Landscape design of hill ecology and rural human settlement environment based on the analysis of geographic information system

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Abstract
This article aims to apply geographic information system to the planning and design of actual villages, comprehensively use different research methods and integrate multidisciplinary theoretical foundations, from the study of settlement, human resources, and its growth theory, the science of rural settlements, and the theory of organic change. In order to learn experience, in order to establish a research system and village planning concept adapted to mountainous terrain and complete the strategy. Then, according to the natural conditions and human disturbance in the EF mountainous area in Watershed D, this paper establishes an index system for the ecological vulnerability of the hills in this area, and according to the needs of the index system, rationally select and determine the specific index to identify each index. Extract data sources and various basic data of geographic information system (GIS), remote sensing (RS), and other technical methods used to process the collected geographic information, and finally form a more reasonable data set required for investigation and analysis for research. Finally, the article focuses on the various problems in the rural human settlement environment, improving the concept of environmental protection from the state, local governments, enterprises, and people’s housing to environmental protection, etc., all of which guide and encourage villagers to play the role of the main body of construction and effectively integrate investment channels Extend to specific construction work. Analyzing the opposites of the four aspects of the landscape design model is beneficial to improving the development conditions of the rural human settlement environment. The example also selects field surveys from rural areas in China and visits by other experts and researchers to compare the country’s guidelines and the special experiences of different regions and the practicality of the optimization plan point by point.

Keywords Geographic information · Hill ecology · Rural human settlement environment · Landscape design

Introduction

The hilly ecological environment is the basic condition for human survival and development, and it is also the material basis and economic factor for the sustainable development of the economy and society. Reasonable use of resources and a good ecological environment are necessary conditions for achieving sustainable economic and social development.

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With the development of social economy, the fragility of the ecological environment of the hills and the ecological safety of the hills has become a hot issue of global concern. Subsequently, this article first clarified the four theories related to the research content of this research, and studied and summarized the role of geographic information system in this research. Secondly, starting with the geological characteristics of mountainous soils, through multiple case studies and data collation, the rural soil characteristics under the influence of mountainous soils are summarized. Based on the research results of the above two properties, combined with current developments, and according to the needs of rural development and human living environment construction, this article adjusts the concept of rural planning. Thirdly, from the overall planning of road traffic organization, water system organization approaches, construction methods, and landscape modeling behaviors, the strategies for coping with slope terrain are studied. Finally, the article uses geographic information system (GIS), remote sensing technology (RS) and other technical means to apply the above strategies to the rural complex problems such as insufficient restoration funds, high idle rate of public facilities, inability to implement soil indicators for landscape planning, and operational difficulties have not yet been resolved. In the current practice and exploration, it is necessary to find solutions to the above-mentioned problems, and how to use modern socialist ideology and theory with Chinese characteristics to propose a management plan for optimizing the Chinese humanistic environment. This is a question that we must answer now, and it is also the implementation of rural innovation in China. The only way to strategy.

**Materials and methods**

**Data acquisition based on geographic information system**

Based on the index system established in the E-F mountain range of the D Basin and the current ecological vulnerability, combined with the possibility and simplicity of data recovery, we have collected and sorted out relevant data. The data variants included in this study mainly include original map data, remote sensing interpretation data, and statistical data.

The main data used in combination with a baseline scan map of a river basin is ≥10°C cumulative temperature, annual average temperature, average annual rainfall in drought and rain erosion, and then digitized, formatted, and interpolated in ArcGIS to obtain necessary regional climate indicators (Houston et al. 1993).

The land use data comes from the fixed land use data provided by the Resource and Environmental Science Data Center of the Chinese Academy of Sciences. This data set is a spatio-temporal information platform for land use conversion based on RS and GIS technology, using Landsat satellite images through human-computer interaction. The 1:100,000 data usage field covering the entire country is supplemented by a visual explanation.

With the support of ArcGIS geographic information system software, a graphic database, and quality database have been established, including land reclamation maps and land use status maps. According to the requirements of the Ministry of Water Resources, the current landslide data includes large categories and speed maps, which are the interpretation results in the 2019 TM remote sensing image (Asgun et al. 2008). The study is divided into two different types: water dissipation and wind erosion, divided into five types of intensities: slight, low, medium, strong, and extremely strong. Around ARCEdit, humans and machines use land and slope as sources to convert groundwater vector data, which is then edited and processed by ARCGIS to restore the eroded hidden vector data. Different soil erosion intensities are represented by different codes, and these codes are called LABEL points (Liu et al. 2018).

DEM data uses SRTM data. DEM data is jointly measured by NASA and NIMA. SRTM stands for space shuttle radar terrain data. Process radar image data to create a digital terrain elevation model. The measurement data covers the entire territory of China. Currently, SRTM3 data with a resolution of 90m in China can be obtained free of charge.

The statistical data and other information mainly come from the “Statistical Yearbook of Province A” and “Statistical Yearbook of Province B” in recent years. The main software used in this study is ArcGIS 9.2 and ArcView 3.3, as well as the main software applications, such as Microsoft Excel 2003 and Microsoft Access 2003.

**Data standardization processing**

With the support of the GRG module of ArcGIS geographic information system software, the mathematical operation function is used to standardize the selected indicators. If the value of the factor is positively correlated with ecological fragility, then formula (1) is used; if the causal value $X_i$ is
opposite to ecological fragility, then formula (2) is used.

\[ X'_i = \frac{X_i - X_{\text{min}}}{X_{\text{max}} - X_{\text{min}}} \]  \quad (1)

\[ X'_i = 1 - \frac{X_i - X_{\text{lni}}}{X_{\text{lni}} - X_{\text{min}}} \]  \quad (2)

Specifically, the following formula (3) can be used to normalize the cause of tilt.

\[ X' = a + \frac{X - X_{\text{abmax}}}{X_{\text{abmax}} - X_{\text{abmin}}} \times (b-a) \]  \quad (3)

In addition, because the relationship between slope and landslide is more complex, most studies believe that the higher the slope, the faster the soil growth, and the greater the possibility of ecological problems such as landslides. If the coupling increases to a certain level, the erosion rate will not increase, and the vulnerability of ecological trends will continue (Jaafari et al. 2014). It can be considered that, consistent with the soil hazard measures issued by the Ministry of Water Resources in 1997, the slope is divided into 5 intervals, and the value of the score is divided into 5 intervals, and the two are parallel (Table 1), so that the slope is constantly changing. In this case, the value of the score will continue to change. This processing method can be called a continuous interpolation factor method. Compared with index grading and calibration (weighting) methods, its accuracy is much higher.

Where X is the standard slope value, X represents the initial slope value; X_{abmax} and X_{abmin} represent the maximum and minimum values of the gradient range of the slope, and b and a represent the minimum and maximum slope values.

**Calculation method of ecological vulnerability of hills**

It can be seen from Table 2 that among the first 8 main factors, the retention rate of contribution is 94.91% (over 90%), while only 5.09% is lack of information. Therefore, if the first 8 main components are selected, the information they carry with the original will be 8.

When the original will be 8.

\[ EVD_i = \sum_1^{17} P_{ij} \]  \quad (4)

| Grade grade | 0–3° | 3–7° | 7–13° | 13–22° | 22–90° |
|-------------|------|------|-------|--------|--------|
| Assignment criteria | 0–0.2 | 0.2–0.4 | 0.4–0.6 | 0.6–0.8 | 0.8–1.0 |

Use the following formula to normalize the average cause of the H_j difference in each indicator to obtain the weight of each indicator (Table 3).

\[ W_j = \frac{H_j}{\sum_{j=1}^{17} H_j(j = 1, 2, \cdots, 17)(4–2) \]  \quad (5)

After standardizing the original data, understanding the models and methods for evaluating ecological vulnerability, and calculating the weight coefficient of each indicator, a comprehensive comprehensive coefficient of ecological vulnerability can be constructed, which includes information about population, resources, environment, and socio-economic development information. Through comprehensive multifactor analysis, the ecological vulnerability is calculated by formula (6), and the comprehensive factor score is obtained, and the ecological vulnerability is determined according to the comprehensive score.

\[ EVD_i = \sum_{j=1}^{18} P_{ij} \]  \quad (6)

If EVD_{i=3} is the ecological vulnerability of the third evaluation unit (ecological vulnerability level), this is the result of combining the final value, and its value is between 0 and 1; P_{ij} is the index j of unit i, and W_j of each index is its weight. Ecological vulnerability is a factor of value, which evaluates the differences within a region.

**Results**

**Analysis of the comprehensive evaluation results of the ecological vulnerability of hills**

With the support of the GRC module of ARCGIS, the spatial core component analysis method can be directly implemented to identify the fragility of the regional ecological environment, and the process can be completed through a simple procedure. According to the above method, the ecological vulnerability map is calculated (Fig. 1). The average value of ecological fragility of the whole area of E mountain–F mountain is 0.491.

In order to better reveal the characteristics of ecological fragility in this area, according to the value of the ecological fragility index, the research is divided into the comprehensive regional degree of ecological fragility.

Today, there is no unified standard to manage environmental degradation, and there is no universally applicable assessment basis. Combining with current research and integrating the natural geographical conditions of the area and the ecological environment created by it, the ecological vulnerability is defined as five levels: slightly fragile, vulnerable, moderately
fragile, strongly fragile, and extremely fragile. According to the ecological vulnerability classification standard, the RECLASS function is used in the ArcGIS GRID module to classify the obtained ecological vulnerability maps to obtain the results of the regional classification (Table 4) and the ecological vulnerability classification map (Fig. 2).

It can be seen from this that the ecological environment of the Dabie mountainous area in the Huai River Basin is relatively fragile, mainly with light, medium and low fragility, and the intensity and extreme intensity are also distributed to a certain extent. The deterioration of a small part of the ecological environment in the region has degraded or exceeded the current level of human resource use and social development. In the long run, it is very serious to maintain this level for a long time when it is lower than the current socio-economic and technological level of. The surface of different weak classes in the study area is shown in Fig. 3:

### Analysis of the spatial distribution pattern of ecological vulnerability

It can be seen from Fig. 4 that the ecological vulnerability of the study area gradually increases with the increase in altitude, while the width of its increase gradually decreases. The low-elevation areas in the study area are usually low plains and hills with low terrain, which are mainly distributed in areas with better hydrothermal conditions (Kayastha et al. 2012). These areas are also relatively densely populated areas with a higher level of economic development, and the degree of ecological fragility is usually low. However, most areas of the study area are on high mountains above 700 meters, and most of them are distributed in the E mountain area to the south of the study area. There is a lot of rainfall, and changes, and most of them are in old revolutionary areas and remote mountainous areas. The economy is backward, and the destruction of human activities is relatively serious. And the ecological environment is also under pressure (Bonham-Carter et al. 1988). On the one hand, it also shows that compared with the topography and landform distribution of the study area, the spatial distribution characteristics are ecologically weak. The ecological vulnerability of high mountain areas is relatively high, while the ecological vulnerability of plains and lowland areas is usually not high. This also shows that one of the main factors of the ecological natural distribution in the study area is topography and landform. Instead, it affects the types of plants in the soil. Even the distribution shows that natural factors such as topography and landform have a more obvious impact on the breadth of human life and resource development in this area (Lv et al. 2017).

In addition, the use of (Table 5) can more clearly reflect the distribution of different vulnerabilities between counties and cities. Area B, County E, and Area C have 1,030.50 km², 1,158.25 km², and 1,026.00 km², respectively. There is no distribution in H County. In most counties and cities, the

### Table 2

| Main factor | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Eigenvalues | 0.1710   | 0.0730   | 0.0474   | 0.042    | 0.0256   | 0.0119   | 0.0137   | 0.0106   |
| Contribution rate (%) | 40.95 | 17.47 | 11.34 | 10.06 | 6.13 | 3.28 | 3.15 | 2.53 |
| Cumulative contribution rate (%) | 40.95 | 58.42 | 69.76 | 79.82 | 85.95 | 89.23 | 92.38 | 94.91 |

### Table 3

| D watershed E mountain-F mountain ecological fragile influencing factors index weight coefficient |
|-----------------------------------------------|-----------------------------------------------|
| Index                                        | Weights                                      |
| Slope                                        | 0.045                                        |
| Average annual rainfall                      | 0.108                                        |
| Rainfall erosivity                           | 0.071                                        |
| Average annual temperature                   | 0.056                                        |
| Average annual accumulated temperature of 210 degrees | 0.068                                        |
| Dryness                                      | 0.048                                        |
| Land Degradation Index                       | 0.026                                        |
| Forest cover rate                            | 0.027                                        |
| Soil erodibility K                           | 0.108                                        |
| Cultivated land area per capita              | 0.092                                        |
| GDP per capita                              | 0.036                                        |
| Per capita net income of farmers             | 0.099                                        |
| “Industry added value per capita”            | 0.030                                        |
| Per capita...industry added value            | 0.051                                        |
| Per capita food production                   | 0.073                                        |
| Engel Index                                  | 0.023                                        |
| Life expectancy                             | 0.025                                        |
distribution is low, only D county is not distributed, especially E county, F county, C district city, and B county are more widely distributed, as shown in Fig. 5:

Different land use methods have different ecosystem structures and ecological service functions, and have different ways and degrees of ecological impact on the regional environment. Different land use differences represent different land use patterns and may also reflect human activities. Under different conditions with poor ecological environment, the surface distribution of different land use patterns shows the relationship between changes in land use patterns and the ecological environment (Fig. 6).

The land use methods described in this study are mainly embodied in land use methods, farming methods, planting structures, and various soil disturbances that cause soil use. With economic growth, all production and construction must occupy land, more employment opportunities and continuous changes in land use are the main reasons for the changes in water and sediments (Wen et al. 2021). In the E mountain area corresponding to different landforms, many different land-use varieties have been formed, including 15 different land-use varieties in 5 categories, including cultivated land, forests, grasslands, waters, and industrial and mining habitats. The ecological vulnerability of different land-use species in the mountains from F to E in the watershed D is shown in Fig. 7.

Soil degradation is a phenomenon and a process that has a profound impact on many environmental factors on the ground surface. It is one of the main forms and direct consequences of destroying the ecological environment. Affected by a variety of environmental factors (such as geology and landforms, hydrological climate, and human factors). Land degradation and the resulting degradation of land, deserts, and other problems are serious environmental problems and disasters worldwide, posing greater risks to the development and survival of human society.

It can be seen from Table 6 that the soil erosion state in the study area is mainly micro-erosion, followed by light erosion, moderate erosion has a specific distribution, and intensity erosion and extreme erosion are less distributed. The micro-eroded area accounts for about 75.5% of the total area of the

| Grade          | Comprehensive evaluation rating | Ecological vulnerability classification range | Area (km²) | Percentage of total area (%) |
|----------------|---------------------------------|---------------------------------------------|------------|-----------------------------|
| I              | Slightly fragile                | <0.42                                       | 4439.5     | 15.97                       |
| II             | Mildly fragile                  | 0.42–0.51                                   | 13953      | 50.17                       |
| III            | Moderately vulnerable          | 0.51–0.60                                   | 5756.75    | 20.70                       |
| IV             | Weak strength                   | 0.60–0.69                                   | 3507.5     | 12.61                       |
| V              | Extremely strong and fragile    | >0.69                                       | 152.75     | 0.55                        |
study area, and the small-eroded area is 19.45%, close to 20%, and the surface distribution is quite large.

It can be seen from Fig. 8 that micro-erosion and small-erosion are widely distributed in the study area, while moderate and above-moderate erosion mainly occurs in the south and north of E Mountain. The distribution of mountain E is more concentrated and increasing, while the distribution of mountain E is extensive and uninterrupted.

Figure 9 shows that as the rate of land degradation increases, the amount of ecological degradation also gradually increases, which indicates a clear positive trend. Generally, the more water and soil loss, the more serious soil erosion, the lower the ecological stability, and the lower the vulnerability. Soil degradation is a common ecological problem in the region, and it is also the most prominent problem among various ecological problems (Colkesen et al. 2016). The overall accuracy of vulnerability assessment is relatively high in other aspects. According to the positive correlation between erosion rate and vulnerability, combined with the erosion rate distribution map, we can also assume that the overall vulnerability of E mountain should be higher than that of F mountain. Mountains and soil erosion are also one of the main driving forces for the development of vulnerability in the study area.

**Analysis of rural landscape planning in Jiangsu’s mountainous areas**

Under the influence of mountainous terrain, planning of villages, roads, water supply systems, buildings, etc. is restricted. Therefore, based on preliminary research data, we first conducted detailed topographic analysis and village-based research (Yang et al. 2020). According to the spatial distribution of the village and the characteristics of the topographical elements of the site, four parts are divided from east to west (Fig. 2).
By comparing the cross-section plan, the topographic planning elements and the foundation of the entire plot are obtained. The topographic height of the rural land shows a natural trend of gradually decreasing from west to east.

Village Z has unique ecological natural resources, which are not only the basic environment for the construction of the village project, but also the realistic basis of its planning. Protecting and using natural models can achieve the sustainability of its ecological environment (Mathew et al. 2007). The article explains how to realize the planting and maintenance of natural patterns by combining and rationally distributing natural resources, so as to protect and utilize the ecological environment. Specifically, the rational organization of natural elements, such as villages, mountains and forests, waters and agricultural land, is the key to creating landscapes with ecotourism value.

The ultimate goal and requirement of village Z in terms of ecological construction is to determine the interconnection between the artificial environment and the natural environment of the village. Therefore, we have carefully checked the current environmental resources through investigation and research. The main planning directions are “form an interconnected water system”, “preserve the original nature of the soil in the ecological soil”, and “change the landscape of the village” (Fig. 11).

Based on a thorough analysis of the soil and the construction status of the village in Z village, it is known that the village is divided into several clusters according to the topography, which is consistent with the model of the zonal agglomeration structure (Hamidi and Jahanshahifard 2018). It is planned to connect the groups through a main road, and the village is planned as “a street, an axis and five groups” (Fig. 12).

Table 5  Table of areas of different ecological fragility levels in the Dabie Mountains of the D Basin

| County name | Area of each type of ecological vulnerability |
|-------------|---------------------------------------------|
|             | Slightly | Mild | Moderate | Strength | Extreme strength | Moderate and above |
| County A    | 438.75   | 1645.5 | 0.00     | 0.00     | 0.00              | 0.00              |
| County B    | 1030.50  | 284.00  | 0.00     | 0.00     | 0.00              | 0.00              |
| County D    | 589.25   | 2314.25 | 575.00   | 0.00     | 575.00            | 0.00              |
| C City District | 1026.00   | 2590.25 | 0.00     | 0.00     | 0.00              | 0.00              |
| County E    | 1158.25  | 469.25  | 0.00     | 0.00     | 0.00              | 0.00              |
| County F    | 106      | 1782.00 | 123.50   | 0.00     | 123.50            | 123.50            |
| County G    | 52.5     | 1775.50 | 5.50     | 0.00     | 5.50              | 5.50              |
| H County    | 8.50     | 1735.50 | 359.00   | 0.00     | 359.00            | 359.00            |
| County I    | 0.00     | 18.25   | 1373.75  | 2513.00  | 3886.75           | 3886.75           |
| County G    | 29.75    | 1215.00 | 25.00    | 0.00     | 25.00             | 25.00             |
| K County    | 0.00     | 22.75   | 1623.75  | 340.50   | 1.50              | 1965.75           |
| L zone      | 0.00     | 62.50   | 705.25   | 4.00     | 709.25            | 709.25            |
| M area      | 0.00     | 38.25   | 1559.75  | 267.75   | 1827.50           | 1827.50           |
| N County    | 0.00     | 0.00    | 0.25     | 382.25   | 151.25            | 533.75            |
| Total       | 4439.50  | 13953.00| 5756.75  | 3507.50  | 152.75            | 9417.00           |
According to the overall planning structure, the rural roads are divided into three floors of standard width. The main road is 4.5 meters, the collective road is 2.5 meters, and the household road is 2 meters. According to the current situation, the width of the road can be easily expressed. The establishment of a main road not only connects the various residents in the village, but also completely connects the road outside the village. This road is the main traffic road of the village, and at the same time the main axis of the village landscape. The area connected with the road leading to Area A is the "New Village Pass" (Kayastha et al. 2013), which attracts tourists into and down the mountain. The end of this road is connected to an external road leading to the next batch of villages that promote rural tourism. Due to the limited space in the village, the width of the main road is set at 4.5 meters, which barely meets the demand for cars. The road network planning diagram of Village Z is shown in Fig. 13:

If road widening encounters courtyards and buildings that affect cable, they should be demolished in consultation with the villagers. If these areas lack the width of the foundation, install permanent soil walls to enlarge the foundation. If you find a "blocked" area that does not correspond to the width of the road, you should reduce the width of the road. As a result, after the three-part repair, three different wiring methods were formed (Fig. 14).

Based on the above, the transformation of the water supply system started from two aspects: "inland drainage and outdoor water delivery". First, drain indoor water, manage flood control systems, and eliminate potential safety hazards. Start with the three points of "blocking external water, draining internal water,

Fig. 5 DEM map of D watershed E mountain-F mountain

![DEM map of D watershed](image)

Fig. 6 Map of land use types in the Dabie Mountains-Tongbai Mountains in the Huaihe River Basin in 2015

![Map of land use types in the Dabie Mountains-Tongbai Mountains in the Huaihe River Basin in 2015](image)
and storing rainwater” (Conforti et al. 2014). There is a dam on the eastern outskirts of the village to stop the flow of rainwater in Village X. However, due to long-term human activities, the vegetation on the hillside of the hill where the village is located has been severely damaged. To this end, we must first restore the ecological environment and reduce the flow of hillsides. Subsequently, the landscape-canal-reservoir drainage system was established, and the inland river water was improved for partial drainage of the sewage treatment system (Fig. 15). The specific operation is based on the original water system and the extended part. Build a complete canal system to prevent flooding. For stable use, the bottom of the ditch is equipped with small stones, and the sides are equipped with stones to block the soil layer (Liu and Yu 2018). On the other hand, rainwater tanks are placed on both sides or one side of the road to collect rainwater and discharge it into the canal. Finally, rainwater from the canal is collected in a water tank (pool) or directly discharged into an external water system.

Discussion

Measures to improve the ecological vulnerability of hills

Strengthen the ability to support ecological science and technology monitoring and assessment of ecologically fragile areas, and establish an early warning system for ecological security in fragile areas. Continue to study basic theories and applications related to ecological protection and construction in fragile areas, actively research, and actively promote appropriate protection and management techniques for different ecologically fragile areas. At the same time, by improving resource efficiency, reducing resource consumption, reducing growth, and carrying out resource ecological protection, the transformation of scientific and technological achievements has been accelerated (Neshat and Pradhan 2015).

Establish and improve relevant policies, laws, regulations, and standard systems for ecologically fragile protected areas, and promote the protection and construction of ecologically fragile areas. As the relevant laws and regulations for protecting and constructing ecologically fragile areas in China are not yet complete, and policy measures are not yet complete, overexploitation of resources and ecological destruction are still major factors such as soil degradation (Devkota et al. 2013). Relevant legislative work should be strengthened, and relevant national laws and regulations should be drafted. The pace should be accelerated to protect the area, the administrative law enforcement system for environmental fragility must be improved, and the management practice of the environmental management commission of the primary ecological construction should be improved. Projects in ecologically fragile areas need to be researched and modeled, and the protection and construction of ecologically fragile areas need to be accelerated. Give environmental management, ecological technology standard management quality and engineering quality acceptance standards (Liu et al. 2014).

Adjust the industrial structure to minimize the destruction of human activities and reduce environmental degradation and excessive development in fragile areas. The source of the fragility of the ecological environment in fragile areas is restricted by structural factors such as topography, natural climate, soil, and natural vegetation in the fragile area, on the other hand, it is strongly disturbed. In economic and social

Figure 7: The ecological fragility of different land use types in mountain E–F mountain in D Basin.

Table 6: The area distribution table of soil erosion intensity in the mountain E–F mountain in the D watershed.

| Soil erosion intensity | Area (Km²) | Percentage (%) |
|-----------------------|------------|----------------|
| Slight erosion        | 21152.9    | 75.5           |
| Mild erosion          | 5450.28    | 19.45          |
| Moderate erosion      | 1291.36    | 4.61           |
| Strong erosion        | 113.57     | 0.41           |
| Extremely strong erosion | 7.38      | 0.03           |
activities, human economic development activities are the main factors that exacerbate the environmental and ecological fragility of fragile areas (Oh and Pradhan 2011). Therefore, actively exploring reasonable ways of economic growth and resilience in ecologically fragile areas, establishing appropriate industrial access systems, preventing or reducing human interference, and reducing population growth pressure on land development are beneficial to remedying the environment (Ferreira 2003). We need to start exploring the management of the industrial structure in order to provide coordinated ecological and economic development for vulnerable areas (Park 2011). According to natural sources, environmental factors and the ability to transport fragile ecological areas, research and create industries that are suitable for the optimization of ecologically fragile areas, encourage industries to enter the classified guidance catalog, carry out industrial structure restoration, regional development, and optimization of industrial space programs. Fast-growing industries such as finance, tourism, and full-service services have a large number of talents and a high value-added economy, focusing on the development of skills and green industries that are sufficient to meet the resource and environmental needs of fragile areas and promote the protection of natural resources (Houston et al. 1988). Ecological resources and the environment are used for the coordinated development of the information industry and other diversified industries, which can realize the rapid development of social economy and the improvement of the ecological environment. At the same time, according to the environment of different river basins or regions, appropriate development plans for green industries in ecologically fragile areas shall be formulated, and the continuous development and growth of industries that are not conducive to improving the green environment shall be strictly restricted (Sun et al. 2010). Vulnerable areas need to implement a comprehensive strategic plan to increase the penetration rate of industry in ecologically fragile areas. Investigate, analyze and study the
development model of the industry, which plays an important role in coordinating the economic development and ecological protection of ecologically fragile areas.

The “four-in-one” makes full use of the principles of material circulation and biodiversity, increases the output per unit area, reduces environmental pollution, and further improves the overall benefits of agriculture. Figure 16 shows the “four-in-one” ecological engineering material cycle diagram:

### Problems in the landscape construction of rural human settlements in Jiangsu

Environmental pollution in rural areas is serious, and resource waste is widespread

Under the guidance of the scientific development concept, we will build a resource-saving and environment-friendly society for vigorous development. But whenever people talk about the countryside, the picture they have in their minds is rubbish floating in the wind, cars parked anywhere or a stream blocked by mud, hills full of dead branches and leaves, and the chaos that has not yet escaped. Even with the emergence of typical ecologically civilized villages, the material conditions, living environment and spiritual civilization of most villages are very poor. Obviously, the ubiquity of the problem runs counter to the requirement of establishing a dual society. The intensity of environmental governance directly determines the degree of improvement in the quality of life of farmers. Initially, the term “four beams and eight pillars” (Paryani et al. 2020) was originally a structural category of buildings. It is now used in a global reform strategy aimed at China. The reform field is also defined by 11 key areas including environmental protection. In the “Three-year Action Plan for Improving the Rural Human Settlement Environment”, improving the rural environment is another priority.
Insufficient investment in the construction of public service systems

The construction of China’s rural public service system has gone through a long process. The rural public service system mainly integrates medical and public health services, public cultural services, public information services, social security services, scientific and technological development services, public transportation services, and social management services (Rabbi et al. 2014). The effective construction of these systems directly affects the construction of rural public areas and the public environment. Today, improving the settlements of the people of the province is not limited to raising material levels. By continuously improving the cultural and spiritual level of most people, the impact of architecture will be even greater. Generally speaking, most of the funding sources for public services in urban areas come from local governments. The stability of investment and the clarity of other funding sources are not high (Taskiran 2010). Government investment is mainly concentrated in health care and transportation, and at the grassroots level such as social security. People’s cultural, educational, and entertainment needs are often in a weak state.

Village planning lags behind village construction for a long time

In order to build a civilized, harmonious, and cohesive village in the modern era, it is necessary to plan the village. Rural planning in most areas of China is unscientific. Rural construction has been lagging behind for a long time, and the impact of its implementation has been unsatisfactory. The planning of the village should not only take into account the planning situation of the county where the village is located, and fully consider the completeness of its construction, but also take into account the coordinated development of different areas of the village to improve the condition of the village (Shimizu et al. 2006). Village construction needs to be orderly. To change the current state of rural planning, innovative governments, and stakeholders must first understand the local rural culture and pay attention to the historical continuity of...
the surrounding landscape. The main factors affecting rural planning are the local land conditions, history and folk customs, basic family structure, and a series of regulations and planning systems. For example, according to the terrain and distribution types of villages, rural residential areas can be divided into flat land types, mountain types, water village types, back mountain types, cave dwellings, and other distribution methods. According to the relative location of the city, it can be divided into rural, urban, and suburban distribution models (Wang and Li 2017). According to the degree of influence of different social and cultural factors, it can be divided into agricultural, industry, commerce, and balanced development. Regulations related to rural planning also include laws, administrative regulations, local laws and regulations, and technical and ethical standards. As a result, rural planning covers many areas. Different areas and increasingly complex conflicts require the cooperation of the government, farmers, and social forces to resolve. For example, in outdoor construction plans, farmers should be encouraged to follow the design features and traditional culture of certain villages, and take into account various factors, such as the real quality of life and energy consumption, environmental protection, and reasonable data calculations for farm-related personnel, and use typical demonstration methods to spread advanced architectural concepts to farmers and try to eliminate blind housing construction (Zhang et al. 2018).

Analysis of the causes of defects in the landscape construction of rural human settlements in Jiangsu

The slow change of farmers’ consciousness under the traditional concept of human settlements

It is worth acknowledging that China’s residential building system has many theoretical connotations and a long history of practice. The distribution of many famous buildings and residences shows a reasonable planning and arrangement research model. It is precisely because of the previous research
and legacy of ancient architectural science that our modern standards in layout, distribution, landscape construction, and other humanities have a more reasonable foundation in experience, and our architectural culture also reflects more history. Sex. With the continuous changes in production and living conditions, there were many feudal superstitions in the past, and the choice of building materials and the location of farmers did not meet the needs of the new building environment. Compared with cities, this problem still exists in most rural areas today, and farmers also have their own homes and misunderstanding of policies.

Inadequate implementation of laws and technical standards related to the construction of rural human settlements

The law on the construction of urban residential areas has not yet been issued. In fact, the high degree of concern for rural environmental quality only began at the 17th National Congress of the Communist Party of China. A large number of guiding opinions on rural environmental protection came into being. These guiding opinions will provide us with guidance in the construction of civilized ecological civilization in the future. The reason why the process of drafting laws on housing construction, environmental assessment, and building materials standards in rural areas lags behind rural construction practices is that, in one feature, the size, location, and rural resources of different regions have complex characteristics. Creating multiple models is an important principle, so in practice, you will inevitably face many shortcomings. Self-organization behavior is the most important aspect of farmers’ construction behavior. Establishing a living environment for residents will maintain a self-construction model with the family as the main investment and the main body of decision-making and execution, and it will be relatively weakly
constrained by external instructions. “From the day when they owned their own home, they showed their sense of ownership and local feelings.” Every family has very different requirements for their own house, and every skill demonstrated in the process of building a house is the result accumulated over the years. However, self-organized rural construction will inevitably produce energy waste, land disputes, and unreasonable spatial planning. It does more harm than good to the entire rural development, which makes the situation more urgent.

Long-term emphasis on economic development, ignoring ecological development

As an important part of the construction of China’s ecological civilization, the construction of a new type of ecological countryside is of great significance to improving the living and production environment in China’s rural areas. As China’s national long-term development policy, the construction of ecological civilization is in progress. In the construction of a new ecological countryside, various requirements for economic and environmental benefits must be weighed. Neither the former nor the latter can be ignored.

Strategies for the landscape construction of rural human settlements in Jiangsu

Put an end to major demolition and construction, and retain the original village appearance

The appearance of the village consists of two parts: the residence and the garden landscape. In the process of residential and rural reconstruction or reconstruction in China, there are two situations. One is to imitate many typical Chinese villages separately, or learn separately from their architectural experience, and build rows of the same brick houses, creating a situation of “one thousand villages, one side”, which lacks humanistic characteristics. Others copy various foreign architectural design styles and participate in the construction of so-called Western and European styles, which are inconsistent with local and customary customs and often lead to inconsistencies between architectural styles and interior design. In addition, most villages use reinforced concrete as construction materials, and the lack of natural resources and the expression of natural elements have led to the neglect and waste of local resources. The most common problem with the use of reinforced concrete is that when the house is destroyed, its reuse
efficiency is low, which hinders the sustainable development of the environment. In addition, not all areas and buildings need to be constructed with reinforced concrete. Local natural resources must be integrated, new materials must be actively used, and the local characteristics and wishes of farmers must be fully reflected. Although the creation of rural garden landscapes has appeared, it can be said that few systematic studies have been conducted on them. Regarding construction deficits and chaotic construction everywhere, the focus of rural garden research is looking for rules and regulations in the planning and construction of rural medium-sized gardens, trying to explore the model of rural gardens and the development of rural gardens in the future, in order to effectively guide the development of rural gardens. Planning and future rural planning schemes, the key to breaking through the barriers of rural garden landscape design is to fully understand the difference between rural gardens and urban landscapes from the beginning of planning, and realize that buildings must be based on natural ecology and cannot leave the local natural conditions to create a surface building. Therefore, the ultimate goal of landscape design is to improve the performance of the rural environment and enrich the rural landscape.

**Reasonable layout of the whole, key coordination parts**

As a whole, cities and villages must have two parts of stability and change in the development process, and these two parts must always be complementary and connected. Respecting the historical and cultural background left by ancestors contributes to the sustainable development of the local area. In addition, cities and villages continue to develop and grow, and they will not continue without change. Finally, in the process of establishing a human framework, the principle of combining place construction and spirit must be respected. Spirit is a
subjective world formed by people’s approval, and the changes inside and outside the region should be renovated according to people’s needs. Emphasizing the principle of combining place and spirit, it is required to design landscape styles according to the laws of human activities, behaviors and spiritual characteristics to form a complete urban style and reflect the multi-level urban cultural connotation.

Conclusion

From the analysis of the relationship between the ecological vulnerability of the study area and various geographical factors: the ecological vulnerability of the study area gradually increases with the increase of altitude. For the different land uses under study, in terms of type, grassland has the highest vulnerability, followed by industrial buildings and mining land, and other land, water surfaces and forest soils for different purposes, depending on their vulnerability. With the rapid increase of land degradation, ecological vulnerability has gradually increased, showing a clear positive correlation trend overall. An accurate analysis of the principles of optimization of rural residential areas in China and a careful summary of optimization methods has profound theoretical and practical significance. Improving the living environment of the surrounding people is an important part of the rural innovation strategy. On the one hand, it has theoretical guidance for improving rural production conditions and quality of life. On the other hand, it is important that China should further narrow the gap between urban and rural areas, accelerate the process of urban-rural integration, and truly realize modernization by 2035 and build China into a prosperous, democratic, and civilized country. In general, the article provides suggestions for the long-term development of China’s living environment, and adopts new changes, new standards, and new requirements. Taking into account the living environment of rural people in modern times, this article also hopes to enrich the connotation of contemporary human living in the theory of environmental science.

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Declarations

Competing interests The authors declare no competing interests.

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