

Construction of Management and Control System of Ecological Flow Space under the Background of Spatial Planning

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Abstract. Territorial space is the carrier of ecological civilization construction, and spatial planning is a tool to practice ecological civilization. However, the current spatial planning is relatively isolated from the element control and use control of territorial space, especially neglecting the space carrying the connection and flow of natural elements, resulting in the destruction of the system, integrity and mobility between the "mountain, water, forest, field, lake, grass, sand and ice" life communities, which has become an important problem hindering the sustainable development of territorial space. In this context, the author expands the existing concept of flow space that transmits people flow, logistics, capital flow, technology flow and information flow, and relying on the connotation of ecological flow, puts forward that ecological flow space is a space that carries natural activities that have an important impact on human survival and development, reflecting the mobility and connectivity of space in the ecological dimension. The ecological flow space is composed of geological disaster protection corridor, ventilation corridor, river water system corridor, hydrological cycle corridor, animal migration corridor and greenway. The ecological flow space management and control system constructed by the author is specifically composed of three parts: the "three levels and six categories" ecological flow space system, the ecological flow space zoning management and control system, and the ecological flow space activities and indicators management and control system, which reflects the systematization, integrity and mobility among the natural elements of the territorial space, and makes the spatial planning continue to become a tool for practicing ecological civilization.

Keywords: Ecological civilization; Ecological flow space; Control system.

1. Introduction

At present, China's ecological space management and control is carried out under the "five levels and three categories" spatial planning system, showing the characteristics of multi sectoral management and control. Specifically, with the delimitation of "three lines and three areas" as the bottom line constraint, and under the guidance of the green space structure determined by the planning at all levels and the nature reserve system with the National Park as the main body, the control line, use control and rigid control indicators of the planning at all levels will be implemented layer by layer. At the same time, each special plan aims at ecological restoration, ecological security and environmental protection respectively, and carries out zoning and control over the whole territory and space. On the whole, it outlines the pattern of China's territorial space ecological protection and restoration. Among them, in view of the heat is territorial effect and extreme precipitation caused by climate change, as well as the isolation, patching and fragmentation of the ecological environment, the six types of ecological flow spaces in China's territorial space are of great significance to achieve the connectivity and liquidity of the ecosystem and break the key nodes and blocking points of natural activities. Under the current ecological space management and control system, spatial planning has also carried out corresponding practice on various ecological flow spaces. However, at present, the main problem of ecological space management and control is that a hierarchical and classified ecological flow space management and control system has not been formed, specifically including the following four aspects: the types of ecological flow space delimitation and control are not comprehensive, the level of ecological flow space management and control is not perfect, and the separate management and control of ecological flow space destroys the integrity and connection between ecological flow spaces It is difficult to connect the

management and control of ecological flow space with the current "three levels and three categories" spatial planning system of China. Therefore, the author plans to build an ecological flow space management and control system while putting forward the concept of ecological flow space.

2. Putting Forward the Concept of Ecological Flow Space

Since the new century, in order to accelerate the development of regionalization and shorten the information gap, large-scale and high-intensity traffic flow and information transmission have greatly compressed the time of spatial connection, expanded the scope of spatial connection, and reconstructed the space-time organization mode of traditional local space. Against this background, Custer put forward the concept of space of flows from a regional perspective, which is a new spatial form corresponding to local space and reflecting social changes. Peter Hall (2004) investigated the traffic data and financial situation of eight megacity regions in Europe, and proposed that the megacity region closely linked the whole megacity region to become a broader urban region by carrying the flow space of highways, high-speed railways, telecommunications cables and so on, and transmitting the dense flow of people, logistics, capital, technology and information, Jointly undertake node functions in the global urban network[1].

Ecosystem refers to a unified whole composed of biological communities and their environment in a certain time and space. The components of the ecosystem are interconnected and restricted by energy flow, material circulation and information transmission, forming a complex with perfect self-regulation function[2]. In the field of ecology, the German geographer Troll (1939) developed the discipline of territorial scape ecology, that is, territorial scape ecology aims to study the spatial structure, interaction, coordination function and dynamic change of the territorial scape as a whole composed of many different ecosystems[3]. Ecological flow is the content used to describe the interrelationship between ecosystems, including energy flow, material circulation, information transmission, etc[3]. Specifically, ecological flow is a functional flow that reflects the energy conversion, material metabolism, information transmission, value increase and decrease, and biological migration of ecological relations in the ecosystem. It is also a change in the space-time dimension of the ecosystem, such as population birth and death, species transmission, community succession, and interference diffusion[4]. The material cycle is the concrete embodiment of the ecological flow process, which contains a large amount of energy flow and information transmission[5][6]. Ecologist Cadenasso (2006) believes that ecological flow is the highest level expression of the heterogeneity, connectivity and dynamics of the ecosystem. The units of the ecosystem interact through the flow of energy, matter, organisms and information. There is an interactive relationship between ecological flow and ecosystem. The change of territorial scape ecological pattern is bound to cause the redistribution of energy, material and information in spatial flow, and the structure of territorial scape ecological pattern can also be changed by these flows[7].

On this basis, the author creatively puts forward the concept of ecological flow space, and expands the existing concept of flow space that transmits people flow, logistics, capital flow, technology flow and information flow. Relying on the connotation of ecological flow, it is considered that ecological flow space is a space carrying natural activities that have an important impact on human survival and development, reflecting the fluidity and connectivity of ecological space. Ecological flow refers to the energy flow, material flow, information flow, species flow and value flow that are transmitted among natural ecosystems, and are transmitted through four types of carriers: force (including gravity and seismic force), wind, water (horizontal flow and vertical circulation), and Biology (including animals and people). Therefore, as an entity space carrying ecological flow, the ecological flow space is a space that transmits energy flow, material circulation and information transmission between natural ecosystems with force (including gravity and seismic force), wind, water (horizontal flow and vertical circulation), and organisms (including animals and people) as carriers. The ecological flow space management and control system constructed by the author is specifically composed of three parts: the "three levels and six categories" ecological flow

space system, the ecological flow space zoning management and control system, and the ecological flow space activities and indicators management and control system, which reflects the systematization, integrity and mobility among the natural elements of the territorial space, and makes the spatial planning continue to become a tool for practicing ecological civilization.

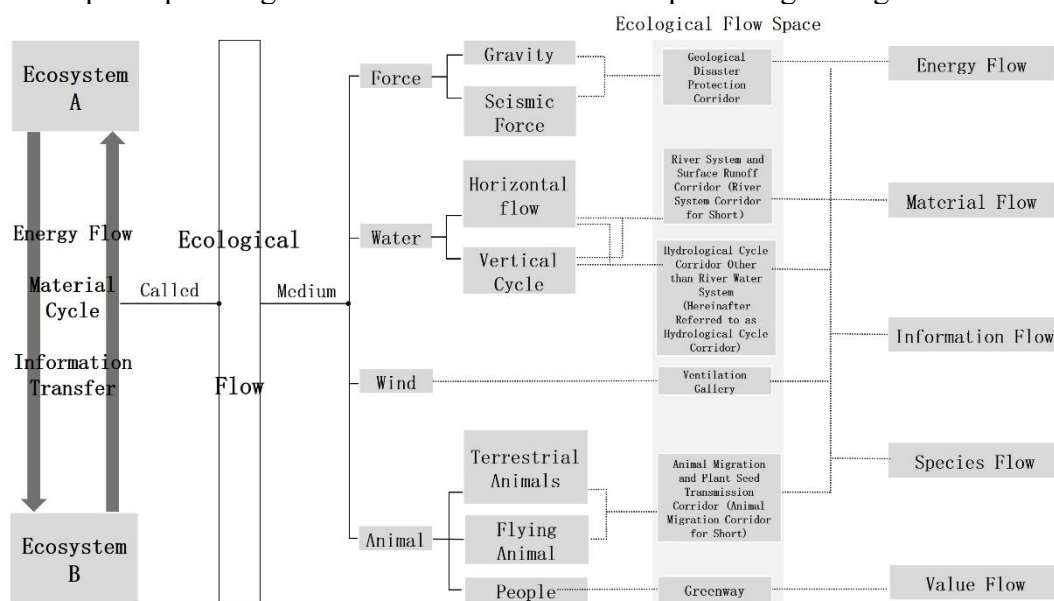


Fig.1-1 Concept and Composition of Ecological Flow Space
(Picture Source: Self Drawn by the Author)

3. Construction of "three levels and six categories" Ecological Flow Space System

3.1 Classified management and control of ecological flow space

On this basis, the author creatively puts forward the concept of ecological flow space, and expands the existing concept of flow space that transmits people flow, logistics, capital flow, technology flow and information flow. Relying on the connotation of ecological flow, it is considered that ecological flow space is a space carrying natural activities that have an important impact on human survival and development, reflecting the fluidity and connectivity of ecological space. Ecological flow refers to the energy flow, material flow, information flow, species flow and value flow that are transmitted among natural ecosystems, and are transmitted through four types of carriers: force (including gravity and seismic force), wind, water (horizontal flow and vertical circulation), and Biology (including animals and people). Therefore, as an entity space carrying ecological flow, the ecological flow space is a space that transmits energy flow, material circulation and information transmission between natural ecosystems with force (including gravity and seismic force), wind, water (horizontal flow and vertical circulation), and organisms (including animals and people) as carriers (see Figure 1-5). Among them, the energy transferred by energy flow is solar energy and geothermal energy, the substances transferred by material flow are water, oxygen, carbon, nitrogen, phosphorus, sulfur, mercury, etc., the information flow and species flow transfer biological gene and genetic information, and the value transferred by value flow is the economic value of natural ecosystem relative to human beings. Therefore, the geological movement with force as the carrier and carrying energy flow, the air flow with wind as the carrier and carrying energy flow and material flow, the horizontal water flow with water as the carrier and carrying material flow, information flow and species flow, the vertical water cycle with water as the carrier and carrying material flow, information flow and species flow, the animal migration and plant seed transmission activities with animals as the carrier and carrying information flow and species flow, and the human carrier Human recreational activities carrying information flow and value flow need

to be carried by ecological flow space. On this basis, the author creatively proposed an ecological flow space system carrying these six types of natural activities (see Figure 1-1).

It should be pointed out that the classification of ecological flow space is based on the fluidity and connectivity of ecosystem and the importance of ecological services, not on the length and spatial form. Therefore, the hydrological cycle corridor that does not present a linear spatial form will be incorporated into the ecological flow space system. The green protection and isolation belt along the high-grade traffic corridor mainly reflects the protection and barrier functions and is not incorporated into the ecological flow space system.

3.2 Hierarchical control of ecological flow space

At the same time, these six types of ecological flow spaces are multi-scale. On the one hand, it can solve the problem that some narrow, short and significant ecological flow spaces cannot be defined at the macro level. On the other hand, different control methods and measures can be adopted for different levels of ecological flow spaces. Different ecological flow spaces can be divided into three levels according to their own ecological flow characteristics, length, width, degree of influence, importance and the level of ecological flow space they rely on, namely, the primary ecological flow space at the macro level, the secondary ecological flow space at the meso level and the tertiary ecological flow space at the micro level.

4. Construction of Regional Control System for Ecological Flow Space

4.1 Spatial integration of ecological flow

Geological disaster protection corridor, ventilation corridor, river water system corridor, hydrological cycle corridor, animal migration corridor and greenway are not isolated in the territorial space, and they will be coupled in the territorial space, which is also the main reason for the author to build a systematic ecological flow space management and control system. Therefore, the ecological flow space will be integrated in the following four cases. First, the integration of geological disaster protection corridor with ventilation corridor, greenway and animal migration corridor. As the geological disaster protection corridor not only limits the width of avoidance on both sides, but also strictly limits various development and construction activities inside, the nature of its territorial is basically a wide green space. Such management and control standards and territorial use composition can well enhance the mobility of air. At the same time, it can also block the construction territorial and meet the citizens' networked and continuous rest needs. Therefore, in the centralized construction area, the geological disaster protection corridor, ventilation corridor and greenway can be integrated along the geological disaster protection corridor. Outside the centralized construction area, the animal migration corridors connecting the nature reserves are often blocked by roads. If there are some geological disaster protection corridors that prohibit development and construction, they are highly overlapped with the migration paths of animals. Second, the integration of river system corridor and greenway. The planning and design of ribbon waterfront footpaths beside the river system is an important way to achieve a beautiful greenway and meet the requirements of citizens for a beautiful territorialscape. Third, the integration of river system corridor, hydrological cycle corridor and animal migration corridor. The hydrological cycle corridors of wetterritorials and most greenbelts are organized along the river water system. These wetterritorials and greenbelts are the natural gathering places, targets and stepping stones for migratory birds. The migration corridor of birds is the river system among the gathering places, target places and footprints, and there is a natural coupling between the two. Fourth, the integration of ventilation corridors, greenways and roads. Roads at all levels of the city are just natural linear public spaces. Unlike geological disaster corridor, river water system corridor and animal migration corridor, ventilation corridor and greenway have strict requirements on surface territorial types. Along with roads at all levels, ventilation corridors shall be formed along the roads, sidewalks and

public spaces on both sides, or the territorial with large setback on both sides of the roads shall be organized into green space.

4.2 Regional control of ecological flow in summer of spatial planning system

As a space carrying highly connected natural activities, ecological flow space has its own use requirements and index constraints according to its own characteristics. It needs to be an important part of the special spatial planning and play a binding role in the overall planning and detailed planning. Therefore, the "three levels and six categories" ecological flow space system should be effectively connected with the spatial planning system, and the ecological flow space system should be controlled by classification at the macro level (city level), the meso level (district level, township level) and the micro level (village, block). At the same time, at the national and provincial levels, while determining the delimitation and control principles of various ecological flow spaces, the river basins and animal migration corridors across provincial and municipal administrative regions are delimited and implemented at the municipal level. Under the guidance of the national and provincial levels, the municipal level at the macro level, the district level and township level at the meso level, and the block level and township level at the micro level are the main units for the delimitation and control of ecological flow space.

5. Construction of Ecological Flow Space Activities and Index Control System

For the ecological flow space, which carries important natural activities, it is impossible to fully reflect the ecological and natural characteristics of the ecological flow space only by relying on the restrictive index control. Therefore, it is also necessary to learn from the experience of the United States to strictly control the access to the use of the ecological flow space, that is, to carefully control the development, construction and other activities of various ecological flow spaces. First, conduct detailed control over the behaviors and activities in various ecological flow spaces, and divide them into three categories: prohibited behaviors, behaviors that must be approved, and proposed behaviors and activities. Second, index management and control based on the characteristics of ecological flow. Comprehensively considering the ecological characteristics of various ecological flow spaces and the ecological flow spaces arranged in combination with them, the specialized and characteristic management and control requirements are determined. Third, indicator control is not just a simple top-down transmission, but a two-way transmission logic combining top-down and bottom-up. Fourth, since the integration of ecological flow spaces is the significance of the linkage of the ecological flow space management and control system, the overlapping areas should be superimposed with the management and control requirements of each ecological flow space. If the control requirements of each ecological flow space conflict with each other, it shall be selected in the priority of geological disaster protection corridor, river water system corridor, hydrological cycle corridor, animal migration corridor, ventilation corridor and greenway.

6. Conclusion and Outlook

At present, there is no formed division standard for the concept of ecological corridor, resulting in no agreement on the composition types of ecological corridor. At present, both linear and banded ecological space and green space are called ecological corridors, which generally include river corridors, green protection and isolation belts along traffic corridors, animal migration corridors, ventilation corridors, wedge-shaped corridors that block the spread of urban space, etc. The division and control of these corridors basically follow the spatial geometric characteristics of the corridors, ignoring the fluidity and connectivity of the ecological space. Therefore, based on the theory of flow space and the connotation of ecological flow, the author creatively put forward the concept of ecological flow space. Mobile space is a space that connects human beings' cross regional and long-distance activities. It mainly realizes the connection and flow of human flow, logistics, capital

flow, technology flow and information flow among human gathering places. Inspired by this theory, the author combines the concept of ecological flow in ecology, which embodies the material circulation, energy flow and information transmission between natural ecosystems, and puts forward the concept of ecological flow space connecting the ecological flow between natural ecosystems. Compared with the concept of ecological corridor with similar meaning, the definition and composition of ecological flow space are clearer, although there are overlaps with the concept of ecological corridor. However, on the one hand, the classification of ecological corridors is mixed. On the other hand, the concept of ecological flow space can better guide the management and control of ecological flow space based on the characteristics of ecological flow. The ecological flow space management and control system constructed by the author is specifically composed of three parts: the "three levels and six categories" ecological flow space system, the ecological flow space zoning management and control system, and the ecological flow space activities and indicators management and control system, which reflects the systematization, integrity and mobility among the natural elements of the territorial space, and makes the spatial planning continue to become a tool for practicing ecological civilization.

The main goal of this paper is to make the land space better become the carrier of ecological civilization construction, and the land spatial planning better become the tool of practicing ecological civilization. Based on the theory of the community of human and natural life and the current situation of ecological space management and control in Beijing, this paper makes a research attempt, but includes the following two deficiencies. First, since this concept is first proposed, although the author is constantly learning the knowledge of ecology, geography and other disciplines, it may not be completely based on the characteristics of the ecological flow space, and the control requirements for some ecological flow spaces are not comprehensive and in place. Second, this paper mainly focuses on the theoretical guidance and the research on the management and control system architecture. It plans to start from an integrated system to control the links between natural elements in a holistic and systematic way, so as to make up for the defects of the traditional management and control of ecological corridors. Therefore, this paper lacks scientific methods to support the specific delimitation of ecological flow space. Based on the research of authoritative scholars in related fields, this paper delimits the ecological flow space and provides principled guidance. Based on these two deficiencies, future research should focus on the following two points. First, in the future, we need to master more knowledge of ecology, geography, geology, meteorology, hydrology and biology, and further refine and deepen the categories and contents contained in the ecological flow space, so as to better formulate control measures based on natural activities and ecological flow characteristics. Second, in the future concrete practice, it is necessary to use more scientific and specialized technical methods to delimit all kinds of ecological flow spaces.

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