

DEBRIS FLOW: SABO INFRASTRUCTURE AS MITIGATION APPROACH

Authors:



Ir. Liew Yuk San
National Water Research Institute of
Malaysia (NAHRIM)



Ir. Ts. Gs. Dr. Safari Mat Desa
NAHRIM

Introduction

Heavy rainfall was observed on August 18, 2021 in the northern part of Peninsular Malaysia, affecting states of Perlis, Kedah, Penang, and Perak. Rainfall station at Mount Jerai and Kampung Singkir Genting had recorded 281 millimetres and 172 millimetres respectively. In a span of 60 minutes, the most total rainfall measured was 91 mm. According to the data recorded by Department of Irrigation and Drainage (DID), the rainfall surpassed the Average

Recurrence Interval (ARI) of 50 years at 6:00 pm on August 18, 2021. The highest point was measured at 8:00 pm, surpassing a 70-year average rainfall event with a total of 270 mm. The Department of Mineral and Geoscience (JMG) also noted unusual intense downpour in a brief duration near Mount Jerai, Yan, Kedah, starting at 2:30 pm. The Isohyet map in Figure 1 shows the 7-hour maximum rainfall around Mount Jerai on August 18, 2021.

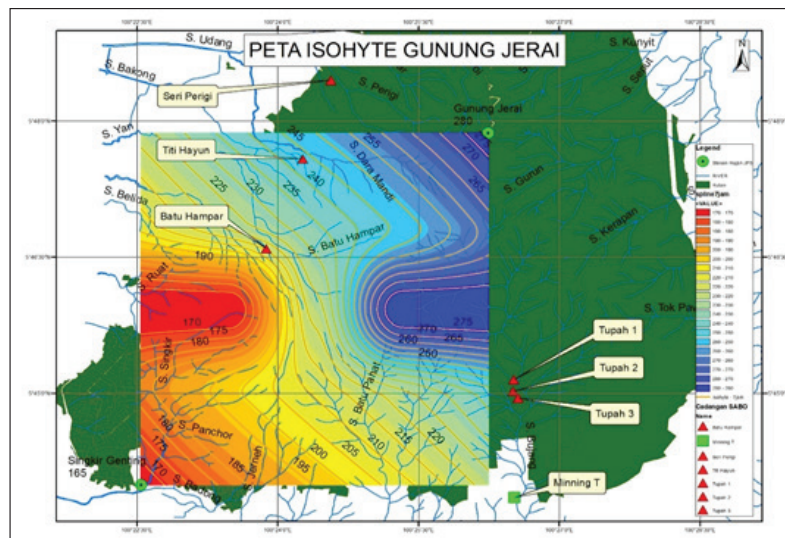


Figure 1: Isohyet map for 7-hour maximum rainfall around Mount Jerai on August 18, 2021 (Source: NAHRIM, 2021)

Consequently, Yan and Kuala Muda districts were hit by debris flow near Mount Jerai, causing significant damage to popular tourist destinations including Titi Hayun Recreational Forest, Batu Hampar Recreational Park in Yan District, and Tupah Recreational Forest in Kuala Muda District. The event occurred due to a sudden increase magnitude of waterfall near Mount Jerai, resulting in mud floods in Kuala Muda and Yan measuring between 0.1 to 0.3 meters and 0.2 to 1.5 meters respectively. Debris mainly from geological shift, landslide, boulders and log has obstructed the river crossings, thus inundated into neighboring communities such as Kampung Tupah and Taman Tupah. The debris flow resulted in 6 fatalities, the evacuation of 258 individuals from 72 households, and losses amounting to RM75 million (JMG, 2023). Figure 2 depicts basic geological data, as well as landslides and debris flow occurrences at Mount Jerai. Figures 3 to 4 display images of the mud flow at the disaster location. The impacted areas consist of the foothills of the mountain and the surrounding river areas, such as Seri Perigi, Terai Bukit, Singkir, Kampung Permatang Keramat, Kampung Lubok Boi, Pekan Yan Besar, Titi Teras, Kampung Acheh, and Kampung Setol. Figure 5 demonstrates the contrast between the situations in Hutan Lipur Titi Hayun, Yan District, Kedah, both before and after the mud flood.

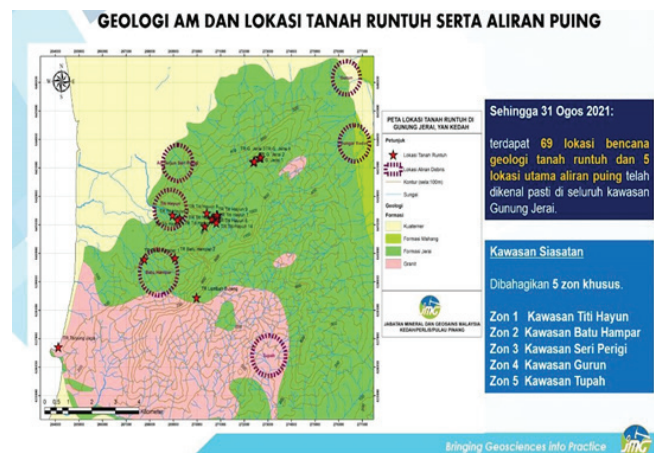


Figure 2: General Geological Data, Landslides and Debris Flow at Mount Jerai (Source: JMG, 2021)



Figure 3: The Debris Flow Situation at the Disaster Location (Source: DID, 2021)



Figure 4: The Debris Flow Situation at the Disaster Location (Source: DID, 2021)



Figure 5: Comparison between the Situations Before and After the Mud Flood in Titi Hayun Recreational Forest, Yan District, Kedah (Source: NAHRIM, 2021)

Sabo Infrastructure- Debris Flow Mitigation Measures

A technical working group comprising agencies such as DID, JMG, and NAHRIM has been established to observe the site and develop measures to reduce the impact of debris flow at Mount Jerai. After several meetings and discussions with stakeholders, NAHRIM has reinitiated the implementation of Sabo Technology, originally proposed for Mount Kinabalu in the year 2018, to be implemented at Mount Jerai. This is to reduce debris flow and minimize its downstream impact. NAHRIM was also assigned to help DID in developing suitable conceptual designs for Sabo Infrastructures in Yan and Kuala Muda District. Figures 6 depicts the Site Visit conducted by NAHRIM and DID Kedah to Yan District and Kuala Muda, Kedah on 27 to 28 August, 2021. This technical visit aimed to assess the potential for building Sabo Infrastructure at various locations where recent debris flows occurred.

Sabo comes from the Japanese words “Sa” and “Bo,” indicating activities to control erosion and sediment in mountainous regions to shield people and structures in lower areas from erosion and sedimentation calamities. Japan has constructed over 50,000 Sabo facilities since 1897 to combat around 1,000 cases of erosion and landslides annually (Nishiyama et al., 2017). Countries like Nepal, the Philippines, and Indonesia have also utilized Sabo

Infrastructures to effectively manage debris flows, thus improving safety and resilience to volcanic disasters (Adhikari, 2008; JICA, 2010; Kompas.com, 2020). The term “Sabo Works” is used to describe the system for protecting mountainous areas. This system consists of small, medium, and large buildings that cover tactics in integrated watershed management (Chanson, 2004).

Sabo Technology, established in Japan in 1897 with the Sabo Act, will be implemented for the first time in Malaysia to prevent debris flow at Mount Jerai. Sabo Infrastructure construction in Kedah will effectively manage debris flow from Mount Jerai, capturing rocks, boulders, sediment, and mud from Yan and Kuala Muda areas. This will lower the chances of property damage, infrastructure destruction, and loss of life caused by debris flow events.

Since October 2021, DID has initiated the design and construction of Sabo Infrastructures at two (2) sites near Mount Jerai namely Titi Hayun Recreational Forest and Bujang River, Tupah 1 at the SADA Water Treatment Plant. The Sabo Infrastructure at Titi Hayun Recreation Forest was completed in June 2023 and displayed in Figure 7.

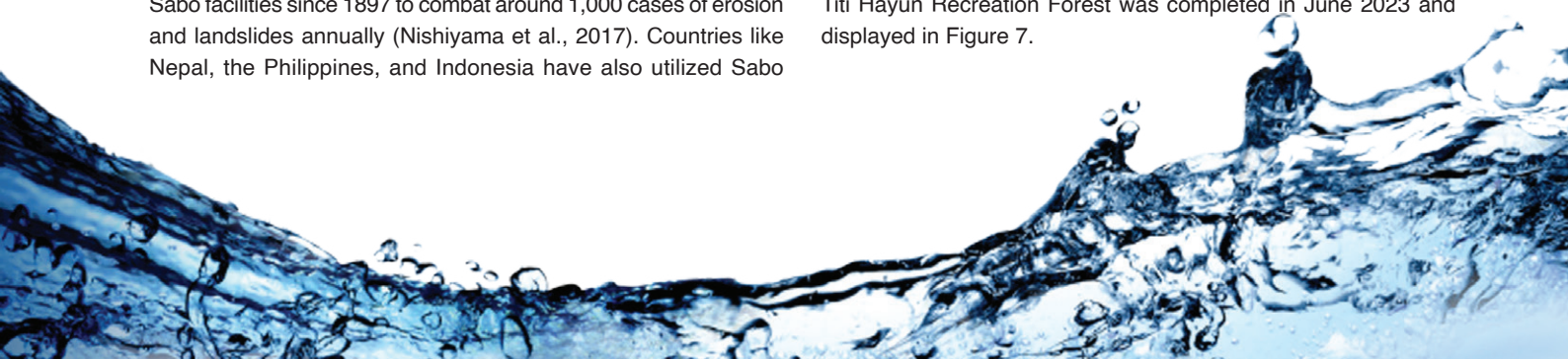




Figure 6: Site Visit by officials from NAHRIM and DID on August 28, 2021 (Location: Puteri Mandi Waterfall, Yan District, Kedah)



Figure 7: Sabo Infrastructure at Titi Hayun Recreation Forest (Source: NAHRIM, 2023)

Way Forward

In addition to the Sabo infrastructures, other mitigation measures must be established for a comprehensive and efficient debris flow management system. The summary of these measures are as follows according to NAHRIM (2021):

- a) Establishing an integrated management and monitoring plan for managing debris flow incidents in eco-forest parks and state forest parks through:
 - i. Installation of warning signboards for debris flow incidents in recreational areas of Eco-Forest Parks and State Forest Parks.
 - ii. Installation of a suitable real-time prediction and warning system in Eco-Forest Parks and State Forest Parks.
 - iii. Installation of monitoring systems such as soil movement
- iv. sensors and Closed Circuit Television (CCTV) for early detection in critical areas.
- iv. Development of a Debris Flow Forecasting and Warning System.
- v. Formation of a Task Force Group for collective and integrated monitoring of debris flow incidents.
- b) Designing Search, Rescue, and Evacuation Plans during debris flow incidents in Eco-Forest Parks and State Forest Parks according to the priority of tourist and local resident safety.
- c) Data sharing to streamline research projects and optimize study outcomes with smart collaboration with National Disaster Management Agency (NADMA), DID, JMG, Malaysian Space Agency (MySA), Forestry Department of Peninsular Malaysia (JPSM) and related State Government.

Conclusion

Implementing Sabo infrastructure at Mount Jerai is a crucial measure to reduce the risk of debris flows. The infrastructure of Sabo Infrastructures strategically placed aims to reduce the impact of debris flows in surrounding areas such as Yan and Kuala Muda, Kedah by trapping rocks, boulders, sediment, and mud during heavy rainfall events. Implementing this proactive measure not only safeguards lives, properties, and infrastructure

but also boosts communities' resilience against natural disasters in mountainous areas susceptible to flash floods and debris flows, demonstrating the efficacy of Sabo technology. Furthermore, setting up a comprehensive management and monitoring strategy for debris flow that includes search, rescue, and evacuation plans can help reduce the impacts of upcoming debris flow incidents.

References

- Adhikari, B. R. (2008). Application of SABO Technology to Control Debris Flow and Landslides: Experience from Mugling-Narayanghat Highway Disaster, Asian Disaster Reduction Center March 2008. Retrieved August 27, 2021, from https://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2008e/6.Nepal.pdf
- Chanson, H. (2004). Sabo Check Dams: Mountain protection systems in Japan. *International Journal of River Basin Management*. Vol. 2. 4 (2004). Pp: 301-307. Retrieved August 27, 2021, from <http://staff.civil.uq.edu.au/h.chanson/sabo.html>
- Department of Irrigation and Drainage Malaysia (DID). (2021). *Laporan Kejadian Banjir 18 Ogos 2021 di Yan/ Kuala Muda, Kedah*.
- Department of Mineral and Geoscience (JMG). (2023). *Bahaya Aliran Puing dan Kepala Air*.
- Japan International Cooperation Agency (JICA). (2010). Sabo Dam Pilot Project. Retrieved September 1, 2021, from <https://www.jica.go.jp/project/english/philippines/0600933/news/general/100616.html>
- Kompas.com. (2020). *Mengenal Sabo Dam, Solusi Penanggulangan Banjir Lahar Gunung Merapi*. Retrieved August 27, 2021, from <https://www.kompas.com/tren/read/2020/11/22/190500965/mengenal-sabo-dam-solusi-penanggulangan-banjir-lahar-gunung-merapi-?page=all>
- National Water Research Institute of Malaysia (NAHRIM). 2021. *Slaid Pembentangan Webinar Perhutanan: Kejadian Kepala Air: Kaedah Mengatasi dan Hala Tuju Penyelidikan*. 21 September 2021.
- Nishiyama, K. (2017). Outline and Future Strategies Sabo Works in Japan. Technical Conference on Sediment Disaster Risk Management, Japan-Austria. 18 May 2017.