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CASE STUDY ON PUBLIC HEALTH PREPAREDNESS IN MALAYSIA - LESSONS LEARNT FROM MOUNT KINABALU EARTHQUAKE

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List of Abbreviations

ADMIS	: Advanced Decision and Dissemination Malaysia Seismic and Tsunami Information System
AGE	: Acute Gastroenteritis
CBDRM	: Community-Based Disaster Risk Management
CPRC	: Crisis Preparedness and Response Centre
EMRT	: Emergency Medical Response Team
EMT	: Emergency Medical Team
GIRN	: Government Integrated Radio Network
GIS	: Geographic Information System
IMAM	: Islamic Medical Association of Malaysia
IMARET	: IMAM Response & Relief Team
METMalaysia	: Malaysian Meteorological Department
MOH	: Ministry of Health
MOSAR	: Mount Kinabalu Search and Rescue Team
MyHDW	: Malaysia Health Data Warehouse
NADMA	: National Disaster Management Agency
NGOs	: Non-Governmental Organizations
OSC	: On-Scene Commander
OSCP	: On-Scene Control Post
PFA	: Psychological First Aid
POCGN	: National Weather & Geophysics Operations Centre

RAT : Rapid Assessment Team
RRT : Rapid Response Team
TEC : Temporary Evacuation Centre
UMS : Universiti Malaysia Sabah
URTI : Upper Respiratory Tract Infection

ABSTRACT

Introduction: The earthquake of magnitude 6.0 on Richter scale that struck Mount Kinabalu on 5th June 2015 at 7.15 am Malaysia time (GMT+8) had significant impacts, affecting not only the climbers and staff at the site but also communities across Sabah. Mountain earthquake rescue operations present significant challenges due to the rugged terrain, remote locations, and complex logistics involved. Earthquakes in mountainous regions often trigger landslides, avalanches, and rockfalls, which can obstruct roads and complicate access for rescue teams. **Objective**: This paper aims to delineate the challenges of disaster health management, focusing on search and rescue response, public health management of temporary evacuation centres, post-event psychosocial support, and business continuity, particularly in the context of earthquake management in Sabah, Malaysia. **Methods:** Secondary data in the form of meeting minutes and event reports from the archives of Sabah State Health Department, Ministry of Health Malaysia, spanning the period from 5th June 2015 to 16th July 2015 was collected. Thematic coding scheme based on objective was developed. The findings derived from the analysis of meeting minutes and event reports were presented using narrative summaries in the results section of the paper. **Results:** The Mount Kinabalu earthquake response highlighted key areas for improvement in disaster preparedness and response. Challenges included poor interagency collaboration and communication issues due to inadequate infrastructure. The absence of early warning mechanisms and risk maps hampered search and rescue efforts, with responders relying on local guides. Medical responses were hindered by weather conditions. Managing mental health post-disaster was complex, requiring extensive support. Public health issues arose in evacuation centres due to disrupted water supplies. Additionally, damage to healthcare facilities necessitated the use of alternative locations to ensure service continuity. **Conclusions:** In summary, the Mount Kinabalu earthquake response highlighted the importance of investing in specialized training, equipment, local responders, and infrastructure to enhance preparedness and response capabilities, ultimately reducing the impact of similar disasters on communities and ensuring a more effective and coordinated response. Ongoing

evaluation and adaptation based on lessons learned will be instrumental in improving disaster resilience in the region.

Keywords: Mount Kinabalu; Public Health; Preparedness

INTRODUCTION

Malaysia is relatively protected from the severe impacts of typhoons and earthquakes. While it is geographically located near the Pacific Ring of Fire, an area known for its high seismic and volcanic activity, Malaysia is not directly within this zone (1). The country experiences occasional tremors, primarily due to its proximity to neighbouring countries like Indonesia, which is part of the Ring of Fire. The Ring of Fire is a horseshoe-shaped belt that runs around the rim of the Pacific Ocean, characterized by a high number of earthquakes and active volcanoes. Despite being close to this area, Malaysia's location just outside the belt spares it from the more frequent and severe seismic disturbances experienced by countries directly on the Ring of Fire.

However, it's important to note that while Malaysia is shielded, it is not entirely immune. The country has experienced isolated seismic events, such as the 2015 earthquake in Ranau, Sabah, but these are not directly caused by the Ring of Fire and are considered rare occurrences. Overall, Malaysia's geographical position provides a level of natural protection against the more devastating effects of the Ring of Fire's seismic activities. Ranau earthquake was the highest ever recorded earthquake in Malaysia since 1976 at Lahad Datu, Sabah (2).

Sabah is relatively prone to seismic (earthquake related) activities as it is situated on the south-eastern Eurasian Plate, bordered by the Philippine Plate and the Pacific Plate. Sabah has experienced low to moderate seismic activities due to the interaction of these main tectonic plates and several active fault lines (2). Between 1900 and 2016, 182 earthquakes with moment magnitude ranging from 2.9 to 6.0 have been recorded there. For example, Lahad Datu earthquake may occur every 65 years, whilst Ranau earthquake every 25 years (3).

The earthquake of magnitude 6.0 on Richter scale that struck Mount Kinabalu on 5th June 2015 at 7.15 am Malaysia time (GMT+8) had significant impacts, affecting not only the climbers and staff at the site but also communities across Sabah (4). The highlight of the widespread consequences included sensation of the tremor at 14 districts all over Sabah. There were 300 people at the incident site at the time of the earthquake. A total of 282 people were rescued, out of which 37 people suffered earthquake-related injuries and sadly, 18 people lost

their lives. Mountain earthquake rescue operations present significant challenges due to the rugged terrain, remote locations, and complex logistics involved.

Earthquakes in mountainous regions often trigger landslides, avalanches, and rockfalls, which can obstruct roads and complicate access for rescue teams (5). These natural hazards not only hinder timely arrival of first responders but also put rescue teams at risk. Additionally, the high-altitude conditions can lead to health risks like altitude sickness, further limiting both the physical endurance of rescuers and the operation's efficiency (6). The aftermath of such a disaster extends beyond immediate casualties, affecting local economies, health facilities, and livelihoods. This event serves as a reminder of the importance of disaster preparedness and resilience, particularly in regions prone to seismic activity. The experience gained from this earthquake will undoubtedly contribute to improving future responses and mitigating the impact of similar events.

OBJECTIVE

This paper aims to delineate the challenges of disaster health management, focusing on search and rescue response, public health management of temporary evacuation centres, post-event psychosocial support, and business continuity, particularly in the context of mountain earthquake management in Sabah, Malaysia.

METHODS

Data Collection

Secondary data in the form of meeting minutes and event reports from the archives of Sabah State Health Department, Ministry of Health Malaysia spanning the period from 5th June 2015 to 16th July 2015 was collected. The selection criteria for these documents were based on relevance to the Mount Kinabalu earthquake occurred on 5th June 2015. Specifically, daily Crisis Preparedness and Response Centre (CPRC) earthquake disaster meetings, and after-action reports were focused on. The meeting minutes and event reports were sourced from the Sabah State CPRC archives. The data extraction process involved obtaining hard copies of these documents and organizing them chronologically for analysis.

Data Analysis

The authors developed a thematic coding scheme based on the research objective. The data were coded according to themes such as status of affected healthcare facilities, search and rescue response, public health management of temporary evacuation centres, and post event

psychosocial support. Each coded segment was tagged with metadata including meeting date, participants, and key agenda items.

Analytical Approach

Textual analysis was employed to explore the content of the meeting minutes and event reports. Patterns and trends related to challenges of disaster response were identified within the coded data. Additionally, we conducted a cross-referencing analysis between meeting minutes and event reports to triangulate key findings and validate interpretations. Thematic analysis was applied to categorize and synthesize the identified themes across different meetings and events. This involved iterative review and refinement of themes to capture the nuances and complexities of project management processes as documented in the secondary data.

Ethical Considerations

Confidentiality of the secondary data was maintained throughout the analysis process. Access to the documents was restricted to authorized researchers only, and all data were anonymized to protect the identity of individuals mentioned in the meeting minutes and event reports.

Reporting

The findings derived from the analysis of meeting minutes and event reports were presented using narrative summaries in the result's section of the paper. Interpretations of the findings will be grounded in the context of challenges of disaster health management.

RESULTS

The response to the Mount Kinabalu earthquake in 2015 involved a coordinated and multifaceted approach by various agencies and organizations to ensure effective public health management and emergency medical response. The response involved mobilization of 727 health personnel from across Malaysia and support from Non-Governmental Organizations (NGOs). The breakdown of the key actions and roles include:

Activation of District Health Office Operations Room

The activation of the District Health Office Operations Room initiates a structured response to address public health needs in disaster-affected areas. As part of this response, the

Rapid Assessment Team (RAT) and Rapid Response Team (RRT) are deployed to quickly assess and address urgent health concerns. The Operations Room coordinates all public health activities both at and around the disaster site, ensuring that resources are allocated efficiently and actions were taken promptly. Key preventive measures are implemented to reduce the risk of infectious and vector-borne diseases, protecting vulnerable populations from potential outbreaks. Additionally, rigorous monitoring and control of food safety and drinking water quality are conducted to safeguard public health, thereby preventing the spread of disease in the aftermath of the disaster.

Hospital Activation Plan

The Hospital Activation Plan is a crucial component of disaster response, focusing on rapidly expanding medical services to meet the surge in demand. Under this plan, the Emergency Medical Response Team (EMRT) and surge capacity resources are deployed to provide immediate and specialized medical assistance to those impacted. To strengthen the response, additional medical personnel and resources are mobilized from other districts and states, ensuring that adequate support is available to handle the increased volume of patients. This strategic mobilization enhances the hospital's capacity to deliver timely and effective care during critical periods, safeguarding the health and well-being of the affected population.

State Crisis Preparedness and Response Centre (CPRC)

The State Crisis Preparedness and Response Centre (CPRC) plays a pivotal role in disaster response by facilitating interagency collaboration and coordination, streamlining efforts across various sectors to ensure an organized and effective response. CPRC oversees the mobilization of essential resources, including personnel and equipment, to where they are most needed. Additionally, the centre prioritizes risk communication, keeping the public well-informed and educated about the current situation, safety measures, and any evolving risks. To provide real-time updates, CPRC prepares spot reports and situational reports, ensuring that all stakeholders have the latest information to make timely and informed decisions.

Psychological First Aid (PFA) and Mental Health Support

Psychological First Aid (PFA) and mental health support are critical components of disaster response, addressing both immediate and long-term emotional needs. PFA is provided to victims and responders to help them cope with initial distress, offering essential support for those dealing with trauma. In addition, continuous mental health and psychosocial support

interventions are implemented to assist affected individuals and communities as they navigate the aftermath of the disaster. These coordinated efforts, involving multiple agencies and response teams, underscore the significance of integrated emergency management and effective communication channels, ensuring a holistic approach to recovery and resilience-building during crisis situations. The findings from the Mount Kinabalu earthquake response as gathered from the meeting minutes and event reports underscore critical areas for improvement in disaster preparedness and response.

Search and Rescue Response

1. Interagency collaboration: Interagency collaboration is key during such crises, but as documented, challenges arise when different organizations are unfamiliar with one another's protocols and resources.
2. Communication issues: The issues with communication infrastructure highlighted the necessity of reliable and resilient communication systems. The poor coverage of the Government Integrated Radio Network (GIRN) at the incident site, attributed to geographical challenges and insufficient transmitter coverage, significantly impacted communication during the Mount Kinabalu earthquake response. Responders had to depend solely on mobile phones during the disaster response, which can be risky due to potential network disruptions.
3. Early warning mechanism and risk maps: The lack of early warning mechanisms and risk maps significantly hindered the search and rescue efforts, as responders were confronted with unfamiliar terrain and relied heavily on local mountain guides for navigation. Tragically, four of these guides lost their lives while bravely assisting stranded climbers during the earthquake.
4. Medical response in low-temperature, high altitude environment: Medical Emergency Response Team (MERT) who was on the way to the summit of Mount Kinabalu using helicopter found that landing was not possible due to thick fog and they only managed to lower down blankets for the victims. Search and rescue team was unable to reach the summit to provide clothing and food assistance to the victims due to bad weather. Medical response was provided at the foot of Mount Kinabalu at Kinabalu Park to treat victims who managed to descend.

Psychosocial Support

Managing mental health challenges was particularly complex following the tragic earthquake. Emotionally unstable youth, along with a group of angry survivors who descended during the night, added to the difficulty. Compounding this, all staff operated in a cold environment and faced numerous aftershocks.

In the weeks following the earthquake, ongoing mental health and psychosocial support interventions were crucial and continued to be provided to the affected local communities. During the 2015 earthquake, a total of 221 personnel from the Ministry of Health (MOH) Malaysia collaborated with volunteers from NGOs such as MyCare, the Islamic Medical Association of Malaysia (IMAM), the IMAM Response & Relief Team (IMARET), and Universiti Malaysia Sabah (UMS). Their efforts were focused on providing crucial PFA to local communities and response personnel, addressing immediate emotional needs in the aftermath of the disaster. At the end of response period, 5,558 people were given mental health and psychosocial support services including responders, mountain guide, and local villagers.

Public Health Management of Temporary Evacuation Centres

Public health issues arose due to a mud flood that disrupted the clean water supply, necessitating urgent action. Authorities responded by sourcing clean water from neighbouring districts and arranging transportation of drinking water to the affected areas and temporary evacuation centres (TEC) which housed 819 victims in four TECs at Kundasang Hall, Ranau Community Hall, Marakau Hall, and Tun Said Keruak Community Hall. The incidence of communicable diseases such as Acute Gastroenteritis (AGE), Upper Respiratory Tract Infection (URTI), and mumps at the TECs posed additional challenges, particularly due to the lack of isolation facilities to prevent the spread of infectious illnesses.

Business Continuity

A total of 31 healthcare facilities spanning over five (5) districts of Ranau, Tuaran, Kota Belud, Papar, and Putatan reported damage during the event which included two hospitals, seven health clinics, three maternal and child health clinics, and 19 rural health clinics. For facilities that were classified as unsafe for habitation, alternative facilities were in place for service continuation including even renting of villagers' house. Healthcare personnel whose living quarters were damaged were advised to look for temporary house rentals.

DISCUSSION

The National Disaster Management Agency (NADMA) in Malaysia plays a pivotal role as the central coordinating body for disaster management efforts nationwide. National Disaster Management Agency (NADMA) Directive No. 1 serves as a foundational document outlining policy and mechanisms for national disaster and relief management (7). This directive delineates the roles and responsibilities of various agencies involved in disaster response and recovery. During disaster management operations, multiple agencies collaborate at On-Scene Control Posts (OSCP), with leadership under an On-Scene Commander (OSC). This coordinated approach ensures effective and unified response efforts.

Enhancement of Early Warning System by Malaysian Meteorological Department (METMalaysia)

The absence of early warning mechanisms underscores the critical importance of comprehensive disaster risk assessment and management. By implementing tailored early warning systems specific to hazards like earthquakes in mountainous regions, vital time for preparedness and evacuation efforts can be provided. To address this need, METMalaysia introduced the Advanced Decision and Dissemination Malaysia Seismic and Tsunami Information System (ADMIS) in 2017 (8). This system allows the National Weather & Geophysics Operations Centre (POCGN) to issue earthquake bulletins and disseminate them to the public and disaster management agencies through multiple platforms within 8 minutes of each occurrence.

In addition, a Seismic Hazard Map was developed in 2019, providing critical information on earthquake-prone areas (9). Furthermore, 77 Seismology Centres have been established across Malaysia, with a significant number located in Sabah, to enhance seismic monitoring and response capabilities in disaster-prone regions. SEISCOMP3, a real-time earthquake monitoring system, plays a pivotal role in seismic activity surveillance at the Natural Disaster Research Centre (NDRC) of Universiti Malaysia Sabah (UMS), facilitating rapid detection and analysis of regional earthquakes (10,11). These initiatives represent proactive steps towards enhancing early warning capabilities and disaster preparedness, highlighting the commitment to safeguarding communities from seismic risks through informed decision-making and timely interventions.

Capacity Building

Since the 2015 incident, there has been a concerted effort to enhance capacity-building activities for all involved agencies, organized by Sabah Parks as the custodian of Kinabalu National Park. This includes the development of detailed risk maps to aid responders in making informed decisions during crises. Standard Operating Procedures (SOPs) for Earthquake Disaster Management were jointly produced by NADMA and all relevant agencies. Sabah State Health Department under MOH Malaysia issued specific guidelines for disaster response at Mount Kinabalu and the Kinabalu National Park.

The sacrifice made by the mountain guides who lost their lives while saving tourists underscores the courage and dedication of those engaged in rescue operations. Their local expertise and knowledge are invaluable assets during emergencies, highlighting the importance of recognizing and supporting these essential responders to enhance resilience in disaster-prone areas (12). Mountainous terrain, compounded by additional risk factors – such as adverse weather, night operations, high-altitude exposure, technical ground tasks, and complex air rescue manoeuvres – creates a particularly challenging environment that imposes unique physical and psychological demands on personnel (13,14). To bolster preparedness, three full-scale simulation exercises were conducted since 2016, with each planned two years apart. However, due to the global COVID-19 pandemic, the simulation scheduled for 2020 had to be postponed. Nevertheless, activities resumed in 2022 with another comprehensive simulation exercise (15) (Figure 1).

Figure 1: Interagency Personnel at the Mount Kinabalu KM 7.5 Mark During Full Scale Exercise in 2022. Source: Suleiman et al., 2025

The trail map of the Mount Kinabalu hike now has the outlines for the distances of ascent, descent, and marking of designated helipad areas for potential evacuations (Figure 2). The primary gathering point on the mountain is Panalaban Basecamp, requiring a 6 km trek with an

elevation of approximately 3,200 meters above sea level. This highlights the significant physical and mental demands placed on responding personnel, emphasizing the importance of rigorous capacity-building efforts.

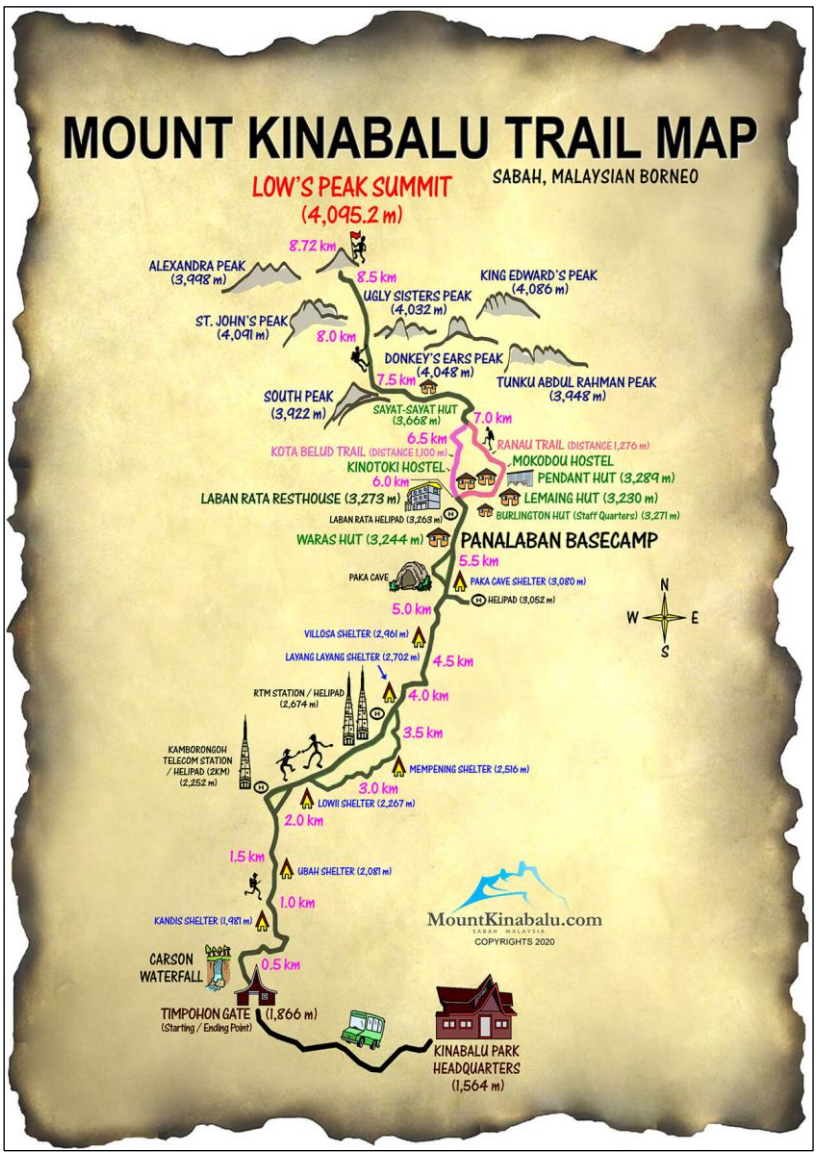

Figure 2: Mount Kinabalu Trail Map

Source: Mount Kinabalu Climb Information & Booking Centre, 2020

Helicopters play a vital role in emergency response, particularly in mountainous regions where access can be challenging. Their ability to transport rescue teams directly to the site of an incident and evacuate patients is invaluable, especially through winching and short-haul operations. In the European Alps, for example, helicopters are extensively utilized for major casualty incidents (MCIs), significantly contributing to saving lives (16,17). The training and

exercises conducted also tested this aspect of rescue, made possible with the development of trail map and designated helipad areas (Figure 3).

Figure 3: Testing of Helicopter Rescue at KM 6 Mount Kinabalu in 2022

Source: Suleiman et al., 2025

The Mount Kinabalu Search and Rescue Team (MOSAR), a team of firefighters specialised with competent expertise to conduct rescue tasks in mountainous conditions was established in 2015 following the Ranau earthquake and has since conducted countless missions to ensure the safety of climbers on Mount Kinabalu (Figure 4).

Figure 4: MOSAR Team with Other Agencies Work Together to Transport Patient

Source: Suleiman et al., 2025

Continuous capacity-building initiatives, including training, simulation exercises, and infrastructure improvements, are essential for ensuring effective response and resilience in managing disasters at Mount Kinabalu and similar high-risk environments.

Improving Guidelines, Resources and Communication

Moving forward, it is imperative to continuously update MOH Malaysia guidelines to ensure they remain relevant and effective. Recently, the development of the Guidelines of Human Resource Mobilization During Public Health Emergencies, tested during the 5th Regional Collaboration Drill (RCD), has significantly enhanced coordination of Emergency Medical Team (EMT). To improve communication systems for more effective disaster response in the Mount Kinabalu area, collaboration with telecommunication strategic partner, Sapura Group, to deploy mobile transmitters, thereby enhancing coverage during emergencies has been in place and tested.

Additionally, regular updates on resources and equipment are maintained at the National and State CPRC. MOH Malaysia have also enhanced the function of Malaysia Health Data Warehouse (MyHDW) Geographic Information System (GIS), to enable monitoring of district risk profiles and disaster resource management, among other critical functions (18). These initiatives aim to bolster preparedness, coordination, and resource management for future disaster response efforts.

Whole-of-Society Approach

In MOH Malaysia disaster health management approach, the adoption of a comprehensive whole-of-society strategy by engaging diverse stakeholders, including civil society, communities, academia, media, private sector, NGOs, voluntary associations, families, and individuals is taken. This collaborative effort aims to strengthen community resilience and societal readiness in disaster situations. MOH Malaysia prioritizes public health, healthcare services, and medical-related matters. NADMA, as the primary disaster management agency, conducts periodic Community-Based Disaster Risk Management (CBDRM) activities with communities in disaster-prone areas. Meanwhile, MOH Malaysia leverages on a network of community health agent known as MyCHAMPION, who play a vital role in delivering healthcare services and disseminating essential information within their communities. Active collaboration with local community leaders, organizations, and volunteers contribute to building trust and facilitate effective information dissemination and resource mobilization

during emergencies (19). Through training sessions and workshops, community members are empowered to enhance their capacity to respond to health-related emergencies, including providing PFA.

MOH Malaysia strategic partner, METMalaysia, continuously educates the public on disaster preparedness, emphasizing the importance of readiness by promoting initiatives like Disaster Bags and providing guidance on appropriate actions to take during earthquakes and other disasters. This comprehensive approach underscores Malaysia commitment to strengthening disaster resilience at all levels of society.

LIMITATION

One limitation of this study was the potential for bias in the documented perspectives within the meeting minutes and event reports. Additionally, the availability of certain documents and completeness of information varied across different meetings and events, which could impact the comprehensiveness of our analysis.

CONCLUSION

In summary, the Mount Kinabalu earthquake response highlighted the importance of investing in specialized training, equipment, local responders, and infrastructure to enhance preparedness and response capabilities, ultimately reducing the impact of similar disasters on communities and ensuring a more effective and coordinated response. Ongoing evaluation and adaptation based on lessons learned will be instrumental in improving disaster resilience in the region.

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AUTHOR CONTRIBUTION

Each author contributed significantly to the conception, design, and execution of this study. The specific contributions of each author are outlined as follows: MS, PKC, and AZC conceptualized the paper, contributing to the formulation of the research questions, methodology, and overall structure of the manuscript. All authors contributed to analysis, interpretation of results, and manuscript preparation. MS, HY, PKC contributed to critical

review of the article and approval of the article. Additionally, all authors have read and approved the final version of the manuscript and agreed for publication.

CONFLICTS OF INTEREST

The authors do not have any conflict of interest to declare.

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REFERENCES

1. Sulaiman SS binti, Farish MML bin MM, Ismadi PNN binti, Moosom VS, Yusrizal ZA binti M. Is Malaysia Located In The Pacific Ring Of Fire? A Legal Perspective. 2019;181–90.
2. Tongkul F. Active tectonics in Sabah – seismicity and active faults. Bull Geol Soc Malaysia. 2017;64:27–36.
3. Termizi AK, Tongkul F, Harith NSH, Roslee R. Earthquake Threats in Ranau - From the Sources of Mensaban and Mesilou Fault. IOP Conf Ser Earth Environ Sci. 2022;1103(1).
4. Wang Y, Wei S, Wang X, Lindsey EO, Tongkul F, Tapponnier P, et al. The 2015 M w 6.0 Mt. Kinabalu earthquake: an infrequent fault rupture within the Crocker fault system of East Malaysia. Geosci Lett. 2017;4(1).
5. Agency FEM, Garthwaite M, Jackson L, Wang X, Mendoza R, Hart S. Earthquake Safety at Home: A Guide for Homeowners and Renters. Vol. 10, International Journal of Disaster Risk Reduction. Washington, D.C.: FEMA; 2020. 22–29 p.
6. Garthwaite M, Jackson L, Wang X. Challenges in Mountainous Earthquake Response. Int J Disaster Risk Reduct. 2014;10:22–9.
7. UKK A. NADMA directive to guide Disaster Management and Risk Reduction - Ahmad Zahid [Internet]. 2024. Available from: https://www.nadma.gov.my/bi/media-en/news/1294-nadma-directive-to-guide-disaster-management-and-risk-reduction-ahmad-zahid
8. Secretariat A. Catalogue-in-Publication Data Strengthening Asean Multi-Hazard End To End Early Warning System For Natural Disasters An Assessment of Current Capacity ASEAN-Disaster Management-Natural Disasters Early Warning System-Prevention and Mitigation ASEAN: A Comm. ASEAN Secr is [Internet]. 1967;(February). Available from: www.asean.org.
9. Sauti NS, Daud ME, Kaamin M, Sahat S. Earthquake Risk Assessment of Sabah, Malaysia Based on Geospatial Approach. Int J Integr Eng. 2022;14(5):38–48.
10. Mustapha MM, Alias N, Abdullah Z. Real-time seismic monitoring in Sabah: Enhancing earthquake preparedness using SEISCOMP3. J Geophys Res. 2020;125(5):1234-45.
11. Ahmad Z, Lim CK, Hassan S. SEISCOMP3 applications in regional earthquake detection at Universiti Malaysia Sabah. Seismol Res Lett. 2019;90(3):678-85.
12. Post TB. Emergency response centre needed in Sabah – NIOSH. Borneo Post [Internet]. 2016; Available from: https://www.theborneopost.com/2016/06/12/emergency-response-centre-needed-in-sabah-niosh/
13. Tomazin I, Ellerton J, Reisten O, Soteras I, Avbelj M. Medical Standards for Mountain Rescue Operations Using Helicopters: Official Consensus Recommendations of the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). High Alt Med Biol. 2011 Dec 1;12(4):335–41.
14. Brugger H, Maeder MB. Mountain emergency medicine. In: Safeguarding Mountain Social-Ecological Systems. Elsevier; 2024. p. 57–61.
15. Miwil O. Mount Kinabalu SAR requires involvement from more rescue agencies. 2022; Available from: https://www.nst.com.my/news/nation/2022/06/802805/mount-kinabalu-sar-requires-involvement-more-rescue-agencies
16. Johnsen AS, Fattah S, Sollid SJM, Rehn M. Utilisation of helicopter emergency medical services in the early medical response to major incidents: a systematic literature review. BMJ Open. 2016;6(2):e010307.
17. Bekelis K, Missios S, Mackenzie TA. Prehospital helicopter transport and survival of patients with traumatic brain injury. Ann Surg. 2015;261(3):579–85.

18. Admin. From Data to Action: GIS technology in Malaysian healthcare [Internet]. 2024. Available from: https://www.healthcareasia.org/2024/from-data-to-action-gis-technology-in-malaysian-healthcare/
19. Munir FW. Mount Kinabalu guides to receive rescue training, equipment. 2015; Available from: https://www.nst.com.my/news/2015/09/mount-kinabalu-guides-receive-rescue-training-equipment?m=1#google_vignette