International Journal of Environment, Agriculture and Biotechnology
Vol-9, Issue-3; May-Jun, 2024
Peer-Reviewed International Journal
Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Ecological Sensitivity Assessment of Xinyi City in Guangdong Province Based on GIS and AHP

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Received: 25 Mar 2024; Received in revised form: 06 May 2024; Accepted: 22 May 2024; Available online: 06 Jun 2024

Abstract— *Ecological sensitivity analysis is an important basis for urban planning and layout. This article selects six ecological evaluation factors, including altitude, slope, aspect, water environment, vegetation NDVI, and land use, to construct an ecological sensitivity evaluation system for Xinyi City. Using the spatial analysis techniques of GIS and the Analytic Hierarchy Process (AHP), a comprehensive evaluation was conducted on six ecological evaluation factors. Meanwhile, the natural breakpoint method was used to divide the results into five levels: extremely sensitive area, high sensitive area, medium sensitive area, low sensitive area, and non-sensitive area. The results indicate that the ecological sensitivity of Xinyi City is generally high, and land use type, vegetation coverage, and water environment are the main factors affecting ecological sensitivity. The five sensitive areas, from non-sensitive to extremely sensitive, account for 0.71%, 18.44%, 38.88%, 33.01%, and 8.96% of the total area of the city, respectively. The highly sensitive areas of Xinyi City are distributed in the northeast, while the non-sensitive areas are distributed in the southwest. The comprehensive evaluation of ecological sensitivity and spatial layout in this article can provide a basis for land use construction planning and ecological environment protection in Xinyi City.*

Keywords— ***Ecological sensitivity assessment; Geographic Information Systems (GIS); Analytic Hierarchy Process (AHP); Xinyi City***

I. INTRODUCTION

With the development of society and the advancement of technology, the scope and intensity of human impact on the natural environment are constantly increasing, leading to the expansion and intensification of regional ecological and environmental problems such as desertification, salinization, soil erosion, and acid rain. These regional ecological and environmental problems are seriously threatening the atmosphere, land, and water resources that humans rely on for survival, resulting in significant direct and indirect economic losses every year. A good ecological environment is an important foundation for human survival and sustainable development; therefore, protecting the ecological environment and conducting ecological environment assessments are particularly important [2, 3].

Ecological sensitivity refers to the degree to which an ecosystem reflects human behavior, interference, and changes in environmental conditions, indicating the likelihood of ecological environmental problems occurring in a region. It refers to the ability of ecological factors to adapt to external changes or pressures without endangering environmental quality. If various ecological factors in a region are difficult to recover after being damaged, then the ecological sensitivity of the region is strong; on the contrary, it is weaker [5]. The essence of ecological sensitivity assessment is to clearly identify potential ecological problems in the current natural environment and implement them in specific spatial areas. This type of research began in the late 20th century and was defined by the academic community as the self-recovery ability of ecosystems to resist external adverse effects under specific spatiotemporal conditions. Through ecological sensitivity evaluation, it can reflect national or regional ecological changes and spatial differentiation patterns, laying the foundation for land and resource utilization and ecological environment protection [7, 8].

Ecological sensitivity assessment (ESA) is currently a research hotspot, and many scholars have conducted relevant research. Through a review of domestic literature, it was found that ecological sensitivity assessment has a wide range of research fields and diverse research scales. Among them, research areas include watersheds, cities, wetlands, nature reserves, etc. The research scale extends from national, geographical region and provincial levels to cities and counties. In addition, research methods mainly use traditional weight determination methods, such as principal component analysis (PCA), the analytic hierarchy process (AHP), the expert scoring method, and the maximum value method [9]. There are currently three main research directions. One is ecological sensitivity research targeting certain ecological and environmental issues. For example, Mo et al. conducted sensitivity analysis on flood disasters in Guangxi, providing countermeasures for disaster prevention and reduction [10]; Wang et al. analyzed sensitive areas of soil erosion in China and proposed zoning plans [11]. The second is to conduct ecological sensitivity analysis on the ecological value of cultural landscapes. Zhong et al. conducted an ecological sensitivity analysis on the tourism landscape of Qinghai Province, providing reference for the sustainable development of ecotourism [12]; Li et al. conducted an ecological sensitivity analysis on the upper reaches of the Yangtze River from the perspective of spatial pattern [13]. The third is to analyze the sensitivity of urban ecology. Yan et al. used indicators such as soil erosion, river water quantity, and quality as evaluation factors to conduct ecological sensitivity analysis in Beijing [14]. Gan et al. analyzed the trend of ecological sensitivity changes in the Guangdong-Hong Kong-Macao Greater Bay Area over the past 20 years [15], providing a scientific basis for green and sustainable development and environmental management in the Guangdong-Hong Kong-Macao Greater Bay Area.

Xinyi City, as the only national key ecological functional area in western Guangdong, is an important ecological barrier and water source conservation area in the coastal area of western Guangdong, ensuring the ecological security and water resource supply of the coastal area. With the booming development of emerging economies and tourism, human activities have a series of negative impacts on the ecological environment, such as resource scarcity, severe environmental pollution, and ecosystem degradation. Therefore, a comprehensive evaluation of the ecological sensitivity of Xinyi City is of great significance for its urban planning and industrial layout.

This article takes Xinyi City as the research area, analyzes its ecological sensitivity, explores its spatial layout, and provides a decision-making basis for land use planning, environmental restoration, and sustainable development in Xinyi City. The main approach is to use spatial analysis of GIS and AHP to conduct single factor analysis on six ecological evaluation factors and to comprehensively analyze multiple factors by weighted superposition, which can provide a scientific basis for the future economic development, construction, and ecological environment protection of Xinyi City.

II. STUDY AREAS

Xinyi City, a county-level city under the jurisdiction of Guangdong Province, is managed by Maoming City. Located in the southwest of Guangdong Province, in the northern part of Maoming City, between latitude 22 ° 11 Å 10.2 "to 22 ° 42 Å 25.2" north and longitude 110 ° 40 Å 36.1 "to 111 ° 40 Å 29.4" east, the city is 57.656 kilometers wide from north to south and 102.719 kilometers long from east to west. It borders Yangchun to the east, Gaozhou to the south, Beiliu and Rongxian in Guangxi to the west, and Luoding and Cenxi in Guangxi to the north. National Highway 207 runs through the entire area from north to south, making it one of the sub-central cities connecting the southwestern and central southern regions of Guangdong. The total area of the city is 3101.7 square kilometers, accounting for 1.75% of the total area of Guangdong Province. Under its jurisdiction are 18 towns, including Zhenlong, Shuikou, Beijie, Jindong, Dingbao, Chidong, Baishi, Dacheng, Huaixiang, Hongguan, Chashan, Cinnabar, Guizi, Pingtang, Qianpai, Heshui, Xinbao, and Sihe, as well as 2 street offices, including Dongzhen Street Office and Yudu Street Office. The Municipal Government's Office is on Dongzhen Street. (Figure 1).

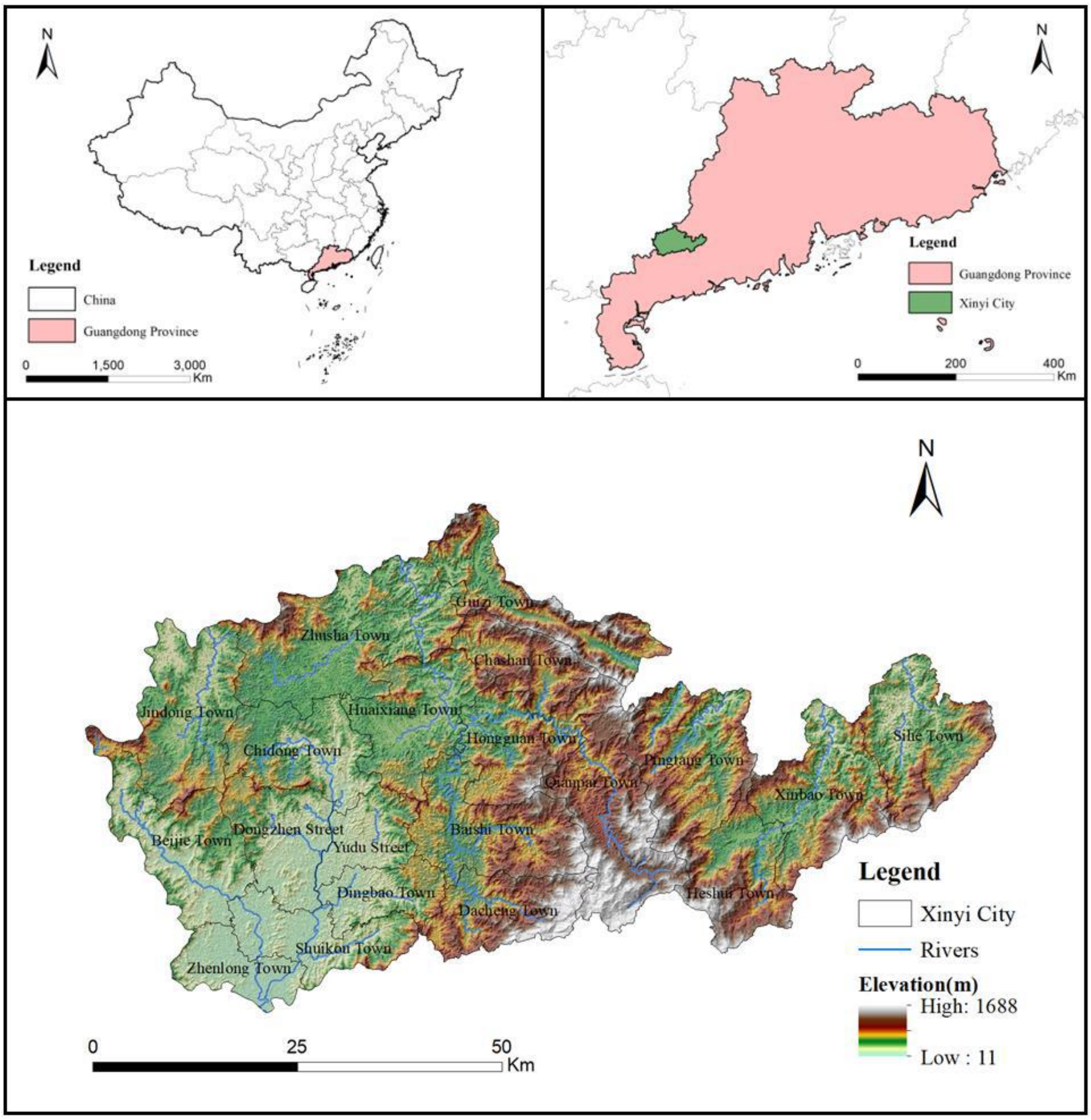

Fig.1 Geographical Location and Overview of Xinyi City

The terrain is high in the northeast and low in the southwest. Within the territory, there are steep mountains and rivers crisscrossing, with elevations ranging from 50 meters to 1704 meters. The eastern part is mainly composed of Zhongshan with elevations above 800 meters, while the western part is mainly composed of low mountains and hills with elevations below 800 meters. There are 80 mountains with an elevation of over 1000 meters and 371 peaks with an elevation of over 500 meters. The highest point is Datianding, with an altitude of 1704 meters, which is the highest peak in western Guangdong. There are five soil types within the territory, including yellow soil, red soil, lateritic red soil, paddy soil, and tidal sand soil.

The river is divided into the Pearl River basin and the Jianjiang basin. There are 12 rivers with a catchment area of over 100 km^2 in the city, including Dongjiang River (the upstream main stream of Jianjiang River), Beijie River, Xiaoshui River, Baishi River, Shadi River, Qianpai River, Guizi River, Zhusha River, Bailong River, Shazi River, Sihe River, and Jindong River. There are 9 roads between 50 and 100 km^2 and 28 roads between 15 and 50 km^2. The total storage capacity of lakes in Xinyi City is 59.705 million m^3, with 2 medium-sized reservoirs and 39 small reservoirs.

Belonging to the South Asian tropical monsoon climate, the climate is warm, with sufficient sunlight and abundant rainfall. The rain is hot in the same season, with hot summers and cool winters. The frost-free period is long, with cold damage in spring, easy flooding in summer, and occasional typhoons in autumn. The average annual temperature in the city is 19.6~23.2 °C, and the average annual rainfall is 1543.1~2233.2 millimeters. The hottest month of the year is July, with an average temperature of 28.6 °C. The coldest period is from January to February, with an average temperature of 12.9 °C.

III. DATA AND METHODS

3.1 Data Sources

The data used in this study includes administrative boundary maps of the study area and 30 m of digital elevation model (DEM) data (sourced from the geospatial data cloud, https://www.gscloud.cn/search). River water system data in Guangdong Province, 2022 GlobeLand30 surface cover data, and the 2022 1 km Normalized Vegetation Index (NDVI). We are using ArcGIS software to mask and crop data, extract slope and aspect factors using DEM, and use a unified coordinate system and projection system.

3.2 Study Methods

After collecting data, six single ecological evaluation factors were selected based on the characteristics of Xinyi City, namely elevation, slope, aspect, water environment, normalized difference vegetation index (NDVI), and land use. Grade single factors and draw an ecological sensitivity factor analysis chart. Then, the Analytic Hierarchy Process (AHP) is used to establish weight values for analysis and evaluate the grading level. Finally, the comprehensive analysis results of ecological sensitivity were obtained (Figure 2), and relevant data such as spatial distribution and area proportion were analyzed and evaluated.

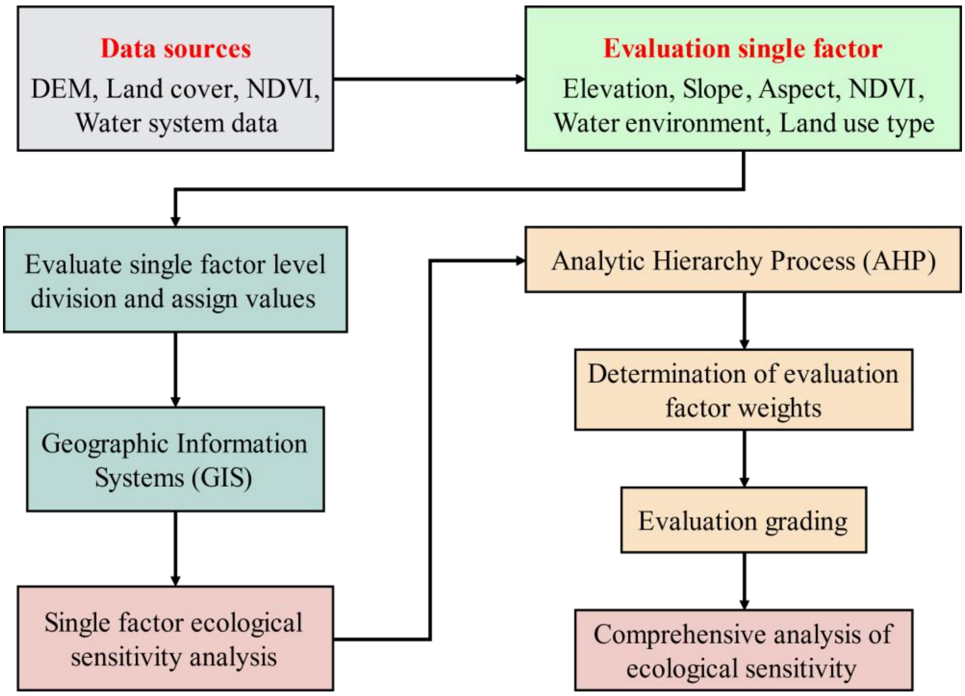

Fig.2 Technical Roadmap

3.3 Ecological Sensitivity Assessment

This article will use GIS and AHP to evaluate the ecological sensitivity of Xinyi City [16]. Ecological sensitivity refers to the scientific method of analyzing the adaptability of various factors in the ecosystem within a study area to external disturbances, mainly through reasonable numerical analysis of multiple data points. It can accurately reflect the adaptability of the study area to external disturbances under the influence of various factors [17]. It is worth noting that the factors affecting ecological sensitivity are very complex, with diverse causes and manifestations [7]. The size of the research scale, the ecological environment status of the study area, and the level of socio-economic development all affect the selection of evaluation indicators [18]. The ecological sensitivity factors vary in different regions, and there is no unified standard for selecting factors. Thus, it is necessary to select representative sensitive factors of the main environmental characteristics based on the inherent mechanisms of ecological environmental issues and the environmental conditions of the research area.

This study uses ecological sensitivity evaluation methods to select appropriate evaluation factors, analyze and grade relevant data, and ultimately generate comprehensive evaluation results as a reasonable basis for urban ecological planning. This evaluation method avoids the lack of scientific data guidance in the planning process and also avoids planning decision-makers leaning towards personal subjectivity, thereby reducing the negative impact on the ecological environment.

3.4 Selection of Evaluation Indicators and System Construction

AHP refers to a decision-making method that decomposes elements related to decision-making into levels such as goals, criteria, and plans and conducts qualitative and quantitative analysis on this basis. This method is a hierarchical weight decision analysis method proposed by American operations researcher Professor Satie from the University of Pittsburgh in the early 1970s, applying network system theory and multi-objective comprehensive evaluation methods. This method can easily solve complex factor-sorting problems. In addition, the GIS is an important tool for ecological sensitivity research, which collects and integrates massive geographic data over a certain period of time based on geographical conceptual space. After data analysis combined with GIS, visualization can be achieved, and spatial analysis and related data calculation and extraction can be carried out.

3.4.1 Selection of Evaluation Factors and Classification of Sensitive areas

To study the single-factor impact, this article refers to relevant papers on regional ecological sensitivity evaluation. Based on the research objectives, the comprehensive characteristics of the ecological environment in Xinyi City, as well as the principles of ecological sensitivity and data availability, ecological evaluation factors with characteristics of the study area [5] were selected, including elevation, slope, aspect, NDVI, water environment, and land use. Assign ecological sensitivity values of 9, 7, 5, 3, and 1 to each individual factor, representing extremely important, very important, quite important, somewhat important, and unimportant. At the same time, based on the strength of ecological sensitivity, it is divided into five different levels of ecologically sensitive areas, namely extremely high sensitive areas, high sensitive areas, medium sensitive areas, low sensitive areas, and non-sensitive areas. (Table 1)

Extremely sensitive area: It is most sensitive to human activities for development and construction. If there is interference or destruction, it will not only affect the area but also lead to devastating damage to the ecosystem of the research area. For this purpose, the protection zoning plan should list the area as the most in need of key protection. We must strictly protect the natural ecological environment, and urban construction must not occupy land arbitrarily. At the same time, we must do a good job of ecological restoration. Plan the construction of nature reserves and forest parks, and establish natural and environmental education bases without affecting the environment.

High sensitivity area: It is highly sensitive to human activities and development, making ecological restoration difficult. It plays a very important role in protecting the ecosystem and its functions in extremely sensitive areas. In protection zoning planning, this type of area can be regarded as a secondary key ecological protection area.

Medium sensitive area: It can withstand a certain intensity of human activities, but excessive development and construction can also damage the natural ecological environment in the area, resulting in slow ecological restoration and difficulty in ecological restoration. Therefore, reasonable protection measures need to be considered in the planning of protection zones.

Low sensitivity zone: capable of withstanding a significant amount of human development and construction activities but also prone to natural disasters such as soil erosion when severely affected, resulting in slow ecological restoration. In protection zoning planning, these areas can be considered general-level protection areas.

Non sensitive area: capable of withstanding large-scale human development and construction activities with diverse land use methods. In protection zoning planning, this area can be considered to have the lowest level of protection. We should vigorously carry out economic construction on the basis of ensuring ecological system security while paying attention to the reasonable layout of production space, living space, and ecological space. We should be guided by the harmonious coexistence between humans and nature, pay attention to creating green spaces, pay attention to ecological benefits, and build a modern city that is livable and suitable for business, promoting sustainable development of the city.

According to different levels, areas with higher ecological sensitivity indicate greater sensitivity to human development and construction activities, higher ecological value, and should be listed as key protected areas. Regions with lower ecological sensitivity mean that they can withstand a certain level of human development and construction activities, and their land can be used for multiple purposes with relatively low protection levels.

Table 1 Classification Criteria for Single Factor Ecological Sensitivity

Sensitivity level	Evaluation factors					
	Slope	Elevation	Slope aspect	Water enviro-nm ent	NDVI	Land use
extremely sensitive（Score9）	>55	>1700	North	50<	>0.8	Water bodies
high sensitive（Score7）	40-55	1300-1700	Northeast Northwest	50-200	0.6-0.8	Forest and cropland
medium sensitive（Score5)	25-40	900-1300	East and West	200-500	0.4-0.6	Grassland and shrubs
low sensitive（Score3）	10-25	500-900	Southeast Southwest	500-800	0.2-0.4	Bare land
non-sensitive（Score1）	0-10	<500	South	>800	<0.2	Construction land

3.4.2 Determination of Ecological Factor Weights

Use the AHP method to distinguish between the target layer and the indicator layer. The target layer is comprehensive ecological sensitivity, while the indicator layer refers to the six ecological evaluation factors mentioned above. Based on the actual situation of the research area, the weight calculation method of relevant literature is cited for comprehensive evaluation, which includes experts scoring each factor, establishing a factor judgment matrix, and calculating the weight values of each factor based on the specific scores of each ecologically sensitive factor. The weight values between each factor cited in this article are shown in Table 2 [2, 7]. To verify the validity of the weight results, a consistency test is conducted using the consistency ratio as follows:

$$CI = \frac{\lambda_{max}-n}{n-1} \quad (1)$$

$$CR = \frac{CI}{RI} \quad (2)$$

The calculation results of the AHP show that the maximum eigenvalue λ_{max} is 6.3548, and the CI value is 0.0710. According to Table 3, the corresponding RI value is 1.26. According to the formula CR=CI/RI=0.0563<0.1, through a one-time test, it is shown that the result of single factor weighting is acceptable [23].

Table 2 Single Factor Ecological Sensitivity Weights

Evaluation factors	Elevation	Slope	Slope aspect	Water environment	NDVI	Land use
Elevation	1	1/2	1/2	1/3	1/4	1/5
Slope	2	1	1/2	1/2	1/3	1/4
Slope aspect	2	2	1	1/2	1/3	1/5
Water environment	3	2	2	1	1/2	1/3
NDVI	4	3	3	2	1	1/2
Land use	5	4	5	3	2	1
Weight	0.0531	0.0780	0.0947	0.1487	0.2407	0.3847

Table 3 Judgment Matrix RI Standard Values

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49

IV. ANALYSIS AND RESULTS

After selecting six ecologically sensitive factors, establish a single factor sensitivity grading standard, including extremely high sensitivity, high sensitivity, medium sensitivity, low sensitivity, and insensitivity. Visualize and analyze through GIS, calculate its area and proportion (Table 4), and conduct spatial analysis and subsequent exploration.

Table 4 Summary of Single Factor Ecological Sensitivity Grading Area and Proportion

Evaluation factors	Unit	Non sensitive	low sensitive	medium sensitive	high sensitive	extremely sensitive
Elevation	Area/km^2	2566.16	849.63	163.2	25.87	—
	Proportion /%	71.19	23.57	4.53	0.72	—
Slope	Area/km^2	771.06	1958.76	798.51	62.79	1
	Proportion /%	21.47	54.53	22.23	1.75	0.03
Slope aspect	Area/km^2	442.58	916.65	864.89	915.46	452.58
	Proportion /%	12.32	25.52	24.08	25.49	12.60
Water environment	Area/km^2	2825.53	244.32	292.8	189.1	53.07
	Proportion /%	78.38	6.78	8.12	5.25	1.47
NDVI	Area/km^2	—	0.28	19.53	971.93	2613.08
	Proportion /%	—	0.01	0.54	26.96	72.49
Land use	Area/km^2	25.74	0.02	3	3569.89	6.17
	Proportion /%	0.71	0.001	0.08	99.03	0.17

4.1 Elevation Factor

The highest altitude in Xinyi City is 1688 meters. The terrain is mainly mountainous and hilly, with higher terrain in the northeast and lower terrain in the southwest. According to the analysis of the results, the ecological sensitivity of the elevation factor is relatively low, and the proportion of non-sensitive areas is relatively high. The high sensitivity area, medium sensitivity area, and low sensitivity area account for 0.72%, 4.53%, and 23.57%, respectively, with a total area of 1038.7 km², distributed in the central and eastern regions, such as Dacheng Town, Qianpai Town, Heshui Town, Chashan Town, Guizi Town, etc.; the non-sensitive area covers an area of 2566.16 km², accounting for 71.19% of the total area, distributed in the west and northeast (Figure 3).

4.2 Slope Factor

Slope can indicate the steep terrain of a region, which is closely related to soil erosion, soil moisture content, and soil fertility and can affect the development and utilization of land and the layout of urban construction. Under the same conditions, the larger the slope, the poorer the ecological carrying capacity of the region, the greater the degree of interference from various factors, the more fragile the ecosystem, and the higher the sensitivity of the region. The results show that the natural terrain of Xinyi City is relatively steep, and the ecological sensitivity of slope factors is mainly low and medium. It is widely distributed in the study area, with an area of 2757.18km², accounting for 76.76% of the total area. Next is the non-sensitive area, with an area of 771.06km², accounting for 21.47% of the total area, mainly distributed along river banks. The high sensitivity area and extremely high sensitivity area with a slope greater than 40 ° account for 1.75% and 0.03%, respectively, with an area of 62.79 km² and 1 km², concentrated in Guizi Town, Qianpai Town, and Dacheng Town, with a relatively small footprint (Figure 4).

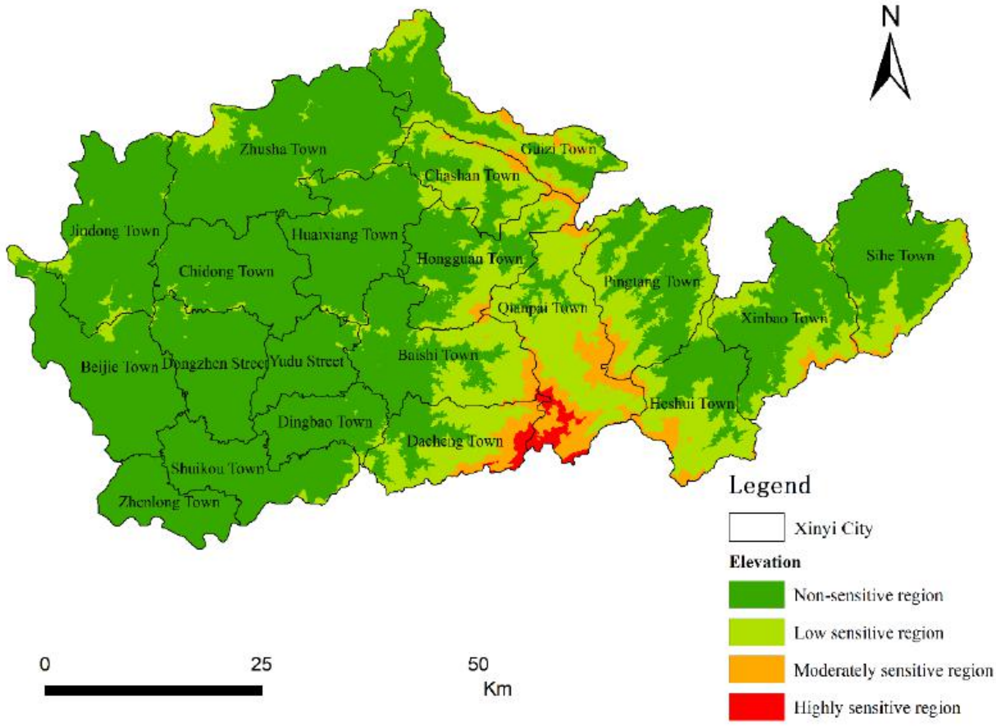

Fig.3 Analyses of Elevation Factors

4.3 Slope Aspect Factor

The terrain of Xinyi City is complex and diverse, with numerous mountains and hills, rivers, lakes, and mountains crisscrossing each other. The overall ecological sensitivity of slope factors is relatively uniform. Among them, the non-sensitive and low-sensitive areas account for 37.84% of the total area, with an area of 1359.23 Km², facing south, southeast, southwest, and east in four directions. The medium sensitive area, high sensitive area, and extremely sensitive area account for 24.08%, 25.49%, and 12.60%, respectively, with an area of 864.89km², 915.46km², and 452.58km², are facing east, west, northeast, northwest, and north directions. In summary, in the future development and construction process of Xinyi City, regional land use planning should be done in advance. Under complex terrain conditions, achieving the coexistence of ecological environment protection and socio-economic development promotes regional sustainable development (Figure 5).

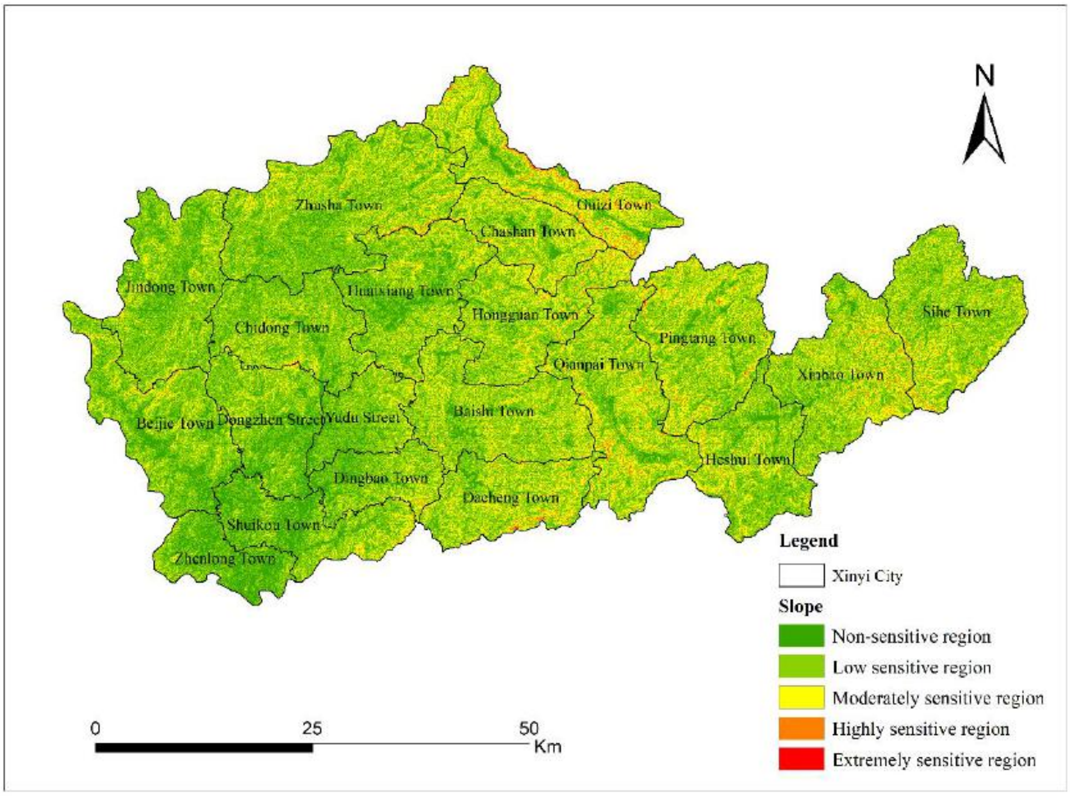

Fig.4 Slope Factor Analyses

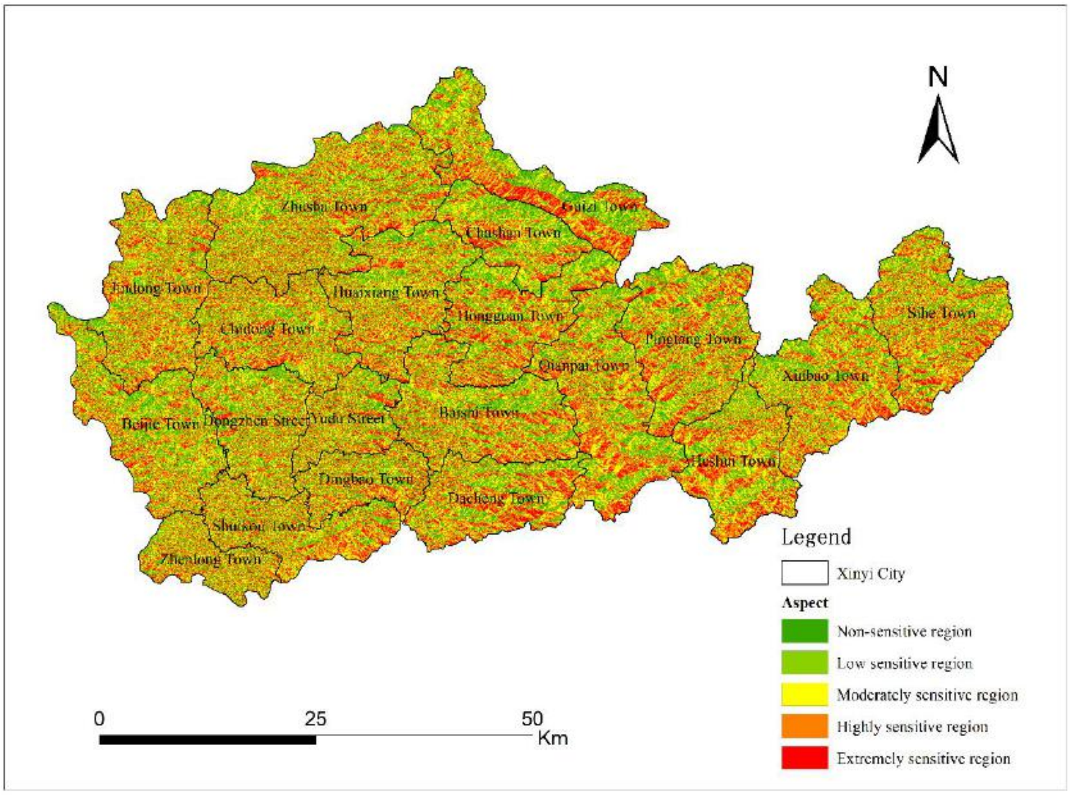

Fig.5 Slope Factor Analyses

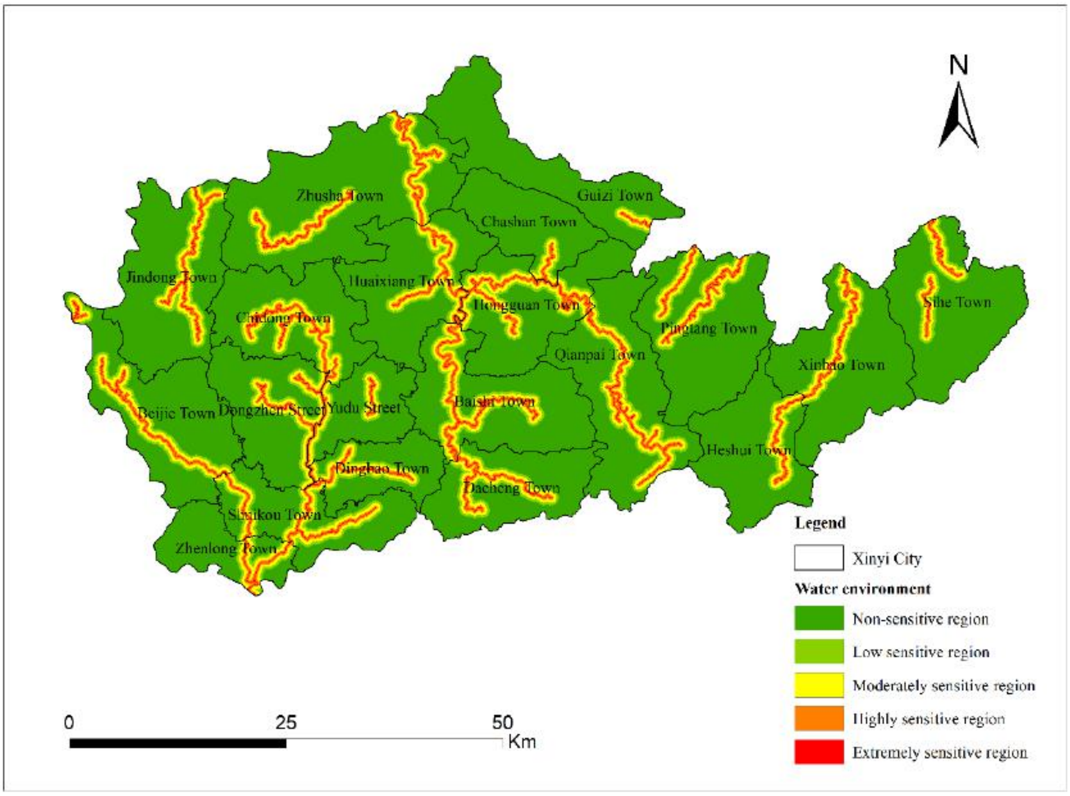

Fig.6 Analysis of Water Environment Factors

4.4 Water Environmental Factors

Through the buffer analysis of GIS, the water environment data of Xinyi City was analyzed, and it was found that the closer to the water environment, the higher the ecological sensitivity, while the further away from the water environment, the lower the sensitivity. Xinyi City has a small water area and a sparse surface river network. The overall ecological sensitivity of water environmental factors is low, with extremely sensitive areas and highly sensitive areas accounting for 6.74% of the total area of the city, with a total area of 242.17 km². The water environment in this area is easily affected by human activities, making it highly ecologically sensitive. Secondly, non-sensitive areas account for 78.38% of the total area of the city, with an area of 2825.53 km². The water environment in this area is not easily affected by human activities (Figure 6).

4.5 NDVI Factors

Xinyi City has a forest area of 212200 hectares, a forest coverage rate of 68.28%, and a forest volume of 16.9444 million m^3, ranking among the top in the province. It is a national ecological protection and construction demonstration zone and a national key ecological function zone. The ecological sensitivity of NDVI factors in Xinyi City shows a characteristic of high in the northeast and low in the southwest, with the lowest being at the junction of Dongzhen Street and Yudu Street. Result analysis shows that the ecological sensitivity of NDVI factors in Xinyi City is generally high, with extremely sensitive and highly sensitive areas accounting for 72.49% and 26.96%, respectively, covering an area of 2613.08km² and 971.93km². The medium-sensitive area accounts for 0.54%, with an area of 19.53km². The low-sensitivity area accounts for 0.01%, with an area of 0.28km² respectively (Figure 7).

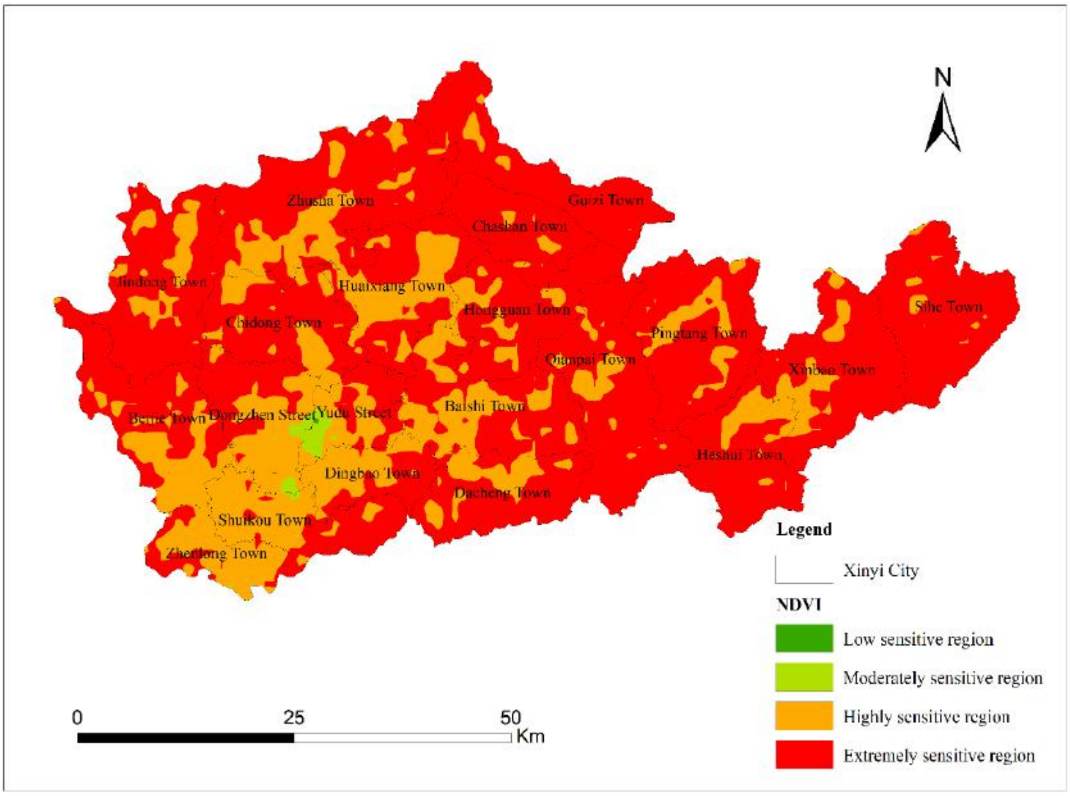

Fig.7 NDVI Factor Analyses

4.6 Land Use Factors

According to the current land use situation in Xinyi City, land use types are divided into 5 categories: water bodies, forest land and arable land, grassland and shrubs, bare land, and construction land. The area of the medium-sensitive area is 3km², accounting for 0.08% of the total area. The area of the high sensitivity zone is 3569.89km², accounting for 99.03% of the total area. The extremely sensitive area covers an area of 6.17km², accounting for 0.17% of the total area. The results indicate that the ecological sensitivity of land use factors in Xinyi City, except for the areas along the Jinjiang River in the urban area, is mainly high sensitivity, distributed in the east, north, and west, with a large forest area. Among them, the ecological function of forests plays an extremely important role in protecting the ecological environment of Xinyi City and promoting regional sustainable development. Secondly, the construction land in Xinyi City is mainly concentrated in the urban area, with an area of 25.74km², accounting for 0.71%, while the area of bare land in the city is relatively small, accounting for only 0.001% (Figure 8). Therefore, scientific and rigorous construction planning must be carried out in the process of development and utilization to reduce damage to the ecological environment. For different types of land use, reasonable development should be carried out to achieve sustainable development in Xinyi City.

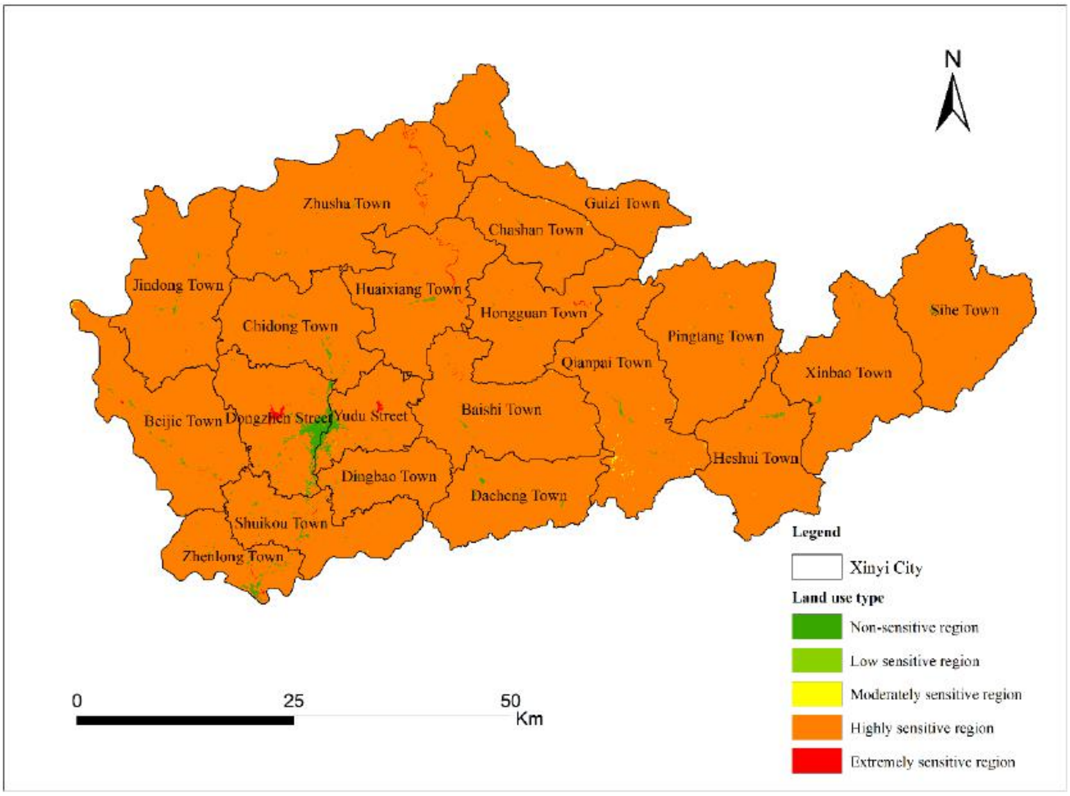

Fig.8 Analysis of Land Use Factors in Xinyi City

4.7 Comprehensive Analysis of Ecological Sensitivity

This article selects six ecological evaluation factors: elevation, slope, aspect, water environment, vegetation NDVI, and land use type. By using GIS and AHP to perform weighted superposition analysis on various evaluation factors, a comprehensive evaluation map of ecological sensitivity in Xinyi City (Figure 9), a statistical table for comprehensive analysis of ecological sensitivity in Xinyi City (Table 5), and an ecological sensitivity table for each town (street) in Xinyi City (Table 6) were obtained.

The overall ecological sensitivity of Xinyi City is relatively high, showing a decreasing pattern from northeast to southwest. The proportion of extremely sensitive areas and high sensitive areas is 8.96% and 33.01%, respectively, with a total area of 1506.07 km². They are mainly distributed in river and riverbank areas, which are mostly crisscrossed by mountains and rivers, with large undulations and steep slopes. Therefore, in the process of construction and utilization, special attention needs to be paid to the protection of the ecological environment in these areas. The medium-sensitive area and low sensitive area are 1395.36km² and 661.65km², respectively, accounting for 38.88% and 18.44%, respectively, mainly for human production and living areas outside the city center, with a certain scale of construction land. The non-sensitive areas are concentrated in the central and southern parts of Xinyi City, accounting for 0.71% of the city's area with a total area of 25.37km². The area has a high degree of urbanization, a large scale of construction land, high transportation accessibility, and convenient production and life for the people. However, in the process of economic and social development, ecological security still needs to be valued and maintained to achieve sustainable development.

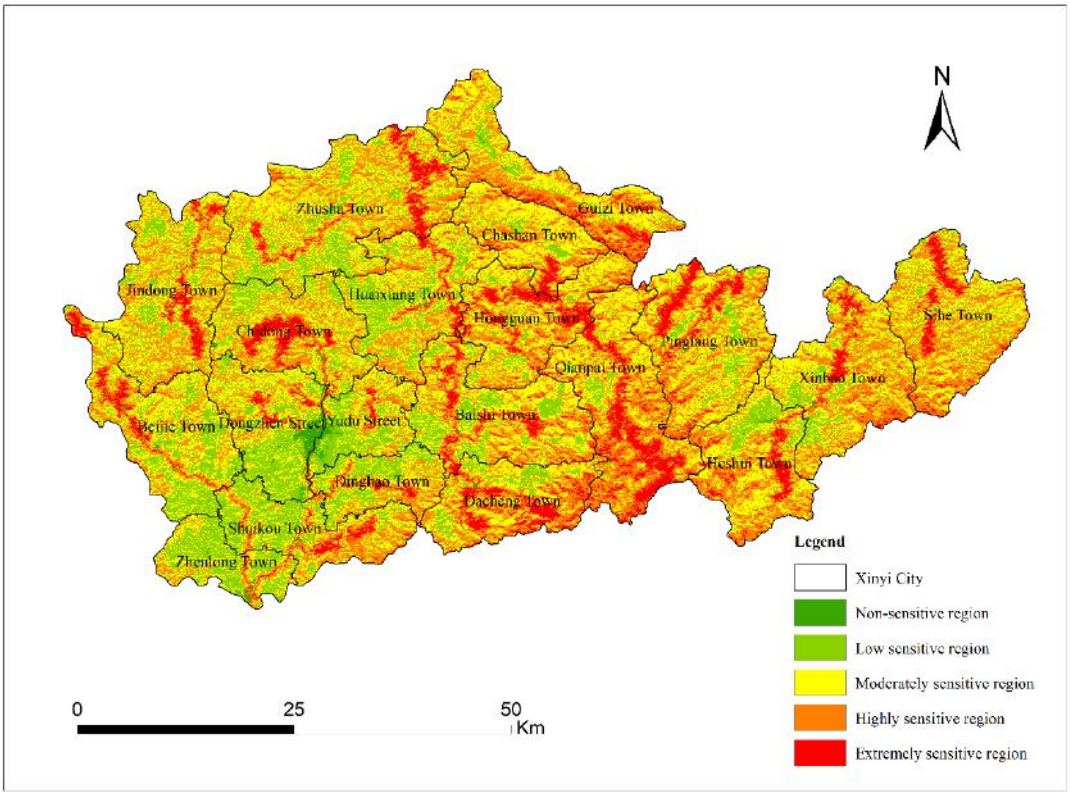

Fig.9 Comprehensive Evaluation of Ecological Sensitivity

Table 5 Comprehensive Analysis and Statistics of Ecological Sensitivity in Xinyi City

Ecological sensitivity evaluation	Comprehensive evaluation index	Area /km^2	Proportion /%
Non sensitive	(1.96,4.25]	25.37	0.71
low sensitive	(4.25,5.45]	661.65	18.44
medium sensitive	(5.45,5.88]	1395.36	38.88
high sensitive	(5.88,6.34]	1184.55	33.01
extremely sensitive	(6.34,8.11]	321.53	8.96

Table 6 Ecological Sensitivity Table of Each Town (Street) in Xinyi City

District	Unit	Non sensitive	low sensitive	medium sensitive	high sensitive	extremely sensitive
Dongzhen Street	Area/km^2	9.95	54.40	53.84	25.64	5.38
	Proportion /%	6.67	36.46	36.08	17.18	3.61
Yudu Street	Area/km^2	3.91	35.28	33.98	18.31	2.50
	Proportion /%	4.16	37.54	36.15	19.48	2.66
Baishi Town	Area/km^2	0.32	40.11	82.35	66.61	20.12
	Proportion /%	0.15	19.15	39.31	31.79	9.60
Beijie Town	Area/km^2	1.23	59.80	83.84	50.47	14.19
	Proportion /%	0.59	28.54	40.01	24.09	6.77
Chashan	Area/km^2	0.11	9.07	59.82	39.00	9.66

District	Unit	Non sensitive	low sensitive	medium sensitive	high sensitive	extremely sensitive
Town	Proportion /%	0.09	7.71	50.84	33.15	8.21
Chidong Town	Area/km^2	1.01	35.04	65.23	53.54	18.50
	Proportion /%	0.58	20.22	37.64	30.89	10.67
Dacheng Town	Area/km^2	0.56	17.65	50.16	59.11	23.84
	Proportion /%	0.37	11.66	33.15	39.06	15.75
Dingbao Town	Area/km^2	0.72	31.52	33.30	25.01	4.38
	Proportion /%	0.76	33.20	35.08	26.35	4.62
Guizi Town	Area/km^2	0.32	16.70	76.72	74.59	15.44
	Proportion /%	0.18	9.09	41.75	40.59	8.40
Heshui Town	Area/km^2	0.66	20.01	63.66	64.80	15.92
	Proportion /%	0.40	12.12	38.57	39.26	9.65
Hongguan Town	Area/km^2	0.13	15.48	66.50	65.91	25.01
	Proportion /%	0.08	8.94	38.43	38.09	14.46
Huaixiang Town	Area/km^2	0.53	52.46	78.17	51.11	8.21
	Proportion /%	0.28	27.54	41.04	26.83	4.31
Jindong Town	Area/km^2	0.73	37.59	92.74	77.06	14.65
	Proportion /%	0.33	16.87	41.63	34.59	6.58
Pingtang Town	Area/km^2	0.30	24.02	89.51	84.51	25.85
	Proportion /%	0.13	10.71	39.93	37.70	11.53
Qianpai Town	Area/km^2	0.20	11.32	77.96	99.22	50.05
	Proportion /%	0.08	4.74	32.65	41.56	20.96
Shuikou Town	Area/km^2	1.29	46.96	47.20	41.07	9.13
	Proportion /%	0.88	32.24	32.41	28.20	6.27
Sihe Town	Area/km^2	0.25	17.41	83.69	88.87	18.11
	Proportion /%	0.12	8.36	40.17	42.66	8.69
Xinbao Town	Area/km^2	0.53	26.00	85.94	85.10	14.66
	Proportion /%	0.25	12.25	40.49	40.10	6.91
Zhenlong Town	Area/km^2	2.12	45.45	30.27	13.25	2.00
	Proportion /%	2.28	48.83	32.52	14.23	2.15
Zhusha Town	Area/km^2	0.49	65.27	139.85	100.72	23.80
	Proportion /%	0.15	19.77	42.36	30.51	7.21
Baishi Town	Area/km^2	0.32	40.11	82.35	66.61	20.12
	Proportion /%	0.15	19.15	39.31	31.79	9.60
Beijie Town	Area/km^2	1.23	59.80	83.84	50.47	14.19
	Proportion /%	0.59	28.54	40.01	24.09	6.77

V. CONCLUSION

The advent of the industrial and information age has brought about rapid urbanization and development for people. People should not only enjoy the convenience of production and life but also be vigilant for danger, dialectically view the urban prosperity and ecological damage brought about by development, and correctly view and solve various ecological and environmental problems that have already emerged. With the rapid development of urbanization, Xinyi City inevitably causes damage to the ecological environment. To protect the ecological environment and maintain ecological balance, this study provides some references for the future development of Xinyi City. This article selects six ecological evaluation factors, including elevation, slope, aspect, water environment, vegetation NDVI, and land use, to establish an ecological sensitivity evaluation system. The conclusions drawn from this study are as follows:

(1) The sensitive areas in Xinyi City are composed of high- and medium sensitive areas with overall high ecological sensitivity. Among them, the areas with relatively small ecological damage are located in the southwest of Xinyi City.

(2) The main factors affecting the ecological sensitivity of Xinyi City are land use type, vegetation coverage, and water environment.

(3) The spatial distribution of ecological sensitivity in Xinyi City shows a decreasing pattern from northeast to southwest. The extremely sensitive and highly sensitive areas are distributed in areas with high terrain, complex terrain, and close to rivers and lakes in Xinyi City. The extremely sensitive areas must strictly protect the natural ecological environment and cannot be occupied arbitrarily. High-sensitivity areas can be used to construct nature reserves and develop ecotourism in a reasonable manner. The non-sensitive areas are mainly concentrated in the urban center of the southwest of Xinyi City. The terrain is flat, suitable for human production and life, and the construction land is large. These areas have a stable ecological structure and strong anti-interference ability and can be developed and constructed reasonably on the basis of protecting the ecology. Low- and medium-sensitive areas are mainly distributed in human residential areas outside the central urban area. The construction land in these areas is relatively large, and these areas can be moderately developed, but natural resource protection needs to be strengthened. Urban ecological sensitivity assessment helps to understand the ecological security status and development potential of cities, guide urban planning, promote ecosystem stability, optimize ecological patterns, and build modern cities that are livable and business-friendly.

(4) Qianpai Town, Dacheng Town, Hongguan Town, Sihe Town, Pingtang Town, Guizi Town, Heshui Town, and Xinbao Town have the highest ecological sensitivity, and special attention should be paid to their future urban development and land use, and scientific and rigorous decision-making and planning should be formulated.

ACKNOWLEDGEMENTS

The author is grateful for the research grants given to Ruei-Yuan Wang from GDUPT Talents Recruitment (No.2019rc098), Peoples R China under Grant No.702-519208, and Academic Affairs in GDUPT for Goal Problem-Oriented Teaching Innovation and Practice Project Grant No.701-234660.

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