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Research Article

Investigating the dam failure process and associated risks: A case study of Doroudzan dam

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Abstract

Introduction

The issue of dam failure is critical due to the severe risks it poses to human communities. Dams play a vital role in water resource management and energy production, and any failure can result in significant loss of life and property. Given the importance of dams, particularly earthen dams, analyzing and understanding the factors that lead to their failure is essential. The Doroudzan Dam is one of the most significant dams in Iran, vital for water supply and agriculture in the region. This study aims to investigate the potential failure of the Doroudzan Dam and the associated risks. Utilizing numerical modeling through the MIKE 21 software, which allows for precise simulation of water flow and structural behavior under various conditions, this research evaluates the impacts of dam failure on downstream areas, including flood levels, flow velocities, and affected regions. The results indicate that a failure of the Doroudzan Dam could lead to severe flooding and extensive damage in downstream areas, impacting residential zones, agricultural lands, and critical infrastructure. These findings underscore the necessity for preventive measures and proper dam design. Additionally, educating local communities about the potential hazards of dam failure and conducting regular emergency drills can help mitigate losses and damages. This research demonstrates that employing scientific methods and advanced technologies can reduce the risks associated with dam failures and prevent human and financial losses.

Materials and Method

This study employs the MIKE 21 software, a sophisticated tool for two-dimensional modeling of water environments and flood scenarios, developed by DHI in Denmark. MIKE 21 utilizes advanced technologies to accurately simulate surface flows, dam breaks, sediment transport, and other hydraulic processes. The modeling process in MIKE 21 is based on two main methods: the finite difference method on structured grids and the finite volume method on unstructured triangular grids. This flexibility allows for high-precision simulations of various scenarios. For this study, the Doroudzan Dam, located on the Koor River near Marvdasht, Fars Province, was selected. The dam, completed in 1971, regulates approximately 760 million cubic meters of water annually for agricultural irrigation and municipal water supply. The modeling focused on assessing the potential flood

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risks associated with dam failure, utilizing parameters such as breach width and height to simulate scenarios of sudden dam failure and evaluate the subsequent flood wave propagation.

Results and Discussion

The modeling results illustrate the potential consequences of a dam failure, indicating various risk zones downstream of the Doroudzan Dam. The simulation revealed that the red zone represents the highest risk area, which is critical for management and evacuation planning. This zone encompasses residential areas and agricultural lands that are particularly vulnerable to flooding. The yellow, green, and blue zones indicate varying flood intensities, with the yellow area experiencing high flood severity and the green area showing lesser impacts. The flow patterns and discharge rates were also analyzed, revealing that the initial peak discharge could exceed 10,000 cubic meters per second, posing a significant threat to downstream communities. The rapid increase in discharge highlights the urgency of implementing effective flood management strategies and early warning systems. Additionally, the study emphasizes the importance of continuous monitoring and maintenance of dam structures to prevent such catastrophic events.

Conclusion

The analysis of the Doroudzan Dam provides valuable insights into the catastrophic consequences of dam failure. The findings not only confirm the potential hazards but also offer significant opportunities for enhancing risk management and preparedness for similar incidents. Key factors influencing dam failure include the limited response time for evacuation, the impact of topography on flood intensity, and the vulnerability of surrounding areas. Establishing efficient early warning systems and public education about dam failure risks are crucial for minimizing casualties and property damage. Furthermore, continuous hydrological and geotechnical studies are essential for adapting to climate changes and ensuring the safety of dam structures. This research underscores the need for integrating advanced technologies in risk management and emphasizes the importance of community involvement in disaster preparedness initiatives.

Conflict of Interest

The author declares no conflict of interest regarding the authorship or publication of this article.

Data availability statement

The data and results used in this research will be available through correspondence with the author.