Postprint: Differential Assessment of Land Ecological Vulnerability in the Yarkant River Basin

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Abstract

Comprehensively assessing the land ecological vulnerability of the Yarkant River Basin provides a decision-making basis and theoretical support for key watershed management and restoring oasis vitality. This paper takes the Yarkant River Basin as the study area, obtains data for different indicator layers across various periods from 2008 to 2018, and comprehensively calculates the ecological vulnerability index of the study area using the raster calculation function of ArcGIS 10.5 and the natural breaks classification method. The index is then divided into five vulnerability levels to characterize its spatiotemporal distribution. The research results indicate that: in terms of spatial distribution, the study area is dominated by micro-degree and mild vulnerability zones, accounting for 35.67% and 33.63% of the area, respectively, mainly distributed in the alluvial fan plains of the middle and lower reaches of the Yarkant River; moderate and severe vulnerability zones constitute the next largest proportion, accounting for 14.89% and 12.93%, respectively, mainly distributed in the mountainous and hilly areas of the upper reaches of the Yarkant River; the extremely vulnerable zone has the smallest area proportion at only 2.89%, but its area still reaches 3,000 km², mainly distributed in the densely populated areas of the middle and lower reaches of the Yarkant River, exerting a "barrel effect" on the overall ecological environment of the basin. The continuous deterioration of the ecological environment in local areas has affected the balance between overall ecological pressure and the ecological "threshold" of the basin. In terms of temporal distribution, the overall evaluation index decreased by 0.04324 from 2008 to 2011, by 0.00541 from 2010 to 2014, and by 0.05686 from 2014 to 2018. Although the land ecological vulnerability index decreased to varying degrees across different periods, and the overall ecological environment of the basin shows an improving trend, moderate, severe, and extremely vulnerable zones remain widely distributed. There is an urgent need to study their distribution patterns and propose specific regulation and control measures for different vulnerability zones.

Full Text

Preamble

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This study employs ArcGIS 10.5 software and the natural discontinuity classification method to comprehensively calculate the ecological vulnerability index of the Yarkant River Basin. The vulnerability levels are divided into five categories, revealing the following spatial distribution patterns: micro-vulnerable and slightly vulnerable areas dominate the basin, accounting for 35.67% and 33.63% of the total area respectively, primarily distributed across the alluvial fan plains in the middle and lower reaches. Moderately and severely vulnerable areas represent secondary proportions at 14.89% and 12.93% respectively, located mainly in the hilly upper reaches. Although extremely vulnerable areas constitute only 2.89% (approximately 3,000 km²), these zones are concentrated in densely populated regions of the middle and lower reaches, exerting a "barrel effect" on the basin' s overall ecological environment.

Temporal analysis from 2008–2018 shows the overall evaluation index decreased by 0.04324 during 2008–2011, by 0.00541 during 2010–2014, and by 0.05686 during 2014–2018. While the ecological vulnerability index declined across all periods, moderately, heavily, and extremely vulnerable areas remain widely distributed, indicating persistent localized environmental degradation that disrupts the balance between ecological pressure and the basin' s ecological threshold.

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4 Conclusions

(1) **Spatial Distribution Characteristics**: Micro-vulnerable and slightly vulnerable areas dominate the Yarkant River Basin, with proportions of 35.67% and 33.63% respectively. Moderately and severely vulnerable areas account for 14.89% and 12.93%, while extremely vulnerable areas, though only 2.89% of the total area, are concentrated in densely populated zones and significantly impact overall basin ecology.

(2) **Temporal Evolution Trends**: From 2008 to 2018, the basin' s overall ecological vulnerability index exhibited a declining trend, with reductions of 0.04324, 0.00541, and 0.05686 across the three sub-periods. However, the widespread distribution of moderately to extremely vulnerable zones indicates that localized environmental degradation continues to threaten the basin' s ecological balance.

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Abstract

A comprehensive evaluation of land ecological fragility characteristics in the Yarkant River Basin, Xinjiang, China provides a decision-making basis and theoretical support for river basin key management and the restoration of oasis vitality. In this study, the Yarkant River Basin is the research area. By obtaining the relevant data of different index layers in each period from 2008 to 2018, we used the grid computing function of ArcGIS 10.5 and the natural discontinuity classification method to comprehensively calculate the ecological vulnerability index of the study area. We divided the vulnerability into five levels and presented its spatiotemporal distribution. Results show that in the spatial distribution, the study area is dominated by micro- and slightly vulnerable areas, with an area ratio of 35.67% and 33.63%, respectively, distributed in the alluvial fan plain in the middle and lower reaches of the Yarkant River. The proportion of moderately and severely vulnerable areas was secondary, accounting for 14.89% and 12.93%, respectively, distributed in the hilly areas of the upper reaches of the Yarkant River. Although the proportion of extremely vulnerable areas is only 2.89%, which is 3000 km², distributed in densely populated areas in the middle and lower reaches of the Yarkant River, it plays a role of the cask effect on the overall ecological environment of the basin. The local ecological environment continues to deteriorate, resulting in a balance between the overall ecological pressure of the basin and the ecological threshold. Regarding the time distribution, the overall evaluation index decreased by 0.04324 from 2008 to 2011, and the overall evaluation index decreased by 0.00541 from 2010 to 2014. The overall evaluation index decreased by 0.05686 from 2014 to 2018. Although the ecological vulnerability index of each period decreased to varying degrees, the overall ecological environment of the basin improved. However, the moderately, heavily, and extremely vulnerable areas are still widely distributed. Based on the representative SRP model and field survey, this study proposed some methods. In the micro- and slightly vulnerable areas, basic pollution control is needed. In moderately and severely vulnerable areas, ecotourism should be developed, and food crops should be converted to export-oriented forestry and fruit growing. The sustainable development of orchards, farmhouses, and other rural plain ecotourism resources should be promoted. In extremely vulnerable areas, strict control of space use and ecological immigration should be implemented.

Keywords: land ecological vulnerability; SRP model; Yarkant River Basin

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