

Hazard Assessment and Zonation of Visitor Risk at Geosites: A Case Study of the Mayan Basin, Binalood Mountain Range, Iran

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Original Article

Abstract

INTRODUCTION: The rapid growth of geotourism and the increasing number of visitors to geosites have made visitor safety a critical challenge in geotourism destination management. In many mountainous regions, insufficient spatial hazard assessment and the lack of strategically planned rescue infrastructure can lead to severe consequences for tourists. Accordingly, this study aims to assess and map visitor hazard at geosites and to identify optimal locations for rescue stations in the Mayan Basin of the Binalood Mountain Range.

METHODS: This study employed a descriptive-analytical approach by integrating fuzzy logic, Artificial Neural Networks (ANN), and GIS-based spatial analysis. Geomorphological, topographic, accessibility, land-use, and environmental parameters were collected and fuzzified within a GIS environment. The resulting fuzzy layers were subsequently input into a single-layer neural network model to determine the relative weights of the criteria. Based on the weighted integration of these factors, a continuous hazard index, a hazard zoning map, and an optimal spatial allocation of rescue stations were generated.

FINDINGS: The hazard zoning results indicated that the largest portion of the study area falls within the moderate hazard class, while all 12 selected geosites are located in moderate to very high hazard classes. This pattern reflects the simultaneous occurrence of high geotourism value and potentially hazardous geomorphological conditions. The hazard zoning results indicate that a large proportion of the study area falls within the moderate hazard class, while all twelve identified geosites are located within moderate to very high hazard zones. This distribution highlights the coexistence of high geotourism potential and hazardous geomorphological conditions. Furthermore, the spatial allocation analysis reveals that the proposed rescue stations are primarily situated in moderate hazard zones adjacent to high-risk areas, allowing effective coverage of vulnerable geosites.

CONCLUSION: According to the results, The results underscore the importance of integrating hazard assessment with spatial planning in geotourism management. The proposed framework offers an effective tool for enhancing visitor safety, mitigating natural hazard risks, and supporting the sustainable development of geotourism in mountainous regions.

Keywords: Geosite; Hazard zonation; Artificial Neural Network; GIS; Mayan Basin

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Introduction

Geotourism is a form of tourism based on various aspects of the geological and/or geomorphological heritage of the Earth (1), and is founded on a strong emphasis on sustainability, education, tourism experience, and local communities, all of which represent the core principles of geotourism (2). However, ensuring the safety of visitors and the protection of the environment is crucial for sustainable development and visitor satisfaction (3).

Resource conservation and visitor safety constitute two fundamental elements of sustainability in any

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