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AN ANALYSIS OF ECOLOGICAL FLOW AND SPATIAL ORDER AT MULTISCALE LEVELS

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Abstract*: *Taking Yang Peiru's proposition of "the Third Ecology" as the theoretical background, this paper briefly analyses the natural utility of terrain and its material representation. Moreover, this paper expounds the important ecological effects of material spatial forms, that is, the objective and rich forms of spatial patterns bear different and sustained ecological flows. At the same time, this paper also discusses the land chimera and its spatial and temporal scales, takes land chimera as the research object of spatial order, and studies the relationship between ecological flow and spatial order from the four scales of ecological region, urban structure, landscape unit and architectural space. Finally, this paper returns to the design itself, emphasizes the feasibility of design with ecological intervention, and illustrates the cross-space and time-scale characteristics of ecological design with the characteristics and effects of ecological flow, and emphasizes the complexity of ecological design.

Keywords – The third Ecology, ecosystem, spatial order, ecological flow, ecological design

I. INTRODUCTION THEORETICAL BACKGROUND

According to Professor Yang Peiru's (Yang, 2010) proposition of "The Third Ecology", the theory of eco-urbanism has three levels according to the relationship of development. One is the theory of sustainable social needs, which is called " the first ecological theory ". Because of the contradiction between supply and demand between existing resources and development, and the basic relationship between strategic guidance and ecological sustainability, it is necessary to understand the development control and resource protection at the government level, as well as the social demand and behavior control at the individual level, and to change the consumption attitude towards limited resources. However, in the face of the increasingly pressing energy demand, the rapid depletion of natural resources and the severe global climate, the first ecology theory has been unable to meet people's needs, so the "eco-efficiency theory" has emerged. In addition, "eco-efficiency theory" takes the breakthrough of science and technology and the development of environmental management and control as the background, relies on scientific production, clean technology and eco-industrial system to improve the ecosystem effect, and further alleviates the conflict between development and environment. Moreover, eco-efficiency theory covers smart and sustainable approaches, including dematerialization and optimization of system energy, material flow and input, transformation and output. In addition, the "eco-efficiency theory" is also called "the second ecology theory", which implies the optimism of science and technology. At the same time, the "ecosystem compatibility theory" extends the "space" dimension for the concept of sustainable development. By means of material space form and the bond between various ecological flows such as substance, energy, water and organic matter, it makes it possible to reconstruct the metabolic and symbiotic relationship among ecology, city and industrial system, which is also the concept and method of "the third ecology theory".

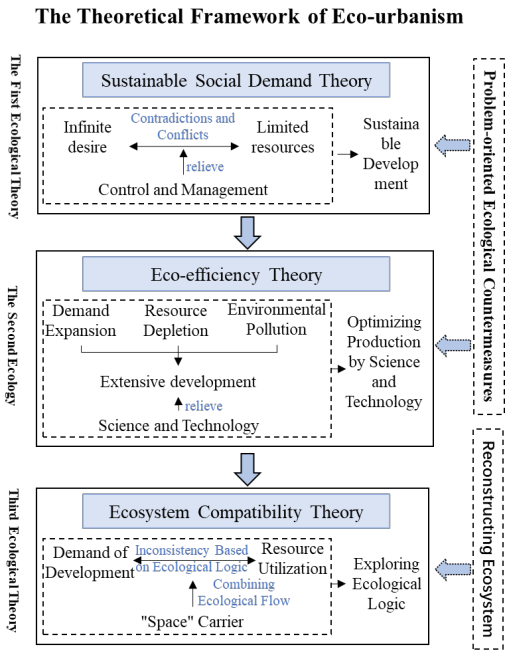

Fig. 1 Yang Peiru's Third Ecological Theory

Although the third ecology theory is different from the traditional urban planning and design for greening control, it also follows the ecological design concept of restoration and promotion, compensation and adaptation. Moreover, the third ecology theory takes the improvement design of the material space carrier of the ecosystem as the design method, intervenes in and improves the ecosystem ecological flow with the multi-level and multi-angle design, and finally reconstructs the ecosystem with the ecological flow.

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Furthermore, "the Third Ecology theory" studies the relationship between material form and ecological flow, which is an important theoretical basis of this paper.

II. The Relationship between Material Space Form and Ecology

Material space form, which can be expanded into a broad spatial order, has important ecological effects. Taking nature as an example, its space and artificial space are different in form and intention, different from the geometric order of human society and the characteristics of survival and development, and its spatial form is more inclusive and unconscious. Moreover, nature relies on topography, carries natural ecological flow and its effects, and promotes corresponding spatial patterns. Firstly, terrain dominates surface runoff and microclimate by solar radiation, and interacts with them. After system integration, water flow, vegetation, geomorphological characteristics and production activities are finally determined. In addition, as far as human perception is concerned, terrain, because of its abundant scale and trend relationship, also produces various mobile and stable senses for human beings.

Human beings move in a variety of spatial forms of human settlements to form sensory experience (Lynch, 1976). At the same time, this feeling experience is also applicable to the urban grid system environment. The grid is a flexible framework for urban spatial development, which carries a variety of types and opportunities, and combines different development and needs to organically generate appropriate blocks. In other words, the three-dimensional city of urban grid and block is not only an artificial terrain, but also an artificial ecological environment and micro-climate. Thus, for the ecological effect, spatial order plays a vital role and is the decisive factor.

Secondly, the topographic material surface is another category of material space form, which further controls the ecosystem utility and operation mode. For example, many human projects affect the ecological flow and system functions, such as the Three Gorges Water Conservancy and desert desert control. Moreover, the complex structure of different topography and surface layer of different substances carries multiple forms of ecological flow. In addition, the process of adaptation and feedback of mobile agents, such as information, material, energy, and the coupling between mobile carriers, will stimulate the occurrence of species evolution, climate and hydrological changes, disaster disturbances, and eventually, form a relatively stable form of surface space.

Material morphology is not only the objective carrier of realizing ecological cycle and flow, but also the re-understanding and emphasizing of space, which is helpful to the analysis of the internal relationship of ecosystems.

III. Spatial Order and Ecological Flow

Artificial and natural space interweave with the surface to form a composite structure of the surface, which is like a chimera embedded in different surface coefficients and land types. In 1995, Professor Furman (Wilson, 1995) put forward the concept of "land chimera". He defined the scope of land chimera as "city-region". It refers to the integration of regional environmental ecosystems and land use systems. At the same time, Professor Furman also pointed out the "time-space" two dimensions of chimera. The "space" dimension is the spatial pattern within the chimera, while the "time" dimension includes the whole process from chimera, hydrological change, biological migration, vegetation succession to its spatial pattern change. On this basis, an important basic spatial element, patch, corridor and matrix, which can be used to describe the two-dimensional chimera is proposed. This enables ecological science and urban planning to establish a common communication interface.

Scale is an important subject in ecological space theory. Ecology expands "scale" (Zhou, 2002) to three measures of space, time and organization, which correspond to the scale, cycle and succession of ecological research objects and the relationship between organizational structure. Scale selection is the starting point and basis of scale research, and the critical values of different ecological scales are generally determined by the differences of ecological processes and ecological phenomena and general laws of a certain object of study. In terms of human perception and perception, land chimera forms cover various spatial scales. If the focus is on the landscape and regional scale related to human land use, it can be divided into four scales: ecological region, urban structure, landscape unit and architectural space.

A. Eco-region

As far as the ecological region is concerned, it has the largest scale and the most abundant and stable element forms and contents. At the same time, the landscape composition of the large ecological patches in the ecological region is the best. Internal water sources and valley corridors are stable, rich in species and suitable for distribution, and the matrix forms are mostly woodland and field. It is worth noting that the evolution of patch spatial patterns can be recognized by texture, and the features of texture in nature are extensive. Moreover, a single patch size is not the best model to protect ecological diversity. The ideal model should be to connect patches of different scales through different ecological channels to form a stepping stone system.

The stepping stone system is mostly formed between two large patches, and the ecological relationship between the two patches is established through small vegetation patches and channels. In addition, the degree of connectivity determines the stability of the stepping stone system, and the form and strength of the connection are the key to the connection function. Moreover, the high connectivity stepping stone system has the function of corridor, which can help some small organisms migrate. The corridors in the region can be divided into Valley corridors, vegetation corridors and traffic corridors. At the same time, the multi-scale ecological patches, the special texture matrix and the various random combinations of rich corridors constitute the spatial order at the regional scale.

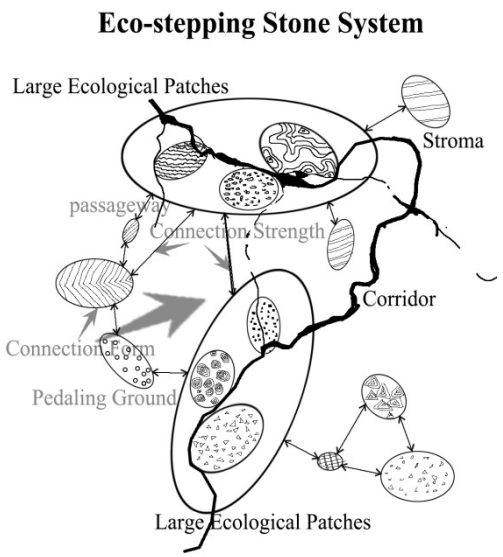

Figure 2 Diagram of Eco-stepping Stone System

B. Urban Structure

From the perspective of urban structure, cities, as mixed landscapes and "second nature", have become typical of Man-made Ecological environment. Its internal spatial order can be simply divided into four parts: street network under topographic background and its formed space corridor, green space system, river network and internal space-time relationship. As a flexible framework for urban spatial development, urban grid bears diverse types and opportunities under different climatic and environmental backgrounds. Correspondingly, the space corridor enclosed by the street network bears the passenger and freight transport corridor and infrastructure system which is dominated by human production activities. Greenland system includes urban parks, squares, street greenlands, small pleasure parks and river network, which are organically combined to form a stepping stone system of organisms, which can provide migration and habitat opportunities for organisms, and can form artificial ecological environment and micro-climate.

C. Landscape Units

On the level of landscape unit, its spatial order is mainly composed of vegetation, terrain and land use, and is influenced by the fluctuation of urban settlement bridging and development policy information. Taking wetland environment as an example, wetland is an important biological stepping stone with various ecological functions, such as water purification, water flow regulation, reducing the probability of floods, and increasing biodiversity. At the same time, we must clearly realize that almost all landscape units will inevitably be affected by human beings, and their protection, planning, development, manufacturing and other processes will be more or less affected. Therefore, there is a sensitive interaction between landscape pattern and biological population distribution in wetland parks. Moreover, the structure, function and streamline of native landscapes will be disturbed or destroyed by human activities such as planting, digging and filling, building setting and path laying. Due to the participation of organized human activities, the dominance of its natural landscape function will be readjusted. In addition, streamlines and habitats will also occur, such as changes in hydrological trends and forms, soil destruction and improvement, habitat adjustment and path barriers. At the same time, hydrological changes (such as changes in dry and wet seasons) or dynamic changes in vegetation will also affect the spatial patterns of landscape and environment. Moreover, natural and human forces alter the landscape pattern and function together, which constitutes the operation logic of the ecosystem.

D. Building Space

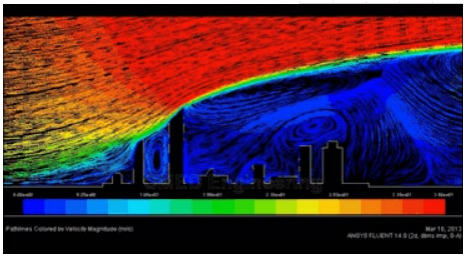

Figure 3 Heat Island effect

Figure 4 Land subsidence diagram

Figure 5 Urban Rainwater and Flood Disasters

From the perspective of architectural space, it has reached a high level of design intervention in small-scale space, whose spatial order is composed of architectural form and elements and internal design logic, forming a stable or changing internal and external space environment on which ecological flow depends. Moreover, the original external space environment of the building must be disturbed by the building and change the ecological flow mode. The original ecosystem environment is affected by buildings, and the urban surface temperature, humidity and air convection change, forming the heat island effect. Moreover, the land subsidence caused by bad production, mining and groundwater extraction. At the same time, excessive

pavement and surface runoff change will also lead to rain and flood problems. In addition, the competition of space-time resources among buildings caused by building demand will produce a space order similar to building concession. The interior space of the building bears the material and spiritual needs of human production and life. The scale and organization form of the space realize the movement of people and things in the space. The design logic of space realizes the ecological flow within the space by means of material and organization relationship, creates the suitable environment for lighting, lighting, ventilation, sound insulation, heat insulation and other requirements, and forms the corresponding space form.

IV. Complexity of Ecological Design

The practical significance of regression theory, based on the design of spatial order at various scales, can realize the transformation of ecological flow and ultimately achieve the goal of ecological intervention. However, it is necessary to clarify the dialectical relationship between "flow" and "form" in eco-urbanism. In ancient China, the ancient philosophers expounded this mutual definite relationship with the view that "function is restricted by form or restriction".

In addition to the above awareness, we should also be aware of the two complex aspects of ecological design. First, the cross-scale characteristics of flow and effectiveness. In addition to the ecological flow at different scales, the system flow and its effects at different scales are complex and unpredictable. Moreover, eco-city is based on the theory of mutually definite relationship, and its design inevitably has cross-scale characteristics. In addition, Professor Karl Steinitz of Landscape Architecture (Steinitz, 2008) proposed an analytical framework - "the relationship between scale and system complexity" to explain this situation. Causality and design strategies of the same or different spatial scales are not replicable. Moreover, the larger the spatial scale, the higher the system complexity; the finer the spatial scale, the higher the environmental awareness. Therefore, the study of the inter-scale penetration relationship and its ecological utility relationship is the focus of eco-city design. Secondly, the time dimension of ecological flow and effectiveness. In the ecosystem, there exists an adaptive process of mutually definite relationship, as well as the biological cycle and ecological succession caused by other factors besides the influence of spatial order. Moreover, this dimension interweaves with spatial order, which makes ecological design more complex in dealing with ecosystems.

V. Conclusion

As far as the development of ideal human settlement environment is concerned, the system of spatial ecological utility is studied and analyzed in this paper. At the same time, this paper also provides systematic theoretical judgment and construction basis for the specific design of space planning and design industries such as architecture and planning. This paper hopes to help the city, a complex ecosystem, to activate the internal ecological flow and to coordinate the internal composition of the symbiosis.

To sum up, the spatial ecological utility cannot be separated from resources and science and technology, and the organic combination of the three is the ideal model. Taking architecture as an example, it has practical significance to build human living space. At the same time, it also consumes a lot of energy and resources. Therefore, architectural design must optimize natural resources under the condition of abiding by ecological rules. In site selection, the inherent characteristics of building types and the organic combination of environment should be fully considered to ensure the harmonious relationship between architecture and ecology. In architectural design, we should simulate and synthetically analyze the geological conditions, wind environment, light environment and so on, and find the best design space form (height, angle and organization relationship), material and technology. At the same time, it is necessary to coordinate the design, technology and resource utilization, effectively avoid secondary modification and remedial design, and achieve the sound development of architectural ecology.

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