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Disaster Management on Small Islands; Lessons from Flash Flood Disaster in Rua Village, Ternate Island, Indonesia

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ABSTRAK

Pulau kecil dianggap sebagai wilayah yang rentan terhadap bencana alam dan perubahan iklim. Hal ini dikarenakan segala keterbatasan yang dimilikinya termasuk ukuran kecil, terisolasi, penduduk yang padat, kedekatan laut, dan ketergantungan pada sumber daya alam. Kejadian bencana banjir bandang yang terulang di Pulau Ternate memperlihatkan masih kurangnya tata Kelola bencana di pulau kecil. Sehingga penguatan tata kelola kebencanaan di pulau kecil perlu menjadi perhatian mengingat intesitas bencana diperkirakan akan meningkat dimasa depan. Dengan menggunakan kasus bencana banjir bandang di kelurahan Rua, Pulau Ternate, penelitian ini bertujuan untuk menganalisis faktor-faktor penyebab banjir bandang tersebut dan mengevaluasi manajemen bencana di pulau Ternate. Menggunakan metode penelitian kualitatif dan kuantitatif, kami menganalisis data-data yang dikumpulkan dan menvisualisasikannya dalam peta tematik. Hasil penelitian menunjukan bahwa faktor-faktor seperti curah hujan, kemiringan lereng dan aliran sungai, karakteristik batuan penyusun dan kestabilan tanah serta karakteristik pergerakan tanah merupakan faktor penyebab kejadian banjir bandang di kelurahan Rua. Selain itu, tata kelola bencana yang belum baik menjadi permasalahan yang dihadapi semua pemangku kepentingan di Ternate untuk mewujudkan masyarakat tangguh bencana.

Kata kunci: Banjir Bandang, Pulau Ternate, Tata Kelola Bencana, Pulau Kecil

ABSTRACT

Small islands have been identified as regions that exhibit susceptibility to natural disasters and the impacts of climate change. This arises from a multitude of constraints, such as limited size, geographical isolation, high population density, closeness to the ocean, and reliance on natural resources. The recurrent flash flood calamities on Ternate Island underscore the deficiencies in disaster management strategies for smaller islands. It is imperative to enhance disaster management on small islands, particularly in light of the anticipated escalation in the severity of disasters in the future. This study examines the underlying factors contributing to the flash floods in Rua Village, Ternate Island, as well as assessing the effectiveness of disaster management strategies implemented on Ternate Island. Through the application of both qualitative and quantitative research methodologies, we meticulously examined the gathered data and represented it in a thematic map. The findings of the study indicated that elements such as precipitation, topography, and river dynamics, along with the properties of rock composition, soil stability, and land movement characteristics, contribute to the occurrence of flash floods in Rua Village. Moreover, inadequate disaster management challenges all stakeholders in Ternate who are striving to establish a community resilient to disasters.

Keywords: Flash flood, Ternate Island, Disaster Management, Small Island

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1. INTRODUCTION

Natural hazards and climate change have been regarded as one of the most significant global concerns in the past two decades. Disasters have escalated in both frequency and intensity, resulting in unprecedented damage to property and loss of human life. Small islands are regarded as the most susceptible locations to disasters and the effects of climate change. The primary characteristics of small island communities encompass limited size, isolation, significant rurality, closeness to the sea, reliance on natural resources, frequently insufficient adaptive capacity, elevated poverty rates, income inequality, and poor educational attainment. Abenir et al. (2022) elucidated that small islands are particularly susceptible to food insecurity and chronic poverty due to their reliance on mainland agriculture and restricted access to market institutions and technologies.

In line with disaster management, disaster risk reduction initiatives in small islands necessitate more rigorous efforts than those in large islands (Lessy et al., 2024a). This is partially due to each island's distinct traits and typologies (Mutaqin et al., 2021). Consequently, a crucial element in disaster risk reduction is an enhanced comprehension of the hazards that provide substantial hazards and vulnerabilities, encompassing community vulnerability, economic vulnerability, built environment susceptibility, and natural vulnerability (UNISDR, 2017).

Ternate Island, a small island in North Maluku Province, Indonesia, features a unique volcanic topography and geomorphological characteristics. The island features a volcano at its center, characterized by a high gradient from the coastline to the summit. Ternate Island is documented as facing numerous hazard (Lessy et al., 2024b). The National Disaster Management Agency (BPBD) has recognized nine potential hazards on this island: floods, flash floods, landslides, extreme weather, extreme waves, coastal erosion, earthquakes, tsunamis, volcano eruptions, forest fires, and social conflicts. Recent studies concentrate on the effects of individual hazards, including tsunamis (Ervita et al., 2019; Yudhicara & Lukman, 2024), coastal erosion (Angkotasan et al., 2012; Lessy & Abdullah, 2021), volcanic eruptions ((Firmansyah, 2011; Hidayat et al., 2020), landslides (Ikqra, 2013; Ikqra et al., 2012), earthquakes (Sulaeman & Cipta, 2012; Supartoyo, 2015), floods (Lessy et al., 2017; Priambodo & Kamis, 2020), and extreme weather events (Sabrina et al., 2021).

On Ternate Island, floods and landslides have transpired, particularly due to excessive rainfall (Priambodo & Kamis, 2020). In 2011 and 2012, fla

sh floods occurred due to the outburst of cool lava from Mount Gamalama in Tubo Village (Aryuni et al., 2019; Masinu et al., 2018). On September 23, 2017, Rua Village flooded due to the Akemalako River's overflow (GamalamaNews, 2017). This flood affected 52 houses, one elementary school, the village office, and the waserda building (Fadli, 2017). On July 1, 2020, the second subsequent flood transpired in the same area (Rua Village) due to intense rainfall exceeding two hours, resulting in the inundation of numerous residences (Cermat, 2020).

The most recent flash flood occurred in Rua Village, Ternate Island, on August 25, 2024. This flash flood was the third occurrence in the past decade. The incident transpired at approximately 03:30 WIT and resulted in numerous casualties as it occurred during the early morning hours when residents were asleep. According to information from the emergency response command post, the expected death toll is 19 individuals, with 15 more injured. Furthermore, it led to substantial damages, comprising 25 damaged residences, one prayer room, and disrupted road access.

The third flash flood in the same location indicates a pattern of recurrent disaster events. Following the priorities outlined in the Sendai Framework, the necessary actions to respond to this flash flood disaster include comprehending disaster risks and enhancing disaster readiness to facilitate an effective response and "build back better." Comprehension of catastrophe risk encompasses all dimensions, including hazard characteristics and environmental factors. This knowledge can be utilized for pre-disaster risk assessment, prevention and mitigation, and the formulation and execution of suitable preparedness and successful disaster response (UNDRR, 2015). This study aims to examine the causes of flash floods, delineate the flash flood hazard index, and assess disaster management on Ternate Island. This study will inform local governments and stakeholders in policymaking and strategy formulation to develop disaster-resilient communities, particularly on Ternate Island.

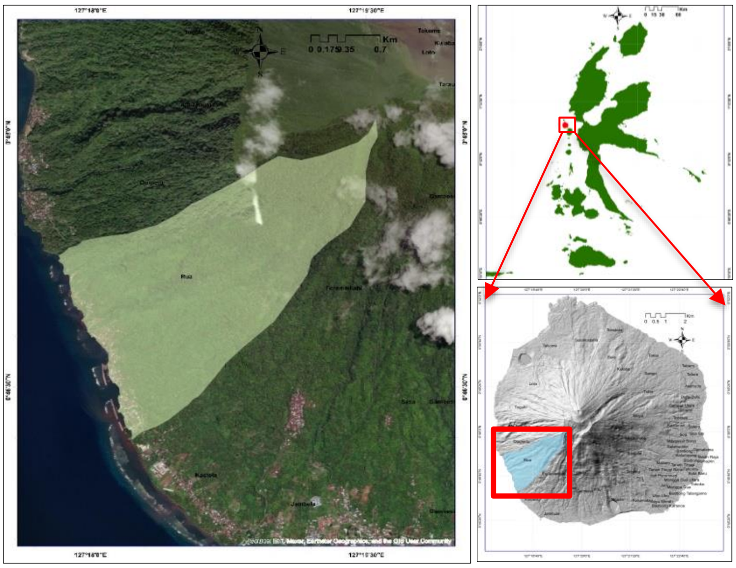

Figure 1. Study Location

2. METHODS

2.1. Study Location

Rua Village is situated within the Pulau Ternate sub-district of Ternate city, North Maluku Province (Figure 1). The village encompasses an area of 3,287 km^2 and has a population of 1,607 individuals, which includes 778 males and 829 females. A total of 483 families exists, with an average household size of 3.3 individuals per family. The livelihoods of the village population are primarily comprised of fishermen and farmers. The Ternate City Statistics Agency reported 500 families engaged in plantation farming, 8 families involved in cattle breeding, and 250 families participating in fishing activities. Additionally, there are six household craft groups (BPS Kota Ternate, 2024).

This village offers several basic service facilities. Three kindergartens and one elementary school represent the educational facilities. Health facilities comprise one public health center and one center for pre- and postnatal health care and information. Additionally, the religious facilities include one mosque, and four small mosques (mushalla) designated for worship, along with twenty kiosks serving as economic facilities

Similar to other regions in Ternate City, the climate in Pulau Ternate District is tropical, characterized by a regional climate with two distinct seasons: the Northwest season and the Southeast season, interspersed with two transitional periods (BPS Kota Ternate, 2024). Moreover, the shape of the Ternate Island land is cone shaped. This landform results from the deposition process of volcanic eruptions and features slopes that range from slight to extremely steep. Meanwhile, the Rua village is located in the southwest of Ternate Island with a landslide hazard area in the moderate to high category (Ikqra et al., 2012)

2.2. Data Collection and Analysis

This research comprises multiple stages and employs an exploratory qualitative methodology, incorporating both primary and secondary data sources. Initially, this study analyzes the factors that lead to flash floods at the designated location to elucidate their roles in the flooding phenomenon. The components comprise rainfall, topography, river discharge, geological properties, soil stability, and characteristics of land movement. Data for analysis were sourced from multiple open-access platforms available on the website. Rainfall data was obtained from the website https://data.chc.ucsb.edu/products/CHIRPS-2.0/global_daily/ Topographic data for slope and river flow can be sourced from the website https://srtm.csi.cgiar.org. Land movement and stability data are available at https://vsi.esdm.go.id/portalmbg/. Disaster risk and threat maps can be accessed through https://inarisk.bnpb.go.id/. The collected data were analyzed and visualized using Google Earth Engine and ArcGIS 10.8 software, resulting in spatial maps. Subsequently, we examined the landslide-prone regions on Ternate Island and superimposed them with the research site. Eventually, we assessed disaster management on Ternate Island. The research process is illustrated in Figure 2.

The next stage, we performed an assessment of disaster management in Ternate through a literature review. Data and information were derived from study documents provided by BNPB, BPBD Ternate, scientific journals, and both print and internet media pertaining to flash flood occurrences.

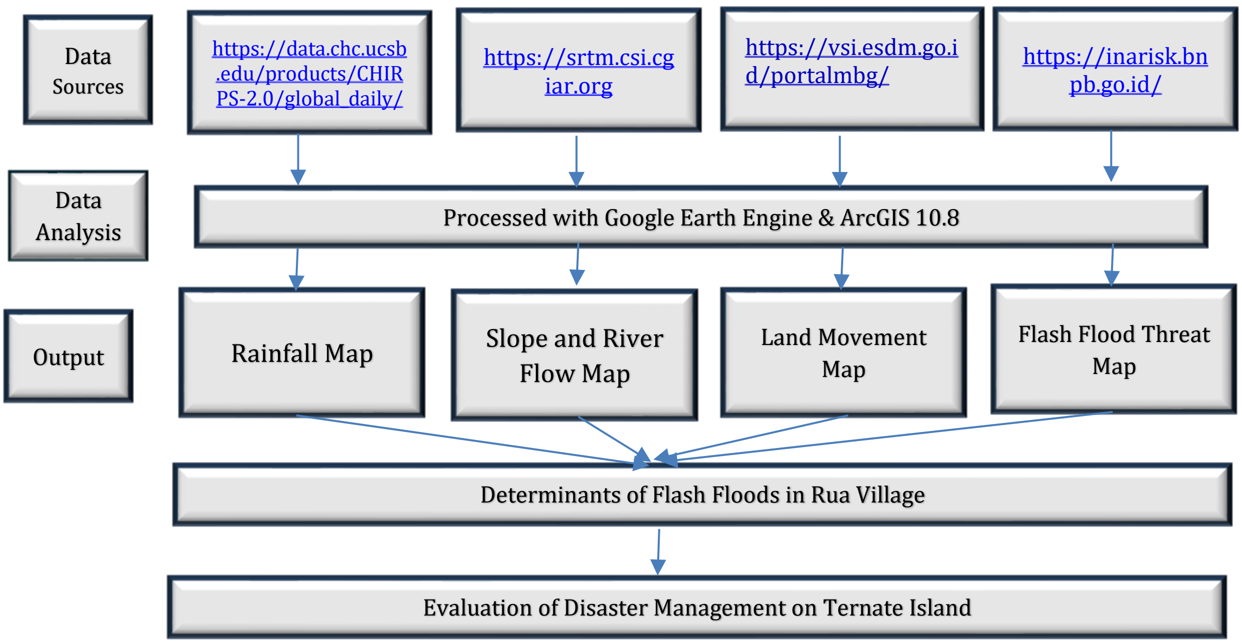

Figure 2. The Research Flowchart

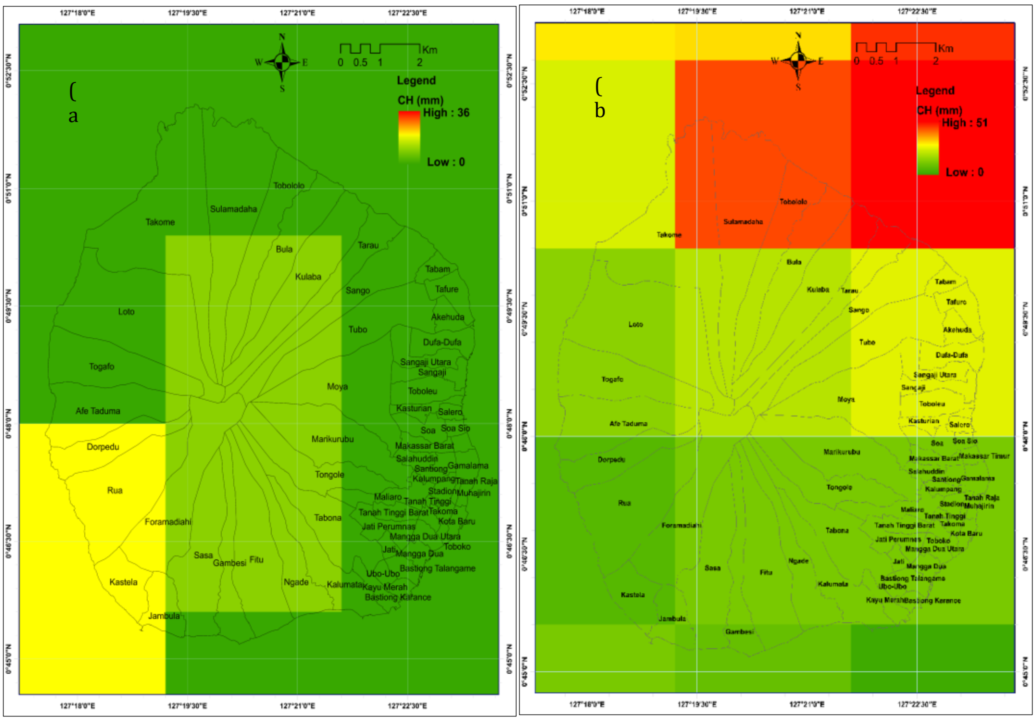

Figure 3. Rainfall Distribution Pattern on Ternate Island on August 24, 2024 (a) and August 25, 2024 (b)

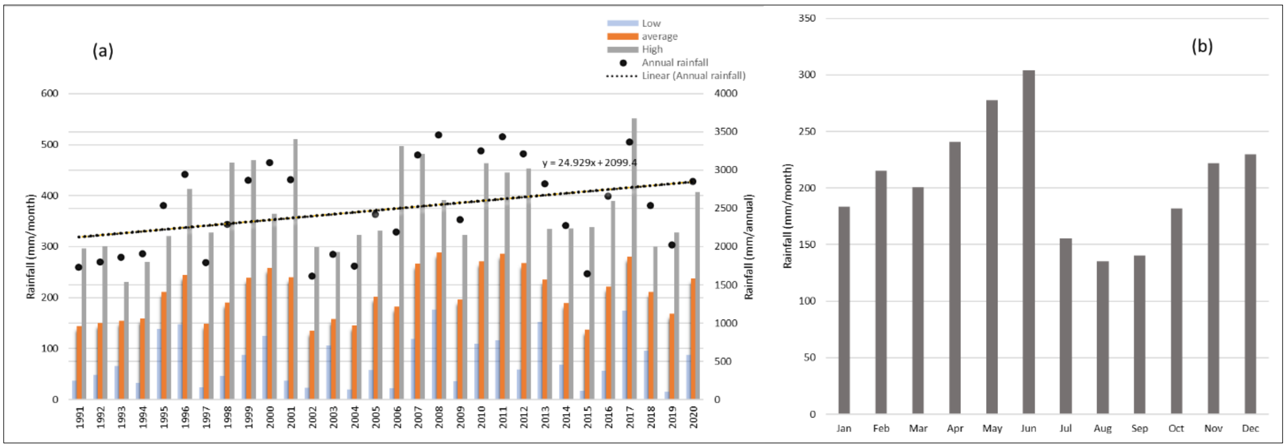

Figure 4. Rainfall Trends on Ternate Island 1991-2020 a) Annually, b) Monthly

3. RESULT AND DISSCUSSION

3.1. Triggering Factors for Flash Flood Disasters

3.1.1. Rainfall

Flash floods represent a natural disaster characterized by a short duration, typically instigated by intense rainfall events and intensified human activity in mountainous regions (Chen et al., 2025; Li et al., 2023; Liu et al., 2017). Thus, rainfall is the initial parameter examined in this study.

The analysis of rainfall distribution using CHIRPS data for August 24 and 25, 2024, on Ternate Island revealed an uneven pattern across the island. On August 24, 2024, rainfall measurements ranged from 0 to 31 mm (Figure 3a), while on August 25, 2024, the range was from 0 to 51 mm (Figure 3b). In the Rua Village area, rainfall was categorized as moderate on both days; however, the Gamalama peak area experienced a significant increase in rainfall.

Moreover, according to data analysis results, the Meteorology, Climatology, and Geophysics Agency (BMKG) Ternate estimates that rainfall intensity will reach 75 mm. The intensity peaks at 50 mm/hour. The maximum rainfall peak is observed between 03:00 a.m. and 05:00 a.m. This is due to air mass convergence, which coincides with an active low-pressure area in the Northeast Pacific Ocean near Halmahera in multiple districts and cities within North Maluku. Ramadhan et al. (2024) argue that the active Madden-Julian Oscillation (MJO) is a primary factor influencing rainfall variability, including extreme rainfall events in Indonesia. The MJO travels from the Indian Ocean to the Pacific Ocean at a 5-10 m/s speed within 30–60 days. However, the extent to which it influences extreme rainfall events varies by region in Indonesia. In short, high rainfall in the peak area of Mount Gamalama for two hours results in water masses flowing toward the lower coastal regions of Ternate Island. Chen et al. (2025) documented a flash flood in Sichuan Province, China, on August 21, 2023, resulting from significant rainfall in the mountainous region, leading to 52 fatal accidents. Al-Rawas et al. (2024) noted that flash floods typically occur during periods of intense rainfall lasting less than four hours. This indicates that significant rainfall at the study site can lead to flash floods in a short time.

We also analyzed the rainfall distribution pattern in Ternate Island from 1999 to 2020 (Figure 4a). Over the thirty-year period, rainfall in Ternate exhibited variations in both monthly and annual totals. The range of rainfall quantities extended from a minimum of 1615 mm to a maximum of 3454 mm, achieving an average of 2486 mm. The linear trend line indicates an upward trajectory in yearly rainfall during this era, suggesting a heightened likelihood of increased precipitation. The monthly precipitation on Ternate Island fluctuates, as historical statistics indicate (Figure 4b). Precipitation levels rise from January to June, subsequently declining until August. September witnesses a substantial rise in precipitation levels. The rainy season extends from December to June, while the dry season occurs from July to August. Given the anticipated rise in rainfall distribution patterns, the government and community must plan for and be vigilant regarding potential future flood disasters. The findings align with Ramadhan et al. (2024), indicating that the Madden-Julian Oscillation (MJO) significantly influences rainfall variability in the Indonesian Capital City (IKN) during the rainy season from November to May and the dry season from June to October.

3.1.2. Topography and River Flow Pattern

The topography is regarded as having the most significant impact on the landslide disaster process, as slope stability is inherently linked to the angle of the slope itself. Topography, reflecting the elevation of a region, significantly influences the possibility of flash floods occurring from highlands to lowlands (Riaz & Mohiuddin, 2025; Wang et al., 2025). The steeper the incline, the more readily the soil and rocks upon it will be influenced by the force of gravity. Consequently, landslides are exclusively associated with steep inclines and do not manifest on level or gently sloping terrains (Ikqra et al., 2012). The topographic analysis indicated that the disaster site featured a steep gradient, with closely spaced contour lines reflecting a winding surface relief, culminating at the summit of Mount Gamalama (Figure 5a). Firmansyah (2011) noted that Ternate Island features a notable physical slope exceeding 40%, reaching its highest point at Mount Gamalama in the island's central region. Standard gradients typically range from approximately 2% to 8% in coastal regions.

Ikqra et al. (2012) noted that the topography of Ternate Island is associated with landslides, which typically occur in regions characterized by steep slopes and volcanic activity. This region frequently features river bends and transitions in slope, particularly from steep to gentler inclines, which serve as channels for water flow (Sulistio et al., 2020). The topographic map indicates that between 600 and 1400 m altitudes, the contours become increasingly dense, signifying a steeper slope gradient. Li et al. (2023) research in the Sichuan region identified a high landslide vulnerability at an elevation of almost 1100 m, with slopes ranging from 30% to 60%.

Ternate Island's complicated topography and elevation result in a radial river flow pattern that commences at the summit of Gamalama and drains into the coastal region (Figure 5b). According to Riaz and Mohiuddin (2025), the flow pattern and distance from the river are critical factors determining the likelihood of flooding in certain regions. In addition, Li et al. (2023) assert that the erosion and sedimentation processes in river basins during extreme rainfall scenarios will significantly impact landslides and can easily result in secondary disasters, including flash flooding. This demonstrates that the Rua village area is traversed by numerous rivers originating from Mount Gamalama's summit. Consequently, excessive rainfall has the potential to result in flash floods.

3.1.3. Rock Formation and Land Movement

Landslides show up when a mass of soil on a steep incline shift over a watertight layer saturated with water, typically due to rainfall. A significant clay content characterizes this layer; should it become saturated with water and subsequently fail to maintain sufficient strength to support the load and pressure exerted by the water above, a landslide is likely to ensue (Titisari et al., 2019). Consequently, the composition of rock constituents and soil stability are elements that significantly affect the occurrence of landslides (Sulistio et al., 2020). Before the occurrence of a landslide, it is typically foreshadowed by the development of fissures or fractures within the rocks situated at the apex of the landslide crown (Naryanto et al., 2019).

According to the Geological Map of Ternate Island, the rocks in the disaster area are categorized as Littoral Eruption Deposits and Pyroclastic Flow Deposits. As well as andesite-dacite breccias and volcanic eruption pieces that look like bread crusts, these are made up of lithic and tuff volcanic breccias (Figure 6a) (Santoso, 2024). According to Mutaqin et al. (2021), lahars, lava, and breccias connected to the Young, Adult, and old phases of Gamalama make up most of Ternate Island's composition in the interim. The surface deposits consist of stratified layers of alluvium, comprising silt, sand, and gravel. Debris pyroclastic deposits (pr) comprise ash, tuff lapilli, and many layers of pumice lapilli that came from Gt, Gd, and Gm. They are only slightly consolidated and have not broken down yet.

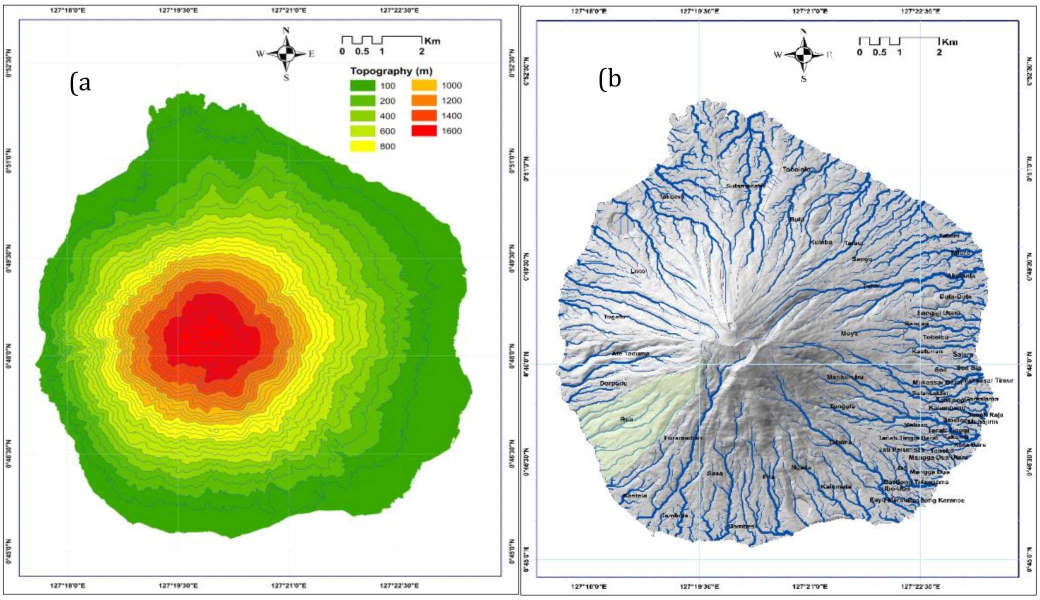

Figure 5. Topographic Map (a) and River Basin (b) on Ternate Island

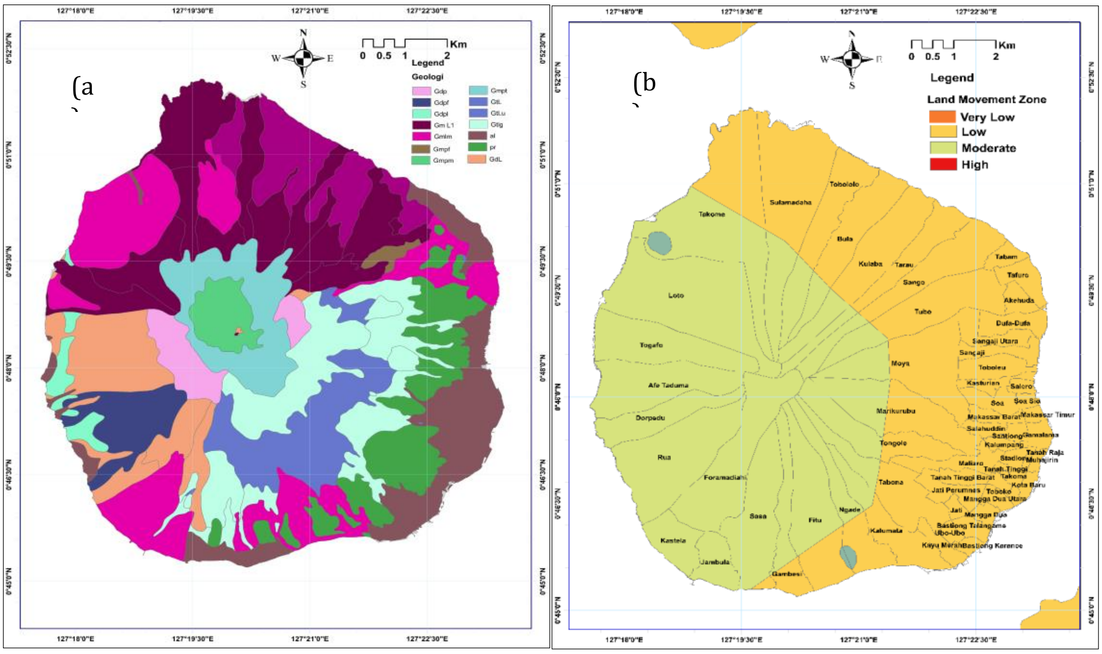

Figure 6. Geological Map (a) and Land Movement (b) of Ternate Island

Moreover, the Young Pyroclastic Deposits (Gmpm), the Pyroclastic fall deposits (Gdp), and the Old Gmalama Mountain (Gt) are noteworthy geological formations. According to Figure 6a, Rua Village is situated within the Gamalama II volcanic facies, characterized by its composition of volcanic eruption materials. These materials are highly susceptible to erosion and destruction, especially when under the influence of significant rainfall events that make it easier for them to travel to alternative locations. Moreover, the aggregation of substantial materials obstructing the flow distribution pathway results in water overflowing from the primary river course (Abubakar, 2024). In the Rua flood incident, the transported material was amalgamated with rock fragments, resulting in significant damage.

The features of land movement constitute a significant factor that precipitates landslides. Elements like high rainfall intensity, the steepness of the slope, the load applied, the presence of impermeable layers, the thickness of the soil solum, and the specific gravity of the soil have a significant impact on the dynamics of slope-forming materials like rocks, debris, and soil (Sulistio et al., 2020).

The study conducted by Hartono and Hadun (2021) revealed that the soil characteristics in the Foramadiahi region, situated at an elevation of 354 meters above sea level, exhibit a clay soil texture class for layers I and II. In contrast, layer III is classified as dusty clay loam, while layer IV presents a sandy clay texture. The soil consistency in layers I and II is sticky due to its moisture content. In wet conditions, the lumps in this layer can be easily destroyed. This suggests that the soil is susceptible to erosion in the event of rainfall. Menawhile, Naryanto et al. (2019) argues that the delineation between softer and harder rock can be observed in volcanic breccia rock. This delineation serves as a sliding zone for landslides when saturation arises from water infiltration into the soil pores.

Meanwhile, regarding to the land movement vulnerability zone map of Ternate Island, it is evident that the disaster area is within the moderate and low categories (Figure 6b). In this region, the proportion of landslide occurrences exceeds 15% to 30% of recorded events. In this zone, there are moderate landslides, particularly in locales adjacent to river valleys, steep inclines, road-cut cliffs, and slopes that have been altered. Therefore, significant rainfall and/or seismic activity can cause landslides to manifest or reactivate. Further, the analysis of the landslide map reveals that Rua Village falls within the moderate category of landslide susceptibility, suggesting a moderate potential for landslides in this area. In this region, landslides are likely to occur when rainfall exceeds normal levels, particularly in zones adjacent to river valleys, road cliffs, or where the slope has been disrupted (Santoso, 2024).

3.2. Analysis of Flash Flood Hazard Areas

Identifying areas susceptible to disasters relies on two fundamental elements: the likelihood of a threat and the extent of the documented impact of the disasters that have transpired (Badan Nasional Penanggulangan Bencana, 2012). Consequently, examining flood hazards involves a thorough spatial analysis of boundary maps, river basin maps, digital elevation models, landslide hazard maps, and river network maps. Lessy et al. (2024b) study of flash flood hazards on Ternate Island and their spatial mapping of those hazards shows that areas likely to be affected by flash floods are along the river's path, starting in the highlands and moving to the coast. Consequently, regions adjacent to the river basin are susceptible to classification as vulnerable areas across low, medium, and high categories (Figure 7b). The analysis of the area susceptible to disasters indicates that West Ternate District possesses a significant potential for flash flood hazards, characterized by a high hazard category encompassing an area of 327.6 hectares.

In contrast, the Central Ternate sub-district exhibits a comparatively diminished potential for flash flood hazards, encompassing an area of 18.1 hectares. The region susceptible to flash floods encompasses 12.6% of Ternate Island's total land area. In the interim, the region at risk of flash flooding within the Rua sub-district encompasses 2.6 hectares classified as high risk and 0.6 hectares categorised as medium risk.

Referring to Figure 7b, a more in-depth examination of the flash flood hazard outcomes was conducted. The site of the incident was situated within a region classified under a high-hazard threat category (Figure 7a). This suggests that this location has historically been, and will continue to be, susceptible to the threat of flash flooding.

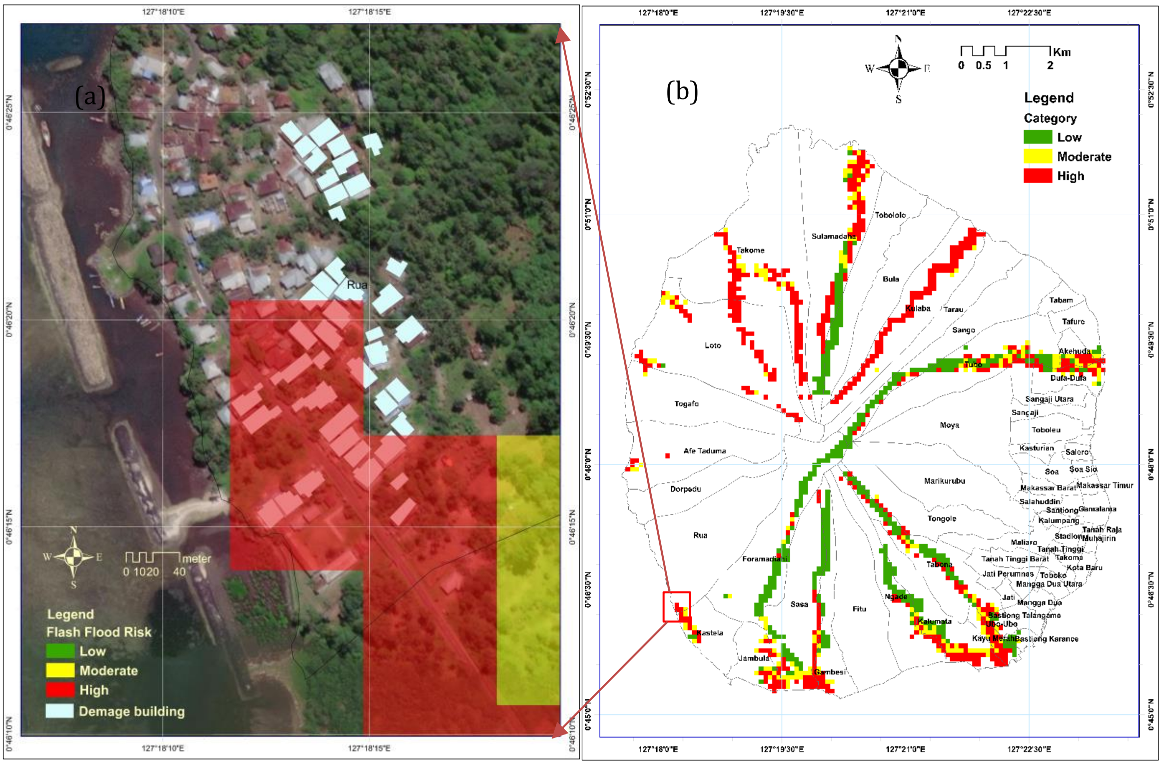

Figure 7. Flash Flood Hazard Map on Ternate Island (b) and Flash Flood Location in Rua Village (a)

3.3. Towards Improved Governance in Disaster Management for Small Islands

Developing effective and efficient risk management strategies is contingent on disaster risk management. Thus, the Indonesian government has implemented Law Number 24 of 2007 on Disaster Management. This regulation establishes the fundamental legal framework for disaster management in Indonesia, offering local governments comprehensive guidelines to prepare communities for disaster threats effectively. Nevertheless, implementing disaster risk management is a complex and multifaceted Endeavor unique to each region of Indonesia. In order to enhance disaster management in Ternate City, we propose several essential components from the flash flood learning experience in Rua village.

3.3.1. Mainstreaming Disaster Risk Reduction into Development Planning

In light of the three-time flash flood incident in Rua village and the fact that Ternate Island is a small island highly susceptible to disasters, our initial recommendation is that the regional government integrate disaster risk reduction into spatial planning. This will ensure that development planning is conducted in accordance with the region's disaster conditions and space requirements.

According to the available reference search results, the government of Ternate City has enacted various regulations pertaining to disaster management, including:

- Ternate City Regional Regulation No. 2 of 2012 regarding the Ternate City Spatial Plan for 2012-2032.
- Regional Regulation No. 10 of 2014 pertaining to disaster management in Ternate City.
- Mayor Regulation No. 15 of 2022 regarding the Detailed Spatial Plan for Ternate Island for 2022-2042.

These regulations are designed to safeguard the community against the potential dangers of disasters, ensuring that disaster management is executed methodically, cohesively, and thoroughly. The regulation further encompasses sustainable environmental stewardship, including waste management, establishing infiltration wells, and enhancing housing quality and slum conditions. A spatial plan that emphasizes the importance of disaster mitigation serves as the foundation for these regulations.

Nevertheless, the incorporation and unification of disaster risk reduction across all sectors and intersectorally has not been fully realized in Ternate. This is evident from the shortcomings observed in the execution of these regulations. Environmental and disaster issues serve as a persistent reminder to all stakeholders. Hydrometeorological disasters and other calamities represent unavoidable threats, particularly given Ternate's status as a small, densely populated island with constrained land resources, contributing to its notable vulnerability to disasters that warrant careful monitoring (Lessy et al., 2024a).

A spatial framework that aligns with disaster mitigation principles should guide urban planning efforts. This measure is implemented to avert the possibility of future disasters in the same region. The Ternate City Spatial Plan document for 2012-2032 addresses areas susceptible to natural disasters and clearly outlines its provisions under the Environmentally Conscious Development pillar as of January 2022. Regrettably, the spatial plan document doesn't work to identify areas susceptible to flash floods as vulnerable regions. The local government provides a list of areas susceptible to flooding, which includes Mangga Dua Village, Bastiong Talangame Village, Bastiong Karance Village, Gamalama Village, and Jati Village. Unfortunately, Rua Village is excluded from this area.

Similarly, the Mayor's Regulation Number 15 of 2022 regarding the Ternate Island Detailed Spatial Plan for 2022-2042 is unsuccessful in addressing areas susceptible to flash floods. This regulation focuses on volcano and tsunami hazards. In fact, floods have impacted the city of Ternate, as evidenced by events in 2011 and 2012 in Tubo village (Masinu et al., 2018). Therefore, spatial planning focused on disaster mitigation is critically important for small island regions that are susceptible to various potential disasters. Eventually, local governments need to implement policies that address the pressing needs of disaster management within the development planning framework. Additionally, data and information concerning disaster-prone regions must be made available to the public, enabling informed decision-making regarding development in areas with significant disaster risks (Redaksi, 2024).

3.3.2. Strengthening Disaster Management

Governance displays strategic measures aimed at mitigating disaster risks, preventing the emergence of new threats, and identifying avenues to address impending disasters effectively. To be effective, governance efforts to lower risks must be compatible with policy tools (finance, infrastructure, law, and communication) and governance frameworks (like actors and institutions). These frameworks and tools must also work well together to deal with specific disaster risks (Triyanti et al., 2022). Enhancing governance necessitates a comprehensive comprehension of disaster risk on Ternate Island. Comprehension should be pursued regarding the various dimensions of vulnerability, capacity, exposure of individuals and assets, characteristics of hazards, and the surrounding environment. This information can be utilized for the assessment of risks prior to disasters, for the purposes of prevention and mitigation, as well as for the formulation and execution of suitable preparedness strategies and efficient responses to disasters.

Given that each region possesses distinct ecosystems, socio-economic conditions, and disaster characteristics, it is imperative to compile an understanding of disaster risk within a Disaster Risk Assessment (DRA) document along with its supplementary materials. The disaster risk assessment document serves as a cohesive framework that offers an in-depth understanding of the disaster risk within a specific area by evaluating the degree of threat, the extent of vulnerability, and the regional response capacity. The outcomes of the disaster risk assessment serve as a foundational element in the development of disaster management policies within the governmental framework. This policy will subsequently serve as the foundation for the formulation of the Disaster Management Plan, which acts as a framework for integrating disaster management into developmental strategies.

According to the Regulation of the Head of BNPB No. 2 of 2012 about the General Guidelines for Disaster Risk Assessment (Badan Nasional Penanggulangan Bencana, 2012), it is mandated that the Disaster Risk Document undergoes an update every five years. Additionally, it may be subject to periodic review every two years or at any moment when a disaster or extreme conditions arise that necessitate a revision of the current study. Regrettably, the DRA document pertaining to Ternate City has expired since 2017. The recurrent flash flood incident in Rua Village raises significant concerns for all stakeholders, necessitating a thorough understanding of the evolving intensity of disasters on Ternate Island to ensure accurate documentation.

The subsequent phase of the risk assessment findings involves the formulation of a disaster management system, which is meticulously documented within a Disaster Management Plan (DMP) document. The DMP document will encompass a comprehensive outline detailing the methodologies and implementation strategies of the organization during the pre-disaster phase, which includes prevention activities, mitigation efforts, preparedness measures, and early warning systems. Moreover, it is essential to establish contingency plans and standard operating procedures (SOPs) prior to the occurrence of a disaster. This is particularly pertinent in the context of multi-threat disaster emergency operations, which typically delineate doctrines, principles, policies, strategies, assumptions, roles and responsibilities, lines of coordination and command, work mechanisms, and operational priorities. These frameworks serve to guide and support effective emergency management in response to disasters (Lessy et al., 2024a).

Moreover, an adequate disaster management framework necessitates establishing supporting infrastructure, including detailed maps of areas susceptible to disasters, efficient early warning systems, clearly marked signs, designated evacuation routes, and temporary assembly locations. These facilities serve a dual purpose, benefiting the local populace and those new visitors to Ternate Island. Nevertheless, the provision of these infrastructural amenities remains significantly inadequate. The presence of an adequate infrastructure, such as an early warning system, does not ensure that the community will react effectively to disasters if the level of preparedness within the community remains insufficient.

3.3.3. Strengthening Community Capacity

Improved capacity of communities in risk reduction offers valuable insights for grassroots engagement (Lassa, 2018). This encompasses the readiness of the community. Preparedness activities encompass a range of anticipatory measures, including strategic planning, resource identification, warning systems, training initiatives, risk communication, public awareness, education, and exercises designed to enhance the safety and efficacy of community responses during a disaster. Thorough preparedness is instrumental in preserving lives, mitigating injuries, curtailing property damage, and minimizing various disruptions that arise from a disaster. Most victims can likely achieve safe evacuation, provided they are given adequate notice from the authorities and have adequately prepared for such an occurrence.

Preparedness activities encompass a range of anticipatory measures, including strategic planning, resource identification, warning systems, training initiatives, risk communication, public awareness and education, and exercises designed to enhance the safety and efficacy of community responses in the event of a disaster. Programs to enhance community capacity can be implemented by establishing Disaster Resilient Villages. Regrettably, as of 2019, merely four of the 60 villages in Ternate demonstrated disaster resilience: Tabam, Tubo, North Sangaji, and Loto (Ichi, 2019).

3.3.4. Proposed Mitigation Plan

Given the recurrence of flash floods on three occasions, a comprehensive series of mitigation activities must be implemented in the study area. Mitigation encompasses a range of initiatives aimed at diminishing disaster risk, achieved through both infrastructural advancements and the enhancement of awareness, alongside bolstering the capacity to confront potential threats posed by disasters. Several proposed mitigation activities, encompassing both physical and non-physical programs, the Ternate government may undertake to include:

a. Constructing embankments in river basins to prevent water overflow beyond a specified height from encroaching upon susceptible regions.
b. Building detention storage. When placed on channels that move quickly, flood dampers absorb and temporarily hold some of the flood volume (detention storage). This ensures that the discharge that goes downstream matches the main discharge of the downstream channel.
c. Implementing a forecasting and early warning system that can enhance the efficacy of flash flood

management initiatives. This system undoubtedly can deliver precise information before the onset of a flash flood.

d. Community management: enhancing community capacity and participation as a measure of disaster-resilient villages through the development of legislation, the organization of institutional forums, and the allocation of funding for disaster preparedness and response.

4. CONCLUSION

This study investigates the prevalence of flash flood disasters by conducting a thorough analysis of the underlying causes of flooding in Rua Village, Ternate City, and addresses issues related to disaster management. The analysis results provide significant insights for future adaptation and mitigation strategies regarding subsequent disasters.

The analysis identifies several primary factors contributing to landslide disasters: steep slopes, volcanic breccia rocks leading to thick, weathered soil formation, disturbed slope stability, and high rainfall. The results of mapping disaster-prone areas indicate that the study area is highly susceptible to flash flood disasters. The experiences of survivors highlight the necessity of enhancing community preparedness to address climate change and shifting rainfall patterns, as well as implementing an early warning system as a proactive measure.

The disaster on Ternate Island necessitates the attention of all relevant stakeholders. This is a crucial element of effective disaster management. Commencing with spatial planning aimed at disaster mitigation and enhancement of disaster management practices. This includes infrastructure development, the creation of disaster response documentation, and the enhancement of community resilience. Finally, due to the limited resources on small islands, collaboration among all stakeholders—government, private sector, academics, NGOs, and communities—is crucial for enhancing resilience.

Nonetheless, the researchers recognize that this study is confined to a single disaster category despite other potential disasters on Ternate Island. Future research is crucial for enhancing resilience on small islands through the integration of diverse disaster types

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