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Original Research Article

## Study on Ecological Restoration of Arid City under Land Spatial Planning System: A Case Study of Lanzhou

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**Abstract:** Due to the rapid development of cities and the acceleration of urbanization in recent years, various policies and plans have been issued one after another. However, many plans are not coordinated and unified, which leads to the imbalance of urban development. Therefore, urban and rural planning begins to transform to land and space planning. The new land space planning system has made a series of important instructions for urban restoration and urban ecological restoration. The “double repair” of the city has become an urgent problem to be solved. At the same time, the “double evaluation” system is used to measure the current situation of urban development. This paper deeply explores the ecological restoration of arid city under the land space planning system of Lanzhou as an example. Through the ecological restoration concept put forward under the land space planning system, at the same time, learning from the new evaluation system, it puts forward new solutions for the urban ecological restoration of Lanzhou. From the perspective of sustainable development, the mode of urban ecological restoration in Lanzhou is deeply optimized, and the new direction of urban development in Lanzhou is deeply adjusted from three aspects of mountain, water and urban overall development.

**Keywords:** Lanzhou; Urban planning of Lanzhou; Land spatial planning system; Urban ecological restoration.

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### 1. Introduction

With the rapid influx of many migrant workers into the cities after the reform and opening-up, China has gradually lifted a series of controls on population movement and accelerated the process of urbanization. However, continued urbanization has also brought a series of contradictions to the sustained, rapid and healthy development of China's economy and society. Based on the contradictions and problems accumulated in the rapid development of urbanization, as well as the overlap and conflict between various types of planning, there is an urgent need to establish a new spatial planning system to build an ecological civilization system, that is, a national land spatial planning system.

Based on the work of the King's spatial planning system, the Central Committee of the Communist Party of China and the State Council issued the Overall Program for the Reform of the Ecological Civilization System (hereinafter referred to as the “Program”) in September 2015. The Program calls for the establishment of a “system for the development and protection of land space, with spatial planning and utilization control as the main means”, and “unified, interconnected, and hierarchical management of national space with spatial governance and With spatial governance and spatial structure optimization as the main content, the national space is managed in a unified, interconnected and hierarchical manner”, and the planning system is committed to solving the problems of overlapping and contradictory spatial plans, overlapping and duplicated departmental responsibilities, and changes to local plans. With regard to the preparation of spatial plans, it is required that “various spatial plans currently prepared by various departments are integrated, spatial plans are unified, and full coverage of the plans is achieved. Spatial planning is a guide for national spatial development and a blueprint for sustainable development. In addition to spatial planning, it is divided into three levels: national, provincial, municipal and county (the scope of spatial planning for municipalities with districts is the municipal districts).”

In the urban ecological restoration of the biggest challenge than China's arid areas, year after year of yellow sand, precipitation is scarce, and at the same time, due to the continuous expansion of the city, the ecological green area is constantly compressed by the soil erosion caused by. Based on the ecological security model plan (economic spatial layout plan) of the ecological environmental protection plan system, this paper analyzes and researches the ecological restoration solutions for arid cities in Lanzhou as an example.

## 2. Overview of the Study Area and Main Issues

### 2.1 Overview of the Study Area

Located in the upper reaches of the Yellow River, Lanzhou is situated in the eastern part of the eastern monsoon, in the northwestern arid zone, and at the confluence of three major natural regions: the Mongolian Plateau, the Loess Plateau and the Tibetan Plateau. With a total area of 13,100 square kilometers, Lanzhou has 5 districts, 3 counties and 3 national development zones, with a resident population of 4,134,000 people. The terrain is high in the west and south, and low in the northeast, and the Yellow River flows from the southwest to the northeast, traversing the whole country, cutting through the mountains and forming a bead-shaped valley with ravines and basins. Therefore, the vegetation and biological characteristics of Lanzhou combine the characteristics of three natural regions, including natural forests, alpine grassland shrubs, semi-arid shrubs, barren grasslands, and arid grasslands, and at the same time conforms to the main ecological types of the Upper and Middle reaches of the Yellow River: a complex environment with diverse vegetation types, representing a wide range of ecological types and typical natural environments, and is the most special ecological zone of the Upper and Middle reaches of the Yellow River. Lanzhou has different ecological environment and natural conditions from other areas due to the uniqueness of its geographical distribution. (The administrative division of Lanzhou is shown in Figure 1, with only five urban areas in the study area.)



Figure 1 Administrative zoning map of Lanzhou city.

Lanzhou has a low forest area, relatively sparse vegetation, rough land, and under the influence of the narrow valleys of the north and south mountain ranges and the towering valleys, the basin is poorly ventilated and heavily polluted, and environmental problems have been an important factor constraining Lanzhou's economic development. The double "bottleneck" topographic conditions of "two mountains and one water" have seriously affected the development and growth of the city. Lanzhou's ecological environment construction can only rely on ecological restoration to improve vegetation coverage and utilize the restoration of the ecological environment to control urban air pollution and improve the living and investment environment.

### 2.2 Major Ecological and Environmental Problems

As Lanzhou is located in an arid area, with less precipitation, and near the Loess Plateau, and subject to local soil conditions and climatic conditions, there are fewer survivable plants. The problem of sand and dust control is urgent. However, due to the continuous expansion of the city in recent years, and did not use the

scientific overall vision of urban planning, some of the old “injury” more visible.

### 2.2.1 Degradation of High and Low Grasslands and Weakening of Ecosystems

The topography of Lanzhou is characterized by two mountains interspersed with a river and high slopes of loess, which makes the land saline and alkaline and makes it more difficult for vegetation to grow. So it causes Lanzhou to be eroded by yellow sand all year round.

### 2.2.2 Lack of Clarity in Site Demarcation

Before that, all kinds of plans in Lanzhou did not give any instructions on green space planning in Lanzhou, resulting in the intermingling of forest land, open space and farmland in the area defined by the distribution of natural forests, with no obvious demarcation area and no scientific way of demarcation, so that the forest margins are in close contact with each other, and the impact of human activities on the forest ecosystems is too great. The state of natural forests as well as their functions are restricted.

### 2.2.3 Low environmental carrying capacity

Most of the areas around the Lanzhou urban area are arid, low-vegetation, barren and fragile ecosystems, while the development of low-elevation grassland ecosystems and the comprehensive ecosystem service capacity are difficult to meet the needs of economic and social development. (Figure.2) The ecological and environmental problems of the city are relatively prominent, with less green space per capita and environmental pollution, especially air pollution, having become a major contributor to environmental problems.

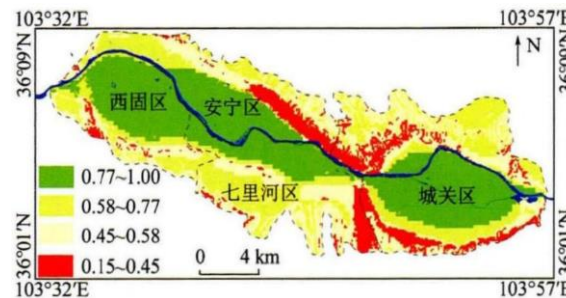


Figure 2 Spatial division of carrying capacity of geo-environmental subsystems in Lanzhou urban area.

### 2.2.4 Poor Natural Conditions

Due to low precipitation and poor natural conditions on the high slopes of the loess, low desert vegetation cover, difficult growth, poor ecosystem development and low self-functioning, it is difficult for the northern region to withstand the threat of desertification. The quantitative assessment of the study “China’s Ecological Environment Quality Evaluation Study” completed by the project team led by Wan Bentai of China’s National Environmental Monitoring General Station shows that the urban E-QI value of Lanzhou's three counties and five districts is 32.56, the biological abundance index is 10.72, the coverage index is 20.24, the water network density index is 18.65, the land degradation index is 22.56, the pollution load index is 9.86, and the pollution load index in the participating assessment areas is 9.86; and ranked 2111 out of 2348 countries participating in the assessment. The ecological quality assessment is detailed in Table 1.

Table 1 Evaluation of the ecological environment quality of the Yellow River section in Lanzhou.

Ranking	Level	Name	EQ-I	Bioabundance index	Plant cover index	Density index of water network	Land degradation index	Negative pollution index
2111		Lanzhou*	32.56	10.72	20.24	18.65	22.56	9.86
2104	Not good	Yongdeng county	32.70	11.50	23.01	8.20	15.76	0.37
2150		Gaolan County	31.67	10.04	19.93	9.32	17.42	0.45
2224		Yuzhong County	29.33	12.22	22.79	10.80	43.61	0.51

Note: “\*” refers to the Chengguan, Qilihe, Xigu and Honggu districts where the urban area of Lanzhou is located. Source: Research on Evaluation of Ecological Environment Quality in China, P134-137.

From the above four points, the existing ecological problems in Lanzhou not only include the natural conditions of Lanzhou, but also due to the lack of various types of planning, the planning did not take into account the carrying capacity of the environment and the appropriateness of urban spatial development and blind development, which makes the ecological problems more and more serious. If we do not intervene in the research method of ecological restoration under the system of national spatial planning to improve the ecological situation of the city, it will cause irreversible damage to the city.

### 3. Ecological Restoration Strategies under Territorial Spatial Planning

#### 3.1 Conceptual Connotation

Urban ecological restoration refers to the urban construction method of restoring damaged mountains and water bodies, repairing and reusing urban brownfield sites, optimizing the ecological spatial layout of urban green space system, restoring the functions of urban ecosystems to purify the environment, regulate the climate and hydrology, and maintain biodiversity, so as to realize the harmonious coexistence of urban people and nature under the premise of reasonably protecting the natural ecological resources of the city. The ecological restoration under the national spatial planning system introduces the concept of “multi-planning” under the original ecological restoration concept, giving priority to land use zoning and optimizing land use as a whole for the purpose of long-term development.

#### 3.2 Ecological Restoration Strategies

Ecological restoration of national land space is a top-level design for the spatial allocation of ecological resources and a spatial expression for the restoration of ecological resources and the implementation of ecological policies. The four ecological restoration approaches should also be adjusted according to the requirements of the new territorial spatial planning (Figure 3). The following three adjustments should be made.

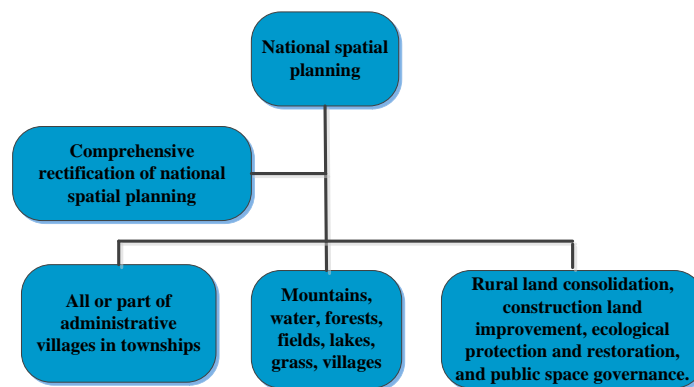


Figure 3 Territorial spatial planning idea map.

##### 3.2.1 Firm Territorial Ecological Restoration

The systematic nature of ecological restoration is reflected in two aspects: first, adherence to problem orientation, finding major ecological contradictions and analyzing the root causes of problems. Usually through local ecological research and investigation, the main problems faced by the local area and the factors affecting the environment are identified. Different solutions are proposed for different problems. Secondly, the spatial research scope is “area”. Firstly, human activities have the greatest impact on the ecological environment on a large scale, so it is necessary to consider expanding the scope of thinking, and look at the ecological situation from the whole city and the whole region. Secondly, new ecological restoration needs to be accomplished under the new system of spatial planning. Problems that could not be solved by the previous small-scale planning and small-scale ecological restoration can be solved by this new platform. Therefore, national spatial ecological restoration can also be understood as ecological restoration on a global scale.

### 3.2.2 Holistic Restoration of the Community of Life

Various types of ecological resource elements have certain material exchange and energy circulation in the territorial space, and embody different spatial heterogeneity and their specific functions within a specific spatial scale! Previously, ecological restoration only solved a single problem, but now the consideration is more comprehensive. Therefore, the ecological restoration strategy should be shifted to the regional of the problem, and the “mountains, waters, forests, fields, lakes and grasses” should be regarded as an interdependent, organically linked and closely related life whole, so as to ultimately realize the comprehensive governance of all elements of the national land space.

### 3.2.3 Integration of Several Regulations

The restoration of ecosystems is not a simple addition of various technical or engineering measures, but is also subject to the multiple influences of human society, the economy and the natural environment. Land space ecological restoration planning is a comprehensive and specialized plan, involving a wide range of spatial elements and requiring the participation of multiple disciplines. Therefore, the spatial ecology of the national territory should be integrated into all the related disciplines in the neighborhood, as well as all the related departments. Changing the original situation of each department working separately and divided into sections, eliminating the tedious matters such as inter-specialty departmental cooperation, and realizing the integrated planning and management of natural resources, which is conducive to the integration of multidisciplinary and multidisciplinary planning in the ecological restoration of national land space.

## 4. Lanzhou Urban Ecological Restoration Strategy

Based on the ecological restoration of Lanzhou under the national spatial planning system, the main restoration idea and goal should be “ecological restoration, green reconstruction and reconstruction of the blue sky”, and the first choice is to restore the area within the ecological control line. In the area, the ecological restoration of Lanzhou can focus on two aspects: on the one hand, through the planning requirements for the ecological base of the restoration, to remove the previous messy vegetation, restore the original mountain veins of the north and south mountains of Lanzhou and at the same time to establish mountain water corridors, to enhance the space for the activities of the species and the living environment, to improve the green corridors on both sides of the city of the long strip, the green parks, green isolation zones and other green infrastructure, to establish a green environmental ecological belt, to improve Lanzhou, the green environment and the ecological environment, the green environment and the green environment. Green environment ecological belt, improve Lanzhou “yellow sand sky” of the old scene, hope to initially achieve the idea of rebuilding the blue sky; another aspect, combined with Lanzhou is being implemented in the “garden Lanzhou” civilized city slogans, ecological greening, pollution prevention and landscape to create a real Another aspect is to combine with the slogan of “Garden Lanzhou” civilized city being implemented in Lanzhou, to make ecological greening, pollution prevention and landscape building practical in the hearts of every citizen, to expand the ecological boundaries of the natural patches, to connect the scattered ecological patches, parks, brown-fields and other important spaces in the surrounding area, to improve the function of the city’s green space, and to alleviate the effect of the urban heat island.

### 4.1 Overall Strategy

Taking national spatial planning as a prerequisite, the “double evaluation” method is used to re-plan the ecological restoration strategy of Lanzhou City. Incorporating the idea of integrating multiple planning, it prioritizes the evaluation of the overall ecological situation, and makes overall planning in a targeted manner, treating all ecological scenes in the urban area as a whole, and changing the ecological status quo of Lanzhou City from multiple directions.

Optimize the overall spatial layout of Lanzhou city, define the overall positioning of Lanzhou city, and

relocate the heavy industries in the city to Lanzhou New District. Determine the four center points of the urban area and ensure that there are enough green zones and parks in the densely populated areas. The existing densely populated areas (Xiguan Cross and Xizhan Cross) are not equipped with enough green belts and city parks. At the same time, the public green environment of the city should be taken into consideration, Lanzhou's overall green situation is poor, except for the Anning District, the green situation is not up to standard, can increase the green rate by increasing the road hedge, sidewalk green space. Clarify the main role of the two mountains, mainly used to resist wind and sand, as well as recreation, should be removed on the hillside of some illegal structures. In Xigu, Anning, Honggu, Yantan in the fringe area of the farmland should be clearly divided into areas, barren land should be returned to forest.

#### **4.2 “Two Hills” Restoration**

Rehabilitation of barren and abandoned hills to increase the greening area and selection of more suitable tree species. Enhance the maintenance and repair works of slopes and slope skirts by improving the grass-roots level and phytoremediation methods to eliminate potential safety hazards. Remove civil buildings that affect the ecological landscape and do not meet safety standards, repair and beautify slopes; use linear mountain engineering to repair damage to the mountain ecosystem.

Integration of recreational parks on the two mountains (Wuquanshan Park, Baitashan Park and Xujiashan National Forest Park) - to become an important participant in the ecological restoration of the mountains. Hiking trails and eco-tourism sightseeing corridors can be built to bring people closer to the mountains, while care must be taken not to artificially destroy the greenness of the mountains.

#### **4.3 Rehabilitation of Vegetation**

The number of green spaces is increased substantially according to the classification of the area in which they are located and the distribution of the population. According to the per capita greening index, combined with the population density with a service radius of 300-500m, various forms can be used to meet the greening needs and increase the compliance rate of the per capita greening standard. Construction of a complete park system which consists of comprehensive parks, community parks and open-air parks.

Aiming at the limited space in the city center, new small parks are built near the five central areas of Lanzhou, namely Xiguan Cross in Chengguan District, Xizhan Cross in Qilihe District, Feijiaying in Anning District, Xigucheng in Xigu and Wanda Plaza in Yantan. The construction of the mini-parks is guided by: (1) a size between 100m<sup>2</sup> and 200m<sup>2</sup>; (2) long-term and short-term recreational activities tailored to the needs of users in the neighborhood; (3) a variety of place-based activities to accommodate the diversity of choices of the neighborhood; (4) and an outstanding social aspect that allows many local residents to interact and socialize on a daily basis.

Comprehensive utilization of various combination methods can increase greening area and optimize greening management level. (1) Demolition and construction of greening: land demolished and relocated from planned shantytowns will be preferentially selected for construction of public greening land. Greening demolition and construction will be combined with the old city renovation and mountainous town renovation projects to strengthen landscaping and upgrading in weaker green areas such as city centers and old towns. (2) Removal of walls and green space edges: creating a transparent and shared green space. Remove and open the walls of parks and squares, remove access to parks and squares, and encourage the opening of secondary green squares in businesses, offices, schools, and other land uses that do not interfere with their use and maintenance, and improve the use of public green spaces. Crowd communication and participation in activities can enhance the vitality of the city. (3) Create green space environments that are more responsive to the needs of citizens, with higher levels of participation and vitality. Appropriate parks should be selected according to the population size and age structure of the planned locality, and the development concept of “one park, one product, four seasonal landscapes” should be put forward by combining the local customs.

#### 4.4 River Restoration

In order to improve and optimize the water quality of the river, additional sand mining trucks can be installed, and at the same time, slope-fixing trees can be planted along the riverbanks, so that the scouring of the river to the soil on both sides of the river can be reduced, and the content of soil in the water can be reduced, which indirectly leads to purification and improvement of the water quality of the urban river. As Lanzhou was an industrial-oriented city before, there were serious problems in sewage treatment and the direction of factory setup. Although some industrial plants and factories were moved out of Lanzhou city on the way of long-term development, there are still Lanzhou Refining and Lanzhou Chemical plants still stationed in the upper reaches of the river for various reasons. The problem of sewage treatment can not be delayed, can consider the use of water artificial oxygenation means, so that the river water ecological natural restoration. At the same time can be increased in the river near the fountain, ladder water features and other infrastructure, the river into the river, to promote the river inside and outside the flow of water exchange faster, to improve the river water circulation rate, thereby increasing the oxygen content of the water body, to prevent the accumulation of pollution in the water body.

From the perspective of optimizing bank protection, priority should be given to the selection of ecological bank protection. This kind of way in the practical application of low cost and quick results, but also can effectively improve the river ecological system. The establishment of ecological slope protection should choose the right plants, can not choose some will cause secondary pollution of tree species, at the same time should be in different slope slope protection to choose different types of tree species.

#### 4.5 Bin River Landscape Restoration

The rich coastal scenery is combined with crowd recreational activities. According to the characteristics of water bodies and plant landscapes corresponding to the aquatic environment, landscape recreational activities and ecological education are organized on the riverbanks and green spaces on both sides of the river in conjunction with the existing Waterwheel Park, Lily Park, Dragon Park, Olympic Park and Fable Story Garden to provide nearby residents with opportunities to get close to nature and experience ecology. The environment around the river can be divided into three parts: waterfront tourism, urban waterfront recreation and rural ecological waterfront. Waterfront Tourism and Sightseeing Zone: (1) The ecological wetland park along the river will form a waterfront tourism and sightseeing zone, integrating tourism, entertainment, shopping, leisure and experience. (2) Urban Waterfront Resort Zone: Fully organize water recreation activities, focusing on active recreation, reasonably arranging urban functions in conjunction with the surrounding land, strengthening the type of recreation along the riverbank, and ornamental aquatic plant breeding. (3) Rural ecological waterfront area: the adjacent water is open to visitors, with more seasonal river beaches and wetlands on both sides and good natural ecology. Suitable for low to medium intensity recreational activities.

The seasonal change of river level creates several riverside landscapes in the Yellow River. (1) Constructing the Dry Creek Park in the dry water area of the river: Since the planning area is high in the east and west and low in the middle, the east and west channels are mostly dry during the dry water period, and using the dry riverbed as the dry river edge can avoid the dry river channel affecting the aesthetics. (2) Natural ecological "flow" using pebbles and plants: Gravel can be placed in the sunken area of the riverbed and walked on during the dry season, while during the rainy season, water will seep into the ground to nourish aquatic plants.

By using infrastructure and plants to create a sense of space at the same time, the entire riverfront belt is divided into multiple parts, and in the vertical landscape, the natural advantages of plants themselves, forming a sense of space created by the staggering of heights, thus forming a ladder-type landscape and increasing the sense of hierarchy in the landscape. At the same time, through the planting of different heights of plants in different heights of the ramp to achieve the visual effect of the realization of the flush.

The concept of virtual space is introduced to increase the sense of space. The expansion of virtual space

and the restoration of coastal ecology can effectively change the narrow sense of space, effectively expand the space, visually expand the scale of the whole landscape, and solve the problem of insufficient river interface.

## 5. Conclusions

Under the new planning standards, the primary issue for urban development in Lanzhou is urban ecological restoration. Improve the ecological environment of the city, improve urban public services, enhance the quality of urban space, and enhance the vitality of the city, thus enabling the city to continue to move towards a healthy and sustainable development under the new normal. With the passage of time to continuously promote the focus of urban construction, towards a healthy and green sustainable development change.

Under the influence of territorial spatial planning, ecological carrying capacity evaluation is particularly important in ecological restoration. Using the “double evaluation” method to carry out ecological construction work is an important means to achieve high-quality development and ecological civilization construction in the new era. By studying the connotation of ecological carrying capacity, the method of evaluation and the limitations of theoretical cognition, and by comprehensively considering the local ecological environment and socio-economic and social carrying capacity, new ecological restoration methods are practicably proposed under the guidance of national land planning to restore the local ecology.

## References

1. Tang Dongfang. Study on Urban-Rural Integration of Employment[D]. South China Normal University, 2002.
2. Huang Jinchuan, Lin Haoxi, Qi Xiaoxia. The type zoning of Beijing-Tianjin-Hebei synergistic development under the perspective of spatial management [J]. Progress in Geographic Science, 2017, 36(01):46-57.
3. Jiang Xiaojuan. Research on Land Space Optimization Based on Ecological Civilization Construction[D]. Lanzhou University, 2019
4. China Urban Planning Network. Unified Planning System to Better Play the National Development Planning Strategic Orientation Role[EB/OL]. 2018-12-10. <http://www.planning.org.cn/news/view?id=9251>.
5. Liu Zhiyuan. Research on natural forest protection and countermeasures for restoration of degraded natural forests[J]. Shanxi Forestry, 2009(04):19-20.
6. Zhang Longsheng, Chen Daojun, WU Xiaozhou. Building an Ecological Network of Urban and Rural Integration to Create Ecological Lanzhou[J]. Development, 2011(04):64-65.
7. Department of Urban Construction, Ministry of Housing and Urban-Rural Development. Guidelines on Urban Ecological Assessment and Rehabilitation[Z]. 2016.
8. China Academy of Urban Planning and Design. Catalyzing and Transforming[M]. Beijing:China Architecture Industry Press, 2016.
9. Wang Kai. Double repair, make city life better [N/OL]. <https://mp.weixin.qq.com/s/-nmUtcNjtt4uA6TUpUc-tQ>.
10. Gao Shichang. Theories and methods of ecological restoration of land space[J]. China Land, 2018 (12):40-43.
11. Yang Nan, Tan Xuwei, Yu Zongxing. Planning strategy and practice of ecological restoration of land space in Shenyang[J]. Planner, 2020, 36(13):34-38, 45.
12. Cao Yu, Wang Jiayi, Li Guoyu. Ecological restoration of national land space: conceptual thinking and theoretical cognition. China Land Science, 2019(7):1-10.
13. Shi Nan, Lv Bin, Peng Zhenwei et al. Discipline development in the context of spatial planning system reform[J]. Journal of Urban Planning, 2019(1):1-11.
14. Ma Linzhong. Discussion on turf transplantation technology in the construction of highway projects in



- alpine areas[J]. Gansu Agriculture, 2004(09):88-89.
15. Yu Kongjian, Wang Xin, Lin Shuangying. Urban Design Needs an Abnormal “Bigfoot Revolution”- Sanya’s urban “double repair” practice[J]. Urban and Rural Construction, 2016 (09)
  16. Ni Mindong. Chen Zhe, Zuo Weimin. Urban design strategy of eco-region under the concept of “urban double repair” -Take Ningbo Xiaoyangjiang Area as an example[J]. Planner, 2017 (03)
  17. Dong Wen, Xie Jing. Work framework and planning practice of “urban dual repair” in Qianjiang City, Hubei Province. Planner, 2017(12).
  18. Huang Hao. Research on Urban Ecological Restoration Strategy under the Concept of “Urban Shuangxiu”- A Case Study of Urban Shuangxiu Special Planning in Miyi County[J]. Low Carbon World, 2019, 9(04): 9-10.