in order to upgrade the optimization of economic structure (Ye Minting et al, 2008). Based on the favorable eco-environment and the government's support, Shenzhen East Overseas Chinese Town has been built into national eco-tourism demonstration plots, which are typical "natural + artificial landscape" and also a new landmark of Shenzhen's even Asian ecological landscape. There is an original ecological mountain- the Meisha Mountain Top; and the Three Chau Tin Reservoir, Yuejin Reservoir and Shangping Reservoir, so-called source of life of the community; and original ecological Sanzhou Tea Plantation. During the planning, building and management of the scenic zones, much attention has been paid to special mountain climate, water resource protection area, ecological control line, re-vegetation, water and soil conservation and some other sensitive problems, which accords with EI theory.

The essential function of EI is to offer sustainable eco-service to administrators, tourists and residence of OCT East through maintaining the completion and health of natural construction and functions. It includes making products in the eco-system, the cause and maintenance of biological diversity, adjustment of climate, mitigation of droughts and flood disasters, preservation of soil and renewing of fertility, purification of air and water, detoxification and decomposition of rejected materials, circulation of materials, fertilization and seed dispersal of crops and natural vegetation, pest management, origination and development of human cultures, benefits of human senses and spirits and so on. It builds up a bridge between abstract eco-system service and the actors of the scenic spots the tourists appreciate, so people can ensure and maintain the natural and ecological system which is of crucial importance to the whole park. Therefore, EI ensures safety and health of the ecological process of the park, protects regional characteristics and cultural status, and rebuilds the spiritual relationship between people and land (Yu Kongjian, 2005; Richard Forman, 1995). It is an effective landscape safety system.

During the building up of ecologicalization in OCT East, the functions of EI in ecological protection and restoration include the following three points.

- **To protect biological diversity and safety**

The system of EI ecological protection and restoration becomes an ecological network, which helps to lead the movements of living beings in different habitats. For example, in the Sanzhou Tea Plantation of the Tea Stream Resort Valley, beautifully designed channels of ecologization unite effectively the mosaic structures of the resorts, which ensures the spatial distribution of living beings' habitats, the continuity, the changing of internal structure, and differences of the habitats around in the original ecological tea plantation, and forms a whole ecological network of view lines and guard lines.

- **To provide continual eco-system service**

Borrowed from the services sorted out by Constanza (1995), the OCT East can offer these ecological services to the community around: production in eco-system and basic services, such as the designs of aerial cable-stayed bridge, hollow walking corridors and forest for conservation of ecology and so on to maintain biological diversity; subsurface drip irrigation and controlling system in the mountain golf course in the Wind Valley to carry on biological control; environmental benefit of eco-system, such as water purification, air purification and climate regulation in artificial wetland; spiritual enjoyment in eco-system, such as the Bamboo Valley which turned from a waste water channel to a pollution-free backyard garden by the means of "water distributing and field lifting-up", and the eco-channels in the Tea Stream Resort Valley which lead tourists into the forest of tea that contains lots of anions to relieve their pressures.

- **Support functions of ecological infrastructure.**

It has the functions to restore and sustain the steadiness of natural environment, such as the reasonable design of traffic road and choosing of ecological vehicles, the multiple uses of the new-typed clean energies- water, wind and light.

Because of the above functions of ecological protection and restoration, EI laid the foundation of building up a complete system of natural ecological protection and restoration.

3.2.2 Application and practice of landscape ecology

Any point in landscape belongs to patch, corridor or matrix, which compose the basic unit of landscape, and are the main decisive factors of how landscape functions, patterns and process change with the change of time. Patch refers to the nonlinear surface areas which are different from surrounding environments in the outward appearance and have certain inward uniformity. It is a spatial ensemble of

influence factors of geography, climate, biology and humanity. It has particular structural forms and its manifestations are the input or output of substances, energy or information. Corridor refers to linear or banded structures which are different from the patches on both sides in landscape. Matrix is the background base that is the most widespread and has biggest continuity in landscape. It is the main component, the frame and the base. It's differentiation creates patch and corridor. Patch and corridor are distributed in matrix. Patch-corridor-matrix can mutually transform continually. Landscape ecology provides a kind of "spatial language" to describe eco-system, which is more specific and concrete in describing landscape structure, functions and movements, it meanwhile helps to explore the relationship between landscape structures and its functions.

In eco-tourist area of OCT East, the Knight Valley, Tea Stream Valley and Wind Valley, the three resorts are patches which are inlaid within an area of nearly 10 square kilometers. The design for them followed these principles: centralized model outside the area, distributed model inside the area and the combination with surroundings. The corridors which connect the patches are the pathways among the three parks and those between resorts and hotels. There are three levels of corridors: those outside the area, those inside and those within patches. The design uses mostly the existing natural pathways, avoids the ecologically sensitive zones, and ensures that the amount of passers-by accords to the environmental capacity. The matrix is the natural background of the whole eco-tourist area. The design gives some prominence to mountain massif and natural colors, thus, many new resorts have been constructed through the shift of matrix to patch.

3.3 Practice of eco-protection and restoration in OCT East

The three theme parks, Knight Valley, Tea Stream Valley and Wind Valley have been built in OCT East, which unites tourist functions such as ecological motion, holiday tours, outdoor sports and so on. Its designing idea is "recycling reasonably the eco-resources, living in harmony with nature" and carries on the idea, "taking protection as the most important" all through the process of planning and building.

3.3.1 Microcosmic EI individual designs

In the fierce market competition, OCT East carried on all kinds of artificial green ecological designs to the parks based on EI theory, which has pushed the development of ecology, environment protection, energy conservation and recycling, and opened a way to success of national eco-tourism demonstration plot. At present, IE theory has been applied in the three theme parks, Knight Valley,

Tea Stream Valley and Wind Valley in order to protect and restore the ecological environment. The following chart shows the particular EI individual distributions, types, titles and connotations.

Table 1 : Microcosmic EI individuals in OCT East

Parks	Types of facilities	Microcosmic EI individuals	Connotation
Knight Valley (recreation area)	Electric facilities	Windmill in the cloud	Using pollution-free wind and water to generate electricity, protect atmospheric environment and give supply to 24-hour monitor lights and artificial waterfall
		Hydropower generation	
	Traffic facilities	Ecological road design	Avoiding weak ecological zones and using existing pathways as much as possible; choosing pollution-free materials such as Finnish raw wood, cobble, etc., in order to protect completion continuity and health of biological habitats
		Environmental protection vehicle	Electric cable cars, mini-trains, battery cars, jalopies, green buses, protecting atmospheric environment
Construction facilities	Slope protection & revegetance project	Laying stress on the restoration of vegetation on both cliffs to avoid water loss and soil erosion	
Tea Stream Valley (original ecological tea plantation)	Sewage purification facilities	Artificial waterfall of Knight Valley	Good example of "combination of outside landscape and inside green office building", which intensifies the use of land and buildings
		Artificial wetland	An integration of sewage purification, landscape and scientific education; water conservation, pollutant degradation, biological diversity protection, climate adjustment, flood regulation and drought resisting, ensuring water recycling in the park
	Electric facilities	HDVA	Supplying 24-hour continuous power to lighting and controlling system
	Traffic facilities	Ecological channel	Through aerial settings, paving raw wood and altering existing pathways to ensure biological species' migrating, spreading and communication
	Landscape facilities	Sundial on sloping field	Sundial combining timing warning and landscape to solidify sloping field, with main aim of avoiding water loss & soil erosion and slope sliding
		Service facilities	The Interlaken Ecological Hotel
Green commercial service facilities	Offering no EPS products or tableware; souvenirs made of or from environmental-friendly materials and through environmental-friendly process		
Wind Valley (golf sports park)	Sewage disposal facilities	Low energy public facilities for daily uses	Using widely green and pollution-free materials and water-saving wares and recovery paper
		Underground sewerage system	Preventing pesticide, fertilizer and sewage to collect underground to affect reservoir water quality; guiding and controlling, preventing spreading
	Underground water and soil security protection facilities	Sewage pond in the course	Monitoring the requirement of pesticide, fertilizer and water and providing according to the needs to save energy and protect environment
Vegetation & lawn afforestation facilities	Vegetation & lawn ecologization	Subsurface & drip irrigation and controlling system	Making the best of original vegetation; choosing suitable grass seeds and species according to land and usage; for example, species of tee ground, fairway, green and lawn bear tramples and mowing (frequently, short), have strong resistance and are not easy to squeeze leaf juice, etc.; species in roughs bear characteristics of extensive management resistance and weed infestation resistance etc.

From Table 1, we can see that EI individuals provide favorable physical carrier, avoiding and reducing the influences of resorts and tourists to the parks, and implements the eco-protection and restoration of eco-environment such as water, soil, living beings, air etc. These EI individuals were designed by the park, which shows it deserves the title of national eco-tourism demonstration plot.

3.3.2 Design and mode of EI eco-protection and restoration system

Combined with self-organization characteristics of eco-environment and EI core ideology, according to the microcosmic EI individuals in 3 theme parks, and under the guidance of synthesized performance target of economy, society and ecology, the essay tries to build up an ecological protection and restoration system including microcosmic EI individuals in the 3 theme parks to ensure the natural steadiness of the whole ecological tourist area.

Upon analysis of steadiness of EI individuals and prediction of tourism ecological capacity, with the 3 parks taken as 3 inlaid patches of landscapes, and with the interconnection of ecological traffic corridors (such as electric cable cars, forest mini trains, aerial ropeways, the existing Yansan Roda, etc.), the essay forms an ecological protection and restoration system of network where artificial work and natural systems are in harmony. It consists of EI stems (ecological traffic corridors), EI branches (ecological recreational channels in the parks), EI leaves (artificial wetland, Windmill in the cloud, sundial, reservoir type power pond, and sewage pond etc.). With the number of tourists increasing and the eco-environment capacity of the park enlarging, EI protection and restoration system gives play to its function of self-organization, within a range of threshold value, the system can resist the influence of micro-degree, low-degree or moderate degree and restore itself to a certain degree to ensure the natural ecological environment is under a healthy condition (Xiao Duning, 2004). However, when the external influence caused by tourist flow is over the range of threshold value of protection and restoration, the healthy and balanced condition of the natural environment will be broken, the functions of EI system will disappear or be replaced, so the result will be unpredictable. Therefore, it is necessary to be aided with related management scheme system of management department of OCT East, to eliminate the unpredictable or potential effects and realize the goal of protecting and restoring the natural ecological environment (See Figure 1).

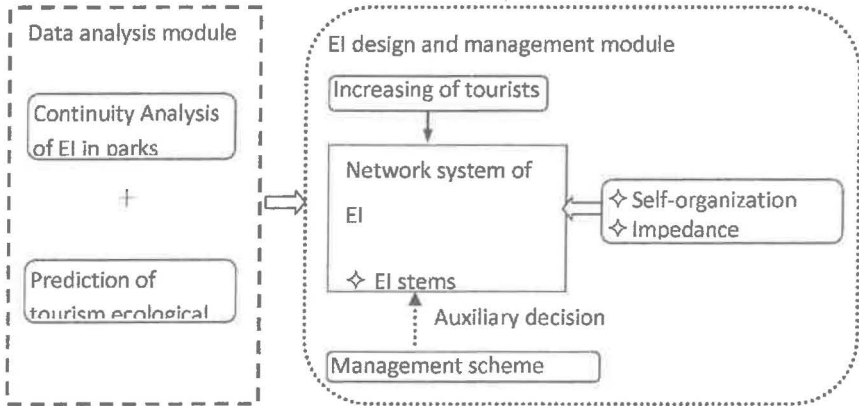


Figure 1 Protection and restoration system of Ecological Infrastructure

In management level, the goal of ecological design and emergency management can be achieved through EI protection and restoration system. The particular management plan system will be carried on from the following three aspects.

a) Scheme of easing tourists flow. Theoretically, the problem of easing tourists flow can be solved through cable cars, mini trains, wooden path, battery cars, aerial ropeways etc. But because of the special attraction of cable cars and mini trains, during real operation, tourists are most likely to choose the two. The maximum capability of cable cars is 800 people per hour; mini trains also have limited capability too. It will be a hidden danger if intensive tourists flow can not be eased as soon as possible. Therefore: (1) adding another route of mini trains can solve the problem. (2) adding another ecological mountain path to add one more choice for some tourists, so the flow can be eased to some extent, serving multiple purposes. (3) Extending Yansan Road, trying to choose zones where ecology can be restored easily to satisfy more self-riding tourists in their one-day tour, thus the rush hour of back tour can be eased. (4) Building up "Wind Line" like "Happy Line", the traffic line traveling around the resort, which is a theoretical design of dispersion of tourists, and to be considered with terrain, geology, soil, etc., in OCT, East.

b) Processing scheme for environment stress caused by intensive tourists. Presently 5-star hotels have been built up in the park. Once divisions, damages and pushes happen to tourist resources, there will be less attraction. Thus, designing

ecological hotels which bears recycling characteristics is the first choice for holiday accommodation infrastructures.

c) Design scheme of entrances setting and ticket system follow-up. Some types of ticket business can be set up. For example: independent ticket system in 3 parks, or twosome mixed ticket price system. Knight Valley is mainly for recreation, while Tea Stream Valley for holidays, so the two has many mutual complements. Wind Valley is a mountain sports park for which membership system is suitable. These designs are good for tourists to choose the traveling routes self-directedly. More entrances can be added at these places: Interlaken, Tea Stream Valley, the south of golf course in Wind Valley, the connection of cable car station and mini train station, and so on.

The setting up of the EI eco-protection and restoration systems in OCT East aided with management scheme system can deal with ecological and environmental problems in long term, improve natural service functions in resorts in an all-around way, and save investment of management and maintenance greatly. Ultimately, the safety and health of natural ecological system will be guaranteed, the community around and even Shenzhen residents will get sustainable natural and ecological service, then EI will lead to change of regional spatial and pattern, and is a base of setting up ecological function region.

4. Conclusion

Through abundant data collection, field survey and empirical analysis, based on EI theory, the probes into the practical problem of the application of EI theory in the process of natural and ecological protection and restoration in OCT East which carries much human impacts. Under the guidance of landscape ecology, the authors discuss the application of EI theory in OCT East from microcosmic level and macroscopic level: i. Discussing the functions and characteristics of microcosmic EI individual in different parks; ii. On this base, the authors set up an ecological protection and restoration network system which bears EI stem, branches and leaves. Finally, taking park management scheme as an auxiliary and emergent decision basis will help to protect the natural ecological environment of the scenic spots and community around, and help to offer ecological services continually and steadily. Although the scenic spot of OCT East has been developed in the region with favorable resources and under government's guidance, the application of EI

theory in the design of ecologization will be a guidance in future eco-tourism development. The creative mode of environmental protection promotion, recycling, energy saving and so on in the OCT East will bring more obvious demonstration effects to the national eco-tourism demonstration plot.

Acknowledgment

The work is a result of the Soft science and technology plan project, namely "Development model demonstration of the eco-tourism Sample Area in Guangdong province—a Low-carbon Industry Choice issue based on the main function zoning" (Grant Number. 2010B070300048), supported by Science and Technology Department of Guangdong Province.

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