Framework and Strategies for Managing Sediment-Related Hazards in Taiwan

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INTRODUCTION

Taiwan's land is composed of approximately 70% hillsides. Long affected by natural conditions such as typhoons, torrential rains, and earthquakes, sediment disasters occur frequently. This leads to the alternating and compounding occurrence of various disaster types, including debris flows, large-scale landslides, and unstable post-disaster sediment, posing immense risks to hillside settlements and public infrastructure.

To address these challenges, Taiwan has established an integrated framework for sediment-related hazard management based on risk management principles. Within this framework, hazard-specific strategies have been developed for debris flows, large-scale landslides, and unstable sediment, enhancing disaster preparedness, emergency response, and long-term watershed resilience.

FRAMEWORK FOR SEDIMENT-RELATED HAZARD MANAGEMENT

Taiwan has established an integrated framework for sediment-related hazard management based on the principles of Risk Management (Figure 1). The framework consists of four core processes—Risk Identification, Risk Estimation, Risk Evaluation, and Risk Treatment—which provide a systematic basis for hazard assessment, decision-making, and risk reduction.

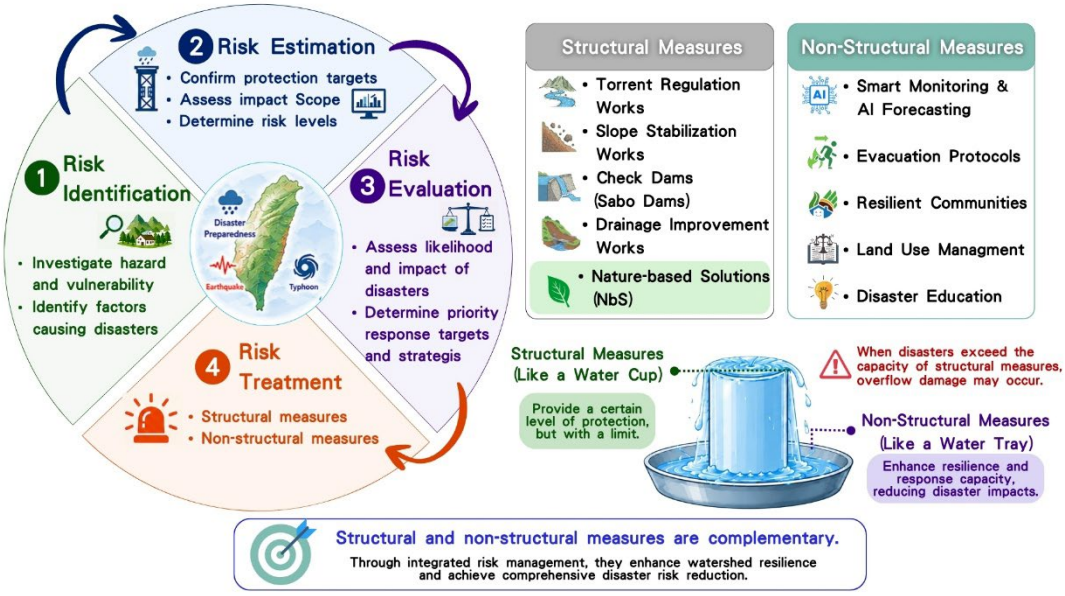


Fig. 1 Framework for Sediment-Related Hazard Management in Taiwan

Structural measures, including torrent control works, check dams, slope stabilization, and Nature-based Solutions (NbS), provide physical protection against sediment-related hazards. Non-structural measures, such as hazard investigation, monitoring and early warning, evacuation planning, land management, and community participation, enhance preparedness and watershed resilience.

HAZARD-SPECIFIC MANAGEMENT STRATEGIES

Figure 2 summarizes Taiwan's hazard-specific management strategies in response to major disaster events. Each strategy addresses distinct hazard characteristics while complementing the existing framework for sediment-related hazard management.

Debris Flows

Following the devastating debris flow disasters triggered by Typhoon Herb in 1996, Taiwan progressively developed an integrated debris flow management framework, including potential debris flow torrent mapping (1999), a rainfall-based warning system (2002), and community-based disaster preparedness (2004).

Large-Scale Landslides

In response to the catastrophic impacts of Typhoon Morakot in 2009, Taiwan expanded its hazard management framework to address Large-Scale Landslides. The strategy emphasizes potential area delineation, multi-scale monitoring, and long-term slope stability assessment. Currently, 94 Potential Large-Scale Landslide Areas are under continuous monitoring.

Unstable Sediment

The Mingba Keru Bridge disaster during Typhoon Lupit in 2021 prompted Taiwan to establish an Unstable Sediment management strategy focusing on post-event sediment investigation, sediment dynamics analysis, and early warning for secondary sediment hazards. To date, 962 unstable slopes and 323 potential sediment outflow locations have been identified.



Fig. 2 Hazard-Specific Management Strategies for Sediment-Related Hazards in Taiwan

CONCLUSIONS

Taiwan has developed an integrated framework for sediment-related hazard management by integrating structural and non-structural measures with hazard-specific strategies. This framework enables tailored management of debris flows, large-scale landslides, and unstable sediment according to their distinct characteristics. Taiwan's experience offers a practical model for mountainous regions adapting to increasingly complex sediment-related hazards under a changing climate.

Keywords: Sediment-related hazards; Risk management; Debris flow; Large-scale landslide; Unstable sediment