

Landscape Architecture Planning and Design Based on Landscape Ecology Theory: A Case Study of Waterfront Landscape Planning and Design of Dapo Town

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Abstract With the rapid development of urbanization, landscape architecture has become an indispensable component of daily life. In order to achieve better landscape effects and protect the ecological environment, landscape ecology theory can be integrated into landscape planning to carry out disciplinary crossing and integration research between landscape ecology and landscape architecture. In this study, based on the basic theories of landscape ecology, the waterfront landscape of Dapo Town was designed, with the aim to achieve ecological balance in planning, showcase biodiversity, and create a harmonious landscape ecological environment which can benefit both nature and people. This design combined artificial and natural elements while improving the natural environment, which promoted a harmonious relationship between humans and nature, thus enriching the spatial organization of the city, and playing a role in regulating the urban environment and climate.

Keywords Landscape ecology theory, Landscape architecture planning and design, Dapo Town, Waterfront landscape

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With the development of society, people are becoming increasingly keened to the pursuit of spiritual level day by day. Thus, the planning and design of landscape architecture is no longer just about simple route planning, plant planting, and the creation of architectural ornaments. Instead, it focuses on economic development, cultural connotations, and ecological environment protection, and it aims to create comfortable places with natural vigor through the combination with the principles of landscape ecology. There are various applications of landscape ecology theory in landscape architecture planning and design, which is integrated through the process from the early stage of site environmental investigation to the overall route, functional zoning, plant matching of the planned site, so as to make the entire planning and design more scientific and reasonable, thereby meeting people's spiritual needs from the entire environment, which can make them relaxed in both body and mind and get closer to nature.

In the history of gardening, it is recorded that ancient gardens were mostly privately owned by the royal aristocracy, no matter Chinese gardens or foreign gardens. However, the present modern gardens serve every citizen. The purpose of modern gardens is to serve people, whether it is for sightseeing or for their gathering and distribution functions. During the industrial revolution in early modern Europe, the construction of gardens and green lands was to build urban parks and infrastructure, which

aimed at addressing environmental, air pollution, and issues affecting human health that arose from urban development and population growth. On the other hand, modern gardening has gradually developed into various design directions, such as ecologism, land art, postmodernism, structuralism, and landscape modernism^[1]. After a series of changes from the structural form, infrastructure, and constituent elements of gardens to the development and transformation of low impact sites, a set of landscape planning models was finally formed. In today's garden construction, some garden landscapes are inevitably prone to transitional repetition in form and lack their own characteristics. Therefore, combining with landscape ecology theory and technology, the creation of garden landscape should renovate the site but pose no effects on its own sustainable development, and retain its own characteristics while reflecting the overall development of the entire region. At the same time, garden designers also need to conduct more profound exploration and analysis of the theory of landscape ecology, and think as comprehensively as possible in the practical process^[2].

1 Basic principles of landscape ecology applied in landscape architecture

In the construction of contemporary garden landscapes, in order to ensure the scientific and rational planning and achieve the goal of protecting the ecological environment in the design,

most planning combines the basic principles of landscape ecology theory and use the landscape ecology of "patch-corridor-matrix model", which includes 3 basic elements: patch, corridor, and matrix, so as to make the structure and dynamic expression of the entire landscape space more accurate and clear^[3]. The use of landscape ecological evaluation in landscape planning and design refers to the comprehensive evaluation of the existing environmental status, available resources, and ecological functions of the landscape based on the relevant principles of landscape ecology. This is mainly a comprehensive understanding of landscape functions and an important foundation for landscape planning and design^[4].

The application of landscape ecological pattern analysis in landscape architecture planning and design can provide scientific basis for landscape architecture construction, facilitate the construction of a safe pattern for landscape architecture, enhance the pertinence of landscape architecture construction, determine the main construction route, analyze ecological problems within landscape architecture, and plan the ecological pattern of landscape architecture^[5]. By analyzing the landscape pattern and understanding various basic elements, designers can conduct a detailed analysis and reorganization of the overall spatial pattern and the relationship between landscape structures within the site. They also can adjust or construct new landscape structures to increase landscape heterogeneity and stability by combining or introducing new

landscape elements^[6]. There is no doubt that every designer, out of the need for ecological protection, would incorporate ecological ideas into their design, apply ecological principles to study the dynamic changes in structure and landscape function, and adopt a systematic approach to study the landscape pattern, which can optimize the landscape structure, utilize and protect landscape resources^[7].

In this paper, some basic principles of landscape ecology such as ecological balance, mutual benefit and symbiosis, and biodiversity are selected and applied in practice, so as to provide more substantial guidance for the overall landscape pattern, construction, and vegetation matching.

1.1 Principle of ecological balance

Whether it is forests, grasslands, or lakes, all are essentially constructed by various life elements such as animals, plants, microorganisms, as well as elements such as light, water, soil, air, and temperature. These elements are interrelated and mutually restricted, forming a complete whole. When these elements form a relatively stable balance through interactive behavior, it is named ecological balance. The maintenance of ecological balance is a continuous process that involves the evolution of organisms and the replacement of populations, and the process involves a sustained impact on the existing balance to construct a new one. For example, plants planted in different regions (with different altitudes, temperatures and climates) should be selected based on their benefits and advantages over disadvantages, in order to achieve a balanced ecological environment and maintain it better for a longer period of time.

1.2 Principle of mutual benefit and symbiosis

The creatures living in the same ecological environment can interact with each other to coexist together, so they depend on each other, store for each other and thus benefit each other. Mutual benefit and symbiosis are also widely used in gardens, such as tall trees and low shrubs. Shade loving plants planted under trees can survive better, while low shrubs with dead branches and rotten leaves can provide nutrients for large trees. This is also a manifestation of mutual benefit and symbiosis in gardens.

1.3 Principle of biodiversity

Biodiversity is composed of all plants, animals, and microorganisms as well as all their genes, and various ecosystems on earth^[8]. The plants in gardens should be multi-level, diverse in variety, and various in combination,

forming ecological diversity in plant application. Landscape greening design cannot do without the inherent laws of its community, and it must also follow such rules. Landscape plants should not only have ornamental value, but also be able to protect the environment, so as to achieve good ecological benefits while greening the environment.

2 Landscape architecture planning and design

For contemporary people, landscape architecture is no longer just a place for play or leisure, but also has the function of environmental protection and relaxing the mind. Plants in landscape architecture not only absorb carbon dioxide and release oxygen, but also have functions such as purifying the air, promoting physical and mental well-being, and promoting good health. At the same time, they can also regulate humidity and reduce noise.

2.1 Concepts of landscape architecture planning and design

Landscape architecture planning and design is a scientific and reasonable construction of landscape elements such as mountains, water, terrain, and landscape architecture within the site, using existing habitat resources and combining modern horticultural technology and artistic conception according to different regional characteristics, while adhering to natural and economic development and protecting the natural environment. It is then decorated with trees, shrubs, herbs, vines, and other plants to create a leisure and entertainment space based on nature, providing people with various activity venues.

2.2 Content of landscape architecture planning and design

Before planning and designing landscape architecture, the planning objectives should be clearly defined, but not to blindly pursue magnificent scales. Instead, landscape architecture should be integrated into the natural environment of the site during planning and design. Each region has its own landscape and cultural characteristics, and landscape design should not only be mechanical imitation. Landscape architecture planning and design should reflect regional cultural style. In planning and design, it is important to understand and meet the needs of the surrounding audience. In the construction of landscape architecture, attention should not only be paid to creating visual effects, but also to practical feasibility, cost investment, and later management; moreover, the construction of landscape architecture

should not damage local ecological, but should adapt to the local environment. In the selection of plants, plants in gardens should not be randomly configured, and the diversity of plants in landscape gardens should be ensured; it is not enough to only focus on the types of plants and ignore specific specifications and varieties; plants should be planted according to the growth characteristics of different regions, and reasonable economic designs can be made according to local economic development^[9].

3 Principles and ideas of landscape architecture design in landscape ecology

3.1 Design principles

3.1.1 Respecting the site and making scientific and reasonable planning. In the preliminary investigation of the site, it is necessary to have an understanding of the terrain and topography of the site, the local temperature and climate, as well as the statistics of the original plants and buildings on the site. It should also include investigating and organizing the surrounding environment, such as the residential population and roads. Appropriate entrance and exit settings and site route settings should be selected after various investigations and analyses. In the planning, the terrain and topography should be appropriately preserved or modified as little as possible to conform to the design of the terrain. The so-called respect for the site refers to the preservation of the original resources of the site and the rational planning and transformation, which means that the original resources should be processed in an optimizing way without wasting, so as to protect the natural resources and ecological environment of the site.

3.1.2 Focusing on plant combinations and giving priority to local tree species. As for the combination of garden plants, large trees, small and medium-sized trees, shrubs, herbaceous vines are often used. For different regions, the combination of plants should also follow the local natural landscape, and it is not easy to introduce plants to reduce the risk of species invasion. Using local plants can not only improve the survival rate of plants, but also showcase unique plant landscapes and protect ecological balance. When planting, it is also important to respect the ecological habits of plants. For example, light-requiring plants are planted on wide lawns, while shade-requiring plants are planted under tall trees. The plant landscapes should be created based on different functional zones, and appropriate plant species should be

selected according to the people in the region. For example, it is best to choose non-toxic, thornless, and lint free plants for residential areas; for the areas intended for children, it would be wise to choose non-toxic, thornless, and lint free plants with bright leaf colors. While creating landscapes, it is also important to consider the physical health of the target audience.

3.1.3 Exploring local cultural characteristics, creating and promoting distinctive landscapes. In landscape architecture, the planning and design should avoid the singularity and repetition of landscapes, and highlight the heterogeneity of landscapes and local cultural characteristics.

3.1.4 Integrating humanistic thinking with the idea of protecting ecological environment. The creation of landscape architecture is based on the protection of natural ecology, and the site ecology is the priority in the preservation and transformation of terrain, landforms, and original site resources. Landscape architecture is mainly to serve people. Although various landscape design elements are used to meet the material and psychological needs of different groups of people, the premise of landscape architecture is to reduce the impact on the ecological environment of the site. Therefore, more attention should be paid to people's need of getting close to nature.

3.2 Design philosophy

3.2.1 Resource reuse and sustainable development. Whether it is the site consolidation in the early stage, the transformation of terrain and landforms, or the calculation of earthwork in vertical design, in the planning process, it is necessary to achieve the rational utilization and recycling of resources, make the most of existing resources, reduce resource waste, and minimize changes to the original site environment while reducing costs. The use of landscape pattern analysis can arrange the planning of the entire site more scientifically and reasonably. When planning different types of landscape architecture, it is important to pay attention to the analysis of landscape ecological patterns. Environmental protection and sustainable development concepts cannot be ignored even in the development of landscape architecture industry with regional characteristics.

3.2.2 Overall planning, coordinating local and overall aspects to serve the needs of people. Overall planning is to clarify the theme and target idea of the entire plan, while planning is to reflect on the demonstration effects of each part. In terms of local design, different functional landscapes can be created based on zones, but

each part must be related to the overall theme.

4 Application of landscape ecology principles in landscape architecture design and planning

4.1 Using science and technology to construct a scientifically reasonable modern landscape

Analyzing the ecological pattern of the landscape before landscape design and planning can scientifically guide landscape architecture to better implement planning, protect species diversity in the area, and take reasonable measures to promote sustainable development and evolution of the ecological environment within the landscape architecture^[11]. In the construction of modern landscape architecture, modern science and technology as well as ecological design ideas should be utilized as much as possible. For example, in the early stage of site investigation, the landscape ecological pattern can be used to analyze the planning direction of various landscapes, local landscapes, and overall landscapes in the site, refine the construction of landscape elements such as roads, zones, buildings, and understand their original animal and plant resources, in order to ensure the accuracy of the required data for the site, accurately understand all elements of the site, and facilitate more reasonable resource allocation in the subsequent planning and design. The ecological design in landscape architecture is also conducive to deeply exploring and accumulating problems, applying modern technological means to solve them, and modifying and improving the design scheme as much as possible from the detail level, which can lay a good foundation for later operation and management^[12].

4.2 Repairing damaged natural ecological landscapes

Reasonable landscape planning and design can make decaying landscapes full of vigor (such as renovating abandoned mining areas or factories), restore and construct damaged natural landscapes, which can turn them into places for people's leisure and entertainment as well as improving their ecological environment. Take the transformation of the quarry garden in the Chenshan Botanical Garden in Shanghai for example. The mine was originally a century old artificial mining remains. Based on the requirements of mining enclosure and ecological restoration, the garden designer combined with the reclusive ideology of ancient Chinese concept of "the Peach Garden", utilized the existing mountain and water conditions, and closely integrated with the natural terrain,

deepening people's understanding of nature; then they reused the furrows of the current mountain body, deeply engraved it, and gave it the form and artistic conception of Chinese landscape painting^[13]. The overall design is tailored to the characteristics of the old mining area, preserving the appearance of the original building and combining it with plants that can absorb and degrade harmful substances for cluster design. It not only restores the ecological landscape but also preserves the historical traces of the mining area and improves the ecological environment of the entire mining area.

4.3 Utilizing the construction of landscape architecture to protect natural landscapes or improve the ecological environment

Landscape architecture can arrange the internal natural ecology as a whole by combining landscape ecological theory to carry out design planning, which can meet the needs of aesthetic sensory expression. The integration of flowers, plants, trees, mountains, and strange rocks can make ecological landscapes show multiple expression characteristics^[14]. By combining and matching various types of plants, the entire internal ecology can be more complex and diverse, which is conducive to the growth of plants in the entire environment, thus beautifying the landscape while positively affecting the environment. For example, in landscaping construction, the shelter forest belt, also known as forest belt, is a general term for tree rows with protective functions planted in a strip-like manner. According to the protection requirements, the shelter belts include various forms such as windbreak and sand fixation forest belts, farmland protection forest belts, grassland protection forest belts, and stream bank protection forest belts. Generally, trees and shrubs are planted together or trees, shrubs, and grass are combined to regulate the climate, prevent and control disasters, improve the environment, and ensure agricultural and animal husbandry production^[15]. The construction of shelter forest belts is also a form of landscape creation in gardens, which uses a mixture of plants to establish a regular landscape beauty, reflecting rhythmic beauty. On the basis of protection, the belts can improve the ecological environment and make the entire environment more stable.

5 Planning and design of waterfront landscape in Dapo Town

5.1 Current status of the planned site

The project is located on the bank of the

Xishui River in Dapo Town, Xishui County, Guizhou Province (Fig.1). The site has an area of approximately 30,000 m² and is in a north-south strip shape along the river. Located in the northeast of Xishui County, Dapo Town borders Qijiang County and Jiangjin District to the northeast, Wenshui Town to the south and Sanchahe Township to the west. The total land area of the town is 167.7 km², with high terrain in the north and low terrain in the south. The town has obvious three-dimensional climate, with the highest altitude of 1,577 m (Feige Village) and the lowest altitude of 850 m (Shijingba Village). The Xishui River winds through the town from north to south.

There is no construction on the site, and most of the roads are dirt roads formed from daily walking. There is a stone slab road near the riverbank, but due to incomplete embankment construction, the road is exposed to water flow flushing during flood season, suffering from serious erosion damage, so there are few people passing through it. The water pollution of Xishui River in Dapo Town is severe, with domestic sewage and garbage discharge polluting the water body. In recent years, after treatment, the water body has been basically restored, the shore environment has gradually improved, the garbage has been basically cleared, and its ecological environment has been restored. There are few plants within the design scope. Within the site, there are *Pterocarya stenoptera*, *Morella rubra*, *Prunus L.*, *Eriobotrya japonica*, *Salix babylonica*, and local vines such as *Lonicera japonica*, as well as local shrubs such as *Hypericum monogynum* and *Rosa roxbunghii*. There are bamboos near the water, pines and *Cryptomeria fortunei* near the mountain. Since there are relatively few plant species, more plant species should be added in later design to grow together with the local plants, which are the dominant species.

5.2 Main design content and ideas

The theme of the project is the waterfront leisure and amusement park, mainly aimed to serve the residents of the town, including local residents, school teachers and students, government hospital staff and patients, as well as tourists. Different functional zones are designed for different groups of people, and reasonable arrangements are made to the basic service facilities (chairs, rest benches), garden buildings (pavilions, corridors), and garden ornaments (sculpture ornaments, stone placement) in different areas, with the pursuit of harmonious interaction between garden buildings and the surrounding

environment, as well as people's lives, and mutual respect and full integration to involve in the continuity of local culture^[17]. As a waterfront landscape, waterfront platforms, waterfront trails, observation platforms are installed to provide people with places to fish and play in the water (Fig.2-3).

The park is divided into six areas: leisure and entertainment area, activity lawn area, tranquil rest area, scenic area, private activity area, and walking and exercise area, to meet people's different needs. The entrance is equipped with a square for gathering and distributing activities.

The waterfront landscape emphasizes the design of revetments, which is constructed after giving consideration to the lowest and highest water levels of the river. Resources can be utilized reasonably, and locally available stone materials can be used as block stone revetments, which is economical and environmentally friendly, or as slope revetments to protect the water side slope^[18]. Stone can also be used as characteristic ornaments or some infrastructure within the park, which can reflect the karst features of Guizhou, reflecting the excellent local ecological environment, as well as the theme development of summer resorts and emotional towns.

5.3 Design elements

The shape of the site is designed according to the flowing direction of the river and the distribution trend of residential areas, presenting a wave like curve shape along the river, which is in an overall belt shape flowing along the river^[19]. The site has a slight slope along the mountain, so the design goes well with the mountain terrain, creating a rolling landscape without changing the original slope of the adjacent areas. A viewing platform can be built along the mountain to provide a panoramic view of the entire park^[20]; waterfront walkways and waterfront platforms are designed in the waterfront area, which are used for waterfront fishing; plants are mainly of local species going with common flowers and shrubs. The design gives full consideration to natural landscapes, improves and regulates the natural environment, integrates artificial and natural elements, and promotes harmonious relationships between humans and nature. It enriches the spatial organization of the city and regulates the urban environment and climate, making the urban layout more reasonable, scientific, and healthy. As a representative area of the open space in the city, it reflects the local cultural characteristics and facilitates better coexistence between humans and nature (Fig.4).

5.4 Plant design

In the design, plants are used in combination with large trees, medium trees, small trees, flowering shrubs, small shrubs, vines, and herbaceous flowers, with *Firmiana simplex*, *S. babylonica*, *Osmanthus* sp., *Magnolia Grandiflora* and *P. stenoptera* as the main skeleton base, and local fruit tree species such as *M. rubra*, *Prunus L.*, *Prunus persica* are kept as part of the landscape, so as to achieve ecological and economic benefits. The bamboo forest near the water is also kept to add more elegance. The plant configuration is rich in color and variety. For example, the evergreen *Prunus cerasifera* and the deciduous *F. simplex* show the ornamental characteristics of plant leaf colors. *F. simplex*, *S. babylonica* and *P. stenoptera* are deciduous trees, while *Osmanthus* sp., *M. Grandiflora* are evergreen trees, and the combination of deciduous and evergreen leaves makes the landscape green all the year round. Hydrophilic plants are planted near the shore to reflect the characteristics of the waterfront landscape, with *Metasequoia glyptostroboides* and *S. babylonica* planted by the water, accompanied by flowers such as *Glaucolus × gandavensis*, *Iris tectorum* and *Canna indica*. Full use is also made to the local shrubs of *H. monogynum* and *R. roxbunghii*, as the former can be used for ornamental purposes while the latter can be used for both ornamental and edible purposes, which is both economical and visually appealing.

6 Conclusion

The interactive development between landscape ecology theory and landscape architecture closely connects humans with environmental protection. Applying the basic principles of landscape ecology in landscape architecture can make the planning and design more scientific and reasonable, and also make the landscape in the garden more sustainable and long-lasting. At present, landscape architecture construction is highly valued by society and government, and landscape ecology theory plays a crucial role in landscape architecture design. Therefore, focusing on landscape planning and design, the further application of landscape ecology knowledge to specific landscape construction techniques can not only improve the landscape environment and the landscape management level, but also better balance the ecological environment, which can protect the ecological environment and also has a positive impact on local economic development.



Fig.1 Location



Fig.3 Profile

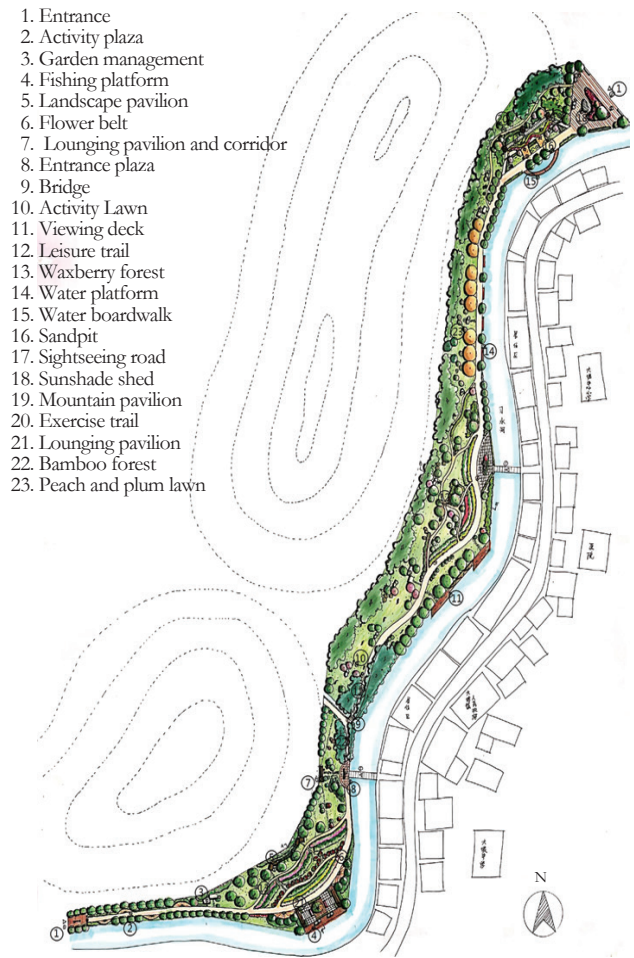


Fig.2 Plane



Fig.4 Effect

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development of technology can effectively solve the problems of residents' life. Urban planning has the characteristics of traditional utopian theory, which is American people's pursuit of individualism and egalitarianism. Another main reason was that the living environment of American cities was bad and the crime rate was rising. The public wanted to move to the suburbs to live a pastoral life, which reflected the idea of anti-urbanism and promoted the suburbanization of the United States after World War II to a certain extent.

2.5 Intensive and sustainable planning ideas—Thinking based on new urbanism and “smart growth”

In the second half of the 20th century, in developed countries in Europe and the United States, more and more citizens moved from the city center to the suburbs. With the decrease of the population in the core area of the city center, the weakening of the popularity of business districts, and the increase of population in the suburbs, the living environment in the suburbs became less ecological and environmentally friendly, and the crime rate in the suburbs increased. The safety of the residents' living environment can not be guaranteed. In response to the above problems, planners began to think about how to deal with urban planning, and the most representative one is the idea of new urbanism and “smart growth”. Different from urbanism, new urbanism does not pursue the disorderly spread of urban space, but advocates urban community management to form an intensive and compact living space. Community units are equipped with complete public service facilities to meet the living needs of residents in the community, so that residents can reach the destination in a comfortable walking time. For shanty towns or urban villages in cities, it is planned to improve their living environment and quality, and transform the old urban space into a revitalized city that is livable and sustainable. The strategy of “smart growth” is proposed to make urban development more in line with the needs

of human subjects. Its core lies in using urban stock space instead of planning in the form of “making a big cake” in the past, so as to reduce blind expansion and emphasize the common development of environment, economy and society. The development mode is compact, concentrated and efficient.

3 Conclusion

Since the founding of New China, the scale of urban development across the country has been expanding continuously. In the process of urban planning, planners mainly learn the urban planning ideas of the Soviet Union and Western countries. As a socialist country, China always puts the people first, and also carries out the “people-oriented” planning thought throughout the whole process of planning^[6].

For the transformation of the main social contradiction into the contradiction between the people's ever-growing needs for a better life and the unbalanced and inadequate development, urban planning should ensure the balance of people's lives and avoid the problems of inequity and injustice. For example, urban public welfare service facilities should be disposed toward the disadvantaged groups, because high-income groups generally live in areas with well-equipped public service facilities, and the residential areas where they live also have relatively high-end and complete living facilities. Meanwhile, they have economic strength to enjoy services that are not available in the surrounding areas^[7]. Therefore, the “people-oriented” planning idea should be deeply rooted in the minds of policy guides, planning workers and people.

With the emergence of global warming, atmospheric environment and other environmental problems, countries in the world are trying to improve their own ecological environment. Urban planning should inherit the way of living in harmony between people and nature. People live in nature, come from nature, and should give back to nature^[8].

The actual situation in China is merely

superficial work, simply dealing with the public participation in the planning work, and completing the necessary materials, without really caring about how to plan the place where the people live and how to build a better life that meets the needs of the people. Therefore, it is urgent to strengthen the enthusiasm of public participation.

The national land space system plan is being drawn up, and the departments of land, housing and environment are being reshuffled, and the planning industry is facing many new challenges. The study and discussion of the predecessors' theories are of great guiding significance for solving many problems in China.

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