



# Research on the Application of Data Visualization Analysis Model Based on GIS in Resource and Environmental Audit

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**Abstract.** This paper provides new ideas and methods for resource and environmental auditing for the construction of ecological civilization and beautiful Hebei in Hebei Province, and helps the coordinated governance of the ecological environment in the Beijing-Tianjin-Hebei region and the green development of Xiong'an New Area. Taking advantage of the green resource and environmental service of geological exploration units, innovative research-based auditing methods are used to conduct ecological sensitivity analysis of Hebei Province using GIS spatial data processing technology. According to the analysis results, ecological and environmental projects can be selected in a targeted manner to carry out resource and environmental audits. On the basis of supervising and reviewing the implementation effects of environmental protection projects, environmental impact assessments can be conducted on the ecological and environmental restoration, the effects of environmental protection measures, and the risks involved. Guided by the results of environmental audits, valuable decision-making suggestions, feasible paths for environmental improvement, and related response measures can be provided to relevant departments, which is of great significance for promoting the rational development and utilization of resources in Hebei Province, reducing environmental damage, improving the ecological environment, and achieving green development.

**Keywords:** GIS, resource and environmental audit, ecological environment

## 1 Introduction

Hebei Province is located in the North China Plain. It is the only province in the country that has grasslands, seashores, deserts, lakes, plateaus, plains, mountains, and forests. It is known as the concentrated "National Geographic Reader"<sup>[1]</sup>. The climate belongs to the temperate continental monsoon climate, with four distinct seasons but significant differences between the north and the south. As a province rich in mineral resources and an important energy and mineral base in the country, Hebei Province has discovered 159 kinds of minerals, and its advantages in coal, iron, gold, molybdenum, and limestone for cement are relatively competitive. However, due to the lack of systematic and effective management in the early stage, the long development and utilization time,

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and the high development intensity, while supporting regional development, it also brings high-intensity ecological and environmental pressure.

As an ecological barrier for the coordinated development of Beijing, Tianjin and Hebei, Hebei Province undertakes multiple tasks such as water conservation in the capital, sandstorm source control, and regional environmental quality improvement. In recent years, the province has continued to carry out projects such as ecological restoration of historical mines and ecological restoration of Baiyangdian Lake with Beijing, Tianjin and Hebei and key mining areas as the core, with remarkable results and continuous improvement in ecological environment quality.

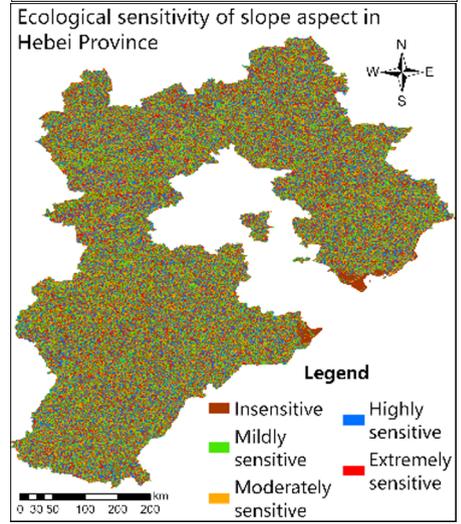
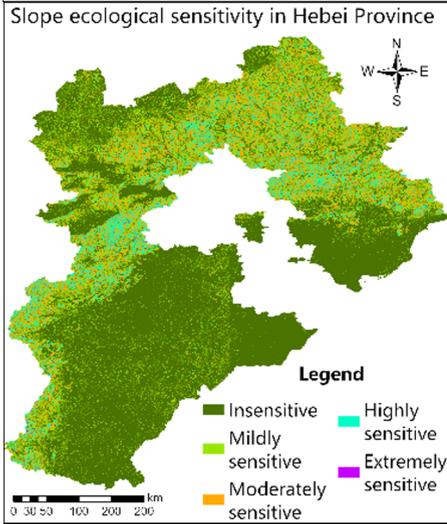
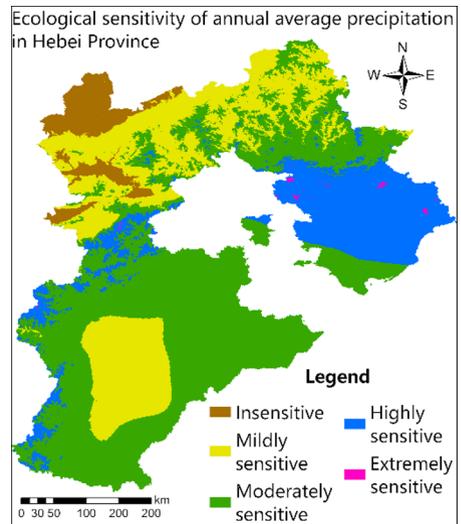
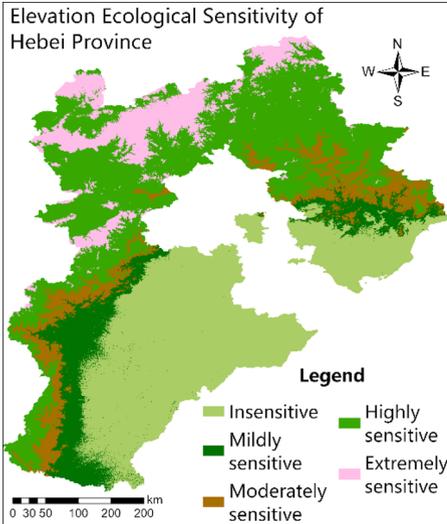
Based on the protection and improvement of the ecological environment in Hebei Province, the over-exploitation and abuse of natural resources are reduced, and the deterioration of the ecological environment is avoided. GIS spatial data processing technology is used to synthesize and superimpose multi-source data layers of different ecological environment evaluation factors, draw an ecological sensitivity analysis map of Hebei Province, and scientifically predict potential environmental risks, which is helpful to take management measures in advance for prevention.

## 2 Analysis of Ecological Sensitivity in Hebei Province

Based on the green transformation, ecological environment protection and improvement of Hebei Province, reducing the over-exploitation and abuse of natural resources and avoiding the deterioration of the ecological environment, firstly, the ecological environment sensitivity evaluation factors were selected based on the relevant ecological environment regulations and literature research<sup>[2-5]</sup>(Table 1); secondly, the AHP method was used to construct a judgment matrix according to the expert scoring method, the weight value of the sensitivity evaluation factor was determined, and the ecological sensitivity evaluation index system of Hebei Province was established (Table 2). Then, GIS spatial data processing technology was used to synthesize and superimpose multi-source data layers of different ecological environment evaluation factors. On this basis, the ecological sensitivity analysis map of Hebei Province was drawn, which is helpful to scientifically predict potential environmental risks and take management measures in advance to prevent them.

**Table 1.** Evaluation factor data source

Evaluation factors	Data Source
Administrative area map	National Geographic Information Public Service Platform
Digital Elevation Model	Computer Network Information Center of Chinese Academy of Sciences
slope	Computer Network Information Center of Chinese Academy of Sciences
Aspect	Computer Network Information Center of Chinese Academy of Sciences
Water buffer	Computer Network Information Center of Chinese Academy of Sciences
Vegetation index	Resource and Environmental Science Data Platform of Chinese Academy of Sciences
Land-use type	Resource and Environmental Science Data Platform of Chinese Academy of Sciences
Average precipitation	Resource and Environmental Science Data Platform of Chinese Academy of Sciences



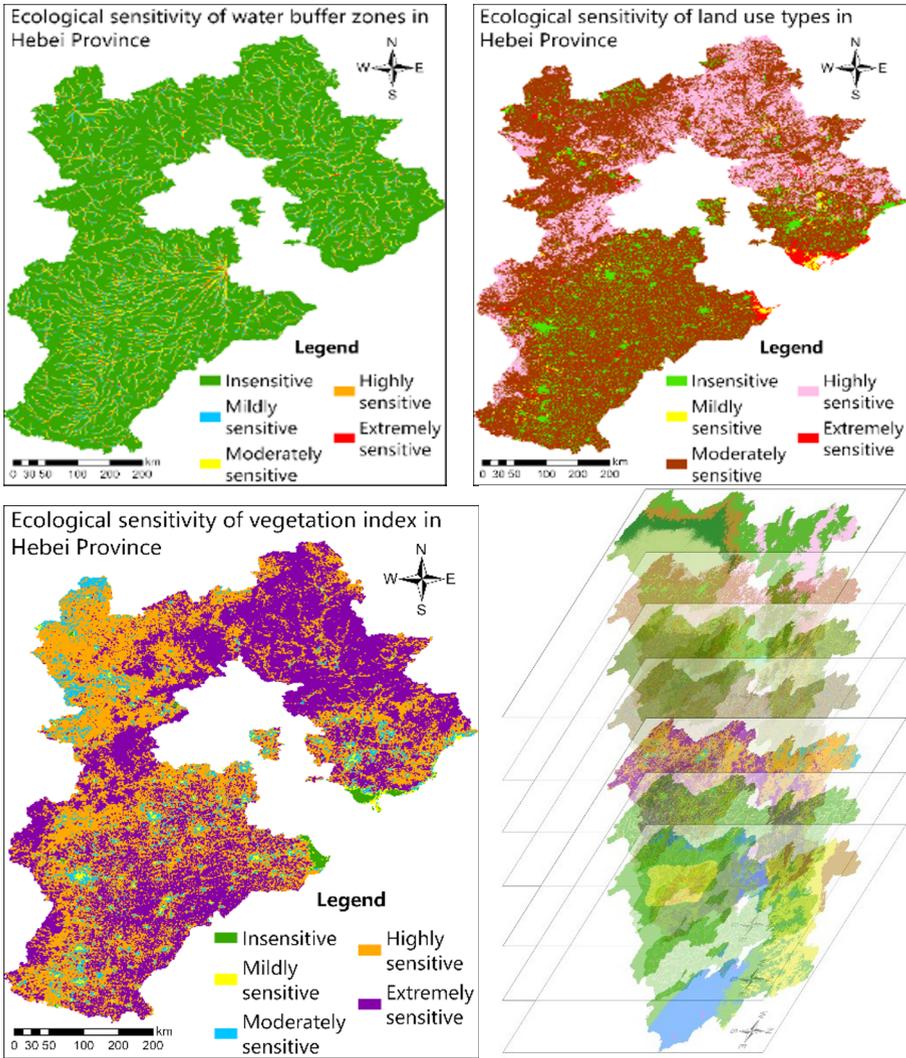
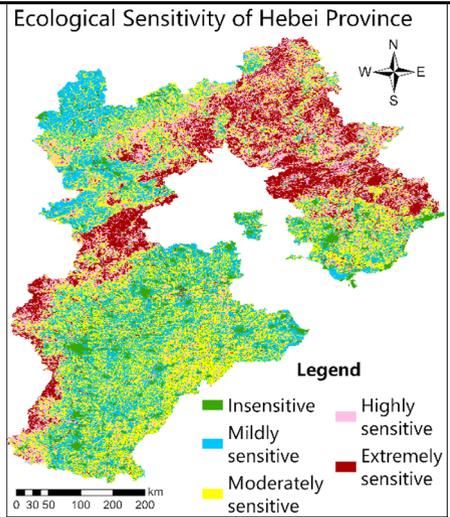


Fig. 1. Composite overlay of multi-source data layers

Table 2. Ecological sensitivity evaluation index system of Langfang City

Evaluation Factor	Inensitive (1)	Mildly sensitive(2)	Moderately sensitive(3)	Highly sensitive(4)	Extremely sensitive(5)	Wi
Elevation	<50m Lake deposits, coastal plains	50-200m piedmont impact plain	200-500m Hills	500-1400m mountain	>1400m Bashang Plateau	0.0491
slope	<8° Gentle	8-15° gentle slope	15-25° medium slope	25-45° heavy slope	>45° steep slope	0.1112
Aspect	flatland	Southeast	East	Northeast	North	0.0266

	south	Southwest	West	Northwest	0°-22.5°	
	-1°-0°	112.5°-157.5°	67.5°-112.5°	22.5°-67.5°	337.5°-360°	
	157.5°-202.5°	202.5°-247.5°	247.5°-292.5°	292.5°-337.5°		
Water	>800m	500-800m	200-500m	50-200m	<50m	
buffer	buffer distance	buffer distance	buffer distance	buffer distance	buffer distance	0.1112
Vegetation index	<0.2	0.2-0.4	0.4-0.6	0.6-0.8	>0.8	0.2459
Land-use type	Urban, rural and unused land	Special land such as factories, mines, large industrial areas, quarries, etc.	Cultivated land, grassland	Woodland	Water bodies, wetlands, oceans	0.3448
Average precipitation	<400mm Semi-arid area	400-500mm Semi-humid area	500-600mm Semi-humid area	600-800mm Semi-humid area	>800mm Wet area	0.1112



**Fig. 2.** Ecological sensitivity analysis map of Hebei Province

Based on the relevant ecological environment regulations and literature research, the geographic information system (ArcGIS) was used to select seven ecological evaluation factors (Figures 1), including elevation, slope, aspect, water buffer zone, vegetation index, land use remote sensing monitoring and multi-year average precipitation. After single-factor ecological sensitivity analysis was performed on each of them, the AHP method was used for weighted superposition of spatial layers, and finally a multi-factor ecological sensitivity analysis map of Hebei Province was obtained (Figure 2). We can draw the following conclusions:

The results of ArcGIS analysis show that the ecological sensitivity of Hebei Province is between [1.2224, 4.5641], and the ecological sensitivity of most regions is moderate or below, but the differences in ecological sensitivity are quite significant. The

ecological environment sensitivity of the central and southern plains of Hebei Province is relatively low, with a large number of insensitive areas and medium and low sensitive areas distributed, and highly sensitive areas and extremely sensitive areas scattered in the Baiyangdian area of Xiong'an New Area and the river and lake water system areas of the Hebei Plain; the ecological sensitivity of the mountainous areas in northern and eastern Hebei, the Yanshan Mountains around Beijing and Tianjin, and the Taihang Mountains in western Hebei Province are relatively high, and highly sensitive and extremely sensitive areas are concentrated in large areas. From the ecological sensitivity analysis map, it can be found that the mountainous areas and waters of Hebei Province where the ecological environment around Beijing and Tianjin is coordinated, the Zhangchengba Shanglin area in northern Hebei, and the Taihang Mountains in western Hebei are areas that need to be focused on in resource and environmental audits.

The land use type (CNLUCC) and vegetation index (NDVI) exhibit intrinsic correlations and hold the highest combined weight (59.07%) among the seven evaluation factors for ecological sensitivity in Hebei Province. This indicates a significant positive correlation between land use types, vegetation coverage, and ecological sensitivity. Once vegetation in natural ecosystems such as mountains, waters, forests, farmlands, lakes, and grasslands is damaged, biodiversity loss will occur, potentially triggering severe ecological issues. In contrast, slope aspect and elevation demonstrate the lowest weights (2.66% and 4.91% respectively), primarily due to topographic influences. Compared to southern regions dominated by mountains and hills, these terrain factors show less pronounced impacts on ecological sensitivity in the predominantly plain-covered northern areas, a distinction determined by the natural geographic characteristics differentiating China's northern and southern regions.

### 3 Conclusions

The ecological sensitivity analysis of Hebei Province plays a pivotal role in addressing the information asymmetry between "audit blind spots" and "environmental performance," offering critical support for environmental auditing. By leveraging this analysis, auditors can precisely identify ecologically sensitive areas and potential environmental issues, thereby determining audit priorities and enabling more targeted audit efforts. Furthermore, it provides a scientific and objective basis for evaluating environmental impacts and risks, complemented by robust informational support. This approach enhances audit efficiency, mitigates audit risks, and facilitates environmental conservation and the achievement of ecological improvement goals. Ultimately, it strengthens the scientific foundation of audit decision-making and promotes the systematic implementation of ecological protection measures.

### Acknowledgement

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