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Research on the Construction of Rural Landscape Ecological Security Pattern for Biodiversity Conservation—Taking Yuecheng District, Shaoxing City, Zhejiang Province as an Example

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Abstract

China's countryside covers half of the country and plays an important role in maintaining the stability and security of the ecosystem. Ecological diversity is one of the important manifestations of ecosystem stability and security. Landscape security pattern is one of the landscape pattern optimization models for biodiversity conservation planning proposed by scholars at home and abroad. This paper selects Yuecheng District, Shaoxing City, Zhejiang Province as the research object, and establishes a comprehensive habitat suitability evaluation of representative species by selecting representative species of Yuecheng District—egret and black muntjac. In this paper, ecological source sites are selected in conjunction with superior planning. We use the MCR model to construct representative species movement resistance surfaces and use cost distance and retrospective cost grids to discriminate ecological corridors. The article combines the analysis of the ecological resistance model and the construction land resistance model, and proposes ecological construction strategies and recommendations for the bottom line control zone, ecological buffer zone and core construction zone.

Keywords

Ecological Security Pattern, Biodiversity, Ecological Corridors

1. Introduction

Biodiversity is the complex ecosystems of creatures and its environment on earth. High-quality biodiversity can not only maintain the balance of ecosystems and improve human settlements effectively, but also play an important role in resisting natural disasters, adapting to climate change, and buffering extreme environmental impacts. However, in recent years, due to the disorderly expansion of urban and rural construction land and the frequent occurrence of natural disasters, the natural ecosystem has been destroyed and the ecological space has been fragmented. As a result, the problem of global biodiversity loss has been exacerbated, which has attracted widespread attention at home and abroad. The protection of biodiversity has become an urgent and important task in the current ecological civilization construction. In October 2021, Xi Jinping proposed at the 15th Conference of the Parties to the "Convention on Biological Diversity" that "biodiversity makes the earth full of vitality and is also the basis for human survival and development. The protection of biological diversity will help maintain the earth's homeland and promote sustainable development of human beings." The meeting customized a global action plan for biodiversity conservation in the next 10 years, which has important guiding significance for human society to strengthen the protection of natural ecological environment.

Ecological security pattern refers to the potential ecological system spatial pattern composed of key parts in different orientations and spatial connections in the natural landscape, which is of great significance to maintaining ecological security. Building a reasonable ecological landscape security pattern and optimizing urban and rural ecological space are important means to improve the quality of the ecological environment and protect biodiversity. Although biodiversity has become a new research hotspot in ecology, there is a disconnect between ecological research content and urban and rural planning, the lack of overall planning among various departments, and the lack of connection between ecological space optimization and ecological security patterns. How to evaluate ecological elements in the context of social factors, build ecological landscape security patterns and protect biodiversity is a current issue of concern.

In the 1990s, Professor Yu Kongjian of Peking University and his research team put forward the theory and method of ecological security pattern for the first time in the world, and continued to conduct research on ecological security pattern on multiple scales [1], such as the macro-level ecological security pattern of the country, the regional ecological security pattern, and the micro-ecological security of cities and villages pattern. At present, the domestic ecological security pattern mainly focuses on the urban spatial development pattern and urban form [2] and ecological infrastructure [3] and as the basis for the constructional detailed planning of urban construction [4] and so on.

Professor Yu Kongjian mentioned that the rural ecological security pattern is the basic unit of the national ecological security network. The countryside is an important part of our country. Rural land occupies half of China's land area. Urban construction pursues maximization of land utilization, which is lacking in ecological aspects. In contrast, the countryside is a good ecological conservation area, which can provide more suitable habitats for animals, and is also an important part of ecosystem protection. The countryside has an ecosystem composed of a life community of mountains, rivers, forests, fields, lakes and grasses, and it is the protector of the ecological environment. In recent years, due to the development of the countryside and the continuous construction and transformation, the ecological pattern has undergone tremendous changes, posing a serious threat to the survival of the original creatures. How to scientifically and effectively protect the rural biodiversity and make the countryside have the potential of sustainable development is an urgent problem to be solved in the rural development. At the same time, the countryside is located in the fringe area of the city, surrounding the urban space, and is the buffer zone of urban development. Its ecological security pattern is of great significance to the sustainable development of the city. Therefore, this paper uses the method of landscape ecological security pattern construction to explore the construction of rural landscape ecological security pattern for biodiversity protection, and provides new ideas for future rural ecological planning.

2. Sample Profile and Data Sources

2.1 Sample Profile

2.1.1 Study Area

Geographically, the Yangtze River Delta is a key area of economic development in china, and its ecological status is important. As an ecological green integrated development demonstration area, the research on biodiversity conservation in the Yangtze River Delta has extremely important practical significance. The Yangtze River Delta region has good natural ecological conditions, many rivers and lakes, and is adjacent to the East China Sea. It belongs to a typical subtropical monsoon climate. The terrain is mainly composed of mountains and hills in the west, plain water network in the middle, and coastal mudflats in the east. The ecosystem is complex and diverse. Among them, Zhejiang region is representative of the ecological environment of the Yangtze River Delta. The research area of this paper is based on the ecological base of the Yangtze River Delta, and Yuecheng District, Shaoxing City. Zhejiang Province is selected as the research object.

Yuecheng District is located in the central area of Shaoxing City, Zhejiang Province, on the south bank of Hangzhou Bay, the west of Ningshao Plain, and the northern foot of Kuaiji Mountain, with a land area of 492.24 square kilometers (Figure 1). The special geographical location makes it have abundant water resources and a variety of animal and plant resources and ecosystems. However, due to industrial development and construction in recent years, the ecological network in Yuecheng District has gradually lost its efficacy, the greening area has been reduced, and the ecological connectivity is insufficient. It is facing serious problems of habitat fragmentation and biodiversity reduction. Therefore, the construction of the rural ecological security pattern in Yuecheng District will eventually achieve the stability of the ecosystem, which has a significant impact on the sustainable development of cities and surrounding areas.

2.1.2 Sample Status

There are various soil types in Shaoxing City, which provide favorable conditions for the comprehensive development of agriculture, forestry, animal husbandry and fishery. The main types of ecosystems include forests, wetlands and marine ecosystems. Due to the high terrain in the west and low east, many mountains, hills and lakes, high environmental heterogeneity, complex ecosystem structure and extremely diverse types, it is the basis for the survival and reproduction of rare animals and the maintenance of regional ecological functions. The diversity of marine ecosystems, coastal ecosystems and island ecosystems is relatively rich, and it also occupies a very important position in the East Sea. In recent years, the thorough implementation of Xi Jinping's thought on ecological civilization, the optimization of natural ecological system construction with high standards, the acceleration of the creation of an upgraded version of beautiful Shaoxing, and the vigorous implementation of major biodiversity conservation projects have attracted more and more rare wild animals and plants to "settled" in Shaoxing.

macro geographic location, meso-geographical location, microgeographical location, geographical location of the study area

Figure 1. Location Map of Yuecheng District (Source Self-drawn by the author).

Yuecheng District belongs to the subtropical monsoon climate zone, where is warm and humid with abundant rainfall, which is suitable for the growth of animals and plants. The topography of the region is high in the south and low in the north. The central and northern parts are a broad water network plain. The southern part is low mountains and hills or remnant hills. The north is crisscrossed by rivers, the water network is dense. The main rivers, such as the Pingshui River, Lizhu River, Nanchi River and Potang River, originate in the Huiji Mountains and flow into Hangzhou Bay from the south to the north, while most of the other rivers alternate vertically with them, running east-west through the north and south of the district. The mountain range in the territory is an extension of the Huiji Mountain Range, and the terrain in the south is highly undulating, with many steep mountains. The natural environment and its later transformation have formed the unique landscape form and pattern of Yuecheng District, which is an important ecological conservation area. The proportion of cultivated land, forest, grassland, shrub land, wetland, water area and built-up area in Yuecheng District is 35.74%, 20.54%, 2.65%, 0.05%, 10.39% and 30.63% respectively.

2.1.3 Sample characteristics

The ecological background of Yuecheng District is relatively good. The water system resources are also rich. The rivers, lakes, fields and fields are intertwined, and the ecological environment is well balanced. The regional characteristics are especially obvious, and it is a typical water town in the south. It has a water area of more than 18%, a dense network of water and many lakes. Through continuous development, villages have been built according to the river and clustered into different groups, forming a spatial pattern in which the water system is the backbone and villages are distributed according to the direction of the water system (Figure 2), and also forming a living pattern of living in lakes and ponds and paddy fields. The ecological background of water towns and the living form of living by the water have a long history, providing relatively superior ecological environment and landscape resources for the development and construction of cities and towns.

The habitat types in Yuecheng District are diverse, including forests and green areas, rivers and lakes, as well as wetlands, farmland and mountains. The diverse topography provides diverse habitats for its organisms and rich biological species resources, with 153 families, 449 genera and 879 species of plants, 3 species of wild plants and 16 species of secondary plants under national level protection. There are nearly 480 species of wild animals, including 354 species of birds, 72 species of two reptiles, more than 50 species of animals, 18 species of wild animals under national-level protection, and 82 species of second-level protection. Including egrets, black muntjacs, green-headed ducks and other rare animals crossing (Figure 3), there is a rich and typical regional biodiversity.

Figure 2. Characteristics of the current situation of Yuecheng District (Source Author’s own photos).

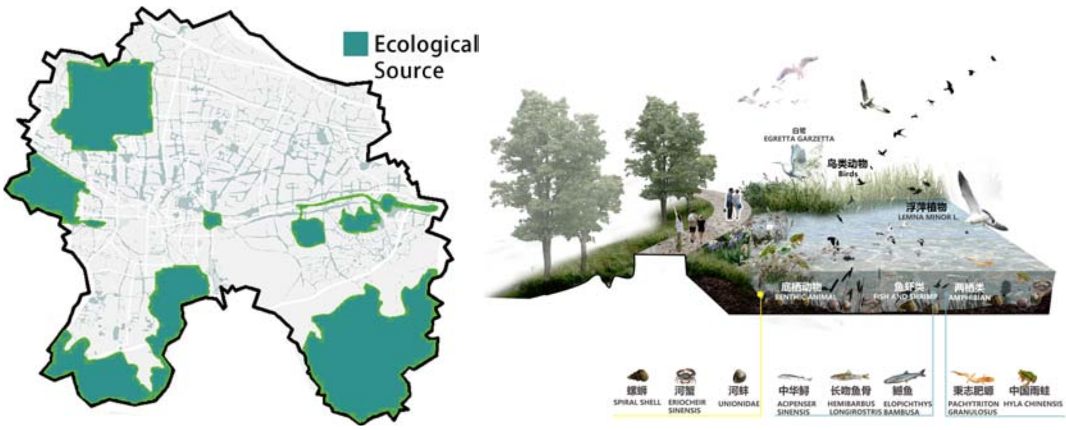


Figure 3. Ecological Sources and Biological Resources of Yuecheng District (Source Self-drawn by the author).

2.2 Data sources and pre-processing

The main data in this paper include the 2020 land use data of Yuecheng District, Shaoxing City, Zhejiang Province, which is obtained from the geospatial data cloud. The Landsat 8OLI remote sensing image of June 2020 is selected as the basic data for analysis. Based on the “Classification of Land Use Status” and the actual situation of the study area, the land cover types were classified into seven categories: arable land, wetland, grassland, shrubland, water, forest, and construction land. The DEM elevation was obtained from the GDEM30m accuracy data of the geospatial data cloud, and the data of slope and slope direction were extracted by stitching and cropping in ArcGIS10.8 software. The land use data were obtained from the geospatial data cloud of Chinese Academy of Sciences (http://www.gscloud.cn/).

The study was conducted in five hospitals in Slovak republic and in three hospitals in Czech Republic. The actual empirical data collection was conducted in months of April to July 2014. We chose a combined route of administration of questionnaires. Doctors and nurses of participating hospitals were distributed a total of 850 questionnaires. The responsiveness of the questionnaires was 78.0% (n=663). The research group enrolled 639 HW from a clinical practice who met the established inclusion criteria:

- Work at in-patient intensive care unit (standard type, or ICU), which can be classified into one of 5 groups (stratification by departments) surgical disciplines;
- Work at the workplace for at least last past 12 months;
- Work in a direct contact with adult patients and conscious patients.

24 questionnaires were excluded due to incomplete filling and non-compliance of inclusive criteria.

3. Evaluation and Construction of Rural Landscape Ecological Patterns Based on Biodiversity Conservation

3.1 Technical routes (Figure 4)

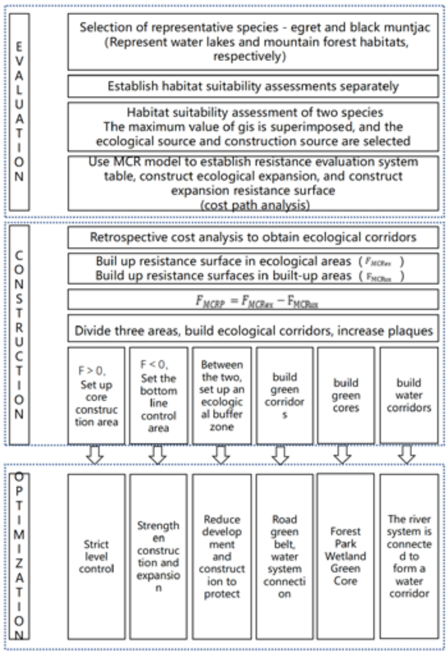


Figure 4. Technical routes (Source Self-drawn by the author).

3.2 Establishing ecological safety pattern evaluation based on biodiversity

3.2.1 Select representative species, establish a habitat suitability evaluation form, and conduct habitat suitability evaluation

Suitable focal species were selected for the representativeness of the species in the Yuecheng area and the status of species presence in the ecosystem, while also reflecting the characteristics of the habitat [5]. According to the topography and habitat system of the study area, we select species that are representative of other species or a certain type of habitat, and do not select endangered species or companion species [6], while the relevant information on the representative species should be sufficient to facilitate the subsequent optimisation of the biosecurity pattern [7]. Multiple selection of birds and mammals as representative species in agricultural landscapes [8]. After understanding the above principles of representative species selection, on-site field research should be conducted to determine the frequency of occurrence and the general classification of species in the study area. On the premise of satisfying the selection principle, combined with the actual research, we select a reasonable representative species.

In the case of the Yuecheng District, the frequency of occurrence in the village area was determined from the results of field research. We choose two representative species in birds and mammals. Because of the representative role of the egret for other species and its wide distribution, most studies in China have chosen the egret as a representative species, which can be used as an indicator species for wetlands. The black muntjac is a Class I protected species in China, and its population has been decreasing with the development of the countryside in recent years. The black muntjac can be used as an indicator species in the woodland and become a representative species for monitoring the countryside habitat. Therefore, the black muntjac and egret are selected as representative species (Table 1).

Table 1. Analysis of representative species in the Yuecheng area

Representative habitat	Species	Habitat conditions	Protection level
Migratory birds, representing habitats such as water and lakes	Egret	It inhabits coastal islands, coasts, bays, estuaries and nearby rivers, lakes, ponds, streams, paddy fields and marshes.	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Mammals, representing habitats such as mountains and forests	Black muntjac	It inhabits mountain evergreen broad-leaved forests and evergreen and deciduous broad-leaved mixed forests and shrubs at an altitude of about 1,000 meters.	Convention on International Trade in Endangered Species of Wild Fauna and Flora

- Create a habitat suitability assessment form and conduct habitat suitability assessments.

Habitat suitability assessment is based on the analysis of species' needs for key factors in the environment (food, shelter, etc.). Based on the establishment of a species habitat selection model, the animal habitats with different suitability are intuitively represented on the digital topographic map and remote sensing map [9]. The main steps of habitat suitability evaluation include: firstly, identifying the dominant or limiting environmental factors affecting the study object, then developing evaluation criteria for the dominant environmental factors, and combining the single factor suitability evaluation to obtain comprehensive habitat suitability evaluation results [10].

By reading relevant references and consulting experts, we determine the relevant factors and relevant resistance coefficients that have an impact on the habitat selection of representative species, and construct a habitat suitability evaluation table for representative species. Through the GIS overlay analysis tool, we establish the habitat suitability evaluation of the representative species. For example, to select multiple representative species, we need to use GIS to perform the maximum value calculation to obtain the comprehensive habitat suitability evaluation, and conduct analysis and research on this. Most of the influencing factors are land cover type, slope, slope aspect, human disturbance [11-13].

- Habitat suitability analysis of egret

Egret is a widely distributed wetland water bird, and it is an important indicator species of environmental quality due to its high requirements on the environment. According to relevant literature [14-16], egrets tend to choose semi-sunny slopes with gentle slopes and an altitude of less than 200m as their habitats, and prefer areas with large water surface area, deep water, and far away from artificial interference (Table 2).

Table 2. Habitat suitability analysis of egret

Evaluation level	Evaluation factor	Classification	Score	Weights
Natural environment factors	Slope	0-10	10	0.15
		10-20	8	
		20-30	6	
		30-40	4	
		40-50	2	
		⩾50	0	
	Slope direction	Southwest, Southeast	10	0.15
		South	8	
		West ,East	6	
		Northwest, Northeast	4	
		North	2	
Distance factor	Distance from the settlement	⩾1000	10	0.1
		1000-600	8	
		600-450	6	
		450-200	4	
		200-0	2	
	Distance from village road	⩾600	10	0.1
		600-450	8	
		450-200	6	
		200-50	4	
		50-0	2	
	Distance from water surface	0-50	10	0.25
		50-100	8	
		100-200	6	
		200-400	4	
		⩾400	2	
Land use factors	Land cover type	Waters	10	0.25
		Wetlands	9	
		Forest	8	
		Shrubland	6	
		Grassland	4	
		Arable land	2	
		Built-up area, bare land	0	

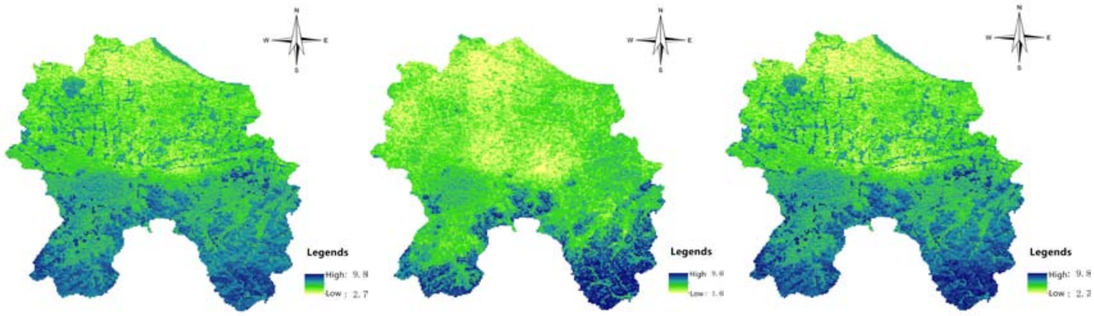
- Habitat suitability analysis of black muntjac

According to relevant literature [17], black muntjac is mainly distributed in areas with more forest coverage, usually at an altitude of more than 800m above sea level, preferring gentle areas close to water sources and areas away from artificial disturbances (Table 3).

Table 3. Habitat suitability analysis of black muntjac

Evaluation level	Evaluation factor	Classification	Score	Weights
Natural environment factors	Slope	15-30	10	0.2
		30-45	6	
		⩾45	4	
		0-15	2	
	Slope direction	South	10	0.2
		Southwest, Southeast	8	
		West ,East	6	
		Northwest, Northeast	4	
		North	2	
Distance factor	Distance from the settlement	⩾1,000	10	0.2
		1,000-600	8	
		600-450	6	
		450-200	4	
		200-0	2	
	Distance from village road	⩾600	10	0.1
		600-450	8	
		450-200	6	
		200-50	4	
		50-0	2	
	Distance from water surface	0-50	10	0.1
		50-100	8	
		100-200	6	
		200-400	4	
		⩾400	2	
Land use factors	Land cover type	Forest	10	0.2
		Shrubland	8	
		Grassland	6	
		Arable land	4	
		Wetlands	2	
		Built-up area, bare land	0	

By reviewing the literature and consulting relevant experts, we analyze the habitat requirements of egrets and black muntjacs, and determine the factors that affect the habitat selection of egrets and black muntjacs: slope, slope aspect, human disturbance, distance from water surface, land cover type. We established corresponding evaluation criteria for each factor, determined scores and weights for the evaluation factors, evaluated the habitat suitability of egrets and black muntjacs respectively, and performed the maximum value operation with gis to obtain a comprehensive evaluation of habitat suitability (Figure 5). Finally, we analyzed of the results of the study (Figure 6).



Egret Black Muntjac Overlay Result

Figure 5. Assessment of habitat suitability for single species and comprehensive species (Source Self-drawn by the author).

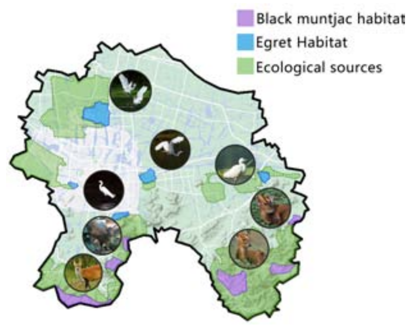
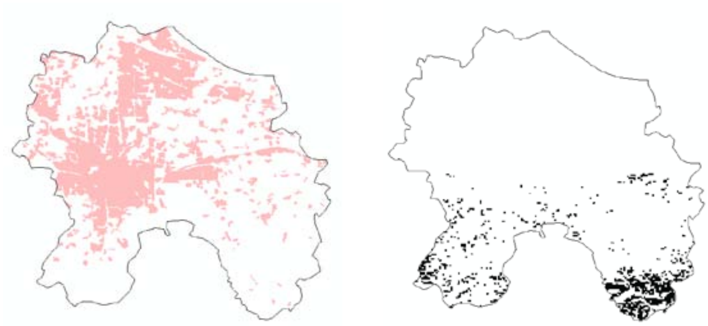


Figure 6. Analysis results of comprehensive species habitat suitability evaluation (Source Self-drawn by the author).

3.2.2 Resistance factor evaluation table and resistance surface construction results

- Identification of "source sites"

The ecological definition of "source sites" refers to the origin of species dispersal, and it is also the habitat of the studied species. This paper selects two sources to study the resistance to expansion. The selection of ecological source sites is based on the comprehensive habitat suitability evaluation of the representative species mentioned above and the priority protection units in the "Shaoxing City". Three Lines and One Single "Ecological Environment Zoning Management and Control Plan" (Figure 7). The construction source sites is the construction land in the land use type.



the construction source sites the ecological source sites

Figure 7. Distribution of the construction and ecological source sites in the Yuecheng District (Source Self-drawn by the author).

- Resistance factor determination

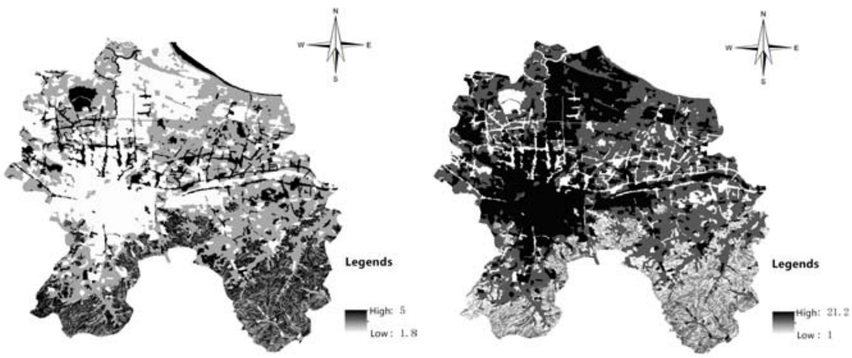
The resistance surface is a collection of elements that can generate resistance to the expansion of the source [18]. To establish a resistance surface, it is necessary to determine the resistance factors and the resistance values of different resistance factors. The resistance value is a relatively reasonable relative value given on the basis of comprehensive investigation and research on the behavioral characteristics of species, so as to reflect the difference between different resistance factors [19]. In this study, referring to Reference 18, when evaluating the resistance value of a single index, the resistance value is divided into 5 grades, and the resistance is represented by 1, 2, 3, 4, and 5 respectively. In order to make the two processes of ecological land expansion and construction land expansion be carried out under the same standard, the same resistance evaluation system is established and each opposite score is assigned, that is, the resistance values of the same factor corresponding to the ecological source and the construction source are opposite to each other. By consulting the literature, the diffusion of ecological sources and construction sources is mainly affected by the land cover type and slope. We have determined the resistance coefficients of each resistance factor to the diffusion of ecological and construction sources, thus constructing a resistance surface evaluation system table (Table 4).

Table 4. Resistance surface evaluation system table

Assignment		resistance factor	
Ecological expansion	Construction expansion	Slope	Type of land use
1	5	0-10	Waters, wetlands
2	4	10-20	Woodland
3	3	30-40	Shrubland
4	2	40-50	Arable land, Grassland
5	1	⩾50	Bare ground, Built-up areas
Weights		0.4	0.6

- Resistance Base Construction and Minimum Cumulative Resistance Surface Generation

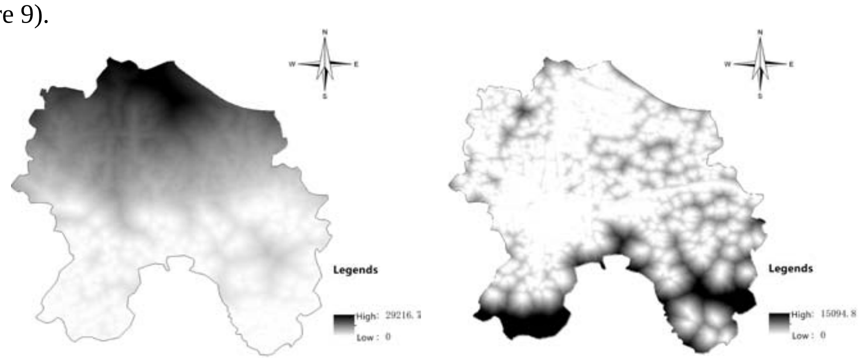
1) The reclassification tool is used to assign different scores of land use types and slopes. The grid calculator is used to calculate the weights, so as to establish the resistance factor base of ecological sources and construction sources (Figure 8).



The construction source sites The ecological source sites

Figure 8. The resistance factor base of ecological sources and construction sources (Source Self-drawn by the author).

2) We calculate the minimum cumulative resistance surface for ecological and built-up source sites using the cost distance tool (Figure 9).



The ecological source sites The construction source sites

Figure 9. The minimum cumulative resistance surface of ecological source and construction source (Source Self-drawn by the author).

- Build ecological corridors

Ecological corridors refer to the types of corridors with ecological service functions such as protecting biodiversity, filtering pollutants, preventing soil erosion, preventing wind and sand fixing, and regulating floods. Ecological corridors are mainly composed of ecological structural elements such as vegetation and water bodies, which represent the same concept as “green corridors”. From the perspective of biological conservation, the American Conservation Management Association defines an ecological corridor as “a narrow strip of vegetation for wildlife, which usually promotes the movement of biological factors between two places” [20]. In this paper, by connecting any two “ecological sources” of comprehensive judgment, superimposing the minimum cumulative resistance model, and selecting the path of least resistance, that is, the ecological corridor. We use ArcGIS to extract raster paths to form polylines and extract ecological corridors to provide support for the construction of the ecological security pattern in Yuecheng District.

3.3 Overlay analysis of MCR results

The same land use unit can promote or hinder the source of ecological protection and the source of urban construction. By comparing the advancement or hindrance of a single land use unit after rasterization, the suitable ecological protection of the land or the livability of the suitable settlement development is evaluated according to the difference between the accumulated resistances of the two ecological expansion processes. The formula is as follows: $\mathrm{F_{MCRP}} = \mathrm{F_{MCRex}} - \mathrm{F_{MCRux}}$. In the formula, $\mathrm{F_{MCRex}}$ refers to the minimum resistance to the expansion of ecological sources represented by the main ecological protection land in Yuecheng District, $\mathrm{F_{MCRux}}$ is the cumulative construction resistance to the expansion of ecological sources represented by urban and rural construction land in Yuecheng District, and $\mathrm{F_{MCRP}}$ is the difference between the two. When it is greater than 0, residential development and construction can be carried out. When it is less than 0, it is suitable for ecological security protection. For the construction of ecological security pattern, the significance of this model is to distinguish the land suitable for biodiversity conservation and the land for settlement development, so as to facilitate the adoption of different protection strategies.

3.4 Ecological security pattern analysis

The minimum cumulative resistance surface of ecological sources and construction sources in Yuecheng District simulated by ArcGIS 10.8 software. It can be seen from Figure 10 that the minimum cumulative resistance value of ecological sources is mainly concentrated in the hilly areas and natural scenic areas of Fusheng Town, Jianhu Street and Jishan Street in Yuecheng District, and gradually increases to the north. Sunduan Street is at the median value of the cumulative resistance. The minimum cumulative resistance value of the construction source is distributed in points in the central and northern part of the urban area, with higher density in the north and lower density in the south (Figure 11).

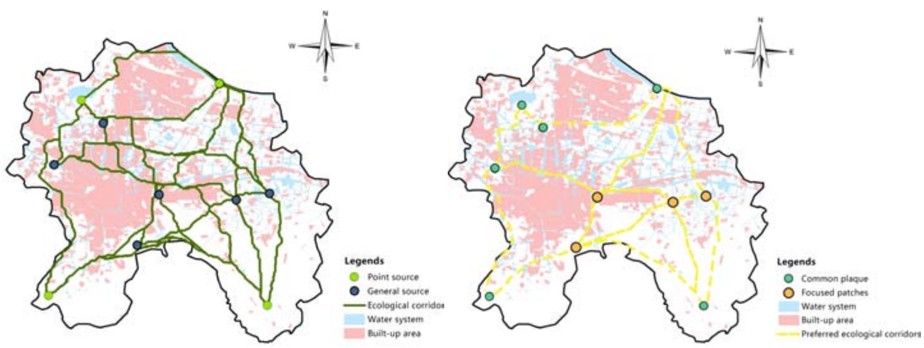


Figure 10. Minimum cumulative resistance surface in Yuecheng District (Source Self-drawn by the author).

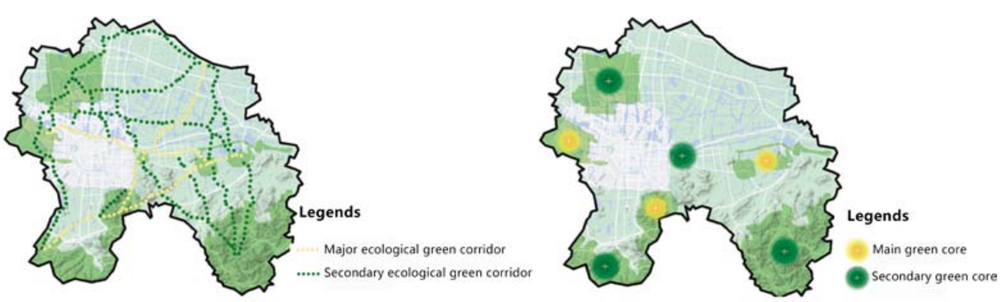


Figure 11. Construction of ecological corridors and ecological green cores in Yuecheng District (Source Self-drawn by the author).

3.5 Analysis of Ecological Resistance Model and Construction Resistance Model

According to Figure 12, the difference between the minimum accumulated resistances of ecological source expansion minus the accumulated minimum resistance of construction source expansion can be obtained. It can be seen from the figure that the southern part of Yuecheng District should be listed as a protective prohibited construction area, that is, the bottom-line control area. The northern part of Yuecheng District should be the core built-up area, and the area between the two should be the ecological buffer zone (Figure 13).

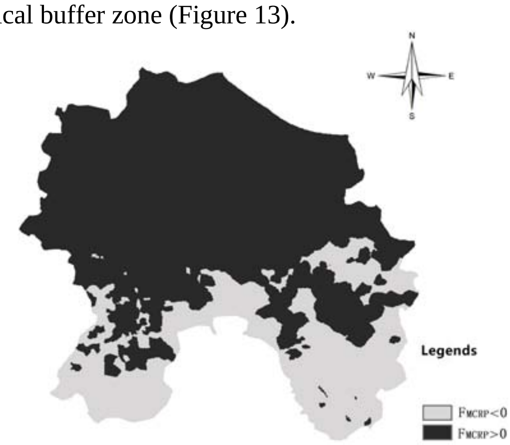


Figure 12. Surface of minimum cumulative resistance difference in Yuecheng district (Source Self-drawn by the author).

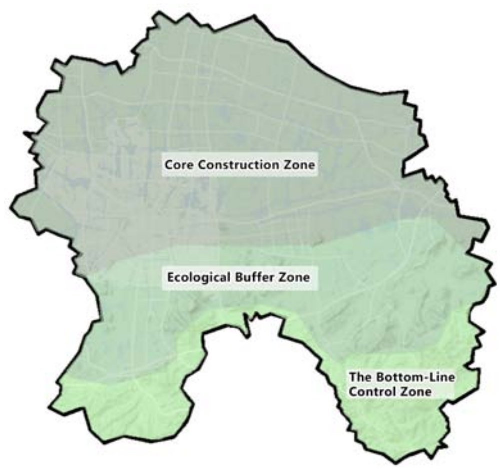


Figure 13. Schematic diagram of the division of the three districts of Yuecheng District (Source Self-drawn by the author).

4. Strategies for the design of ecological spatial pattern of rural landscape for biodiversity conservation

4.1 The bottom-line control zone: build a "green core + water corridor + green corridor" structure to promote the network of ecological spaces

Ecological sources and ecological corridors are the core parts of constructing an ecological security pattern. During the process of spatial expansion, they should implement the strictest level management and control, and insist that the ecological area and function in the bottom-line control area will not be reduced. Human activities are strictly prohibited in the ecological source area, various ecological function restoration work should be carried out, priority should be given to protecting the important habitats of aquatic and wild animals, and improving the integrity of the ecosystem.

Combining the topography, natural resources and space synergy and coupling correlation principle of Yuecheng District, we propose a rural space optimization idea for Yuecheng District (Figure 14). Based on the regional ecological red line and rural green line, we plan the regional ecological network structure. Taking mountains, water, forests, fields, lakes, and grasses as the main substrates, with forest parks and important wetlands forming the ecological green core, we abstract the basic landscape elements such as patch corridors into nodes, dividing adjacent landscape elements or ecosystem connection boundaries abstracted as lines. We have connected the main river systems to each other to form an ecological water corridor, and the green belts along the main roads and the general river systems to form an ecological green corridor to build a protection network at the village street level. We strengthen the main ecological green core to embellish the ecological base, pay attention to the ecological corridor connecting the ecological green core more directly, add ecological stepping stones (green patches), and construct "green core", "water corridor" and "green corridor" (Figure 15), improve the ecological benefits of green space, so as to build an organically connected overall multi-level, networked rural ecological network pattern (Figure 16).

Figure 14. Schematic diagram of the hierarchical maintenance strategy for the three districts in Yuecheng District (Source Self-drawn by the author).

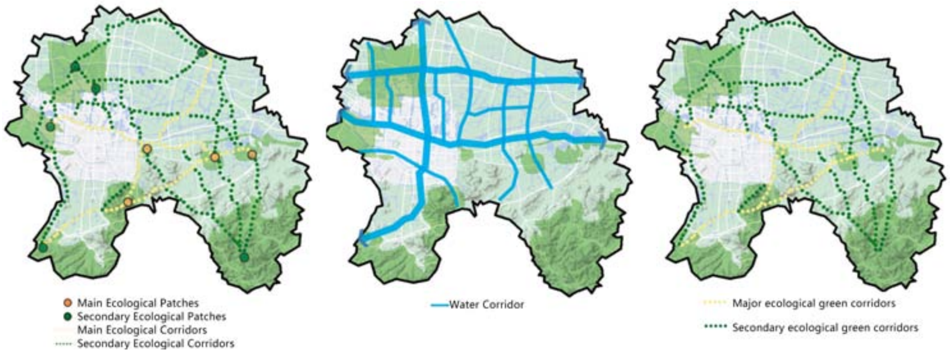


Figure 15. "Green core + water corridor + green corridor" structure (Source Self-drawn by the author).

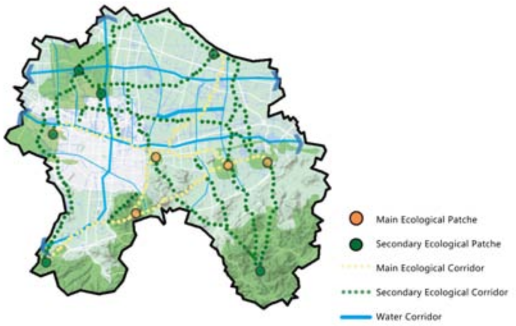


Figure 16. Schematic diagram of the superposition of green core, water corridor and green corridor (Source Self-drawn by the author).

4.2 Ecological buffer zone: low construction rate, greenways, recuperation

Buffer zones are also an important component of ecological security patterns as a back-up resource for the expansion of ecological source sites and to isolate them from external disturbances. The buffer zone is in the transition area between urban expansion and ecological source land, and its development and construction should be reduced and protected (Figure 17) to bring into play rural ecosystem services and ecotourism functions and promote the optimization of the rural ecological environment. Making full use of rural waters and green spaces, strengthening environmental management while carrying out landscape transformation, creating healing and recreational rural landscapes, preserving some wastelands dominated by natural processes, increasing the diversity of habitats, and increasing the complexity of the structural composition and structure of rural green space types. Under the framework of the rural green space system and the greenway network, a walking-based slow walking system is connected and improved, providing a beautiful rural leisure space for the surrounding residents to walk and jog and relax in a way that does not reduce the amount of greenery and shade, bringing a green, ecological, healthy and pollution-free rural life to the people. In terms of construction materials and facilities, it is recommended that ecological, green, environmentally friendly, low-carbon and other relevant aspects be considered, aiming for a minimum impact on the environment. It can create conditions in which people and nature can live in harmony, enabling rural nature to reach a self-healing, self-cycling approach and protecting rural biodiversity.

Figure 17. Habitat Network System and Three-Zone Indicative Plan (Source Self-drawn by the author).

4.3 Core construction zone: promoting human interaction and creating a picture of a healthy and ecological future village

The ecological safety level of the core construction area is at a high level in the region. The natural ecological environment is more stable and the slope is gentler, which makes it suitable for the further strengthening of the construction and expansion of rural settlements, which can take on more productive and living functions. The countryside is an area with a dense concentration of people. In the core built-up area, synergistic benefits should be used as a guiding principle for biodiversity management in the countryside from the perspective of the countryside residents, taking into account the relationship between people and wildlife, respecting each other's living space and pursuing harmonious co-existence. Rural settlements in the core construction area can develop special industries by tapping into the natural and cultural resources of the countryside, so that economic growth can lead to rural revitalisation and achieve high-quality development goals.

In the urban areas of Yuecheng District, the areas with flat terrain, good access and rivers are the most suitable and have the greatest potential for optimisation. By linking the land for rural construction with the land for ecology, the overall optimisation of spatial use is continuously promoted. We promote the transformation of the built-up areas of the countryside into green, low-carbon and ecologically livable areas, ultimately achieving a harmonious coexistence between natural ecology and rural construction, creating a healthy and ecological picture of the future countryside (Figure 18).

Figure 18. Aerial view of ecological security pattern in Yuecheng District (Source Self-drawn by the author).

5. Conclusion

The countryside is a treasure, and the ecological security of the countryside is affected by the city in a dynamic and multi-dimensional manner. The biodiversity and ecological security of the countryside are also important guarantee factors for everyone to live a healthy life. These are the focus of subsequent attention, including how to better integrate ecological control with urban and rural development objectives, how to better coordinate rural development with ecological protection, how to better actively allow the Sansheng spaces to take root in the countryside, how to enhance the implementability of strategies for optimising rural ecological safety, and how to establish a long-term mechanism for ecological development of the countryside.

Results of quantitative studies showed high self-assessment of health professionals in connection with HH, on the contrary, assessment of complying with a process of HH of their colleagues is significantly lower, which may be an evidence of poor compliance with HH in the clinical practice. Attitudes and perceptions of the importance of HH in specific clinical situations signal a high intensity, which indicates that HW perceive HH as an useful measure of prevention of NI and its lack of compliance with HH is for the most respondents perceived as a risk of transmission of infection to a patient.

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References

[1] Yu Kongjian. (2006). The construction of new countryside from the perspective of ethics: the trap and way out of the “new Taoyuan” [J]. The Impact of Science on Society, 2006(03): 26-31.

[2] Xu Yiqing, Yu Dingyi, and Ran Jing. (2021). Construction method of rainwater safety pattern in land space based on watershed coordination [J]. Journal of Natural Resources, 2021, 36(09): 2335-2349.

[3] Yu Kongjian, Li Dihua, Liu Hailong, and Cheng Jin. (2005). Urban Spatial Development Pattern Based on Ecological Infrastructure: The Case of Taizhou of “Anti-planning” [J]. Urban Planning, 2005(09): 76-80+97-98.

[4] Yu Kongjian, Li Dihua, and Duan Tiewu. (2001). Landscape security pattern design and geographic information system application in sensitive areas: Taking Beijing Xiangshan Ski Resort as an example [J]. Chinese Landscape Architecture, 2001(01): 11-16.

[5] Lv Chenyang, Jin Kun, and Wang Xiulei. (2014). Evaluation of potential habitat suitability of saiga antelope in Dongshawo area of Wuwei [J]. Ecological Science, 2014, 33(5): 931-936.

[6] Dalerum, F., Somers, M. J., and Kunkel, K. E., et al. (2008). The potential for large carnivores to act as biodiversity surrogates in southern Africa. Biodiversity and Conservation, 2008, 17(12): 2939-2949.

[7] Yu Kongjian, Wang Sisi, and Li Dihua. (2011). Regional Ecological Security Pattern: Beijing Case [M]. Beijing: China Construction Industry Press, 2011.

[8] Vallon, M., Dietzen, C., and Laucht, S., et al. (2018). Focal species candidates for pesticide risk assessment in European rice fields: A review [J]. Integrated Environmental Assessment and Management, 2018, 14(5).

[9] Lv Chenyang, Jin Kun, and Wang Xiulei. (2014). Evaluation of potential habitat suitability of saiga antelope in Dongshawo area of Wuwei [J]. Ecological Science, 2014, 33(5): 931-936.

[10] Liu Bingwan, Gu Li, and Zhang Bo, et al. (2012). Habitat suitability evaluation of Mongolian gazelle in the Dalai Lake area of Inner Mongolia [J]. Journal of Ecology, 2012, 31(10): 2568-2572.

[11] Wang Jia, Gao Jing, Yuan Muqian, Sun Qiaoyun, and Li Shuai. (2021). Construction of rural landscape ecological security pattern from the perspective of biological protection: Taking Houjialou Village, Yongan Town, Fenxi County, Linfen City, Shanxi Province as an example [J]. Ecological Science, 2021, v.40, No.151, (01): 155-161. DOI: 10.14108/j.cnki.1008-8873.2021.01.020.
[12] Huang Tianli. (2019). Habitat selection of egrets in Hangzhou urban area [D]. Zhejiang Agriculture and Forestry University, 2019.
[13] Chen Liang. (2007). Seasonal changes in habitat characteristics and habitat selection of black muntjac [D]. Zhejiang Normal University, 2007.
[14] Huang Tianli. (2019). Habitat selection of egrets in Hangzhou urban area [D]. Zhejiang Agriculture and Forestry University, 2019.
[15] Zhou Jiajun. (2011). Research on habitat selection of egrets based on GIS technology [D]. Nanjing Forestry University, 2011.
[16] Xiong Hao. (2014). Study on the habitat selection of egrets in Sichuan Urban Wetland Park [D]. Sichuan Agricultural University, 2014.
[17] Chen Liang. (2007). Seasonal changes in habitat characteristics and habitat selection of black muntjac [D]. Zhejiang Normal University, 2007.
[18] Tang Peng, Wang Hao. (2019). Suitability analysis of modern urban green space sponge based on MCR model [J]. Journal of Nanjing Forestry University (Natural Science Edition), 2019, v.43, No.201(03): 116-122.
[19] Li Jianfei, Li Lin, and Guo Luo, et al. (2016). Evaluation of ecological suitability of Zhuhai based on the least cumulative resistance model [J]. Journal of Applied Ecology, 2016, 27(1): 225-232.
[20] Zhu Qiang, Yu Kongjian, and Li Dihua. (2005). The width of ecological corridors in landscape planning [J]. Journal of Ecology, 2005(09): 2406-2412.