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Research on traditional rural planning strategy in eastern Hebei Province under carbon neutrality goal

-- A case study of Malanguan Village

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Abstract

Under the goal of carbon neutrality, rural planning, as an important part of national space planning, has become an important place to build green development. In order to explore the measures and ways to achieve the goal of carbon neutrality in rural areas, this paper selects Malanguan village, a traditional village in eastern Hebei Province, and quantitatively analyzes the carbon emission and carbon sink in the village from the perspective of land nature and villagers' activities. The paper proposes four planning strategies for building a carbon activity index platform for rural areas, constructing a green and orderly planning pattern, creating an ecological space with green water and green mountains, and creating a livable and viable rural space. From overall control to specific construction, the paper discusses ways and methods, in order to provide ideas for the scientific and reasonable planning and development of other similar villages.

Keywords

Rural planning, Carbon neutrality, Carbon emissions, National space planning, Rural living environment, Malan Guan one village.

1. Introduction

Since the reform and opening up, in order to improve the national level, rapid urbanization and industrialization have been carried out. The high-level development is accompanied by a large amount of energy consumption and changes in various aspects. A series of resource problems have also appeared while economic growth, and the total carbon emission is also increasing rapidly. At present, China's carbon emissions account for more than 30% of the global total, making it a major carbon emitter. Based on this, at the 75th session of the United Nations General Assembly, China proposed to strive for the peak of carbon dioxide emissions in 2030, and strive for carbon neutrality in 2060, that is, the "3060" "dual carbon" development goal, which is the overall requirements for the whole society in terms of energy conservation and emission reduction.

According to relevant studies, urban carbon emissions are higher than rural areas, but with the continuous advancement of the national rural revitalization strategy, the urban-rural integration development pattern continues to improve, and the basic spatial pattern of rural areas is transformed in the change. Theoretically speaking, rural transformation is a dynamic and complex system involving development, agricultural production and rural ecology[4]. According to the Bureau of Statistics, China's rural population will be 795 million in 2021, accounting for 62.34 percent of the total population, and there will still be 477 million in 2023, accounting for 33.84 percent of the total. Although the rural population is decreasing, in recent years, under the urbanization and construction of new villages, the energy consumption intensity of rural residents in China has also increased significantly, which is 3.2 times that of 2001, and the carbon emission in rural areas has gradually shown a trend of rising. Therefore,

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the state has put forward a number of requirements for the construction of rural areas to promote the realization of the goal of carbon neutrality in rural areas. The "Implementation Plan for Carbon Emission Reduction and Sequestration in Agricultural and rural areas" requires "actively developing green and low-carbon agricultural and rural areas", and the No. 1 Central text in 2024 emphasizes "Building an IKEA and beautiful rural area", reflecting the importance the country attaches to rural areas.

Through the use of CNKI database to study the "carbon neutrality" in rural areas, it can be found that: first of all, the results are mostly concentrated in the study of low-carbon rural development path to reduce carbon emissions, such as the application of energy-saving technology, the development of new building materials and other technical aspects of the application of research or design strategies related to rural production, life and ecological space. Secondly, the quantitative research results related to carbon calculation, such as carbon emission accounting methods and carbon budget and carbon balance research under the national space system. However, there are few researches on rural planning and development through quantitative analysis. This paper will take the traditional villages in eastern Hebei as the research scope, analyze the problems existing in the traditional rural planning in this area, explore the green and low-carbon development strategy, optimize the rural spatial pattern, and provide development ideas for the same type of villages to achieve the goal of "carbon neutrality".

2. There are problems in traditional villages in eastern Hebei Province

2.1. Rural development defects in eastern Hebei Province

The rural areas in East Hebei mainly include Tangshan and Qinhuangdao in the northeast of Hebei Province, near Yanshan Mountain in the north and Bohai Bay in the southeast. The terrain is high in the northwest and low in the southeast, and reaches the coast. The whole area is divided into two major geomorphic regions: Yanshan Mountain hilly area and Luanhe Plain area. The natural topography and climate make the villages in these areas generally have cold winters and hot summers and poor comfort levels. The specific development defects of villages are summarized in the following aspects.

2.1.1. Lack of reasonable allocation of land use planning, waste of land resources

According to the changes of the rural population of the Bureau of Statistics, the rural population is gradually moving away from the city, especially the young and middle-aged people go out to work, and most of the people left behind are the old and young. Some villages have a phenomenon of sparse population, and there are many idle and damaged agricultural houses in the villages, which cannot be uniformly deployed and controlled due to property rights issues. Further increase the phenomenon of hollowing out of land, waste of land resources, is bound to lead to the increase of carbon emissions. Recently, the "one household, one house" policy in rural areas is a unified allocation of rural resources, but it still needs time to deepen.

2.1.2. Uneven function of ecological adjustment

Due to the different natural topography and climate, the proportion of cultivated land, woodland, grassland and water area in the countryside of eastern Hebei is different. Proper protection of forest, mountain area and water area has a high ecological conservation capacity. Most of the cultivated land and forest land have degraded the natural fertility of the soil, damaged the stability of the ecosystem and reduced the ecological function due to the use of modern chemical fertilizers and pesticides.

2.1.3. Backward infrastructure hinders low-carbon development in rural areas

Document No. 1, 2024, in "Improving the level of rural construction", emphasizes "promoting rural infrastructure to make up for weaknesses", and puts forward requirements in the

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construction of water supply, power supply, transportation, dilapidated houses and digital rural platforms. However, rural areas in eastern Hebei cannot meet the corresponding standards in terms of infrastructure. Although water supply and power supply have been fully realized, the cost of "coal to gas" or "coal to electricity" for heating has increased significantly, and some villagers have changed back to burning charcoal privately, which is bound to increase carbon emissions and runs counter to the goal of "carbon neutrality". In this situation, the living standard of residents is not high, so it is necessary to respond to the call to make up the short board of infrastructure.

2.1.4. The quality of rural living environment is not high

Under the rural revitalization policy, rural areas in eastern Hebei actively carry out public environment construction and improvement work, but there are still rural environmental problems, such as road repair, but neglect the construction of rural public space; The follow-up problems of the toilet revolution -- water supply and drainage cannot be realized in winter; The inappropriate construction of urban buildings or structures in the countryside, which are used infrequently and do nothing to improve the quality of the environment; The appearance of the village is the same, and the regional characteristics and cultural characteristics have not been shown.

2.2. Necessity of "carbon neutral" development in rural areas of eastern Hebei Province

2.2.1. Strong guarantee for realizing the five major rural revitalization

The five major areas of rural revitalization will promote the rapid and effective development of rural areas from the aspects of industry, talent, culture, ecology and organization. Improving rural carbon sequestration capacity through ecological restoration and other measures is a strong starting point for realizing the goal of "carbon neutrality". The improvement of rural economy can not be separated from industry, the coordinated development of the three industries, the development of circular economy, is conducive to the green and healthy development of rural areas; Improving rural infrastructure and advocating green travel are conducive to all-round rural development.

2.2.2. Effective guidance for orderly planning of rural space

In view of the serious waste of rural space, in order to effectively integrate rural land resources and avoid carbon emissions caused by new houses or large-scale demolition and construction, rural space should be included in the territorial spatial planning system, and specific measures and development directions for different Spaces should be put forward to lead the healthy and orderly development of rural areas.

2.2.3. Effective ways to build livable, viable and beautiful rural areas

Improving rural living environment is conducive to attracting rural residents who have left the country to return to their hometowns, and revitalizing local feelings while building their hometowns. Improving the environment is closely related to the goal of "carbon neutrality". Guiding the improvement of living quality, advocating green travel, using energy-saving and emission-reduction construction methods in buildings, and applying green building materials can also improve the utilization rate of resources.

ISSN: 1813-4890

3. Analysis of carbon activity in Malanguan Village, a traditional village in eastern Hebei Province

3.1. Data Sources

3.1.1. Overview of the study area

Malangguan Village is located in the northwest of Malangyu Town, Zunhua City, Tangshan City, Hebei Province, in the Zunhua Basin in the south of Yanshan Mountain. There are continuous hills on both sides of the east and west, water flowing through the middle, surrounded by mountains, and the vegetation coverage rate is over 70%. There is a local folk song: "Qilin Mountain in front, Changrui Mountain in the back, Malan River water through the village." In the Ming Dynasty, Malanyu Pass was an important pass in Jizhou Town of the Great Wall. In the Qing Dynasty, the Green Camp General Army Department was set up here. It was included in the fifth batch of Chinese traditional villages in 2019.

The administrative area of Malangguan Village is 3.354 km2, of which the village area is 0.108 km2, the cultivated land area is 0.853 km2, the orchard area is 2.46 km2, the forest area is 3.27 km2 and the water area is 0.014 km2. There are 391 households in the village with a population of 1592 people.

3.1.2. Data sources

The carbon emission of Malanguan village in Tangshan studied in this paper mainly involves land use data and economic data, among which land use data mainly comes from field survey, investigation, satellite vector map and related documents. The economic data came from the public documents of the state.

3.2. Research Methods

Carbon activities in rural areas mainly include carbon emission (also known as carbon source) and carbon sink, which mainly consider CO2 emission, while carbon sink is to absorb or consume CO2. Spatial properties can be judged by the carbon activities of the two. According to the "Land use Status Classification" and "Village Planning Land Classification Guide" and other relevant norms, the land use nature of the village is integrated, and the carbon system is built. As shown in Table 1:

Table 1 Spatial classification of carbon activities in Malanguan village

Carbon Activity	Large categories of land use	Medium Category	Utilize type
Carbon missions	Land for village construction (V)	Land for village housing (V1)	Rural settlements, public sites
	Non-construction land (E)	Land for Village infrastructure (V4)	Land for transportation
		Agricultural and forestry land (E2)	Woodland, cultivated land, garden
Carbon sinks	Non-construction land (E)	Water area (E1)	Malan River Basin
		Agricultural and Forestry Land (E2)	Woodland, cultivated land, garden land

According to relevant studies, cultivated land and village land of land types mainly consider carbon emissions, while other types of carbon emissions are low and ignored. Cultivated land, forest land and water area belong to carbon sink. Based on different land types, this paper selects coefficient estimation models as follows:

$$E_e \text{（Total carbon sequestration）} = \sum_{i=1}^{n} e_i = \sum_{i=1}^{n} s_i \times \delta_i$$

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Where i is the land type,e_i is the carbon sink or carbon emissions in carbon activities (where carbon emissions are positive, carbon sink is negative), and CO_2 is the calculation unit; s_i is the land area or length; δ_i is the carbon sink coefficient of the land.

The data required in the calculation process are mainly collected from IPCC and related literature. The carbon emission coefficients of various types of land use and activities are shown in Table 2.

Table 2 Carbon emission coefficients of rural land and related activities

Projects		Categories	Carbon emission factor	Units
Land	Residential land	New construction or remodeling	0.8	t/m2
	Arable land	Corn, etc.	42.2	t/km2
	Wood land	-	1.4	t/km2
	Garden plot	Chestnuts, etc	83.0	t/km2
Events	Energy	Electricity	1.110	Kg/kW·h
		Coal	0.714	Kg/kg
		Natural gas	0.448	Kg/kg
		Water	0.912	Kg/kg
	Behavior	Car travel	2.35	kg/km· person
		Bus travel	0.02	kg/km· person
		Waste	0.470	Kg/kg

Table 3 Carbon sink coefficient of rural land and related activities

Projects		Categories	Carbon emission factor	Units
Land	Arable land	Corn, etc.	0.7	t/km2
	Wood land	-	62.3	t/km2
	Garden plot	Chestnuts, etc	52.8	t/km2
	Idle land	-	0.5	t/km2
	Waters	Malan River	3.0	t/km2

3.3. Carbon emission analysis of Malan Guan 1 village

3.3.1. Rural residential area

Rural settlements mainly involve the energy consumption generated by construction and living behaviors such as building houses, which will be divided into two parts and calculated accordingly. The building carbon emissions mainly come from the carbon emissions generated by the new construction or expansion of villagers' old houses. According to the survey, the residential construction land of the village is 36.2 hectares, with per capita 80.3 square meters. Since the village was listed in the fifth batch of Chinese traditional villages List, rural tourism has been developed, and the village has a unified style. One village has been transformed into a farmhouse, covering an area of about 354m2. There is no unified house renewal arrangement in the village, and it is found in the survey that there are few cases of demolishing old houses to build new ones, about 3 households with a floor area of about 482m2. According to Table 2, the emission2 of CO is about 668.8t.

3.3.2. Transportation

At present, there is a main road running north-south along the Malan River in the village, with a length of about 0.4km. The distance between the village committee and the town government is 3.8km, and the distance between the village committee and Zunhua City is 30km. Since

ISSN: 1813-4890

Malangguan Village is located on the east-north road and has a large gathering every 5 days, the villagers take a car to Malangyu town once every 5 days and take a bus to Zunhua once a month. According to the statistics, the annual carbon emission of Malangguan Village in terms of transportation is about 257.704t.

3.3.3. Agricultural and forestry land

The main economy of the village comes from a large area of cultivated land, forest land and garden land. The use of modern chemical fertilizers and pesticides will increase carbon emission, but also lead to the degradation of natural fertility of the soil and damage the stability of the ecosystem. According to the corresponding carbon emission coefficient of rural land type, the carbon emission of agricultural and forestry land is about 244.75t.

3.3.4. Living energy

The daily living energy of rural residents is mainly concentrated in four aspects: electricity, coal, natural gas and water, and a large amount of energy is consumed. The average annual electricity consumption of each household in a village is about 600 kW·h, 2-3t of coal (mainly coal briquets and white coal), 300m3 of natural gas, 35L/d of water, and the calculated carbon emissions of domestic energy is 1148.13t.

3.4. Carbon sink analysis of a village in Malanguan

3.4.1. Water Area

The landscape pattern of "two mountains with water" in Malan Pass village constitutes the most basic ecological elements. Malan River is a seasonal river whose water source is replenished by atmospheric precipitation. The runoff volume varies with the seasons and the amount of water varies greatly. It forms a good landscape belt along the river, which is an excellent carbon sink. Through field research, the water area of Malan River within the village area is about 0.014 km2, and the carbon sink is -0.042t according to Table 3.

3.4.2. Public site

Relying on the Malan Pass section of the Great Wall, a relatively open public site with an area of about 1075m2 is formed. The carbon sink calculated in Table 3 is -0.00054t.

3.4.3. Agricultural and Forestry land

Although arable land, forest land and garden land will produce a large amount of carbon emissions in the production process, the plant growth process will also consume CO2, and the carbon sink is estimated to be -334.206 t according to Table 3.

3.5. Analysis of calculation results

According to the calculation formula and the corresponding carbon sink and carbon emission coefficient, the carbon activity of Malanguan village in one year was measured. The total carbon emission was 2,319.39 tons, mainly from the construction or expansion of houses, transportation, agricultural and forestry land and residents' living energy, accounting for 28.8%, 11.1%, 10.6% and 49.5% of the total carbon emission respectively. The construction of rural residential areas accounted for the vast majority, but the construction of houses was a one-time carbon emission. Living energy is a continuous carbon emission, and this part of optimization needs to be solved. Transportation and agricultural and forestry land also have a high proportion of carbon emissions. From the aspect of carbon sink statistics, based on the unique natural conditions, the annual carbon sink can reach -334.25t, in which water and public places bring less carbon sink, mainly from forest land in agricultural and forestry land. In optimizing the rural spatial pattern, the positive role of this aspect should be highlighted. In comparison, the annual carbon emissions in the villages are still in a high state. Therefore, under the goal of carbon neutrality, the traditional villages in eastern Hebei should actively

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explore ways to reduce carbon emissions and increase carbon sink in the planning, so as to create a peaceful and beautiful countryside.

4. Research on the planning strategy of Malanguan Village under the carbon neutral goal

4.1. Build a rural carbon activity index platform

Build an index platform based on carbon emissions and carbon sinks in carbon activities, sort out their contents, and sort them from highest to lowest in order to form a system network. The carbon emission is mainly from the land nature and residents' life, while the carbon sink is from the relevant rural land for in-depth analysis, assessment and list, uploaded to the platform archive.

4.2. Build a green and orderly planning pattern

From the analysis of carbon activities, it can be found that the carbon emissions related to residents are also high. Therefore, the development intensity should be strictly controlled at the level of territorial spatial planning, and the original rural pattern should be optimized and improved as far as possible. The new construction land should be replaced by functional replacement and the use of abandoned houses and courtyards. Strictly control the encroachment of construction land into farmland and realize intensive land use. We will strengthen the unified upgrading of rural features, supplement rural public space, and focus on those areas that contribute to carbon sequestration.

4.3. Create ecological Spaces with clear waters and green mountains

The unique pattern of "two mountains sandwiched by water" in Malanguan Village is conducive to creating a beautiful ecological space pattern. The cultivated land, forest land, garden land and water area in the village give full play to the role of "mountain, water, forest and field" in carbon sequestration. Among them, the carbon emission of cultivated land and garden land is higher than the carbon sink, mainly because of the high emission production means such as pesticides and fertilizers and their strong dependence, while the forest land has little dependence on pesticides and is an excellent carbon sink resource. Therefore, the ratio of agricultural and forestry land should be optimized, and the farmland should be returned to forest. To enhance its advantages.

4.4. Creating a livable and viable rural space

4.4.1. Life

Building a rural green health system is conducive to improving residents' happiness in life. For rural residential use of modern technology to reduce energy consumption, such as most houses do not use the necessary thermal insulation system, is bound to cause an increase in energy consumption in winter and summer. Some villagers install solar photovoltaic panels, which can greatly reduce the carbon emissions formed when using electricity. More consideration should be given to passive houses and prefabricated houses in newly built houses, which will save manpower, material and financial resources and significantly improve indoor comfort.

The carbon emissions of residents' life and transportation should not be ignored, and green transportation systems should be built as far as possible in the planning. For short distances, optimized walking or bicycle travel modes should be adopted, shared bicycles should be promoted to enter villages, and the spatial pattern of roads should be optimized to improve accessibility and convenience. For long distance, try to avoid the use of fuel cars, promote new energy vehicles, rationally plan bus routes between surrounding villages, set up bus stops, and travel by bus.

ISSN: 1813-4890

4.4.2. Industry

Combining the cultural resources and production conditions of traditional villages, optimize the industrial structure, create farm experience, develop the agro-cultural tourism industry, increase the income generation in the village, and thus reduce the carbon emissions generated during the primary industry farming. Actively develop the secondary and tertiary industries such as processing and production, and build a rural circular economy with the help of digital rural financial media to integrate the three industries. It will also provide jobs for villagers, greatly reduce the degree of hollowing out in the countryside, and make rural people "return to the nest".

5. Conclusion

Under the goal of carbon neutrality, this paper discusses the defects of traditional rural development and the necessity of low-carbon development in eastern Hebei Province, and quantitatively analyzes the carbon emission and carbon sink of different rural elements in Malanguan village. The paper proposes four planning strategies for building a rural carbon activity index platform, constructing a green and orderly planning pattern, creating an ecological space with green water and green mountains, and creating a livable and viable rural space. From overall control to specific construction, the paper discusses and puts forward ways and methods, in order to provide ideas for the scientific and reasonable planning and development of other similar villages.

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