

# On the Construction Model of Rural Water Body Landscape in China based on Local Natural Resources

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## **Abstract:**

The harmonious coexistence between man and nature is one of the significant characteristics of social modernization and the high development of human civilization. With the continuous growth of urban demand for rural ecological resources, the contradiction between the supply and demand of rural space and the capacity of natural environment becomes increasingly prominent. The function of rural water landscape is also rapidly shifting from the production and living mode in the past to the direction of ecological civilization. The key of this study was to explore the scientific nature and regionalism of the water landscape which should be in line with the requirements of ecological civilization in the new stage. Through the field investigation and quantitative analysis of rural areas in Hangzhou, the local materials and the main problems of water landscape construction are clarified, and the reciprocal rules between the ecological security pattern of water landscape and social development attributes were extracted in this work. On this basis, through the establishment of ecological service and management system at different scales, the ecological habitat and human ecological protection network with sustainable development and organic integration of urban and rural areas was constructed. The establishment of self-organizing landscape, the integration between ecological environment and social public and economic health will be promoted, so as to realize the harmonious coexistence of man and nature.

**Keywords:** Rural water body landscape, Ecological network, Rural revitalization, Local natural resources.

## **I. INTRODUCTION**

Rural landscape is the main part of terrestrial ecosystem and plays an important role in the overall man-land relationship [1]. Its diversity, naturalness and inclusiveness are more and more favored by people. In terms of spatial form, "mountain - water - field - forest - lake - grass" are the bases to ensure the sustainable development of regional ecology [2]. In terms of social attributes, it not only includes the social value of villagers' residential units, but also takes into account the economic value of agricultural production and the unique historical culture formed over a long period of time. The natural environment and human settlements have long been coordinated and co-existing, forming a regional complex of sustainable development, embracing the wisdom and ecological connotation of harmony between nature and man. In addition, as a special tourism resource, the countryside is also moving towards the diversification of business forms and industries.

The difference between the countryside of China and western society lies in that China's countryside is a unique social management mechanism composed of consanguinity and geographical relations. After long-term development, it has become a special regional civilization. With the rapid development of China's economy, the research on rural landscape in China is no longer limited to the shaping of landscape features, but how to deeply explore the ecological value and diversified value of landscape, taking it as a new important factor to promote social development, and creating the maximum value for economy and society. The rural water landscape has also shifted from the past production and living functions to the direction of ecological civilization. The ecological construction of water landscape has gradually become the research focus of the rural landscape construction.

This paper attempted to establish a sustainable spatial planning and management system model between landscape and rural development through rational planning and design of the key points of rural water landscape construction, and details are illustrated as follows.

## **II. MATERIALS AND METHODS**

### **2.1 Experimental Site**

The experimental site is located in Hangzhou City, China, including Dongziguan Village, Qinchuan Village, Liye Village, Tangqi Town, Longmen Ancient Town, Heqiao Ancient Town, Changhua Town, Yongcheng Village and Shouchang Town, with geographical coordinates of 118°21'~120°30' E, 29°11'~30°33' N. It belongs to the subtropical monsoon area with abundant rainfall, with an annual average temperature of 17.8°C, an average relative humidity of 70.3%, an annual precipitation of 1454 mm, and an annual sunshine hours of 1765. It is hot and humid in summer, cold in winter, but spring and autumn are the golden seasons for sightseeing, which is typical of subtropical climate.

## 2.2 Methods

Based on the comprehensive evaluation method of AVC (Attraction, Validity, Capacity) proposed by Liu et al.[3], this paper made substantial improvement as follows: the AVC comprehensive evaluation indexes of rural water landscape were selected, an evaluation model with 10 third class indexes and 28 level 4 indexes were built, the feasibility of indexes was screened through the Delphi method [4], the system was verified and statistical analysis was conducted by using the method of Likert scale [5], and AHP analytic hierarchy process [6], was leveraged to calculate the weight of each index from the project level, factor level and scheme level of the index system.

## III. RESULTS

### 3.1 Effect Analysis of AVC Comprehensive Evaluation System for Rural Water Landscape

**TABLE I. AVC comprehensive evaluation system for rural water landscape**

	PROJE CT LEVE L	FACTOR LEVEL	SCHEME LEVEL	THE WEIGH T OF SCHEM E LEVEL	SCORE OF SCHEM E LEVEL	EVALU ATION SCORE
AVC COMPREH ENSIVE EVALUATI ON OF RURAL WATER LANDSCA PE $A \cdot V \cdot C^{1/3} = 0.5193$	Attracti on (B1)	Human elements (C1)	Bridge (D1)	0.0470	0.6	0.0282
			Revetment (D2)	0.0397	0.5	0.0199
			Water wharf (D3)	0.1651	0.8	0.1321
			Waterfront trail (D4)	0.0957	0.4	0.0383
			Waterfront building (D5)	0.0365	0.6	0.0219
			Landscape & recreation facility (D6)	0.2955	0.5	0.1478
		Natural elements (C2)	Water form (D7)	0.1664	0.2	0.0333
			Plants beside (D8)	0.0812	0.6	0.0487
			Animals beside (D9)	0.0459	0.4	0.0184
		Cognitive Elements (C3)	Sound (D10)	0.0271	0.7	0.0190
			Light and shadow (D11)	0.0640	0.5	0.0320
	Validity (B2)	Condition of water (C4)	Quality of water landscape (D12)	0.2192	0.5	0.1096
			Coherence of water landscape (D13)	0.1688	0.6	0.1013
			Fluidity of water landscape (D14)	0.0724	0.4	0.0290
		The waterfront landscape	Water nbank slope (D15)	0.0535	0.3	0.0161
			Land and water boundary condition (D16)	0.1921	0.4	0.0768

		(C5)				
		Biological habitat (C6)	Habitat integrity (D17)	0.0331	0.3	0.0099
			Biodiversity (D18)	0.0994	0.4	0.0398
		The ecological base (C7)	Mountain landscape (D19)	0.0650	0.7	0.0455
			Agricultural landscape (D20)	0.0325	0.4	0.0130
	Capacity (B3)	Resource capacity (C8)	Infrastructure (D21)	0.0236	0.5	0.0118
			Security organization (D22)	0.0838	0.3	0.0251
			Social economy (D23)	0.3489	0.5	0.1745
		Environmental capacity (C9)	Geographical condition (D24)	0.1180	0.6	0.0708
			Tourism management (D25)	0.0545	0.7	0.0382
		Social capacity (C10)	Rural civilization (D26)	0.1212	0.7	0.0848
			Historical site (D27)	0.2179	0.8	0.1743
			Village training (D28)	0.0320	0.3	0.0096

### 3.1.1 Attraction analysis of rural water landscape in Hangzhou area

According to the AVC analysis results of rural water landscape in Hangzhou (Table 1), for the Attraction (B1) of rural water landscape in Hangzhou, the Human Elements (C1) scores higher. Namely, all kinds of Bridge (D1), Revetment (D2), Water Wharf (D3), Waterfront Trail (D4), Waterfront Building (D5), Landscape & Recreation Facility (D6), among which the waterfront trail, water wharf and landscape embody the expectations of people for the hydrophilic nature of rural water landscape, and people are more eager to have interactions and direct contact with water. The analysis results show that the planning and design with respect to water landscape in Hangzhou area is relatively advanced. The scores of Natural Elements and Cognitive Elements (C2 and C3) are in average performance, indicating that people's demand for water landscape is based on the natural environment, and these aspects still needs to be improved. As a result, the local natural landscape should be well preserved when planning and designing, and the seasonal elements can be integrated according to the characteristics of different seasons, to be more specific, the spring element can be designed with winter jasmine, apricots, peaches, cherry, summer with lotus and Chinese rose, autumn with cassia, and winter with winter-sweet, representing the changes of four seasons, in order to enhance the ornamental, ecological compatibility and attractiveness of the water landscape. In terms of Cognitive Elements (C3), it is necessary to strengthen the planning and design of visual and acoustic landscapes around water bodies, so as to form joint forces and attract more people.

### 3.1.2 Validity analysis of rural water landscape in Hangzhou area

The Validity (B2) has a higher weight among the three levels, but the score is relatively low (Table 1), indicating that ecological security is the first consideration for the planning and design of the Condition of Water (C4) and the Waterfront Landscape (C5), which means that Hangzhou still needs to strengthen the protection of water body ecology. Moreover, as the main body of waterfront rural landscape, the Condition of Water (C4) has a direct impact on landscape atmosphere shaping, and its low score indicates the need to

strengthen the protection of water resources. The scores of Biological Habitat (C6) and Ecological Base (C7) are low, so the restoration of the local waterfront habitat should be strengthened in the planning and design process to maintain the biodiversity and habitat integrity of the local area.

### 3.1.3 Capacity Analysis of rural water landscape in Hangzhou area

In the analysis of Capacity (B3) (Table 1), the scores of Infrastructure (D21) and Security Organization (D22) of Resource Capacity (C8), Tourism Management (D25) of Environmental Capacity (C9) and Village Training (D28) of Social Capacity (C10) are relatively low (Table 1), indicating that there should be more communication and coordination with villagers in the future landscape design, so to strengthen the awareness of the villagers as the masters of the village, and to guide the villagers to build a more beautiful village. The Infrastructure (D21) gets a bad score, indicating that the infrastructure construction surrounding the water landscape did not reach the designated position or the infrastructure was lack of local regional characteristics, and the existing design failed to reflect the heterogeneity of landscape. As a result, in the future planning and design, the unique local culture soul should be taken into consideration, and the local history and culture, folk culture should be inherited.

## 3.2 Exploration on the Construction Mode of Rural Water Landscape in Hangzhou

Based on the social management mechanism of rural cohesion and the multiple functional requirements of green space, various landscape patches and corridors should be interpenetrated and connected. Through a comprehensive study on the relationship between land use, landscape pattern and ecological process, the rural water landscape can be optimized by complementary and interdependent landscape functions.

### 3.2.1 Ecological target strategy: constructing the ecological security pattern of rural water-body

In order to solve the contradiction between the protection and development of rural water landscape, the principle of ecological priority should be followed fundamentally, and the planning and design should be carried out on the premise of maintaining the green ecological base. First of all, the same status of spaces at different scales should be defined. The green space around the concentrated residential area with strong functional characteristics should be given equal weight to the green space around the concentrated residential area with strong ecological characteristics, and the landscape types and attributes should be defined. By analyzing the ecological sensitivity of each region, the suitability evaluation was carried out, and the ambit of regional protection, restoration and reconstruction was delimited by quantitative analysis means, so as to form the ecological map-base relationship of “based on green with constructions filling in the blank” (Fig 1), which lays the foundation for the next step of work.

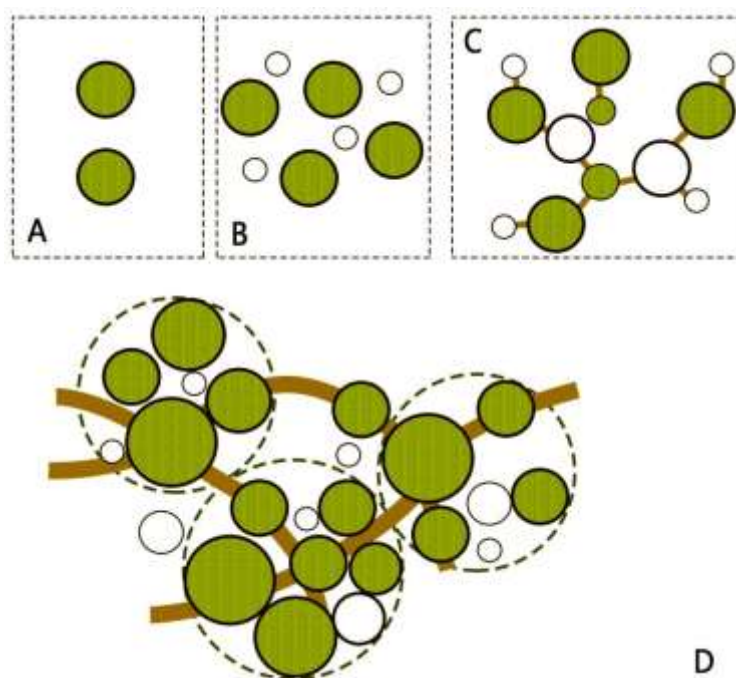


Fig 1: rural water ecological network system

A, Original green space in rural areas. B, Additional green space in rural areas. C, Green space was linked by water network in rural areas. D, Ecological water-network system in rural areas.

### 3.2.2 Production target strategy: optimizing the structure of rural water ecological network

Rural production landscape is the resource accelerator of social development. It is necessary to establish a win-win model between traditional landscape and social economy. Therefore, it is necessary to optimize the structure of rural water ecological network on the basis of constructing the ecological security pattern of rural water. The Production Target Strategy contains two levels, the first is the micro level: the countryside as the main body. Green infrastructure network planning can be applied to inter-combine the areas with all kinds of public demand, cultural heritage, etc. The ecological center control points, ecological connection channels, ecological small sites, etc., were implemented into specific spatial elements and patterns, and an integrated ecological network structure was established, covering multi-functions, multi-objectives, and multi-scales, so as to maximize the benefits of rural resources.

Second, at the macro level: the river basin as the main body, it is necessary to establish the deep connection of the rural water landscape at the watershed scale, so as to solve the problem of the lack of outward organization of the rural water landscape [7], promoting the communication and coordination



between village and village and between village and city. Moreover, integrating it into the overall planning and guidance can help better implement the support of national policies. After the optimization of the network structure, the external organization of the water body landscape would also be strengthened, and the relationship with the surrounding areas could be closer.

### 3.2.3 Living target strategy: developing rural water ecological restoration measures

To strengthen the self-healing capacity of water body, the optimal connection channel and its width should be determined in the first step according to the terrain, water ecological properties, vegetation distribution and the overall rural environment needs, and then the silting and broken river should be treated, the polluted water body should be processed by the ecological engineering method, so as to form a smooth and flowing water system, ensuring the connectivity of corridors [8]. At the same time, it is necessary to focus on strengthening the linkage of lakes, paddy fields, fish ponds and other areas which are closely related to the ecological support function, so as to ensure that the ecological benefits and landscape effects extend to the surrounding areas. Finally, in the process of natural process and human succession, it is necessary to improve the anti-interference ability of water bodies, so as to give full play to their functions in the regulation and utilization of rainwater, local microclimate modification, degradation of harmful substances in the natural state and the maintenance of biodiversity, finally to enhance the self-repair ability of water bodies (Fig 2), making it a green infrastructure of the region and the life support system to maintain the sustainable development of the town [9].



Fig 2: analysis of rural water bank environment

### 3.2.4 Settlement target strategy: building rural water ecological purification system

Connectivity of natural systems is an important indicator of landscape health. For waterfront villages,

in addition to roads, the water system is an important medium within the green infrastructure connectivity channel. The interaction process of water environment contributes to the energy exchange and ecological operation between isolated and fragmented rural landscapes, and ensures the overlap and continuity of water system and green space network, which is one of the important measures to solve the sub-health of water environment. By introducing the advanced experience of sponge city and storm-water management, the water can be purified and become an ecological and natural ornamental resource, and the passive adaptation to landscape elements can be transformed into active protection of landscape habitats. By combining landscape technology engineering with river ecological restoration standards, a low-impact development system of water network in rural areas was developed [10-11], and a closed-loop ecosystem of "artificial restoration -- self-regulation -- regurgitating the environment" was realized, playing an important role in regional ecological balance (Fig 3).



Fig 3: connectivity of natural channels in rural water-body

### 3.2.5 Social target strategy: maintaining the historical human resources of rural water basin

In Germany, planning tasks are organized and managed from the top to the bottom, and the detailed contents are formulated and supervised from the bottom to the top [12]. By means of government control and public participation, planning objectives that meet the wishes of local villagers are finally formed. Lessons were drawn from the mature rural planning models from foreign countries, and the local



conditions were taken into consideration, so that the material space system of the village water (composed of traditional waterfront village water network pattern, lanes of road network, and the waterfront space) and the humanities spirit (inspired and in service of "born with water", with economic, social, cultural and mental activities) requirements were well fit during the process, establishing a resilient mechanism which integrates "society and ecology".

As a social process, the superposition of ecological landscape and comprehensive social functions provides a platform for rural public demands, inheriting and continuing the historical human resources of rural water bodies. It is the internal driving force for the optimization of waterfront rural ecosystem services, as well as a more suitable choice for rural areas. In the management process, the planning was controlled dynamically, the government control mechanism was established, the public participation was attached comprehensive importance, the future development direction of the village was predicted scientifically, and the temporal, scientific and forward-looking design was carried out. This strategy effectively improved the previous situation that the water landscape construction was lack of theoretical and technical guidance, and fully incentivized the participation and enthusiasm of local residents (Fig 4).

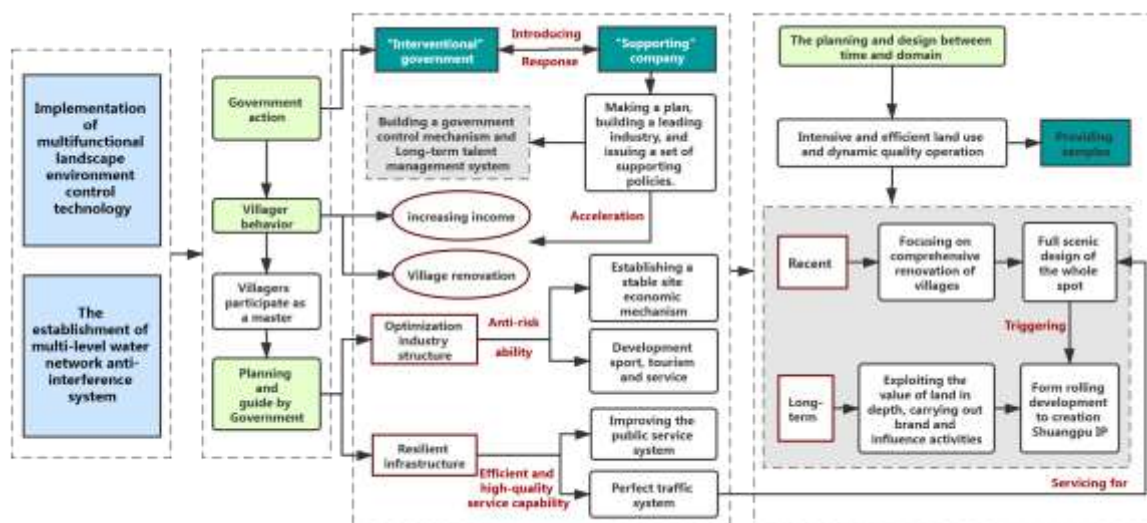


Fig 4: resilience mechanism of society-ecological integration

#### IV. CONCLUSION

The planning based on the unique property of rural land, social development process and land policy is rational and promising. As the most practical scale to judge and shape the relationship between human society and ecological environment, landscape constitutes a stable system, which can ensure the

persistence of energy interaction and information flow [13]. The more complex the system composition, the richer the diversity, the better the health status of the landscape pattern, the higher the elasticity, and the stronger the self-regulation and maintenance ability of the rural subject. The key points to the landscape system architecture are to construct the ecological security pattern of rural water bodies, to optimize the ecological network structure of rural water bodies, to permeate each other with multi-types of landscape functions, and to provide tools for ecological, economic and social benefits through natural solutions.

On this basis, the ecological restoration measures for the rural water were developed, ecological engineering technique was incorporated in landscape design, enhancing the self-regulation function of the water body. The resilience mechanism on the integration of society and ecology was established, maintaining the historical cultural resources and constructing a rural landscape water system with ecological, purified, recreational values (Fig 5).

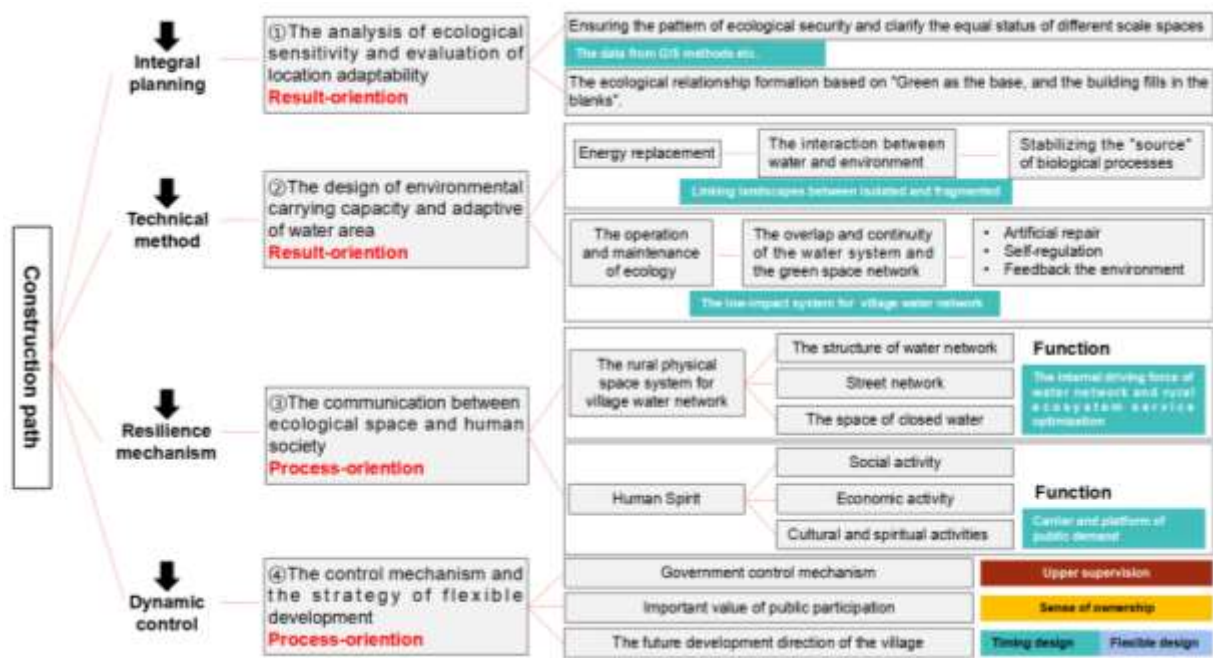


Fig 5: rural water landscape construction mode

In order to shape a rural water landscape with sustainable development, it is necessary to establish a new understanding of the inter-relationship of natural environment, and to innovate the concept and development model. The service ability of resources should be improved when optimizing the environmental resources, so as to enhance the rational and efficient utilization of resources, and to protect the local regional characteristics.

In the context of the current rural revitalization strategy, this paper, guided by the spirit of rural ecological civilization construction, explored the internal logical relationship among people, society and nature in the process of rural construction, focused on the self-organization of landscape construction [14], reasonably guided the comprehensive properties of land, and established a flexible land use mechanism. On the one hand, it promoted the integration and interaction between the ecological environment and the healthy society, taking into account the needs of human beings and nature. On the other hand, through the establishment of ecological service and management system at different scales, the continuous network of rural habitat and human ecology protection in urban and rural areas were constructed to guarantee the regional ecological security [15], functioning as the life support system to maintain the sustainable development of urban and rural areas.

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