ISSN: 2710-0170

Conservation and application of ancient paths based on the perspective of the human habitat environment: the landscape garden approach

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Abstract

In the context of global urbanization and climate change, the protection of linear cultural heritage is facing a double challenge: the concept of living heritage advocated by the UNESCO Charter for Cultural Routes (2008) and the policy requirements of China's ecological civilization construction, which urgently requires the protection of ancient routes to be integrated into the framework of habitat optimization. This study focuses on the core conflicts such as the erosion of modern transportation networks, the conflict between tourism development and authenticity, and the fragmentation of ecological corridors from the perspective of human habitat, constructs a three-dimensional evaluation system of "cultural vitality, ecological resilience, and socio-economics", and reveals that the ancient paths are "socio-economic" and "social-economical" through the spatial syntax of GIS, the cross-scalar analysis method of oral history, ethnography, and microbiome monitoring. Through the cross-scale analysis of GIS spatial syntax, oral history, ethnography, and microbiome monitoring, we reveal the dynamic characteristics of the ancient road as a "social-ecological-cultural" composite system.

Keywords

Ancient routes, heritage conservation, habitat, linear heritage.

1. Introduction

1.1. Background of the study

In the theoretical evolution and practical process of global cultural heritage protection, the protection paradigm of historical and cultural landscape space, as a physical carrier for the survival of heritage value, has experienced significant doctrinal transmutation. The research perspective shows a transformation from the preservation of the form of a single material site to the holistic conservation concept of regional ecosystems, and the conservation dimension extends from the explicit level of material space to the immaterial elements such as cultural genes and the spirit of the place, ultimately forming a systematic research paradigm covering both the material remains and the implicit cultural values [1] . Under the background of globalization and localization, ensuring the sustainable development of cultural heritage by innovating the concept and practice of holistic conservation of cultural heritage becomes an important issue [2] . As an important member of cultural heritage, ancient paths, their preservation, and application have been widely discussed and researched globally. However, due to the current major contradictions such as resource constraints, environmental pressures, and ecological crises, it has become a challenge for constructing human settlements [3] . Urban and rural habitats are facing a bad situation, and the protection and utilization of ancient paths during this period are facing problems in terms of improper utilization, lack of cultural identity, and unknown economic returns [4] .

ISSN: 2710-0170

The systematic study of the urban linear cultural landscape will help to change these problems and has certain practical significance for improving the quality of urban landscape planning and design, green space system planning, park design, and urban design [5] . Strengthening the protection and utilization of ancient paths is in line with the requirements of ecological civilization construction in China.

1.2. Problem statement: conflict between infrastructure development and heritage continuity, fragmentation of traditional ancient road networks and modern settlement patterns

The construction of tourism infrastructure is the basis for guaranteeing the sustainable development of tourism. On the peripheral level, the construction of infrastructure around ancient routes may jeopardize the destruction of ancient routes on a large scale, such as the construction of the Nanshui Reservoir, which basically submerged the ancient routes of Dongping Township below the water line [6] ; on the internal level, there is a lack of rest areas on the ancient routes in the country [7] , imperfect electric power and communication [8] , little construction of sport infrastructures [9] , the appearance of the design is simple and does not conform to the The overall theme style of the ancient stagecoach road and the lack of basic sanitation facilities [10] exist.

The core question is how to harmonize the protection of ancient paths with the needs of contemporary people? Therefore, this study focuses on three major contradictions: ① spatial conflict - the superposition of modern transportation network and ancient road texture leads to the obliteration of historical paths; ② functional imbalance - the erosion of the original authenticity of the ancient paths by tourism development and the neglect of the needs of local residents; ③ ecological fragmentation - the blockage of biological migration corridors and the decline of microclimate regulation capacity. --Functional imbalance - the erosion of the authenticity of the ancient paths by tourism development and the neglect of the needs of local residents; ④ Ecological fragmentation - the blockage of biological migration corridors and the decline of microclimate regulation. The core is to build a dynamic balance mechanism of "protection-utilization-regeneration" to realize the double value of the ancient paths as ecological infrastructure and cultural carriers.

1.3. Significance of the study

At the theoretical level, this study expands the cognitive dimension of cultural landscape protection, and based on the perspective of the human environment, considers the ancient road as a "social-ecological-cultural" composite system, constructs an ecological and cultural corridor strategy, and creates a sustainable landscape planning paradigm. The conceptual framework of "Heritage Infrastructure" is proposed. The concept of "Heritage Infrastructure" includes tourism infrastructure such as public transportation facilities, safety and security facilities, commercial service facilities, recreational facilities, scientific and educational facilities, and environmental sanitation facilities.

At the practical level, it provides replicable models for heritage corridors, and promotes policy innovation (e.g. the establishment of inter-administrative management committees) and technology integration (digital twin monitoring platform). The study validates the central role of the landscape architecture discipline in coordinating the transmission of historical heritage with the optimization of contemporary living environment, contributing Chinese wisdom to global heritage conservation.

Contribution to policies and technical standards: Promote the addition of a "linear heritage synergy clause", and suggest the establishment of an inter-departmental joint approval mechanism. Called for the compilation of the Technical Guidelines for the Conservation and

ISSN: 2710-0170

Utilization of Ancient Roads, stipulating that the proportion of local materials used should be ≥60%.

2. Theoretical foundations

2.1. Habitat science (Dossadias' theory of colonization)

The founder of Habitatology, C.A. Doxiadis, categorized the contents covered by the habitat into five elements: nature, human, society, buildings and support networks [11] . Mr. Wu Liangyong was inspired by Dao's doctrine and constructed a five-element theoretical framework of habitat (nature, people, society, buildings and networks) at the end of the 20th century, emphasizing that human beings and habitat interact with each other and that human beings are the core element. [12] . Habitat science basic research framework diagram (after translation):

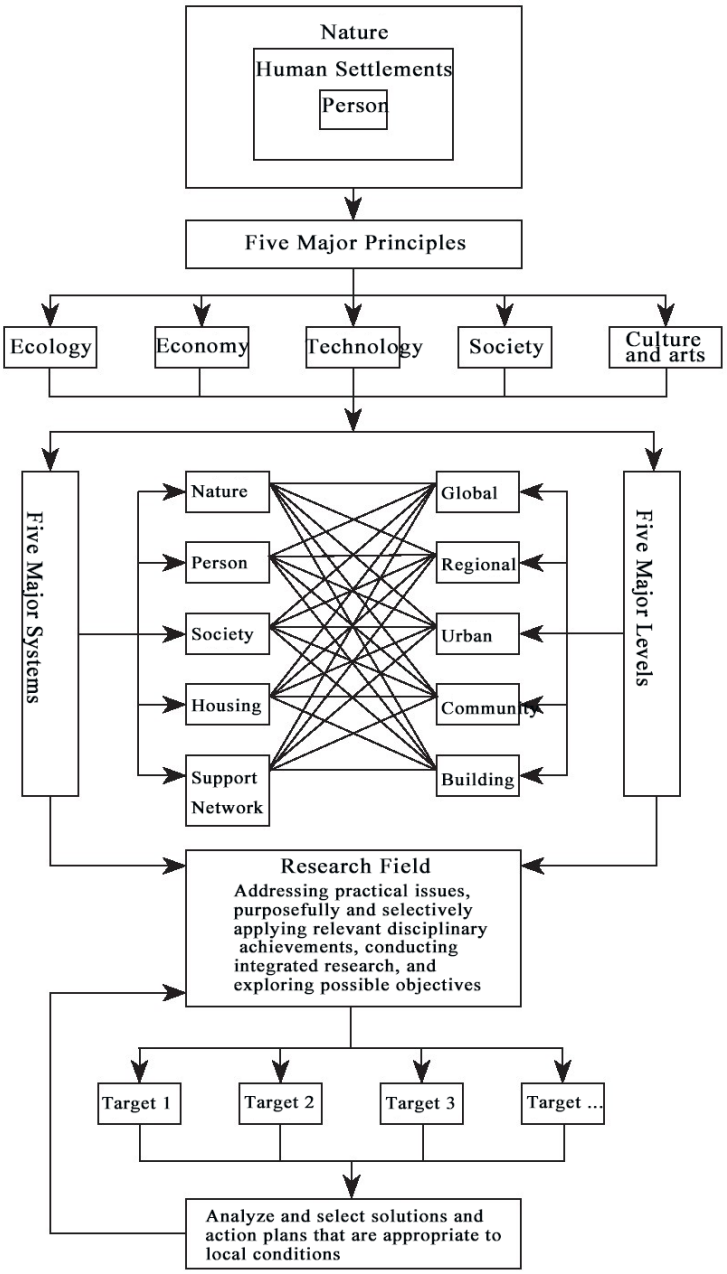

Figure 1:Framework diagram of basic research on human habitat science

ISSN: 2710-0170

2.2. Cultural Landscape Theory

As a new paradigm for heritage conservation proposed by UNESCO, the Historic Urban Landscape (HUL) approach emphasizes the holistic knowledge and management of the dynamic evolution of the urban historic environment, the core of which lies in the integration of tangible and intangible elements, and balancing the contradiction between preservation and development [13] . In the protection and utilization of ancient roads, the HUL method can be adapted through the following multi-dimensional paths: spatial integrity protection, excavation of hidden cultural resources, dynamic adaptive management, and digital technology empowerment.

3. Description of the research methodology

3.1. Spatial dimension: hierarchical control and flexible planning

Spatial superposition analysis: Using GIS spatial syntax technology, identify the conflict areas between the ancient road network and modern transportation (e.g. the overlapping section of the Hui-Hangzhou Ancient Road and the high-speed railway line), and realize spatial avoidance through the strategy of "three-dimensional layering" (underground tunnels/air corridors and bridges), so as to retain the integrity of the ancient road's planar texture (refer to the spatial continuity principle of "Charter for Cultural Routes"). (Refer to the principle of spatial continuity of the Charter for Cultural Routes).

Buffer zone flexibility delineation: Based on the "source" and "sink" theories of landscape ecology, three levels of protection circles are established: 1. core protection zone (prohibit construction, traditional pavement restoration) 2. functional coordination zone (limit development intensity, such as setting up ecological parking lots) 3. development Guiding zone (implanting cultural and creative facilities, adopting reversible construction technology). Graded control is applied to the three levels of protection circles, which should also be combined with policy support and local planning.

3.2. Functional Activation Dimension: Complex Utilization and Low-Intervention Design

Compound utilization: At present, many cities are building greenways and slow-moving systems, which can integrate the rich historical and cultural relics along the coasts, health and leisure spaces, urban agricultural landscapes, urban landscape attractions as well as natural ecological sceneries to jointly create a characteristic multi-functional development area [14] . Therefore, from the perspective of composite utilization, embedding the revitalized ancient roads into the urban slow-moving system setup is a new way to integrate the ancient and modern roads, the countryside and the city, and to integrate the leisure movement with the history and culture. If the slow-moving system is embedded: the ancient road will be transformed into a regional greenway network node (such as the Beijing Xishan ancient road connecting the three mountains and five gardens greenway), so that the greenway system is more in line with the needs of the living environment, and realizes that in the context of nature, it connects human beings and the social linkage, and it has a stronger support network and cultural connotations. The construction of ventilation corridors is conducive to the creation of a "breathing city", the improvement of the ventilation environment, the mitigation of the heat island effect, and the creation of a better human habitat, etc. The use of native vegetation on both sides of the ancient paths builds ventilation corridors and mitigates the urban heat island effect. In addition, it is also possible to select the old road station as a disaster prevention reserve point (Japan's Kumano Old Road Disaster Prevention Material Reserve Model), and utilize a variety of means to ensure the supply of emergency supplies after a disaster, and give full play to its emergency evacuation function.

ISSN: 2710-0170

Low-involvement design application: Establishing a three-dimensional evaluation system of "cultural vitality, ecological resilience and socio-economic", integrating quantitative data and community-based participatory decision-making. Adopting the principle of retaining 20% of the original stones as historical imprints when repairing damaged pavement as the principle of "recognizable restoration" of ancient roads. Currently, ancient towns and villages have become popular places for tourism and recreation, and the development and restoration of ancient buildings is becoming more and more obvious in the field of architecture, and the common damage and restoration methods of ancient buildings in China are also becoming more and more mature. This paper calls for the strengthening of China's ancient road repair initiatives. Nowadays, China has many innovations in ancient road restoration practices, such as the organization of the seminar on the protection of the cultural heritage of the Tea and Horse Road (Ya'an), as well as the implementation of the "2018 Heyuan City, Yue Gan Ancient Road Protection and Restoration and Utilization of the Work Program", "Study on the Protection and Restoration of the Southern Guangdong Ancient Stagecoach Road Protection and Restoration Project Practices", and the "Measures for Protection of the Ancient Roads of Zhejiang Province", which will take effect in Zhejiang province since 2022, have played an important leading role in the activation, utilization, and protection of the ancient roads. And protection has played an important role in leading, a strong impetus to the improvement of China's ancient road protection and utilization system. However, the national ancient road restoration standard policy documents urgently need to promote.

At the level of low-involvement materials: the use of bio-based materials (bamboo reinforced concrete) can be considered for slope stabilization. Replacement of night-time lighting facilities through "light environment regulation" (firefly ecological reintroduction technology). These low-cost, low-involvement forms of technical measures are in line with ecological and economic principles.

3.3. Ecological dimension: biological corridors and microclimate restoration

Ecological Network Reconstruction: Based on the Minimum Cumulative Resistance (MCR) model, the ancient path is used as a stepping stone for wildlife migration: ecological jumping islands are set up at intervals of 500 meters (a case of connecting the macaque monkey habitat on the ancient path in Tianmu Mountain, Zhejiang Province); and natural materials, such as fallen logs and gabions, are used to construct insect hotels.

Microbiome regulation: through macro-genome sequencing technology, screening of indigenous microbial agents (such as Bacillus licheniformis), inhibit the propagation of harmful flora on the surface of the ancient road stone, extending the life of the stone by 3-5 times compared with the traditional chemical protective agents.

3.4. Cultural Dimension: Memory Transmission and Community Empowerment

Decoding of cultural genes: Establishment of "Ancient Road Cultural Gene Bank": Based on BIM+GIS and other related software technology support, a four-dimensional cultural map (time axis + space axis) is constructed from the time axis and space axis, realizing the recording and archiving of material genes and non-material genes. The material genes include post form and milestone style database, etc., while the immaterial genes include the digital archives of the trade horn and the organization system of the pack team.

Community Participation Mechanism: Innovative "Three Common Models": (1) Decision-making: Establishment of the Village Council for the Protection of Ancient Roads. (2) Sharing of benefits: Developing IP derivative products of ancient roads (e.g., those famous for tea along the Huishang Ancient Trail can create a brand of tea cakes, and the proceeds will feed the

ISSN: 2710-0170

protection fund). (3) responsibility sharing: the implementation of the "ancient road adoption" system (enterprises/individuals to adopt 100 meters of road maintenance).

3.5. Technical support system

Digital twin platform: using integrated multi-source data (InSAR deformation monitoring + visitor flow heat map), realizing real-time early warning of the health of the heritage body, and dynamic regulation of visitor carrying capacity.

Material life prediction model: Machine learning algorithms (LSTM neural network) can be applied to predict the maintenance cycle of the paving layer by inputting parameters such as stone porosity, acid rain frequency, etc. (error rate <8%).

4. Discussion and conclusions

There is a need to balance the need for authenticity and accessibility of the heritage in the mechanism for coordinating conflicts, and the negotiation of land tenure systems in urban and rural areas is also very important. The establishment of inter-administrative management committees requires the support of more scholars, personnel from relevant departments, and public participation, which involves increasing publicity about the ancient paths so that people can better understand them in order to better protect them. In addition, with the prosperity of digital technology, digital twin technology in various fields and aspects of the tour interpretation, monitoring and analysis to play more applications, its fast, high precision, labor-saving and other advantages, is making the monitoring and analysis to obtain dynamic results and other ways to produce an uncontrollable positive migration, but which can not be ignored the role of people.

This paper proposes a "hierarchical revitalization" strategy: for example, in the case of the Huishang Ancient Trail, through the dynamic delineation of protected areas, the restoration of local materials and the activation of AR culture, to achieve the enhancement of the carbon sink capacity and tourism revenue, and the simultaneous establishment of a digital twin monitoring platform and inter-administrative management mechanism.

This paper innovatively proposes the theoretical framework of "Heritage Infrastructure", which provides a replicable "protection-regeneration" paradigm for the construction and development of heritage corridors, highlights the core value of the discipline of landscape architecture in the optimization of human habitat and the transmission of historical lineage, and promotes the paradigm transformation of global heritage protection from "static preservation" to "resilient symbiosis". It also highlights the core value of the discipline of landscape architecture in the optimization of human environment and the inheritance of historical lineage, and promotes the paradigm transformation of global heritage protection from "static preservation" to "resilient symbiosis".

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