Low-Carbon Rural Landscape Optimization Strategy Based on Green Infrastructure Evaluation

Jikun Chen *, Zhu Wang

College of Civil Engineering and Architecture, Zhejiang University, Zhejiang, China
* Corresponding author: Jikun Chen

Abstract: Under the background of the new urbanization policy, it has become a general consensus to seek a low-carbon sustainable development urbanization model. The transition from a high-carbon extensive development model to an intensive and efficient low-carbon rural development model will be the development direction of the construction of rural human settlements in the future. Based on the analysis of the existing rural "high carbon emissions" and "low carbon sinks" realistic problems, this article believes that the protection of rural ecological space layout, coordinate the value balance of rural production space, living space and ecological space are the key to future. Subsequently, based on the core technology of green infrastructure evaluation, a green infrastructure evaluation system suitable for rural areas was constructed. At the same time, the theory and methods of restoration ecology were introduced into the evaluation system, and the rural human settlement environment in the studied area was analyzed and evaluated. Finally, in combination with the low-carbon goal of "increasing sinks and reducing emissions", we further propose specific strategies for optimizing and reorganizing rural landscape patterns, aiming to provide strong support for exploring low-carbon sustainable development paths suitable for ecologically sensitive villages.

Keywords: new-type urbanization; green infrastructure assessment; rural landscape; ecological sensitive area; low-carbon strategy

1. Introduction

Since the reform and opening up, the urbanization rate of China's permanent population has increased from 17.9% to 53.7%, and remarkable achievements have been made in urban construction. However, in the process of rapid urbanization, the development of urbanization under the traditional model has also brought a series of thorny problems. Traditional rural development and modern urban civilization are in fierce confrontation. Traditional urban planning and design techniques characterized by "high carbon emissions" have become popular in rural planning and construction, which has caused acute problems; on the other hand, it is not uncommon for the ecological space characterized by "low carbon sinks" to be eroded and receded [1]. Therefore, constructing an urban human settlement environment model under the goal of "increasing sinks and reducing emissions" is a feasible path to achieve a new type of urbanization, and maintaining the value balance between carbon sources and carbon sinks is the best risk for the existing sharp contradictions.

2. Rural Human Settlements under "High Carbon Emissions" and "Low Carbon Sinks"

2.1 Rural Planning and Construction Promote "Carbon Emissions" to Rise Steadily

The current high-energy, high-consumption, high-cost, and high-waste "high carbon emission" model in rural construction is obviously contrary to low-carbon goals. This model also violates the original simple ecological laws and construction wisdom of the country. At the same time, carbon emissions and the process of urbanization are intertwined, and the traditional economic development-oriented urban development model has brought about a series of problems such as the rapid deterioration of the ecological environment and the shortage of resources and energy. Taking the road of low-carbon sustainable development has become a consensus, among which, the establishment of a high-energy-efficiency, low-energy consumption, and low-emission urban construction development model has gained global recognition. In the context of the low-carbon boom, research on low-carbon villages is particularly important.

2.2 Rural Ecological Destruction causes Insufficient "Carbon Sink" Capacity

Vegetation, wetlands and microorganisms in the rural landscape are important "carbon sink" land, and their inherent ecological service functions can support a benign human settlement environment. The acceleration of urbanization has led to the continuous expansion and expansion of urban construction land, while the rural natural environment and ecological space have continued to shrink. The original rich and complete rural landscape

green space system is strongly divided, the green space habitat tends to be fragmented, the normal structure and function of the natural system are damaged to varying degrees, and the "carbon sink" function is continuously weakened [2]. Under the climax of new rural construction, the naturalized and semi-natural patchy landscapes of the countryside are gradually replaced by artificial hard pavement landscapes, and the maintenance costs of rural construction and carbon sinks are gradually increasing.

2.3 The Imbalance between Rural Planning and Construction and Ecological Protection

The rural landscape under the characteristics of "high carbon emission" and "low carbon sink" has the problem of value imbalance between rural construction and ecological protection, that is, economic development-oriented rural construction is eroding the ecological environment while seeking its own development. Causing serious damage to the habitat. In the context of the current new urbanization, rural construction should abandon the old thinking of "development first, then protect", and follow the balance of development and protection according to its own characteristics, so as to achieve low-carbon rural people guided by the goal of increasing foreign exchange and reducing emissions. Housing environment construction.

3. Low-Carbon Model of Rural Human Settlements

3.1 Rural Human Settlements under the High-Carbon Model

The "high carbon emissions" in rural areas mainly come from production and life. From the perspective of rural production space, on the one hand, it is the transformation of rural industrial structure: gradually shifting from the primary industry to the secondary and tertiary industries, and intensive farming and handicraft industries are replaced by high-carbon industries and tourism. On the other hand, the high-carbon model of high-emission and high-energy-consuming production in township enterprises and the lack of environmental protection supervision have made the high-carbon tendency more serious. From the perspective of rural living space, the limitations of the traditional lifestyle of rural residents, such as the backward energy structure represented by logging and firewood, and the popularity of private cars and the increase in trucks have led to a change in the transportation mode of rural residents from "zero carbon". The transition to "high carbon" is the main reason for the "high carbon emissions" in the villages.

3.2 Optimization of Rural Human Settlements under Low-Carbon Mode

Production space, living space and ecological space constitute a complete rural human settlement system. The current imbalance between carbon sources and carbon sinks is mainly due to the blind expansion of production and living spaces that are not constrained by ecological space and natural resources, and the ecological service value of the ecological space as an important carbon sink space has not been reflected, "passive defense "Instead of "proactively attack." The low-carbon model of rural space optimization should reduce the carbon emissions of production spaces and living spaces, improve the carbon sink capacity of the ecological space, enhance the function of the carbon sink system, and reflect the original ecological value of the ecological space (**错误!未找到引用源。**).

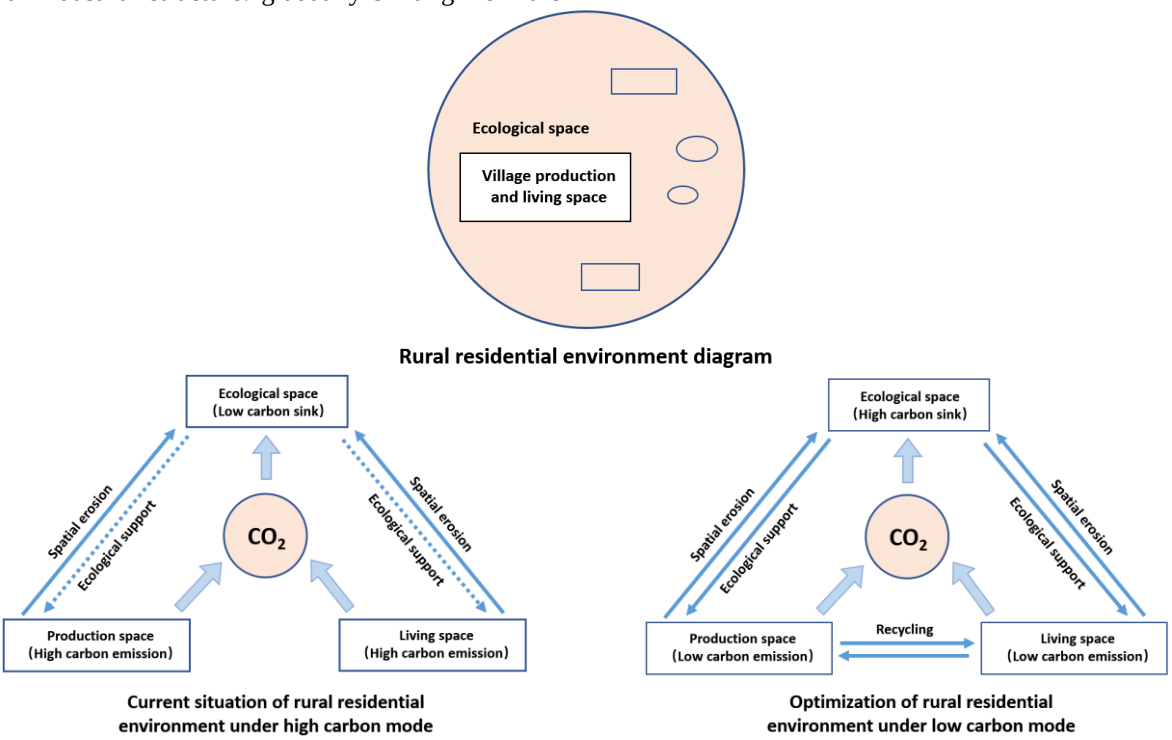

Figure 1. Carbon emission and optimization mode of rural residential environment

3.3 A New Research Framework from an Ecological Perspective

The existing research results on low-carbon villages are relatively rich. Among them, Guo Liying and others combined with the renovation of hollow villages and proposed four ways to achieve low-carbon village construction by reducing energy consumption, reducing pollution, reducing emissions, and increasing carbon sinks [3]. Dong Weiwei and others have established a low-carbon rural indicator evaluation system from eight aspects, including low-carbon industrial structure and low-carbon agricultural production [4]. Wei Huilan and Yang Binru put forward an industrial strategy for China's low-carbon rural development by analyzing the relationship between rural industrial structure and low-carbon rural development [5]. In practice, Dong Weiwei, Liu Pengfa and others have rationally optimized the village planning of Shitou Village in Pan'an County based on a low-carbon perspective [6]. Shipunan and Luo Mingcan have established a suitable low-carbon village evaluation index system based on the regional characteristics of Yuanjiang County, Yunnan Province [7]. Most of the existing research results focus on the production and industrial structure of low-carbon villages, and have not explored the optimization of the rural landscape under the goal of "increasing foreign exchange and reducing emissions", thus failing to effectively structure the ecological space, production space, and living space. The low-carbon cycle of China fundamentally optimizes the rural landscape. However, in terms of balancing economic development and ecological landscape protection, green infrastructure construction can be described as a "weapon". As a natural life support system, it is a smart way to combine land development and ecological protection and efficiently solve ecological protection problems with a network structure [8].

This paper takes the ecologically sensitive area, the area where the contradiction between rural development and ecological protection is the most acute, and uses appropriate analysis and evaluation tools to build a rural GIA landscape optimization system suitable for ecologically sensitive areas to provide valuable decision-making basis for ecological protection and restoration. Under the guidance of the low-carbon target of "increasing sinks and reducing emissions", increase the functions of the carbon sink system, reduce carbon emissions from the source, and construct spatial strategies, implementation strategies and development strategies based on sinks increase and emission reductions (**错误!未找到引用源。**).

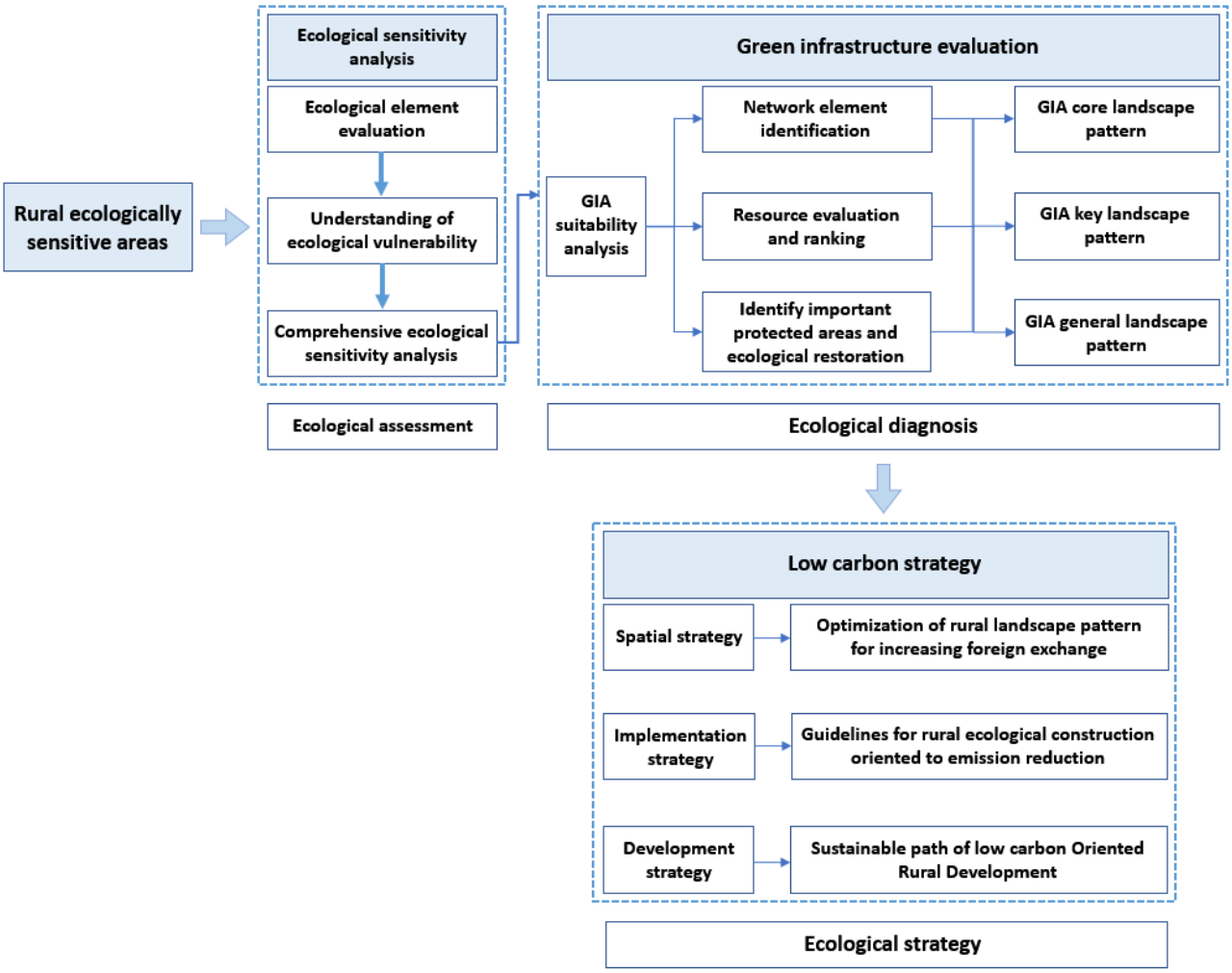

Figure 2. Research framework

4. Construction of Low Carbon Rural Landscape Evaluation System

4.1 Ecological Assessment: Ecological Sensitivity Analysis

Firstly, the ecological sensitivity of the studied area is analyzed, including single factor and multi factor superposition analysis. Through the evaluation indexes of geology, landform, slope, hydrology, biodiversity, soil and climate factors, analyze the adaptability of ecological factors to external pressure or external interference without loss or reduction of environmental quality, so as to form a comprehensive understanding of rural environmental elements in ecologically sensitive areas, More targeted understanding of the environmental advantages and constraints of rural development in ecologically sensitive areas.

The rural ecological environment in ecologically sensitive areas is relatively fragile, but at the same time, it is also the most important part of the regional ecosystem, which plays a role of "pulling one hair and moving the whole body" to the whole regional ecosystem. Moreover, the restoration ability of natural ecological elements in ecologically sensitive areas is weak, which is more likely to cause large-scale ecological degradation. The theory and method of restoration ecology is a good solution to the damaged ecological space in ecologically sensitive areas. The original green infrastructure theory is based on the theories of landscape ecology and conservation biology. This paper applies the principle of restoration ecology to the theory of green infrastructure, and determines the ecological gap and ecological restoration area in the GIA evaluation of rural landscape in ecologically sensitive areas, in order to restore the regional ecological service function and improve the ecological network (Figure 3).

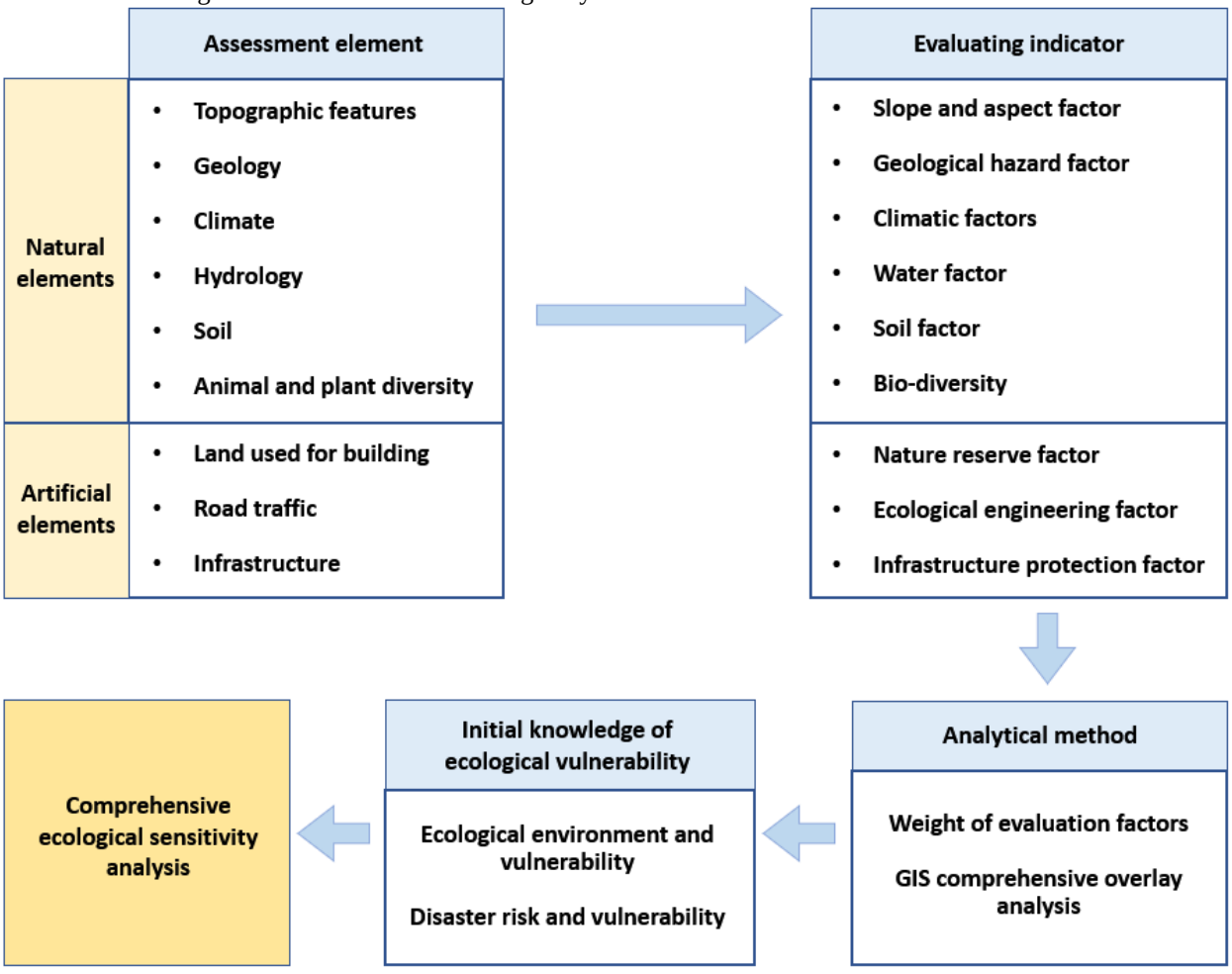

Figure 3. Ecological sensitivity analysis framework

4.2 Ecological Diagnosis: Suitability Analysis of GIA for Rural Areas

4.2.1 GIA element identification

Most of the cases of green infrastructure evaluation are urban, and its framework construction and research system are relatively complete. At present, there are few GIA practices for rural areas. Rural areas are different from cities, and rural landscape is more different from urban landscape. The urban landscape is mainly artificial landscape, taking into account the functions of leisure and recreation, which is manifested in parks, production green spaces, protective green spaces, etc., and spatially reflected in the embedding of green spaces into the urban pattern; the rural landscape is dominated by large-scale natural ecological resources, mainly including farmland and forest land. Spatially, it is reflected that rural settlements are embedded in the natural environment,

which is just opposite to the map bottom relationship of the city. Therefore, in GIA evaluation, specific evaluation indicators should be selected for villages, especially villages in ecologically sensitive areas.

The identification of GIA elements includes the identification of hubs, corridors and buffer zones [11]. Based on the characteristics of rural landscape and the unique natural geographical environment of the study area, the hub is divided into forest land, farmland, pond, hill and so on; the corridor mainly includes rivers, green belts and wetlands; the matrix mainly includes settlement construction land. It is mainly evaluated and measured by landscape pattern indexes such as porosity, shape, density and heterogeneity (Figure 4).

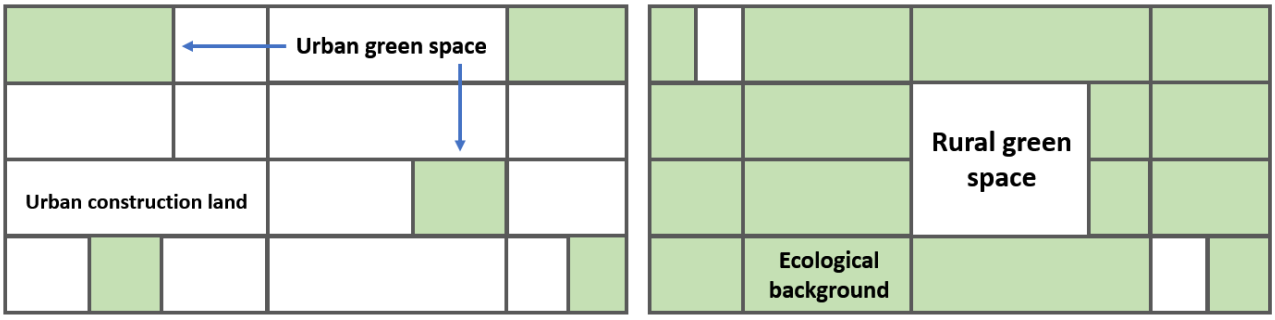

Figure 4. The difference between urban landscape and rural landscape

4.2.2 Evaluation and ranking of GIA resources

The evaluation and ranking of GIA resources aims to judge the importance of identified natural elements in the whole ecosystem, so as to formulate corresponding ecological protection policies. The evaluation and ranking of rural GIA in ecologically sensitive areas are carried out at two levels: the level of GIA network elements (hub, corridor and buffer zone) and the level of map grid unit. At the element level of GIA network, it mainly evaluates and sorts the land use types, identifies the ecological land types of biodiversity, determines the construction time sequence, and formulates differentiated ecological technical guidelines; At the grid unit level of GIA map, the advantages and disadvantages of specific plots are compared and analyzed, the plots with higher ecological value are determined, and the protection areas are classified according to the system of different value levels. For hubs and corridors of considerable ecological importance, the areas that may cause the greatest harm after being damaged need priority protection.

4.2.3 Evaluation and ranking of GIA resources

Through the evaluation and ranking of GIA resources, the most important and irreplaceable priority protection area is determined as the core landscape area of GIA. Effective protection policies are formulated according to the protection status, ecological value evaluation and comprehensive development risk evaluation, and the landscape pattern of corresponding areas is optimized and adjusted. GIA core landscape area mainly includes the hub with the highest ecological value and the top 50% of land development risk, the corridor linking this hub and the top 50% of development risk, etc. The key landscape areas of GIA with weak ecological value and development risk assessment shall be adjusted appropriately without compromising the overall goal of ecological protection. GIA general landscape area mainly includes rural settlement construction land and some areas with low ecological value. For such areas, rural settlement oriented optimization is mainly carried out. Taking different measures according to different evaluation results can spend as few resources as possible to maximize the protection objectives [12].

5. Ecological Countermeasures: Low Carbon Strategy for Rural Landscape Optimization

5.1 Spatial Strategy: Optimization of Low-Carbon Rural Pattern for Increasing Foreign Exchange

"Increasing sink" refers to improving the function of carbon sink system. Vegetation has good carbon storage function. The low-carbon strategy should absorb and fix carbon dioxide in the atmosphere through afforestation, reducing deforestation, protecting and restoring vegetation and other measures. Through GIA evaluation, under the goal of increasing foreign exchange, the rural landscape pattern optimization with the optimal allocation and adjustment of landscape pattern as the core should retain the rural natural space as reasonably as possible [13]. Landscape planning can optimize the combination between rural settlement space and natural ecological elements, realize the reasonable and scientific layout of rural ecological space and other sink increasing space, strengthen the ecological combination of "carbon sink" elements in spatial position, and realize the optimization of rural landscape pattern and the development of low-carbon villages. The main measures to optimize the rural landscape pattern in ecologically sensitive areas are as follows: for areas with high degree of landscape fragmentation, connect the overall landscape structure, optimize the landscape corridor, and treat different types of corridors such as rivers, roads and greenways differently according to their respective landscape functions; Flexibly plan and guide the layout of ecological space, and establish the principle of hierarchical ecological space protection. Through the analysis of key protected areas by GIA, the areas requiring ecological restoration are determined, and ecological restoration is carried out in combination with the relevant theories of restoration ecology. The ecological gap of degraded terrestrial ecosystems such as forest cutting land, abandoned cultivated land, mining wasteland and waste dump shall be restored and reconstructed. The main restoration

technologies include replanting of natural elements and restoration of ecosystem (Figure 5). Rely on the self-regulation and restoration ability of the ecosystem or supplemented by artificial measures to gradually restore the damaged ecosystem or make the ecosystem develop in the direction of virtuous cycle.

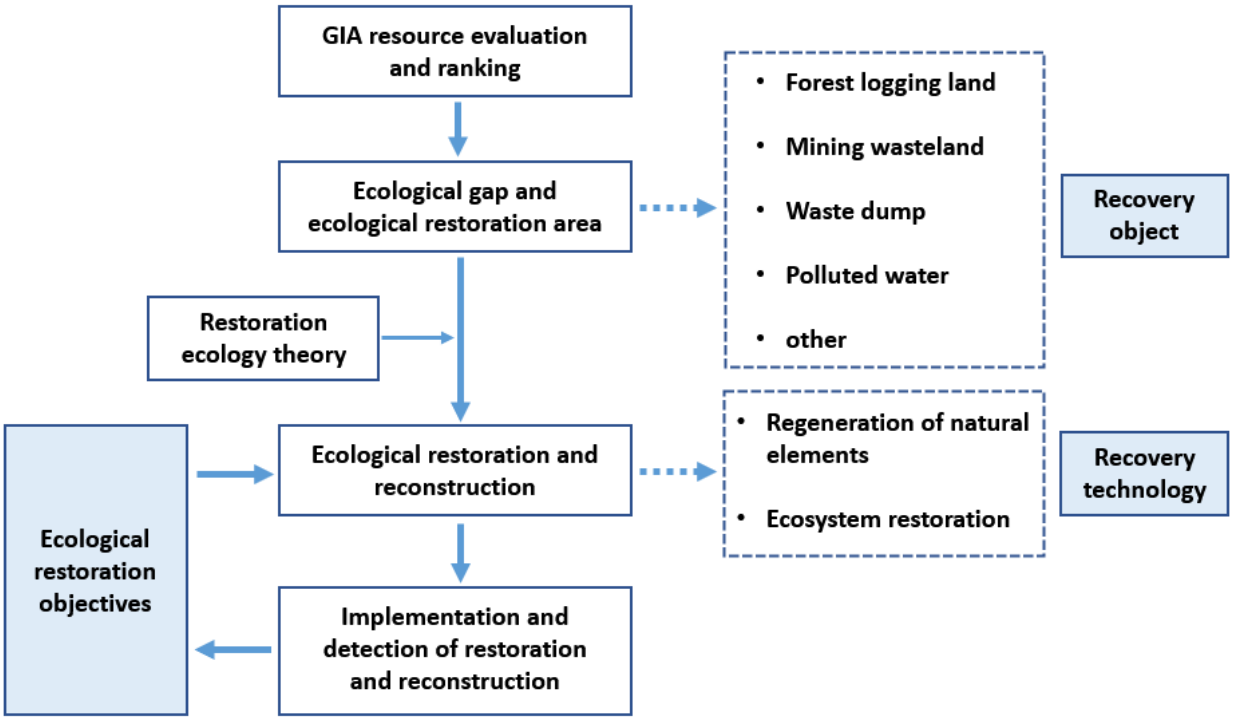

Figure 5. Ecological recovery process

5.2 Implementation Strategy: Guidelines for Ecological Construction of Rural Settlements for Emission Reduction

"Emission reduction" refers to reducing carbon emissions from the source. The source of rural high carbonization lies in the high energy, high consumption, high expenditure, high wave fee and rural high carbonization lifestyle of rural construction mode. Under the emission reduction target, rural areas can build the ecological construction guidelines of rural settlements through the transformation of economic development mode, the transformation of traditional lifestyle and the introduction of low-carbon ecological technology. On the basis of rational layout of rural ecological space, guide rural infrastructure construction based on the idea of emission reduction. Rural infrastructure mainly includes water supply and drainage facilities, garbage collection and treatment facilities, safety and disaster prevention facilities, roads, bridges and safety facilities. Water supply and drainage facilities shall take ecological measures related to rainwater and flood management, such as dry wells, grass ditches, reservoirs, etc. for rainwater and sewage treatment. At the same time, we can also carry out the ecological construction of rural infrastructure from the technical measures and construction methods such as material selection and planting design, and pay attention to improving the ecological benefits of ecological land by improving the system quality of current ecological space.

5.3 Implementation Strategy: Guidelines for Ecological Construction of Rural Settlements for Emission Reduction

According to the positioning of landscape function. Villages can be divided into ecological protection villages, ecotourism villages, ecological agriculture villages, agricultural production villages and agricultural economy villages. According to the ecological needs of different types of villages, we can realize the sustainable development of "win-win in producing areas" by reasonably distributing the ecological space and constructing the ecological pattern of "man land symbiosis". Ecologically protected villages are dominated by ecological protection and have superior natural conditions. Abundant space for increasing foreign exchange such as water resources and forest resources; Ecotourism villages mainly develop ecotourism and have obvious advantages in ecological environment. However, the potential development risk is large: eco agricultural villages are mainly economic forests, fruit forests and greenhouse vegetables. We should pay attention to the negative impact of ecological economy; the primary - industry plays a leading role in agricultural production-oriented villages. There are many farmland and cultivated land, which should be reasonably distributed: Agricultural Economic villages focus on development. We should focus on ecological protection and ecological restoration.

6. Epilogue

The construction of urban and rural living environment is an important strategic node to promote new urbanization in China in the future. As a simple organism under self-organization, rural areas can become a benign link between artificial environment and ecological protection. From the perspective of carbon source and carbon sink. Building a sustainable development model under the guidance of low-carbon goal is the inevitable path of rural

construction and development in the future. It is also a strong response to the new urbanization strategy. Based on the analysis of the existing problems of rural "high carbon emission" and "low carbon sink". It is further proposed that the optimization of human settlements under the low-carbon rural model lies in balancing the value balance between production, life and ecological space. Then, green infrastructure evaluation is taken as the technical core of building a low-carbon rural human settlements model. Thus, it provides a new idea and strategy for low-carbon rural construction and development and ecological protection: from the traditional habitat protection with species as the core to the protection of the overall rural landscape pattern. It aims to optimize the relationship between production, life and ecological space. At the same time, the practice is guided by the low-carbon goal of "increasing foreign exchange and reducing emission". This paper constructs a set of optimization and reorganization methods of the most ecological space suitable for rural areas, and puts forward the optimization strategy of rural landscape pattern and ecological construction guidelines based on "increasing foreign exchange and reducing emission", so as to provide reference for the construction and sustainable development of low-carbon villages.

References

[1] Shan ZR, Huang YP. Analysis of concept connotation, target content, planning strategy and cognitive misunderstanding of new urbanization. Journal of urban planning, 2013, (02): 16-22.

[2] Zhao D, Wang DH. Study on the impact of land use change on ecosystem carbon sink - carbon source - a case study of Wu'an city, Hebei. Anhui Agricultural Science, 2010, (11): 5922 – 5924.

[3] Guo LY, Liu Y, Li YR. Discussion on comprehensive improvement of hollow village and low-carbon rural development strategy. Regional research and opening up, 2012, 31(01): 116-119.

[4] Dong WW, Ma YJ, Bi L. Discussion on index evaluation system of low carbon countryside. Hunan Agricultural Science, 2012, (01): 154-156.

[5] Wei HL, Yang BR. Industrial strategy for low carbon rural development in China. Gansu Social Sciences, 2014, (04): 211-214.

[6] Dong WW, Liu PF, Ma YJ. Exploration of rural planning based on low-carbon perspective -- Taking the village planning of Shitou village, Anwen Town, Pan'an County as an example. Journal of Zhejiang Normal University (NATURAL SCIENCE EDITION), 2012, 35(04): 459-465.

[7] Shi PN, Luo MC. Construction and practical research of low carbon rural evaluation index system -- Taking Yuanjiang County, Yunnan Province as an example. Anhui Agricultural Science, 2013, 41(21): 9126 – 9127.

[8] Pei D. Network approach and priority evaluation of ecological protection -- "green infrastructure" smart protection strategy. Journal of Peking University (NATURAL SCIENCE EDITION), 2012, (09): 848-854.

[9] Mark A B, Edward T M. Green Infrastructure: Smart Conservation for the 21st Century. Washington, D.C.: Sprawl Watch Clearinghouse, 2001.

[10] Talska M A. Stakeholders Perceptions of Green Infrastructure-Case Study based on Green Infrastructure Initiative in Bedfordshire. Oxfordshire: Cranfield University, 2007.

[11] Weber T, Wolf J, Blank P, et al. Restoration Targeting in Maryland's Green Infrastructure. Maryland: Maryland Department of Natural Resources, 2004.

[12] Li YH, Wang Z. Review of Maryland green map plan and Its Enlightenment. Journal of architecture, 2010, (S2): 26-32.

[13] Peng ZW, Wang YC, Gao J, et al. Research on village development strategy and planning in ecologically sensitive areas. Journal of urban planning, 2013, (03): 714.