

Risk identification and comprehensive assessment of desertification in the Ring Tarim Basin

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Abstract: [Objective] The Tarim Basin is an ecologically fragile region with extreme aridity, making desertification one of its prominent ecological problems. Desertification is influenced by both natural and anthropogenic factors, and timely and accurate monitoring and risk assessment are crucial for effective desertification control. However, a single assessment method has limitations, and ensuring the objective validity of the assessment method can improve the accuracy of desertification risk assessment. [Methods] This study establishes an evaluation system with 16 indicators in three categories (natural climate, human activities, and desertification monitoring status) based on the conceptual framework of "three-factor" risk. The entropy combination weighting method is used to construct a comprehensive evaluation index (CEI) for desertification risk, which is then analyzed and evaluated. The CEI is constructed using the entropy combination weighting method, and the risk level of potential desertification occurrence areas in the Ring Tarim Basin is evaluated from 1990 to 2021. [Results] The results show that: (1) in the three-factor weighting analysis, the exposure factor has the highest weight and the vulnerability factor has the lowest weight. The desertification risk in the western part of the Ring Tarim Basin is smaller than that in the eastern part, and the areas with higher risk, vulnerability, and exposure are concentrated in Greenland, while the areas with higher exposure are concentrated in the oasis. The higher risk areas are concentrated in the periphery of the oasis, the primary desert area has lower risk, and the oasis edge area is prone to desertification. (2) The desertification risk in the study area is mainly presented as very low risk, and the high risk and very high risk areas are narrowly and sparsely distributed, mainly in the edge of the oasis and the area of the settlements for industrial and mining use. The desertification risk in the primary desert area is relatively low, and the area above high risk only accounts for 3.0% of the overall area. (3) The 30-year desertification risk level in the study area generally shows that the conversion rate above high risk is slow, and the conversion rate below moderate risk is relatively fast. Low risk is converted to very low risk, and above high risk is converted to moderate-low risk. The area above high risk continues to decrease, the ecological environment improves, and the situation of high and very high risk is controlled year by year. (4) The single-factor analysis shows that land use type (0.68) is the main driving factor, and the two-factor interaction analysis shows that non-linear enhancement mainly dominates among the indicators. The most influential combinations were land use type $\cap$ livestock carrying capacity (0.78) and cropland $\cap$ livestock carrying capacity (0.78). [Conclusion] The risk level of potential desertification areas in the Tarim Basin is mainly affected by human factors, and rational land use planning and the development of intensive and efficiently operated arable land are effective strategies for desertification prevention and control. This study provides timely information on the regional desertification risk level, analyzes its spatial distribution pattern,

reveals its influencing factors and response mechanism, and provides background data reference for effective desertification prevention and control work in extreme arid areas.

Keywords: Desertification; risk assessment; Ring Tarim Basin; Entropy combination weight method; Geographical detector

环塔里木盆地荒漠化风险识别与综合评估

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摘要:【目的】环塔里木盆地作为极端干旱的生态脆弱区域, 荒漠化是突出的生态问题之一。荒漠化易受到自然因素和人为因素的双重影响, 保证荒漠化监测和风险评估的时效性和准确性, 是荒漠化防治的基础与前提。单一的评估方法在荒漠化风险评估中有一定的局限性, 保证评估方法的客观有效性可以提升荒漠化风险评估的精度。【方法】研究基于“三因子”风险概念框架, 建立包括自然气候、人类活动、荒漠化监测现状等 3 类 16 个指标的评价体系, 利用熵组合法构建了荒漠化风险综合评价指数 (Comprehensive evaluation index, CEI), 并对 1990—2021 年环塔里木盆地荒漠化潜在发生区的风险程度进行评估, 【结果】结果显示: (1) 在三因子权重分析中: 暴露性因子权重最高, 脆弱性因子权重最低; 环塔里木盆地西部地区的荒漠化危险性小于东部地区, 危险性、脆弱性和暴露性较高的区域集中在绿洲外围, 原生荒漠区危险性较低, 绿洲边缘地区易发生荒漠化; (2) 研究区荒漠化风险主要呈现为极低风险, 高风险和极高风险区呈狭长、零稀分布, 主要分布在绿洲边缘和居民点工矿用地区, 原生荒漠区的荒漠化风险较低。高风险以上面积仅占总体面积的 3.0%; (3) 研究区 30 年荒漠化风险程度总体呈现: 高风险以上转换速率缓慢, 中风险以下转换速率相对较快。低风险向极低风险转换; 高风险以上向中低风险转换的趋势。高风险以上面积持续减少, 生态环境有所改善, 高风险和极高风险的情况逐年得到控制。(4) 单因素分析显示土地利用类型 (0.68) 是主要的驱动因素; 双因素交互分析显示各指标之间主要以非线性增强为主。影响最大的组合为: 土地利用类型 $\cap$ 载畜量 (0.78) 和耕地 $\cap$ 载畜量 (0.78)。【结论】环塔里木盆地荒漠化潜在发生区的风险程度主要受人为因素影响, 合理的土地利用规划与发展集约高效经营的耕地是荒漠化防治的有效策略之一。研究可以及时掌握区域荒漠化风险程度, 分析其空间分布规律、揭示其影响因素和响应机制, 为极端干旱区开展有效的荒漠化防治工作提供本底数据参考。

关键词: 荒漠化; 风险评估; 环塔里木盆地; 熵组合法; 地理探测器

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