ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

Ecological Sensitivity Analysis of Baiyangdian Basin Based on GIS

Tan Shishuai[a], Huang Weiyong[b,*]

Guangxi University of Science and Technology, Liuzhou, China
[a]t1306282022@163.com, [b]641758436@qq.com
[*]Corresponding author

Abstract: *Taking Baiyangdian Basin as the research object, this paper selects 6 evaluation indexes, including elevation, slope, slope direction, water buffer zone, NDVI and land use type, and uses GIS technology and AHP to analyze ecological sensitivity. The results showed as follows: (1) According to the degree of impact on ecological sensitivity, NDVI, land use type, water area buffer, elevation, slope and slope direction were ranked from large to small. (2) NDVI factor has the greatest influence on the ecological environment sensitivity of Baiyangdian Basin among the 6 ecological assessment factors, and the weight value is 0.31. (3) The ecological sensitivity of Baiyangdian basin is high, and the extremely sensitive area and the highly sensitive area account for 39.67% of the total area. The proportion of moderately sensitive areas was the highest (28.78%). The proportion of low sensitive areas was 20.74%. The proportion of extremely low sensitive areas was the lowest (10.81%). The extremely sensitive and highly sensitive areas of Baiyangdian basin are mainly distributed in mountainous areas and river basins in northwest China. The extremely low sensitive areas are mainly distributed in the areas where human activities are concentrated, such as cities and villages.*

Keywords: *GIS; Baiyangdian Basin; ecological sensitivity; ecological evaluation factors*

1. Introduction

At present, the conflict between human beings and nature is becoming more and more serious. In order to alleviate the relationship between human beings and nature, we adopt ecological restoration and other measures to realize the harmonious coexistence between human beings and nature. Ecological restoration is an important way to achieve the goal of building a beautiful China and achieving sustainable development. Ecological sensitivity assessment can provide guidance for scientific ecological restoration. With the national promotion of ecological restoration, ecological sensitivity analysis plays an increasingly high value.

Ecological sensitivity is the adaptability of an ecosystem to external pressures and its resilience after being damaged. Ecological sensitivity assessment is one of the effective means to identify regional ecological and environmental problems. Ecological sensitivity assessment is an important basis for analyzing and predicting regional ecosystem imbalance and environmental problems, and is also a key content of ecological environment impact analysis and urban ecosystem construction regulation. Ecological sensitivity assessment can provide guidance for scientific ecological restoration.

The concept of eco-environmental sensitivity was first proposed by Ouyang Zhiyun et al in 2000. [1] With the development, the research perspectives of experts and scholars on eco-environmental sensitivity tend to be diversified. The study of ecological sensitivity by Chen Wanji et al. is from the perspective of oasis;[2] Cao Shengxi's research is from the perspective of scenic byway;[3] Jia Hansen's research is from the perspective of green mine;[4] Wang Xiaofeng's research stood in the perspective of nature reserves; Li Jingwen's research stands in the perspective of river basin.[5]

From the perspective of lake basin, this paper selects Baiyangdian Basin as the research object, and selects six regional representative ecological sensitivity factors, namely elevation, slope, slope direction, water buffer zone, NDVI and land use type, to form the ecological sensitivity evaluation index system of Baiyangdian Basin. Ahp is used to determine the weight of each index. Using the spatial analysis of related GIS technology, the single factor ecological sensitivity analysis and multi-factor ecological sensitivity comprehensive analysis of 6 factors were carried out.

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

2. Study area profile

Baiyangdian Valley is located in the middle of North China Plain, between 113°39 '~ 116°11' east longitude and 39°4 '~ 40°4' north latitude. It belongs to the Daqing River system of Haihe River Basin, spanning 38 cities and counties of Hebei and Shanxi provinces and Beijing. The basin area of 31,200 km² is 81.04% in Hebei Province, 11.85% in Shanxi Province, 7.11% in Beijing, and about 85% in Baoding. The topography of the basin is complex, and the terrain is high in the west and low in the east, in order of middle mountains, low mountains, hills, plains and lakes. The mountain area accounts for 64.1% of the basin area.[6]

Baiyangdian Valley is located at the junction of Taihang Mountain and North China Plain. At the same time, it has high altitude mountains and rich plains. It is rich in mineral and oil resources and has a vast area of arable land. However, due to the development of industry and the unreasonable development of resources, Baiyangdian and the river basin have been polluted by large-scale industrial wastewater, excessive livestock and poultry breeding and other problems, resulting in deteriorating water quality, climate change, human flow activities and water resources deployment have led to the continuous reduction of water area. After the establishment of Xiongan New Area, large-scale ecological restoration of Baiyangdian has been carried out, and certain progress has been made, but the benign ecosystem has not been restored. The ecological sensitivity analysis of Baiyangdian basin can provide reference for ecological restoration and regional sustainable development of Baiyangdian Basin.

3. Data sources and research methods

3.1. Selection and grading of ecological sensitivity evaluation factors

The main factors affecting the change of ecological sensitivity include ecology, geography and human factors. This study is to analyze the ecological sensitivity of Baiyangdian basin. Since the Baiyangdian basin has a large area of mountain and plain at the same time, the ecological environment has regional differences, six evaluation factors including elevation, slope, slope direction, water buffer zone, NDVI and land use type are selected for analysis. These evaluation factors are important ecological, geographical and human factors affecting the ecological sensitivity of Baiyangdian basin, and can reflect the ecological sensitivity of Baiyangdian basin. The index system of ecological sensitivity factors in Baiyangdian basin is shown in Table 1.

Table 1: Ecological sensitivity evaluation index system of Baiyangdian Basin.

Rating factor	Very low sensitivity (1)	Low sensitivity (3)	Moderate sensitivity (5)	Highly sensitive (7)	Extremely sensitive (9)
elevation	<200m	200-500m	500-800m	800-1100m	>1100m
slope	<6°	6-13°	13-23°	23-33°	>33°
Slope direction	Flat and due south	Southeast and southwest	Due east, due west	Northeast and northwest	Due north
Water buffer	> 800m buffer distance	800-500m buffer distance	200-500m buffer distance	50-200m buffer distance	< 50m buffer distance
NDVI	<0.2	0.2-0.4	0.4-0.6	0.6-0.8	>0.8
Land use type	Construction land		Cultivated land, shrub land		Wetlands, woodlands, grass bodies and water bodies

3.2. Data source

As the main basin of Baiyangdian is located in Baoding City, Hebei Province, the data of administrative division boundary of Baoding City (from Aowei Interactive map) is selected for research. The data selected for the four evaluation factors of elevation, slope, slope direction and water buffer zone in this study are 30m DEM image map of Baoding City (sourced from geospatial data cloud: GDEMV230M resolution digital elevation data). The data information of vegetation coverage factor is the remote sensing image of Baoding City (from the geospatial data cloud: Landsat8OLI_TIRS satellite digital product, cloud cover ≤5%, and the time range is 2021-2022. The downloaded data identification

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

is: LC81230322021250LGN00, LC81230332021250LGN00, LC81240322020271LGN00, LC81240332021033L GN00).

3.3. Research method

3.3.1. AHP (analytic hierarchy Process)

AHP is a multi-criterion decision analysis method. It was proposed by the American operations research scientist Saaty in the early 1970s to solve complex decision problems. By establishing a hierarchical structure model, the decision problem is decomposed into multiple levels, such as goals, criteria and schemes, and the relative importance of each level element is determined by the pair comparison matrix, so as to obtain the final decision scheme.[7] The advantage of AHP method is that it can combine qualitative and quantitative analysis, deal with decision-making problems in a systematic way, and make the decision-making process more scientific and reasonable. In this paper, only the target layer and criterion layer of AHP are used. The ecological sensitivity of Baiyangdian Basin is the target layer of this paper, and the criterion layer includes six factors: elevation, slope, slope direction, water buffer, NDVI and land use type.

1) Scale determination and construction of judgment matrix. In this paper, the 1-9 scale method (the lowest score is 1, the highest score is 5) is used to compare six indicators in the ecological sensitivity evaluation index system of Baiyangdian Basin by consulting experts and scholars in related disciplines. The degree of comparison is quantified, with the quantized value 1 being equally important, 3 being slightly important, 5 being obviously important, 7 being most important, 9 being absolutely important, and 2/4/6/8 being the middle value of the two scales. After scoring in the scoring table by using the 1-9 scale method, the experts and scholars construct a judgment matrix by geometric average of the scoring matrix of the experts. The judgment matrix constructed in this paper is shown in Table 2.

Table 2: AHP analysis and judgment matrix.

	elevation	slope	Aspect of slope	Water buffer	NDVI	Land use type
elevation	1	0.8	1.008	0.391	0.308	0.385
slope	1.25	1	0.852	0.286	0.255	0.32
Slope direction	0.992	1.174	1	0.213	0.2	0.222
Water buffer	2.556	3.5	4.694	1	0.356	0.468
NDVI	3.25	3.922	5	2.806	1	0.857
Land use type	2.597	3.125	4.5	2.139	1.167	1

2) Consistency check analysis. When constructing the judgment matrix, it is possible to make logical errors, such as A is more important than B, B is more important than C, but C is more important than A. Therefore, it is necessary to use the consistency test whether there is a problem. The consistency test uses the CR value for analysis. If the CR value is less than 0.1, it indicates that the consistency test is passed.[7] The calculation formula for CR is as follows:

$$CR = \frac{CI}{RI} \tag{1}$$

$$CI = \frac{LargestEigenvalue - N}{N-1} \tag{2}$$

Table 3: Consistency test results.

LargestEigenvalue	CI	RI	CR	Consistency test result
6.204	0.041	1.26	0.032	pass

Table 4: Weight of each factor.

Rating factor	weight
elevation	0.08
slope	0.07
Slope direction	0.07
Water buffer	0.19
NDVI	0.31
Land use type	0.28

CR is the consistency ratio; CI is the consistency index; RI is a random consistency index. The CI value has been obtained when the eigenvector is obtained, and the RI value is obtained directly by looking up the table. N is the selected number of ecological sensitive factors. The CR value in this

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

paper is obtained by entering the judgment matrix into SPSSAU for processing, and the consistency test results are shown in Table 3. If the CR value is 0.041, less than 0.1, the consistency test of the judgment matrix is passed, and the weight of the ecological sensitivity factor can be used. The weight results are shown in Table 4.

3.3.2. GIS spatial analysis

GIS spatial analysis is an important technology in geographic information system (GIS), which involves the use of various methods to process and analyze geospatial data in order to extract information about the spatial location, distribution, form, formation and evolution of geographic objects. These analytical methods include geometric analysis, statistical analysis, mathematical modeling, geographic computation, etc., which aim to describe and analyze the target spatial relationship in geographic space and provide services for spatial decision support.

1) Data extraction and reclassification. This step requires the reclassification data for each factor and the area of each level of the data. In this paper, ArcGIS software was used to extract elevation, slope, slope direction and land use type data from 30m DEM image map of Baiyangdian Basin, and multilevel buffer zone of river network of Baiyangdian basin was established to obtain water buffer data. NDVI data was obtained by ENVI software. Then, the reclassification function of ArcGIS was used to classify the 6 ecological sensitive factors, and the ecological sensitivity analysis of each factor was carried out. The elevation, slope and slope direction data are extracted from DEM images by the corresponding functions of ArcGIS, including reclassification, raster plane rotation and area calculation. The data of water buffer were obtained by ArcGIS software through a series of software operation analysis of DEM image map, such as depression filling, flow direction, flow rate, grid calculator, river link, river network classification, grid vectorization, multiple buffer analysis, clip-calculated area, surface to grid, and reclassification. NDVI data were first obtained by ENVI software through radiometric calibration, Mosaic, clipping, and extraction of NDVI for band calculation, statistical value, and vegetation coverage calculation. Finally, they were imported into ArcGIS for reclassification, surface data, and area calculation.

2) Weighted superposition analysis. In this paper, the weights of six ecological sensitivity factors were determined by AHP, and then weighted superposition analysis was carried out in ArcGIS according to the weights of each factor, and the natural breakpoint method was used to divide the six ecological sensitivity levels: very low sensitivity, low sensitivity, medium sensitivity, high sensitivity, and very high sensitivity to obtain the comprehensive ecological sensitivity distribution map of Baiyangdian Basin.

4. Results and Analysis

4.1. Single Factor Ecological Sensitivity Analysis and Evaluation

4.1.1. Elevation Sensitivity Analysis

The height of elevation is the main reason for the law of vertical regional differentiation. The overall distribution of elevation sensitivity in Baiyangdian Basin is gradually decreasing from northwest to southeast, which is due to the fact that this area is located in the transition zone between Taihang Mountains and North China Plain. The proportion of extremely low elevation sensitive areas was the highest in Baiyangdian basin (57.42%), which distributed in the southeast plain area. The low altitude sensitive areas were distributed in the border area between the mountainous area in the northwest and the plain in the southeast, accounting for 14.84%. The medium sensitive area, high sensitive area and extremely sensitive area were distributed in the west, middle and north of the northwest mountainous area, accounting for 11.47%, 8.92% and 7.35%, respectively. The distribution results of elevation ecological sensitivity are shown in Figure 1, and the proportion of each region is shown in Table 5.

4.1.2. Slope sensitivity analysis

Slope has a significant impact on the ecosystem, not only affecting soil erosion and soil erosion, but also affecting the species diversity and functional diversity of plant communities. In Baiyangdian basin, the extremely low slope sensitive areas are mainly distributed in the southeast plain area, and a small amount of them are distributed in the northwest mountain valley area, accounting for 50.82%. The low-grade sensitive areas were scattered, accounting for 18.64%. The moderately sensitive, highly sensitive and extremely sensitive areas accounted for 14.80%, 10.11% and 5.63%, respectively, and

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

were distributed in the northwestern mountainous areas. To sum up, Baiyangdian valley should strengthen the protection of ecological environment in the Taihang Mountains in the northwest to prevent the occurrence of natural disasters such as debris flow and landslide. The distribution results of slope ecological sensitivity are shown in Figure 2, and the proportion of each region is shown in Table 5.

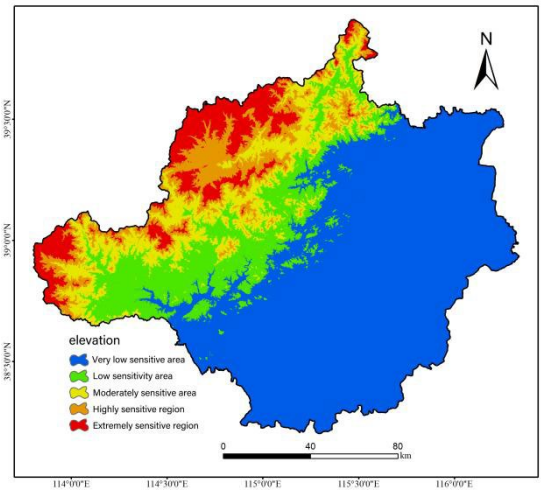

Figure 1: Elevation ecological sensitivity

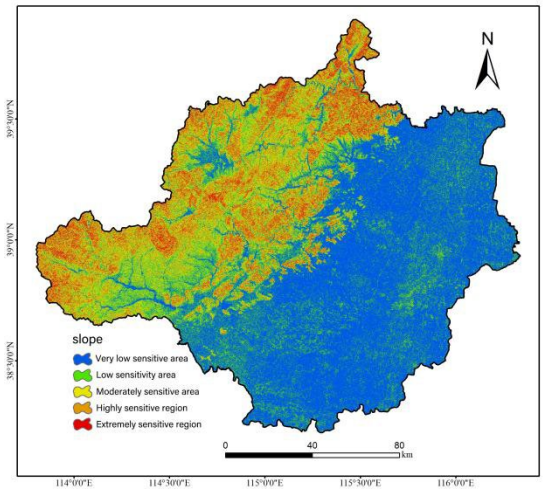

Figure 2: Ecological sensitivity of slope

4.1.3. Slope direction sensitivity analysis

Slope direction refers to the projection direction of the slope normal on the horizontal plane. Slope aspect indirectly affects the type, distribution and growth of vegetation by influencing light, temperature, moisture and soil fertility. The terrain of Baiyangdian valley inclines from northwest to southeast, and the landform is divided into mountain area, plain area and depression area. Low sensitive area, high sensitive area and extremely sensitive area are concentrated in the northwestern mountainous area. The extremely low sensitive areas are more distributed in the mountain valleys of northwest China. The moderately sensitive areas were evenly distributed in the study area. In the southeast plain area, each sensitive level area is staggered. The proportion of low sensitive, medium sensitive and high sensitive areas was close to 25.47%, 24.43% and 23.65%, respectively. The proportion of very low sensitive and very high sensitive areas is relatively small, 15.23% and 11.22% respectively. In summary, through the analysis of slope sensitivity, the ecological protection and restoration of vegetation distribution area and crossover area with high slope sensitivity level should be taken into consideration in the process of ecological restoration in Baiyangdian Basin. The distribution results of slope ecological sensitivity are shown in Figure 3, and the proportion of each region is shown in Table 5.

4.1.4. Sensitivity analysis of water buffer zone

Water buffer zone refers to a certain width set around the water body, mainly used to protect water quality, maintain ecological balance, and prevent pollution and other human interference. The water buffer zone is helpful to maintain the ecological balance of Baiyang Lake, and plays a key role in conserving water source, slowing down flood and retention, regulating regional climate and maintaining species diversity. The proportion of extremely low sensitive area was the highest in Baiyangdian basin, which was 57.71%. The proportion of low sensitive and medium sensitive areas was close, 14.32% and 16.18%, respectively. The highly sensitive and extremely sensitive areas accounted for 8.60% and 3.19% respectively. Due to the influence of climate change and human activities, the ecological environment of Baiyangdian has been destroyed and the function of ecosystem has been degraded. Therefore, the effective management and protection of the water buffer zone is very important for the ecological restoration and sustainable development of Baiyangdian Basin. The distribution results of ecological sensitivity in water buffer zone are shown in Figure 4, and the proportion of each area is shown in Table 5.

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

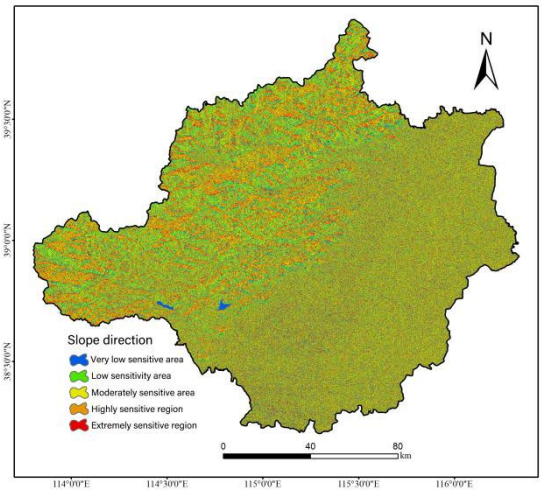

Figure 3: Slope direction ecological sensitivity

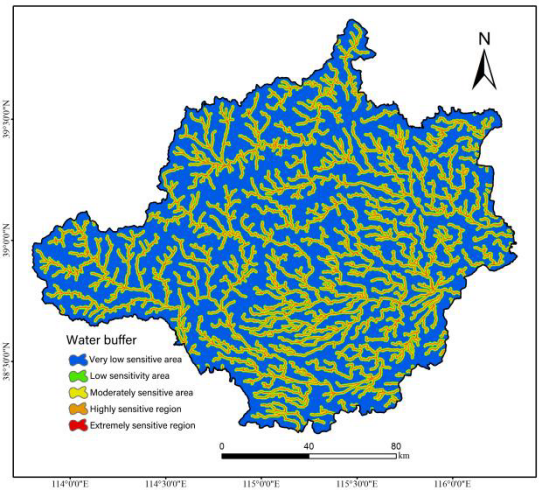

Figure 4: Water buffer sensitivity

4.1.5. Sensitivity analysis of NDVI

NDVI, that is, the normalized difference vegetation index, is a kind of remote sensing technology used in the index, to evaluate and monitor the growth of vegetation. In this paper, the ecological sensitivity level of NDVI is classified according to the Guideline for delineating the Red Line of Ecological Protection. According to the Baoding Municipal People's government website, by the end of 2019, the forest coverage rate in Baoding district of Baiyangdian Valley had reached 34 percent. It is expected that by 2025, the forest coverage rate in Baoding District of Baiyangdian Basin will reach 38 percent, and stabilize at more than 40 percent in 2035. The ecological sensitivity of NDVI in Baiyangdian Basin is relatively high, with the proportion of extremely sensitive and highly sensitive areas being 19.08% and 36.97%, respectively, mainly distributed in the southeastern and northern margins, with sporadic distribution in the western mountainous areas. The medium sensitive area accounted for 25.25%, and the distribution was concentrated in the western mountainous area, and also distributed in the southeast. Low sensitivity areas accounted for 9.10%, mainly distributed in villages and towns. The extremely low sensitive areas were mainly distributed in the gentle slope areas around cities, reservoirs and river valleys, accounting for 9.60%. The distribution results of NDVI ecological sensitivity are shown in Figure 5, and the proportion of each region is shown in Table 5.

4.1.6. Sensitivity analysis of land use types

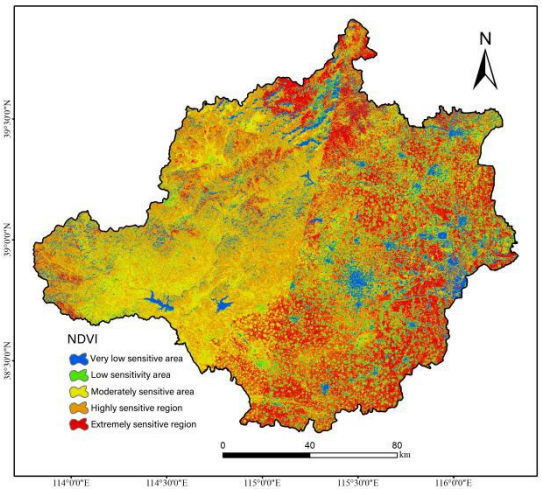

Figure 5: NVDI sensitivity analysis

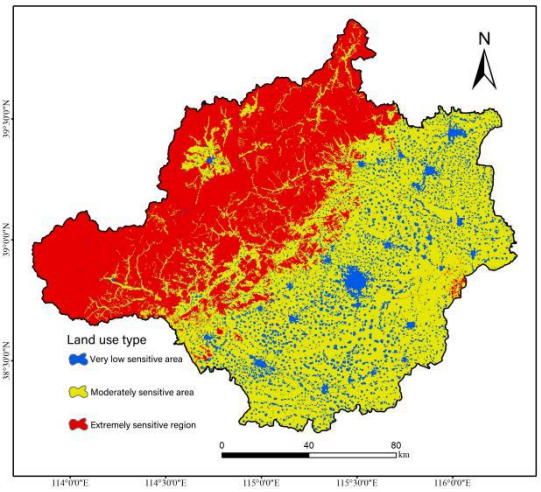

Figure 6: Ecological sensitivity of land use type

Land use patterns are influenced by a variety of factors, including natural factors and human activities. The results of ecological sensitivity analysis of land use type show that Baiyangdian basin is generally of medium and high sensitivity. According to the proportion of evaluation factors in Baiyangdian basin (see Table 5), there is a small amount of construction land in Baiyangdian basin, accounting for 10.21%. Most of the land is distributed in the southeast plain area, and there is a

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

sporadic distribution in the northwest mountain area. The proportion of moderately sensitive areas mainly cultivated land and shrub land was the highest (50.23%), including most of the southeast plain area and the southwest valley area. Wetlands, woodlands, grass bodies and water bodies with high ecological sensitivity account for 39.56%, which are basically distributed in the northwestern mountainous areas and Baiyang Lake area. The distribution results of ecological sensitivity of land use types are shown in Figure 6, and the proportion of each region is shown in Table 5.

Table 5: The proportion of each rating factor in Baiyangdian basin.

Ecological factor	Very low sensitivity (1)(%)	Low sensitivity(3)(%)	Moderate sensitivity (5)(%)	Highly sensitive(7)(%)	Extremely sensitive(9)(%)
elevation	57.42	14.84	11.47	8.92	7.35
slope	50.82	18.64	14.80	10.11	5.63
Slope direction	15.23	25.47	24.43	23.65	11.22
Water buffer	57.71	14.32	16.18	8.60	3.19
NDVI	9.60	9.10	25.25	36.97	19.08
Land use type	10.21		50.23		39.56

4.2. Comprehensive ecological evaluation analysis of ecological environmental sensitivity

Based on the six indexes of elevation, slope, slope direction, water area buffer, NDVI and land use type, a weighted superposition analysis was carried out in ArcGIS software according to the weights of each index obtained by AHP hierarchy analysis, and the natural discontinuous method was used to divide the index into 5 levels. The comprehensive ecological sensitivity evaluation index of Baiyangdian Basin ranges from 1 to 4.93 (see Table 6). The very low sensitive areas (sensitivity index 1-2.03) in Baiyangdian Basin accounted for the least (10.81%), and were mainly distributed in cities, villages and other concentrated areas of human activities in the southeast plain. Low sensitivity areas (sensitivity index 2.03~2.68), medium sensitivity areas (sensitivity index 2.68~3.15) and high sensitivity areas (sensitivity index 3.15~3.60) accounted for 20.74%, 28.78% and 25.73% of the total area, respectively, and were mainly distributed horizontally in Dongchuan District. The low sensitive areas are mainly distributed in the southeast plain, the high sensitive areas are more distributed in the northwest mountainous areas, and the medium sensitive areas are scattered, which are distributed in cultivated land and shrub land. The extremely sensitive areas (sensitivity index 3.60~4.93) account for 13.93% of the total area of Baiyangdian Basin, which are mainly distributed in the northwest mountain area, the southeast wetland and river basin, and the main areas in this area are wetland, forest land, grassland and water.[8] The distribution of ecological sensitivity in Baiyangdian basin is shown in Figure 7.

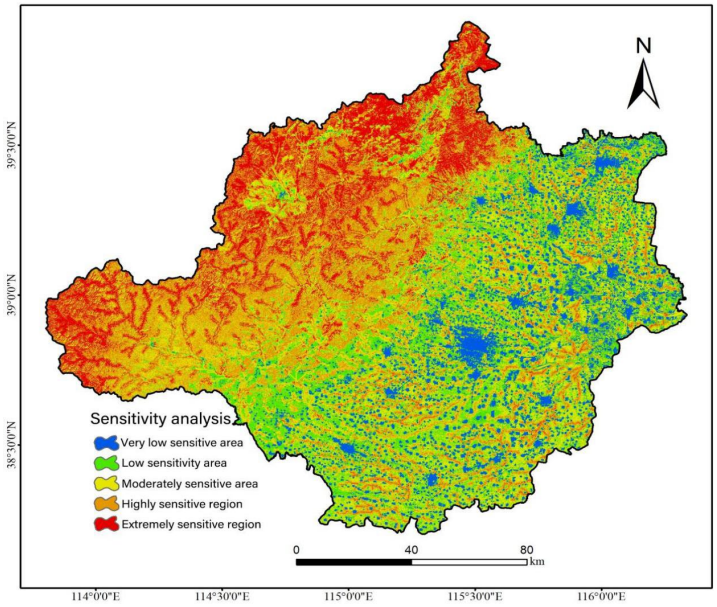

Figure 7: Ecological sensitivity distribution of ecological environment in Baiyangdian basin

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

5. Conclusion and discussion

Based on GIS platform, this paper selects six ecological sensitivity assessment factors, namely elevation, slope, slope direction, water buffer zone, NDVI and land use type, and conducts single factor ecological sensitivity analysis on them respectively. AHP and ArcGIS software are used for spatial analysis to obtain the comprehensive sensitivity of ecological environment in Baiyangdian Basin. The conclusion is as follows:

1) According to expert scores and analytic hierarchy process (AHP) results, NDVI index, land use type and water buffer zone have a high impact on ecological sensitivity, with weights of 0.31, 0.28 and 0.19, respectively. Height, slope and slope direction indexes had a low influence on ecological sensitivity, with weights of 0.08, 0.07 and 0.07, respectively. In the comprehensive ecological sensitivity distribution map of Baiyangdian basin, it can be seen that its distribution trend is basically consistent with the ecological sensitivity distribution of NDVI and land use type.[9]

2) According to the single factor evaluation results, by combining the elevation factor with the slope factor and the slope direction factor, it is found that the overall elevation of Baiyang Lake Basin has a large difference. The high altitude and steep slope are relatively concentrated in the northwestern region, which is a mountainous region, and the ecological environment protection in this region should be strengthened to prevent the occurrence of natural disasters such as debris flow and landslide. The southeastern region has a lower altitude and a slower slope. Most of them are plain, which is conducive to large-scale concentrated crop planting and urbanization construction. From the perspective of ecological sensitivity analysis of water buffer zone, Baiyangdian basin covers a wide area with dense river network and developed water system network, but the total area of Baiyangdian basin is relatively low, and the extremely sensitive area is only 3.19%. It is necessary to strengthen the protection of the water area of Baiyangdian area and speed up the restoration of the overall ecological service function of Baiyangdian. According to the NVDI ecological sensitivity analysis, the overall vegetation coverage of Baiyangdian Basin is high, and the most densely vegetated areas are in the eastern and northern parts of the basin. Vegetation protection and planting in the southern mountainous areas need to be strengthened. If natural disasters such as debris flow, mountain landslide and flood occur in this region, it is easy to affect the eastern urban population and cultivated land dense areas. The construction area of Baiyangdian Valley is less, accounting for 10.21%. The proportion of cultivated land and shrub land was 50.23%. The proportion of wetland, forest land, grass body and water body was 39.56%, mostly distributed in the northwest region. Therefore, from the perspective of land use type evaluation factor, the land use degree of Baiyangdian basin is low, and the spatial distribution of land resources should be rationally planned.

3) The comprehensive ecological sensitivity analysis of Baiyangdian basin showed that the overall ecological environmental sensitivity of the region was relatively high. The proportion of extremely sensitive and highly sensitive areas was 13.93% and 25.73% respectively, the proportion of moderate sensitive areas was up to 28.78%, and the proportion of low sensitive areas and very low sensitive areas accounted for 20.74% and 10.81% respectively of the total area of Baiyangdian basin. The ecological sensitivity increases step by step from southeast to northwest, and the closer the water is to rivers and lakes, the higher the ecological sensitivity is.

According to the results of this study, Baiyangdian basin should be managed in the process of ecological restoration. At the same time of the restoration and management of water resources in the downstream basin, we should strengthen the protection of the upstream ecology, actively carry out afforestation work, rationally plan land resources, maintain the stability of the local ecological environment, and promote the construction and sustainable development of regional ecological civilization.

References

[1] Ouyang Zhiyun, Wang Xiaoke, Miao Hong.(2000).Ecological environmental sensitivity and its regional differences in China. Acta Ecologica Sinica,(11),10-13.
[2] Chen Wanji, ZHAO Yang, CUI Dong.(2023).Study on ecological sensitivity of oasis supported by GIS: A case study of Ili River Valley. Bulletin of Surveying and Mapping,(11),107-114.
[3] Cao Shengxi, Lu Shixue, ZHAO Haiming.(2023).Ecological sensitivity analysis of scenic byway based on GIS -- Taking Chongli Winter Olympics ecological scenic Byway in Zhangjiakou as an example. Industrial Construction,(11),131-133.

ISSN 2616-5872 Vol.6, Issue 5: 73-81, DOI: 10.25236/AJEE.2024.060510

[4] Jia Hansen, GUO Dongyan, Sun Yingxiang.(2024).Spatial distribution characteristics and influencing factors of green mines in China.Geology and Exploration,(11),1-12.
[5] Li Jingwen, LI Zhenhan, WU Haibin.(2024).Assessment and ecological sensitivity analysis of water resources carrying capacity in Fenhe River Basin. Chinese Journal of Environmental Engineering, (11), 359-370.
[6] Han Meiqing, WANG Luguang, WANG Jingfei.(2007).Ecological environment assessment of Baiyangdian basin based on GIS. Chinese Journal of Eco-Agriculture,(13),169-171.
[7] Deng Xue, Li Jiaming, Zeng Haojian.(2012).Analytic hierarchy process weight calculation method analysis and application research. Mathematics in Practice and Theory,(11),93-100.
[8] Yang Yiyuan, Yang Cunjian.(2022).Ecological environment sensitivity analysis of Dongchuan district based on GIS. Bulletin of Surveying and Mapping,(11),7-12.
[9] Liu Ruoqi, Huang Zhiqiang.(2024).Ecological environment sensitivity analysis of Dongchuan district based on GIS. Geospatial Information,(42),54-59.