

## **Evaluation on the Construction and Implementation of Pearl River Delta Greenway from the Viewpoint of “Prototype Features”**

### **1. “Prototype Features” of Greenway**

In 1959, William Whyte mentioned the concept of “greenway” in Secure Open Space for Urban America. Since then, the construction of greenway in full swing by many countries has proved the importance of it. However, the concept of greenway has never been widely unified due to the different construction backgrounds in different places and the differences in breakthrough point of theoretic study. Thereby, the evaluation standards and evaluation systems of greenway after its construction are different.

It is generally recognized that the main sources of greenway in format (space) are “greenbelt” and “parkway”. In the mid-19<sup>th</sup> century, Frederick Law Olmsted, et al designed an urban park system in belt like shape in Boston in U.S., which is a chain of parks linked by parkways, and which is recognized as the modern origin of greenway. In short, parkway is the first prototype of greenway. Starting from this prototype, it is compared with the current greenway theory and practice. It can be found that greenway is developed from parkway. They have vertical and historical connections, that is to say, there are some universal features which have never changed. Even modern greenway theory and practice are started around these features, and they are the deepening and derivation of these universal features. These features are defined as “prototype features” by the author. Studying the “prototype features” can help to ponder over the most basic standards for the construction of greenway, and to establish the basic evaluation system for constructed or under construction greenways. Through comparison and analysis, the “prototype features” of greenway mainly include the following four aspects:

#### **1.1 Connectivity**

The earliest role of parkway is to link cities and urban parks to show linear continuity. The most remarkable feature of green in spatial pattern is its linear feature. The basic effect of line is to link “objects”. These objects can be simplified into points in space and expanded into different specific things of different types and properties, such as cities, forest parks, urban parks, roadside green spaces, etc. It’s worth noting that if the linking objects are weak or not existed, the effect of line will be weakened or even disappeared. Therefore, greenway and linking objects are interdependence. It can be said that greenway is attached to linking objects and not suitable to exist alone. Enough among of lines link “points”, with certain external and internal connections, network can be formed. The intersections of the center of network with lines can form new “points”, and points can be interconnected and form close connections. Thereby, in ideal state, the strengthening of network is making progress continuously with the forming of network. This is the basic forming logic of point, line and network of greenway. It’s worth noting that greenway network (or greenway system) must include the objects linked by the greenway. Only in this way, the system can be intact, and it can be called system.

#### **1.2 Accessibility**

The first parkway built in 1870 ——Eastern Greenway, starts from Boston Garden and extends to the downtown of Brooklyn, which promotes the integration of park landscape and urban landscape, and enhances the accessibility of the park. From the perspective of theoretical study, the accessibility of greenway is emphasized in the definition of greenway by European

Greenway Association (EGWA), and in the six elements of greenway proposed by Gobstert and Westphal. They all believed that accessibility is the essential feature of greenway.

On the one hand, “accessibility” refers to the connection between greenway and the linked objects, on the other hand, it refers to the connection between people and greenway. Based on accessibility, greenway and linked objects promote each other, which improve the accessibility and make the linked objects more dynamic. The stimulation of linked objects (such as the increasing of popularity) can bring out the full use and continuous maintenance of greenway.

It’s worth noting that due to the greenway’s feature of “linear space” and large effective contact area, the accessibility of greenway is greatly increased compared with the existed patch like or block like green spaces, such as patch like park and block like green space in the city. This becomes one of the major advantages of greenway.

### ***1.3 Recreation Abilities of Greenway Itself and Lined Objects***

Early greenways provide space for outdoor activities, and they can take full advantage of the river banks, hills, and other natural terrains. They are the migration routes suitable for taking a walk and cycling. Moreover, they are much easier in getting land than block like park green space. So their recreational tour function shall be emphasized. Recreation ability has always been one of the basic functions of greenway.

Recreation abilities include the “recreation ability of greenway itself” and the “recreation ability of linked objects”. The recreation ability of greenway itself is the property of greenway different from other linear spaces, such as roads, pipelines, etc. For example, roads are mainly used for traffic contacts. Taking an extreme example of expressway, greening can be neglected to guarantee its traffic characteristics, and it can even separate the city. However, greenway is not dominated by traffic. Although it has certain traffic characteristics (decided by its connectivity), this kind of traffic is established on the basis of aesthetic. Whether straight lines or irregular curves, the earliest parkways are always accompanied by plants and beautiful sights. The recreation ability of greenway itself is also reflected by the providing of green space. That is to say, greenway itself is also the destination of recreation. The recreation ability of linked objects will directly affect the utilization rate of greenway. High recreation ability will effectively improve the utilization rate of greenway.

Similar to accessibility, the recreation abilities of greenway itself and linked objects promote each other.

### ***1.4 Agreeableness Function***

Agreeableness function emphasizes the service object of greenway is human. Whether it is the Cuiyun Corridor of China (so far the world’s oldest and best preserved ancient greenway), early parkway or greenway developed at the present stage, we can see that greenway has always been closely related to human activities. For example, tall cypresses have been planted in Cuiyun Corridor. Within 2000 years (since 221 BC of Qin Dynasty), there have been seven large-scale tree planting activities, which has improved the regional environment, and meanwhile they strengthened the outside contact of people in Shu as the ancient Shu roads; parkway is constructed for the convenience of approaching to the park or to meet certain ritual, recreation and aesthetic requirements, and as the chronic living space to communicate with the nature; the greenway at the present stage emphasizes the bicycle paths and foot paths. Greenway provides a new carrier for human activities. The functions of greenway are expanded in later stage, and some greenways weaken the residents’ activities. But guaranteeing the participation of people is still the most basic function of greenway (especially the public service facilities provided for the

greenway). That is to say, the service objects of greenway are increasing (such as the migration paths of animals and the seed propagation paths of plants), but its feature of human services has never changed.

Can “ecological ability” be viewed as “prototype features”? The early construction of parkway was not aware of its ecological features. Even if there were the buds of ecological thinking and specific behaviors (such as planting of trees at both sides), they were serving for the recreation function. This is much different from the ecological function-based greenway (such as guiding the migration of animals) appeared at the present stage. So it cannot be viewed as “prototype features”.

From the earliest rudiment to the present development, greenway has always have the above four “prototype features”. These features constitute the spatial prototype of greenway, and become the necessary but not sufficient conditions of greenway. On these grounds, the greenway is defined as: greenway is a linear space network which starts from agreeableness function, links important open spatial nodes, emphasizes the recreation abilities of greenway itself and the linked objects, and have the possibility of many spatial forms and potential functions.

## **2. Expansion of “Prototype Features” of Greenway**

Through years of development, a large number of relevant theories and practices have emerged. Their concept and connotation have been constantly enriching and improving. The complexity of greenway has been continuously increasing, which is mainly reflected in “spatial diversity” and “function diversity”, and which are the expansion of “prototype features”.

### **2.1 Spatial Diversity**

The most intuitive reflection of spatial diversity is the enlarging of greenway dimension and scale, as well as the level division. The enlargement of dimension and scale is related to the scope expansion of human activities. The improvement of other infrastructures (such as traffic facilities) also increases the approaching opportunity of remote greenway. Although the dimension division of greenway has not been agreed in academy and practice, the expansion of greenway dimension is an indisputable fact. Former parkways are only the roads leading city residents to the park or roads in the park, which are short. For example, the “Emerald Necklace” in Boston is only 16km. However, the present greenway is divided into many levels from different scales, such as regional greenway, urban greenway, community greenway, etc.

During the rapid construction of greenways, some of them even break the linear concept (it shall be noted that their cores are still in linear shape), and become a region related to greenway. This is closely related to the emphasizing of ecological function of greenway (such as the establishment of ecological buffer zone or interface). Some scholars divided the greenways according to their scales (areas). For example, Ahem divided the greenway into four types, which are urban-level greenway (1-100km<sup>2</sup>), district-level greenway (100-10000km<sup>2</sup>), provincial-level greenway (10000-100000km<sup>2</sup>) and regional-level greenway (100000km<sup>2</sup>).

The relations between the lower level and the upper level have always been partial subordinating and partial dissociating. For example, community greenway is probably a part of regional greenway, but it can also be an independent greenway, which is dissociating from the large system and only connects to the urban greenway or even regional greenway. In addition, the development of greenway is separated: one is developing to macro (regional or territorial); the other is micro (community or place). However, the development in both extremes helps the improvement of greenway system and the forming of greenway network.

## **2.2 Function Diversity**

The development of historical and cultural heritage, archaeology, ecological protection, landscape ecology, and other disciplines provides a new perspective for the studying of greenway theory. In practice, the multiple functions can be realized and strengthened by greenway. Therefore, greenway has become the linear space carrier integrating multiple functions, and it is a realization in space. It has evolved from a simple greenway to a comprehensive corridor, including Ecological corridor, Recreational corridor, Esthetics corridor, Economic corridor, etc.

It is noteworthy that the expansion of dimension and scale is related to the integration of multiple functions. The expansion of dimension and scale leads to the generation of different functions (sub-functions) for different sections of the same greenway. The subdivision of these functions may bring different requirements for different facilities. Therefore, unlike road, especially expressway, greenway cannot be constructed in a completely uniform construction standards or modes (such as uniform road width).

In addition, a trend of development for the greenway theory and practice has appeared in later stage, which is network spatial prototype. The biggest advantage of this prototype is counterbalancing the separation of natural habitats by artificial networks (which are traffic networks, such as roads, light rails, motor cars and high-speed rails) by natural network. Therefore, greenways have to form into a network or a system to be fully and maximally effective.

## **3. Pearl River Delta Greenway Practice from the Perspective of “Prototype Features”**

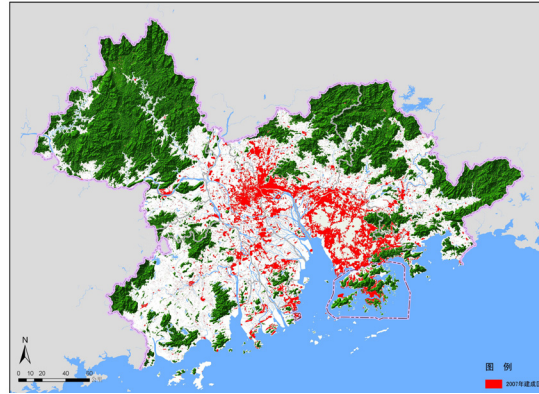
### **3.1 Backgrounds for the Construction of Pearl River Delta Greenway**

Pearl River Delta Economic Zone (hereinafter referred to as Pearl River Delta) locates at the south of China. It includes Guangzhou, Shenzhen, and other seven cities<sup>1</sup>. Its total population is 42.3 million, and its total land area is 41,698 square kilometers. Since the implementation of reform and opening-up policy, Pearl River Delta has become the leading manufacturing region in China. It is famous with the economic development mode of the "Three-plus-one" trading-mix. The rapid economic development and urbanization process has changed the urban landscape. From the remote sensing image of town clusters of Pearl River Delta (Fig.1 and Fig.2), we can see that the expansion of town clusters of Pearl River Delta is obvious, and urban construction land has formed densely continuous city-and-town concentrated area, and the urban population is highly concentrated. Meanwhile, a variety of problems due to urban expansion are urgently needing to be solved, such as the peaking of utilization of land resources (some cities, like Shenzhen and Dongguan, have exceeded the safety bottom line where the percentage of land for construction in the total area of the administrative region of the city shall not exceed 30%), and rapid encroaching on the urban open space. Space planners are in a dilemma. On the one hand, they have to provide spatial carriers to maintain the rapid growth of economy, and the spatial spread is still not completely controllable, which may further reduce the open spaces. On the other hand, they have to provide sufficient open spaces and good living environment, and solve the environmental degradation, space congestion, and other problems brought out by development.



*Fig.1: Distribution of urban built-up area of Pearl River Delta in 1995*

*Source: Song Jinsong and Song Yun (2008) “OR model” and simulation of the growth form of future space of Pearl River Delta*



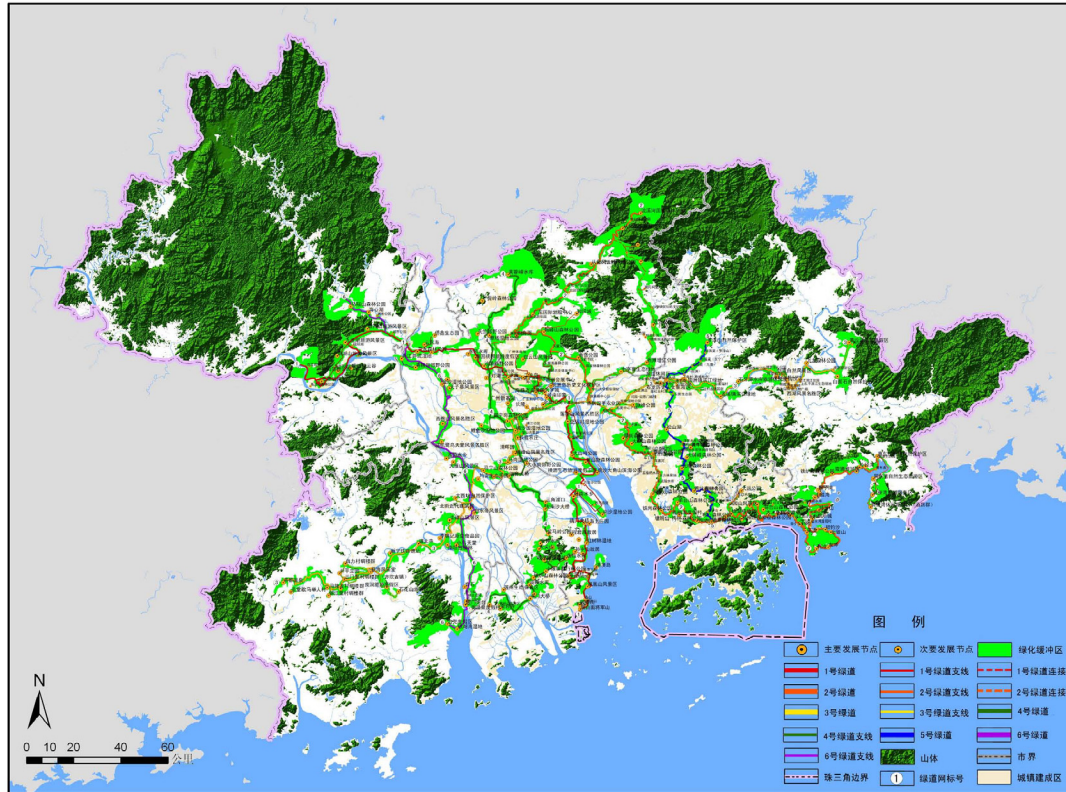
*Fig.2: Distribution of urban built-up area of Pearl River Delta in 2007<sup>2</sup>*

*Source: Master Planning Outline for Greenway Network in Pearl River Delta*

### **3.2 Proposal of Greenway Construction**

Since 1994, more than ten plans have been made for the Pearl River Delta to guarantee the green space and deal with urban sprawl. However, it is proved that the effect is little. The expert forum on the “regional green space” held in February 2009 is a landmark meeting for “greenway” in Guangdong. It was on this meeting the idea of protecting ecological corridors through the establishment of “greenway” was proposed. The original intention is to take measures, such as constructing bicycle paths in the ecological corridor, to enhance the interaction between man and green space, and get the attention of citizens in green corridors, and help their protection.

In January 2010, the government of Guangdong Province planned to take the lead in constructing six regional greenways with the total length of 1690km, and forming the main frame of the Pearl River Delta Greenway Network in three years time (2010-2012) in Pearl River Delta. The government has been planned to realize the goal of “finishing the basic construction in one year, all in place in the second year, and completing and improving in the third year”. It is planned to be built into a landmark project of Guangdong Province, and form new economic growth point (Fig.3). By taking the lead in such a large scale greenway construction project in China, it becomes the landmark event of China’s rural and urban planning and construction in 2010. By the end of June 2011, provincial greenway of 1369.9km has been constructed and the newly increased greening has reached to 913km in all places of Guangdong.



*Fig.3: Layout plan of Pearl River Delta Greenway Network*  
 Source: Master Planning Outline for Greenway Network in Pearl River Delta

### **3.3 Working Methods and Basic Evaluation of Pearl River Delta Greenway Practice from the Perspective of “Prototype Features”**

To guarantee the smooth construction of Pearl River Delta Greenway, the government of Guangdong Province issued the Master Planning Outline for Greenway Network in Pearl River Delta and the Guidelines for Planning and Design of Regional (Provincial) Greenways in Pearl River Delta, which control and guide the many aspects involved in the construction of greenways from the perspectives of policies and technologies. With the “prototype features” of greenway as the research focus, the working methods of Pearl River Delta Greenway practice are interpreted, and the potential problems existed in the construction of Pearl River Delta Greenways are basically analyzed and evaluated in the following text.

#### **3.3.1 Connectivity and Accessibility**

The definition of greenway in the Master Planning Outline for Greenway Network in Pearl River Delta is “a type of linear green open space, usually built along riversides, valleys, ridges, scenery roads, and other natural and artificial landscapes, provided with landscape recreational lines for pedestrians and cyclists, connecting main parks, nature reserves, scenic spots, historical monuments, urban and rural residential areas, etc., contributing to the protection and utilization of natural, historical and cultural resources, and providing sufficient space of recreation and interaction for residents”.





*Fig.4: Schematic view for the analysis of superposition of impact factors*  
*Source: Master Planning Outline for Greenway Network in Pearl River Delta P28*

This definition gives prominence to the connectivity and accessibility of greenway, and emphasizes the comprehensive utilization of existing resources. In practice, the following three aspects shall be mainly considered for the connectivity and accessibility of greenway, such as the route selection of greenway:

- 1) Resource background. Mainly including the natural ecological element, human element, traffic element and town layout element;
- 2) Policy factors. Mainly including the plans from upper levels and relevant existing plans, such as the Coordination Development Planning of Town Clusters in Pearl River Delta (2004-2020), the General Planning for Land Used of Guangdong Province (2006-2020), and the Planning Outline for Environmental Protection of Pearl River Delta (2004-2020);
- 3) Local willingness. After forming the primary thought for the general layout of Pearl River Delta Greenway Network by the Province Housing and Urban-Rural Construction Department, solicit the opinions of all cities and the public from the Pearl River Delta (including cycling association, mountaineering association, and other non-governmental organizations) about the initial scheme, and finally determine the route scheme.

Taking into account of the above three aspects and adopting the method of integrated index, the general layout of greenway network composed by 6 main routes, 4 connecting routes, 22 branches, 18 inter-city interfaces, and 4410 square kilometers of green buffer zone is formed through integrated optimization (Fig.4). The regional greenways link more than 200 main forest parks, nature reserves, scenic areas, country parks, waterfront parks, historical and cultural sites, and other development nodes. They basically cover all regional level important open spaces in

Pearl River Delta. These places are all classified as the green buffer zone. With the total area of 4,410 square kilometers, they account for 8% of the total area of Pearl River Delta.

It can be seen that Pearl River Delta has good resource conditions and endowments. The some of the former unknown places are refreshed out due to the construction of greenway, and become the important nodes of greenway. This also proves that the improvement of connectivity and accessibility plays a big role in promoting the prosperity of linked objects.

### ***3.3.2 Recreation Abilities of the Greenway Itself and the Linked Objects***

Demonstration sections are established for the six regional greenways in Pearl River Delta. Generally, these demonstration sections will be constructed in advance, and the relations between greenway and surrounding environment are fully considered, and their recreation abilities are strong. However, there are a considerable number of greenways which follow the construction standards too strictly at the expense of spatial features, and the desired results are not achieved. As a matter of fact, recreation ability reflects the characteristics of greenway to certain degree. If fully considering the integration of greenway with its natural environment and human environment, spatial features can be found and spatial qualities can be improved.

#### **(1) Integration of greenway and natural environment**

Pearl River Delta has mountain, coast, creeks, countryside, and many other elements of ecological environment, which constitute a unique landscape of Lingnan. While strengthening this framework, the recreation ability of greenway itself is also improved.

##### **1) Greenway and mountains**

Pearl River Delta has flat terrain and U-shaped pattern—its north, east and west are surrounded by mountains, and its south is facing sea. A few mountains are scattered in the plain, like islands in the sea. Due to the poor land suitability compared with plain, they have to be preserved as urban parks, such as Baiyun Mountain in Guangzhou, which has become the city's green lung. Greenways are laid along valleys and ridges, and other linear belt line areas. They are served as a medium for people to be close with nature and provide new platforms to look around the city.

##### **2) Greenway and creeks**

Pearl River Delta is a delta area formed by the alluvial of many creeks, such as Xijiang River, Beijiang River and Dongjiang River. Creeks (specific river form in Pearl River Delta, refers to ditches and small rivers) in this delta are crisscrossing and densely distributed. Due to flood control and other reasons, reasonably allocated and linear continuous greening is always distributed at both banks of these creeks. Therefore, the construction of greenway shall better be started from both bands of these creeks. The planning of greenway shall also be integrated with the planning of creek systems. For example, ferries or water tourism lines, and transition with other traffic modes can be considered at the connecting parts between greenways and creeks. They are all important measures in increasing the distinctiveness.



### 3) Greenway and coast

The coastline of Pearl River Delta is 522.4km. The integration of greenway with the coastline can fully utilize the resource of coast. For example, a greenway from Shatoujiao, Tantiangang to Dameisha waterfront coastline was created in Yantian District of Shenzhen, which links mountain views, seascapes, ports, ecological islands and seafood streets. In addition, some islands near the coast can even be included in the greenway system.

### 4) Greenway and countryside

Vast rural fields are important ecological basis and green open spaces of Pearl River Delta besides mountains, rivers and coast. The agricultural land of Pearl River Delta accounts for 77% of the total land area, and main crop land accounts for 58% of the total land area. Rural fields are always close to the city. So urban population can be directed to the countryside through the construction of greenways to ease the urban congestion and restrict the sprawling development of urban land.

## (2) Integration of greenway and human environment

Pearl River Delta has Lingnan culture, Hakka culture, culture in the special economic zones, and other profound historical cultures and modern cultures. However, many cultures have been fragmented and scattered in the city due to under appreciation. Greenways will link these cultures, like “fragments finishing”, and it can stimulate cultural renaissance. For example, Panyu Greenway in Guangzhou guides ancient celebrities private garden to the city and nature through linking Yuyinshanfang – one of the “Four Famous Gardens in Lingnan”, which is incorporated into the system of sharing landscape resources of cities. It plays a good role in the protection of Yuyinshanfang and the development of greenway.

Besides emphasizing characteristics, the recreation ability shall also be guaranteed by the providing of public service facilities and the participation of a wide range of activities. The recreation ability of linked objects requires the improvement of spatial quality of the linked objects.

### **3.3.3 Agreeableness Function**

The completely covered greenway network of bicycle paths and foot paths proves that the service objects of Pearl River Greenway are mainly people. How to improve the utilization rate of greenway by residents is the key problem in subsequent management.

For regional greenways of such large scale, it shall be considered that if all the preset functions can be brought into play. So the utilization rate of greenway shall be estimated before its construction. First of all, this involves route selection for the greenway, which shall be set in the relatively densely populated areas. Even if the agreeableness cannot be met, the accessibility shall be guaranteed (refers to reaching to the greenway) to serve more people. Secondly, the organization of activities in later stage is quite important. Taking major sports events as an example, the hold of Guangzhou Asian Games in 2010 and the hold of Shenzhen Universiade in 2011 attract more attentions to the construction of greenways.

For now, the Pearl River Delta Greenway is still short of long-term mechanism to stimulate vitality, and spontaneous activities of residents still need time to develop.

### **3.3.4 Spatial Diversity**

According to the different levels and scales of greenways in Pearl River Delta, they can be divided into regional greenway, urban greenway and community greenway. The working mode of top to down is adopted in the construction process, which has strong Chinese characteristics. The sequence of greenways construction is regional greenway first, urban greenway later, and community greenway in the last. This is different from some cities of other countries which already have the basis of greenways (community or urban greenway), where the existing greenways are linked into regional greenway. The provincial level is responsible for the master supervision, technical guidance, inspection, and the establishment of uniform management regulations; while the municipal level is responsible for the organization, implementation, construction management and maintenance, and is the main body for the construction and management of greenways. Due to the concentration of main construction forces, the top to down working method is favorable for the construction of greenway in a large scale.

On the other hand, long construction length, short construction time and fast construction effect provide conditions for the further construction of “regional green space” and “country park”. However, some problems may also appear, such as ecological damage due to not solid foundation work, the lacking of gradual process and the reducing of correction opportunities due to the nearly one-time completion of greenway construction; poor construction of some greenways due to the large amount of routes; the lacking of orientations of six regional greenways without much differences and clear features.

### **3.3.5 Function Diversity**

It is explicitly pointed out in Guidelines for Planning and Design of Regional Greenways in Pearl River Delta that the functions of greenway include four aspects of ecology, recreation, society and culture and economy. But for now, the improvement of recreation function is the most prominent one, and its effect is more obvious. It is mainly reflected in the improvement in bicycle paths, foot paths and supporting service facilities. The economic function is at the second place, such as promoting the development of tourism and relevant industries, and providing employment opportunities. According to statistics, for the cities in Guangdong which are the earliest in greenway construction, the master annual tourism income of the city bringing along by greenway is 0.5 billion Yuan, the annual amount of visitors are increased by 20% before the construction of greenway, and the city brand value is also rapidly increased. From this point of view, greenway seems to become the pioneer in regional development. At present, the Pearl River Delta cities are still expanding. Does greenway represent the future expansion trend of cities to some extent? As a matter of fact, due to the improvement of ecological environment and the increasing land value, the expanding direction of some greenways turns into cities. That is to say it is entirely possible for greenway to turn into the economic corridor or development corridor among cities. Especially for new city zones, these places are still not covered by urban road network and buildings and have good ecological background. If greenway construction can be considered before urban built-up, the ecological framework connection system based on this can provide a development path for the congested and lacking green space old city. This also provides a new planning idea for the preparation of regional planning. However, attentions shall be paid to beware of infringing public interest by private interest.

#### **4. Conclusions**

Generally speaking, the construction of Pearl River Delta Greenway basically meets the “prototype features” of greenway. At present, the most prominent issues are focused on the recreation abilities of greenway itself and linked objects, and the relativity of greenway and human activities. The former is reflected in the shortage of greenway characteristics, and the latter is reflected in the lacking of later stimulating mechanism of vitality. In addition, the realization of ecology, society and culture, and other functions shall be strengthened from view of multi-function integration. The development stages and development modes of Pearl River Delta have their own uniqueness. It is difficult to find a completely suitable reference, and further exploration is required. The Pearl River Delta Greenway is the first step of greenway construction in China. More and more cities and regions will participate in the construction of greenways in the future. Therefore, corresponding construction standards and evaluation systems must be improved to avoid blindness construction.

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#### **Note:**

1 Pearl River Delta include nine cities (Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou and Zhaoqing) .

2 At the end of 1990s, the scope of Pearl River Delta was adjusted.

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