Postprint: Ecological Sensitivity Assessment of the Peripheral Areas of Central Karamay City

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Abstract

Employing GIS spatial analysis techniques, this study selected four ecological environmental factors—soil erosion, land desertification, soil salinization, and biodiversity—to conduct a sensitivity assessment. Results indicate that the periphery of Karamay City' s central urban area is predominantly characterized by extremely and highly sensitive zones. Extremely sensitive zones are primarily distributed north of Shixi Highway on the periphery of Karamay City, south of the industrial park, in the Wuming Lake wetland, and in the western piedmont zone of the Jiayier Mountains, accounting for 37.38% of the area. Highly sensitive zones are mainly distributed across the extensive plain area south of Shixi Highway (excluding wetlands) and in parts of the southwestern foothills of the Jiayier Mountains, accounting for 51.71%. Lightly sensitive and non-sensitive zones are sporadically distributed in the western and northern piedmont of the Jiayier Mountains, comprising only 0.76% of the area. The overall ecological sensitivity of the study area is relatively high; extremely and highly sensitive areas should strictly prohibit non-conservation-oriented development, while moderately and lightly sensitive areas should undergo moderate development under the principle of ecological priority.

Full Text

GIS-based Assessment of Eco-environmental Sensitivity in Peripheral Regions of Karamay Central Urban Area

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Abstract

Based on GIS spatial analysis technology, the primary factors sensitive to ecological environment include soil erosion, land desertification, soil salinization, and biodiversity reduction. The results indicate that extremely and highly ecologically sensitive areas dominate the peripheral regions of the Karamay urban area. Extremely sensitive areas are mainly distributed north of Shixi Road, south of the Industrial Park, the Wuminghu wetland, and the piedmont zone of the Jaye Mountain in the west, accounting for 37.38% of the study area. Highly sensitive areas are primarily distributed across the vast plains south of Shixi Road (except the Wuminghu wetland) and some piedmont zones southwest of the Jaye Mountain, accounting for 51.71% of the study area. Mildly sensitive and non-sensitive areas are distributed only in the western and northern piedmont zones of the Jaye Mountain, comprising merely 0.76% of the area. Overall, the ecological sensitivity of the study area is high; non-protective development should be strictly prohibited in high and extremely high sensitivity zones. Moderate, mild, and non-sensitive areas should be developed moderately under the concept of ecological priority.

Keywords: soil erosion; land desertification; soil salinization; biodiversity; Karamay City

1. Study Area and Methods

The study area covers the peripheral regions of Karamay' s central urban area, with a total area of 940.24 km². The assessment employed GIS spatial analysis technology to evaluate ecological sensitivity based on four primary factors: soil erosion, land desertification, soil salinization, and biodiversity reduction.

1.1 Evaluation Indicator System The assessment utilized a weighted indicator system with classification criteria for different sensitivity levels. Key indicators and their assigned weights include:

Table 1: Eco-environmental Sensitivity Evaluation Indicators

Indicator	Weight	Classification Ranges
Soil erosion modulus (t/km²·a)	0.45	<0.064, 0.051-0.064, 0.044-0.051, <0.044, 22.70-35.35, 35.35-48.75, >48.75
Vegetation cover (NDVI)	0.30	>1600, 1100-1600, 900-1100, 700-900
Soil salinization (g/L)	0.20	<15.59, 15.59-19.61, 19.61-22.65, >22.65
Groundwater depth (m)	0.10	<0.3381, 0.3381-0.6761, 0.6761-1.6903, 1.6903-2.7045, >2.7045
Precipitation (mm)	0.15	115-135

Indicator	Weight	Classification Ranges
Land desertification	0.55	0-3.725, 3.725-11.174, 11.174-21.107, 21.107-36.005, >36.005

Each indicator was classified into sensitivity levels (non-sensitive, mildly sensitive, moderately sensitive, highly sensitive, and extremely sensitive) based on quantitative thresholds derived from remote sensing data, field surveys, and established ecological standards.

1.2 Data Sources Data sources included MODIS imagery (250m×250m resolution) from September 2016 and April-October 2000-2016, 1:10,000 topographic maps, 1:10,000 land use data (2015), soil type data, groundwater depth data, and meteorological data. All data were processed using ArcGIS for spatial analysis and overlay operations.

2. Results

The spatial analysis revealed distinct patterns of ecological sensitivity across the study area. The extremely sensitive zones (37.38% of total area) are characterized by severe soil erosion, high salinization, and low vegetation cover, particularly in the Wuminghu wetland and Jaye Mountain piedmont zones. The highly sensitive areas (51.71%) show moderate to severe degradation across multiple indicators. The combined area of extremely and highly sensitive zones exceeds 89% of the total study area, indicating widespread ecological vulnerability.

3. Conclusion

The ecological sensitivity assessment demonstrates that the peripheral regions of Karamay' s central urban area face significant environmental pressures. The predominance of high and extremely high sensitivity zones necessitates strict ecological protection measures. Development activities should be prohibited in the most sensitive areas, while moderate development may be permitted in lower sensitivity zones under strict ecological priority frameworks. The findings provide a scientific basis for sustainable urban planning and ecological conservation in arid region cities.

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Fig. 1 Geographical location of the study area

Note: Figure translations are in progress. See original paper for figures.