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REVIEW

Flood mitigation in urban areas: Adopting a governance approach

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Abstract. Flood persist as an acute problem requiring resolution because their recurring annual incidence. A body of research suggests that an effective policy approach can reduce the severity of such disasters. Our eneavor aims to assess policy direction of the government concerning flood management, particularly in urban areas. To achieve this, we srcutinize various written materials and documents connected to flood control administration in Indonesia. Our comprehensive review, focusing on the latest flood mitigation implementations, will drive recommendations for adopting a governance approach in flood management. These recommendations will derive from findings of our review. To lessen the risk of flooding, the government mjust establish a robust foundation, both strategically and tactically.

Keywords: Flood hazard; Flood management; Flood mitigation; Disaster management; Urban areas

1. Introduction

According to data from *Badan Nasional Penanggulangan Bencana* (BNPB), as the nation entered the 21st century, the frequency of flood events - being the most recurrent and causing the most casualties - has steadily and significantly increased over the last two centuries (Basuki et al., 2022; Fitriyani et al., 2021). In 2022, there were 3.410 reported disasters covered in various news reports about disasters in Indonesia. From January until November 2022, floods were the most frequent, with 1,407 incidents, followed by 983 extreme weather incidents, 607 landslides, 250 forest fire, and 24 earthquakes (Sucipto, 2022). According to data released by BNPB in December, until 13 December 2022, there were 1,436 flood disasters and 12 other types of other disasters, like forest fire and volcanic eruption (Pangaribowo & Khairina, 2022). These incidence range from floods in Jakarta (Untari & Tolok, 2022), Trenggalek, Lumajang, Blitar, & Malang (Laksono, 2022), landslides in Purworejo (Apriliano & Putri, 2022), Tarakan (Dzulviqor & Arief, 2020), to earthquakes in Cianjur (Hardiantoro & Hardiyanto, 2022), and floods in Enrekang, South Sulawesi (Syamsuddin & Rusiana, 2020).

The occurrences of disasters in Indonesia result in significant loss of life and extensive material to buildings and public facilities, profoundly impacting the community's survival. On December 22, 2022, BNPB released distressing figures, reporting 836 fatalities, 44 individual

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missing, 8,724 injured, and 5,223,227 displaced due to the disaster. Materially, the disaster lesft 98,346 houses damaged, with 33,427 heavily damaged, 19,495 moderately damaged, and 45,460 lightly damaged (Pusdalops, 2022). Furthermore, 1,473 public facilities incurred damage, including 897 educational, 486 worship facilities, 90 health facilities, alongside 157 offices and 321 bridges (BNPB, 2022). Figure 1 presents more detailed data.

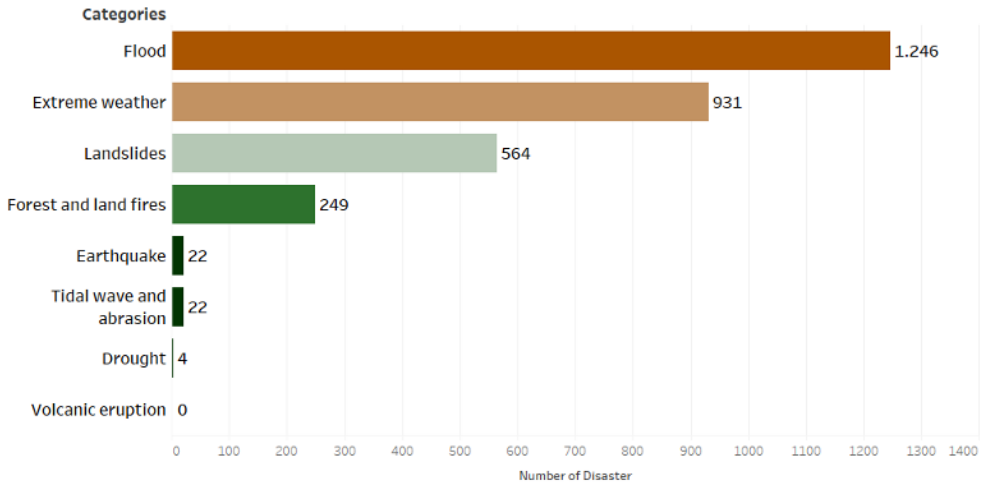

Figure 1. Number of cases by type of disaster in 2022 (BNPB, 2022)

This shows that during the rainy season, nearly the entire country of Indonesia is vulnerable to natural disasters, including floods, landslides, soil erosion, and heavy downpours (Basuki et al., 2022). Figure 1 illustrates that flooding is the most frequent disaster in Indonesia. Floods consistently affect several regions in Indonesia annually, as supported by following data highlighting their recurring high rate each year.

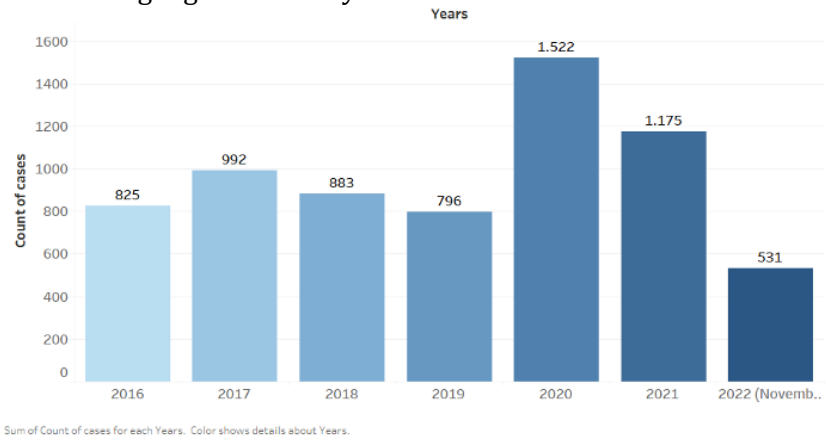

Figure 2. Number of floods in Indonesia in 2016 – 2022 (BNPB, 2022)

Certainly, efforts to address flooding have not seemed sufficiently robust so far, notably in discussions around prevention and preparedness, potentially leading to recurrent flood events (Hapsari & Zenurianto, 2016). This notion is reinforced by a government statement attributing the primary cause of the flooding to natural factors, specifically high rainfall, as seen in South Kalimantan (Adyatama & Budiman, 2021). This statement creates bias, suggesting suboptimal government effort and an inability to mitigate preventable disasters (Ghozali et al., 2016). Moreover, such declarations may limit a more comprehensive analysis from alternate perspectives, for example urban governance. For instance, the annual and repetitive floods in

urban areas influenced by the decreasing green lands due to the construction of residential and industrial buildings, inadequate drainage systems, and poor river management. The complexity of these issue necessitates a thorough examination concerning the government's flood policies in Indonesia, viewed from two perspectives. This review aims to explore academic perspective on the pressing disaster issue and asses the government's practical implementation of various policies in addressing recurring floods occur.

2. Methods

In this study, we decided to use the literature review method. The two primary components of a literature review involve sourcing studies conducted on a subject and summarizing their findings. A literature review satisfies several requirements for completion. It presents and discusses findings of other studies closely related to the current research being conducted (Creswell & Creswell, 2018). Furthermore, besides assisting researchers in planning future studies, literature reviews provide concise summaries of published research on specific topics (Petticrew & Roberts, 2006). We choose this method to explore the evolution of this topic and to assess the evolution of the government's policy approach to flood disaster management.

The study utilized Scopus as the primary source of academic articles for analysis. Initially, 311 publications were identified from various sources and types of writing. To ensure relevance and accessibility, a series of filters were applied. This literature filtering process included the inclusion of only full articles published in English-language journals that offering open-access facilities. These criteria were applied to ensure the availability of full-text articles for comprehensive analysis. Additionally, the search strings "flood AND government OR policy" and "Indonesia" were employed to identify articles directly related to flood policy in Indonesia. Furthermore, filtering based on titles and abstracts was conducted to thoroughly assess the content of the identified articles. This step aimed to narrow down the selection to articles that specifically addressing flood management policies in Indonesia.

As a result of this rigorous selection process, a total of 70 articles were deemed relevant to the study's focus on flood management in Indonesia. The selected articles covered from 2011 to the beginning of 2023. Notably, there was an observed increase in publications starting in 2021, visually represented in Figure 3. This comprehensive methodological approach ensured that the literature review captured the most pertinent and up-to-date scholarly contributions to the field of flood policy in Indonesia.

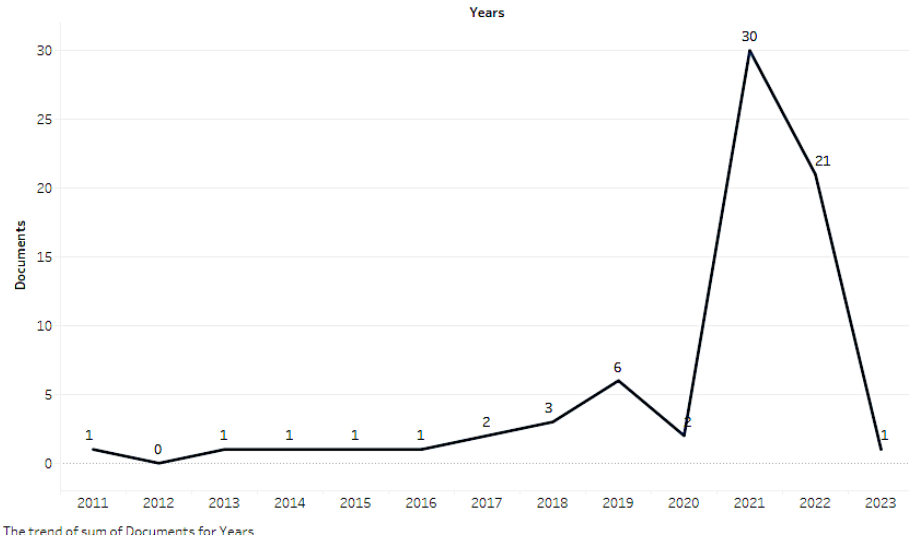

Figure 3. Development of literature

Furthermore, the database containing the discovered articles was processed using VosViewer to determine the related and popular keywords among each article and produce the subsequent visualization. This step was also employed to identify any research gaps.

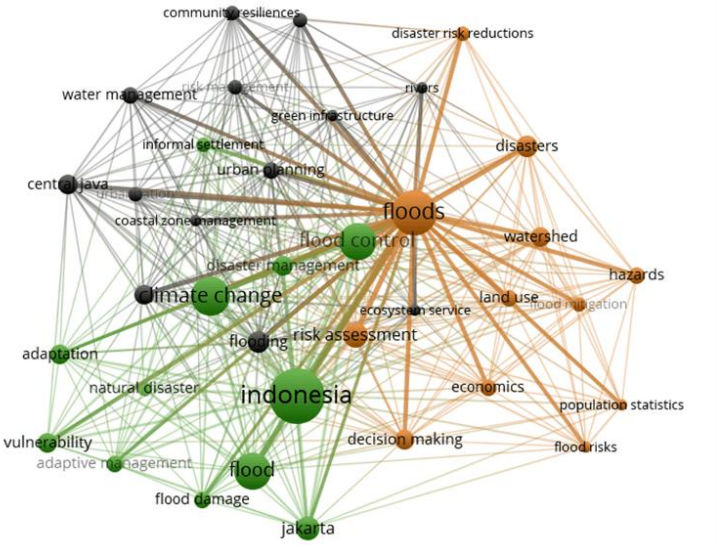

Figure 4. Visualization of keywords related to flood management in Indonesia.

Figure 4 shows three subject matter clusters identified by previous authors in the study of flood management in Indonesia. The cluster depicted in black shows various approaches to flood management, highlighting keywords such as water management, urban planning, green infrastructure, and community resilience. These keywords emerged in Sunarharum et al. (2014) study, which explains the fragmented nature of DKI Jakarta's flood risk management governance across different government levels and suggests measures to strengthen community preparedness. Additionally, Moe et al. (2017) investigated how urbanization-induced changes in land use and land subsidence have contributed to increased flood inundation volume in Jakarta. In relation with this cluster's focuses on urban land use planning, it examines specific locations of concern in Indonesia, emphasizing keywords rivers and Central Java (Handayani et al., 2020).

The subsequent figure exhibits a green cluster outlining discussion on flood management in Indonesia, focusing on challenges posed by phenomenon. Within this cluster, emerging keywords such as 'flood damage' originate from Dewata and Umar (2019), which reviews into how floods annually affect up to 30% of areas in Indonesia. Another study from Salim et al. (2019) introduces the keyword 'vulnerability', analyzing the main causes of vulnerability to flooding and critiquing the failure of the Great Garuda project in addressing these issues. Moreover, Taylor (2015) underscores the necessity for adaptive measures during crisis, asserting that the ability to adapt and mobilize all available resources to increase resilience to climate change is a defining characteristic of successful institutions and communities in building resilience.

Moving on to the orange cluster, the discussion here mirrors the themes in the green cluster. The authors examine into the importance of watershed management in urban areas (Basuki et al., 2022; Gunnell et al., 2019; Nur & Handayani, 2022). They explore how alterations in land use absorption and river flow affect flooding across various urban areas in Kalimantan and the potential impact on the proposed site for Indonesia's new capital city (Kurniawan et al., 2021; Supriatna et al., 2022).

An interesting observation lies in the density of the discussion surrounding flood management, where keywords such as flood mitigation, risk management and adaptive management appear vaguely in the processed source data. This shows a limited focus on

preventive actions, particularly in flood disaster mitigation research. For instance, Mulyadi et al. (2021) investigated the significance of preserving mangroves, particularly in Bandar Bakau region of Dumai City, through mitigation-based mangrove ecotourism. Meanwhile Clegg et al. (2021) developed a conceptual framework identifying key flood management and governance concepts in transboundary watersheds, specifically in the context of Ciliwung. Additionally, Dartanto (2022) conducted a follow-up survey to analyze the long-term impact of natural disasters on Indonesian families. Previous research had limited and had coverage concerning urban flooding situations. This knowledge gap motivated the current research to explore and address areas further development and study in flood disaster mitigation.

3. Results and discussion

3.1. Recent government efforts to control flooding

When discussing current policies dealing with floods in Indonesia, it is necessary to understand the nature of flooding. The BNPB defines flooding as 'an event or condition in which an area of land is submerged due to an increased volume of water' (BNPB, 2014). Floods are characterized as overflow or breakdown of natural barriers, such as rivers, streams, lakes, oceans, or excessive rainfall leading to insufficient drainage of waterways (Douben, 2006; Douben & Ratnayake, 2006). Globally, heavy and/or prolonged rains, intense downpours, tropical cyclones, and monsoon rains stand as primary contributors to flooding (Douben, 2006).

The causes of floods are diverse; in terms of natural disasters, rising sea levels, and high rainfall due to unpredictable cycles such as the La Niña occurrences (Evans & Boyer-Souchet, 2012). However, exploring further into the causes of frequent floods in Indonesia, they often transpire in urban or rural areas where near mines or deforested land (Adyatama & Budiman, 2021; Riski, 2021; Suriyani, 2022; Utami, 2022; Zamzami & Arief, 2023). This analysis aims to address floods as a consequence of human activities, emphasizing the potential for minimizing the impact.

Firstly, considering flooding in urban areas, urbanization is a prevalent occurence in these areas. To illustrate, examining the case of Jakarta, which faces annual flooding, provides a notable example A Twitter post by journalist (Hanifan, 2020) highlighted a contributing factor in Jakarta's floods, beyond heavy rainfall. Satellite images captured in 2006, 2009, and 2014 of Kemang area, Jakarta, exhibited the transformation of green areas previously serving as water catchment sites for nearby housing (Figure 5). These green spaces were replaced by the construction of luxury apartments owned by the property company. This observation align with Budiman et al. (2014) research, revealing changes in Jakarta green spaces (Figure 6). Initially clustered and concentrated on the outskirts in 1982, by 2013, these areas evolved into a scattered pattern with reduced coverage.

Figure 5. Comparison of green areas from 2006, 2009, and 2014 (Hanifan, 2020)

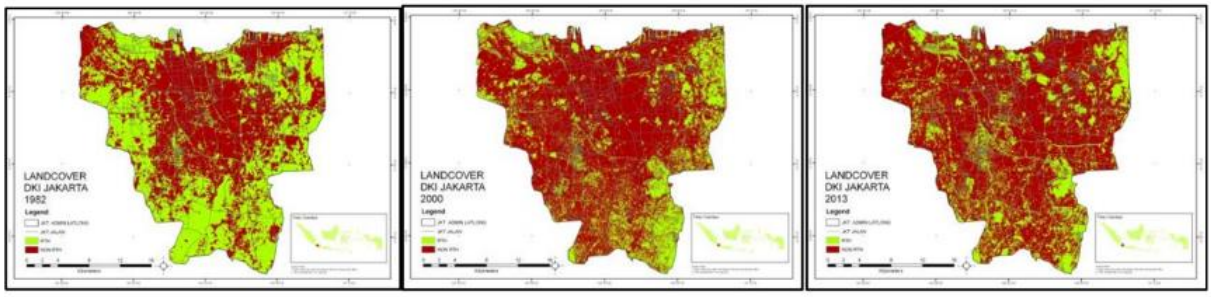

Figure 6. Comparison of green areas from 1984, 2000, and 2013 (Yellow: Green Area, Red: Non-Green Area (Budiman et al., 2014)

This fact highlights how economic entities, especially at the corporate level, contribute to disasters like floods by failing to collaborate with the government in developing urban spatial planning. Green space is a crucial component that requires attention in urban planning contexts. Article 29, Paragraph 1 of the Republic of Indonesia Law Number 26 of 2007 Spatial Planning states the 'The proportion of green open space in the city area should be least 30 percent. However, several major cities fall short of this target. Jakarta achieved only 14.9% of green space target in 2019 (Nadya & Erlyana, 2020), Sukabumi recorded a mere 5.2% of green space in 2015 (Shani & Kurniawan, 2015), and Yogyakarta reached only 19% in 2020 (Wijana, 2020). Surabaya, slightly better among the Java island cities, has 26% green space (Ulfa, 2018). However, these figures still fall below the established standard. The current scarcity of green spaces has led to significant damaging effects, such as the floods previously mentioned.

Meanwhile, in areas distant from urban centers, floods frequently transpire in ex-mining zones or locations that have undergone deforestation due to land clearance for industries and other purposes. Data from Global Forest Watch (2021) shows that Indonesia lost 26.8 million hectares of forests between 2001 and 2019, as depicted in the Figure 7.

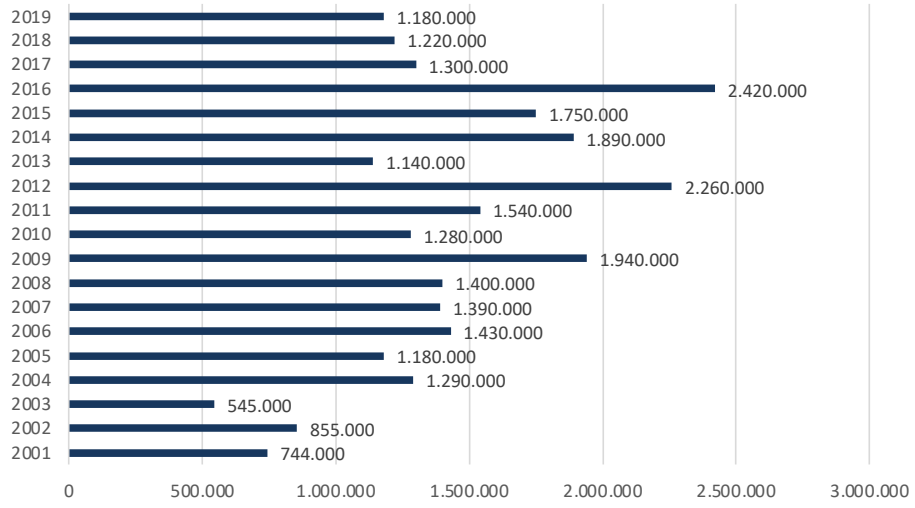

Figure 7. Area of tree cover land subsidence in Indonesia (Global Forest Watch, 2021)

The data indicates ongoing land clearing and deforestation continues in Indonesia under the pretext of development. As a result, flooding becomes an unavoidable disaster. These circumstances require deeper exploration and analysis in policy formulation to mitigate flooding, with a specific focus on urban areas.

The efforts to mitigate floods and implement corresponding policies have been optimally executed by BPNB through various strategies, accelerating the development of a national early warning system for natural disasters, increasing community capacity building through program establishing disaster-resilient villages, and accelerating post-disaster recovery, among others (BNPB, 2015). According to Law of the Republic of Indonesia Number 24 of 2007 on disaster management, BNPB's responsibilities in disaster countermeasures span three phases: pre-disaster, actual disaster, and immediate aftermath. Pre-disaster planning entails preventing disasters by curbing natural resource overuse, formulating disaster countermeasures plans, boosting community resilience, assessing disaster impact and risk, and conducting disaster education (Hapsari & Zenurianto, 2016). However, the post-disaster recovery process, encompassing physical reconstruction and human resource rehabilitation, is notably time-consuming. Conversely, regarding flood management, government initiatives seem to concentrate solely on dealing with disasters as they occur. Operating as an extension of BNPB, BPBD operates regionally. BPBD crucial role lies in formulating flood management policies according to the context and conditions of each region. In terms of flood prevention, BPBD acts as an intermediary among flood prevention stakeholders such as BNPB or other agencies (Isa et al., 2019). BPBD effectiveness varies by region; at times, a lack of personnel hampers the regional government's ability to declare an emergency response status during flood disaster (Muhammad & Aziz, 2020).

In summary, this comprehensive analysis elucidates the multifaceted dimensions of flood disasters in Indonesia, underlining their origins in both urban and non-urban environment, often exacerbated by human activities. The discussion emphasizes the importance of effective policies to mitigate these disasters, encompassing pre-disaster planning, enhanced urban spatial planning, and regional adaptation efforts. It recognizes the challenges and shortcomings in post-disaster recovery and response mechanisms.

3.2. Adopting governance approach in flood management

To minimize the impact of floods, the initiation point begins with policymakers drafting comprehensive disaster mitigation policies. Flood management policies should prioritize mitigation techniques anchored in the principle of preparedness. The government mitigation efforts should adopt a governance approach, encompassing both -term strategic planning and short-term tactical measures (Choi, 2008; Kasdan, 2019). The recommended approach is presented in Figure 8.

Figure 8. Governance approach in flood mitigation

At the planning stage, the strategy leads policies to aimed at lessen flood risk and preparing for potential occurrences. At this level, the results become more practical, evolving into regulations and laws grounded in in prior analyses of flooding causation and the management preparedness. Governments often implements non-structural measures, like strengthening disaster management frameworks, coastal planning, and public education, to prevent floods. Complementary non-structural actions include dykes, coastal-land reclamation, drainage systems, and pump stations (Marfai & King, 2008). Urgency in implementing structural policies government modeling, mapping flood hazards, and establishing early warning system (Marfai & King, 2008). Government-led flood analyses should adopt comprehensive perspective involving various factors beyond natural causes, thereby gathering information and structuring plans for future floods (Junaidi et al., 2018). This work can produce effective policy implementation, particularly in urban areas where urbanization prompts shifts in land use. Handayani et al. (2020) advocate for robust land-use planning and control as crucial measures in protecting cities and densely populated areas. The development of land use planning policies plays an essential role in mitigating flood impacts (Chigbu & Kalashyan, 2015; Handayani et al., 2020). Land use policy offers the opportunity to conduct comprehensive analyses of the land and water potential, exploring diverse approaches to enhance flood-prone areas and mitigate flooding risks (Handayani et al., 2020). Therefore, during the strategic phase of preparing disaster mitigation policies, it is imperative to ensure coordination among sectors, institutions, and governance levels, while integrating strategies (Clegg et al., 2021).

One of the challenges in disaster mitigation stems from community participation. In Indonesian context, diversity resulting from demographic factors such as age, education, and economical background influences how individuals perceive information about flood risk and protection (Soane et al., 2010). Sunarharum et al. (2021) found that communities viewing flooding as a common occurrence are less motivated to take action to reducing flood damage and implementing risk-reducing measures. A crucial aspect in disaster communication is that many people are aware of flood risks in their area but do not change their daily behavior to mitigate these risks. Those living in the flood-prone areas have yet to adopt environmentally friendly behavior (Neolaka, 2012). Therefore, the government should encourage communities to improve flood risk awareness, educate them about flood hazard information, and provide disaster risk education (Alphen & Lodder, 2006). Increasing public knowledge and support for mitigation efforts can reduce the risk of flooding. Sustainable flood mitigation requires cooperation between the government and other stakeholders, employing both structural and non-structural measures (Isa & Mardalis, 2022). Non-structural strategies are important in effectively communicating flood hazard, risks, and mitigation to the public.

Regarding the community, it is essential to strengthen disaster risk reduction education, particularly for students in schools. Teacher often face challenges due to lack of access, platforms, and awareness about disaster risk reduction, impacting their ability educate students regarding disaster awareness (Amri et al., 2017). To address this issue, the government can engage the public through various methods, including briefings, quizzes, storytelling sessions, flood-related videos and photos competitions, and intergenerational workshops (Bodoque et al., 2019).

To foster a disaster-responsive community through a mitigation approach, the government should develop a clear and effective communication strategy. This strategy need to consider sociocultural context and cross-cultural learning in formulating policies aimed at increasing flood risk awareness and reduction (Soetanto et al., 2022). With this approach, flood risk communications policies should not be seen as a one-sized-fits-all communication methods that merely conveys messages without understanding the diverse residents' perspective (Snel et al., 2019). In Indonesia, communities exhibit high collectivity and diverse perspective regarding floods. Through *gotong royong* or communal cooperation, they establish coping mechanism encompassing economic, physical, and sociocultural aspects (Febrianti, 2010). Leveraging this

evidence in risk communication involves utilizing citizens collective efforts to comprehend preventive actions against floods and mobilize individual desires to influence others (Soetanto et al., 2022).

Another crucial aspect in flood mitigation involves tactical planning for actions before, during, and after a flood event. From a governance perspective, this phase emphasizes on operational responses and recovery of disaster (Kasdan, 2019). In the tactical response phase, one scenario involves the early notification process, where BNPB, the sub-district military command (KORAMIL), and village chiefs are alerted by the sluice gate keeprs about the imminent floods (Kardhana et al., 2022). Subsequently, a warning system is activated on a nearby mosque's minaret to alert residents along the riverbank. This scenario represents an easily implementable approach for grassroot communities in the Indonesian context. In the recovery phase, effective communication and coordination are essential for victim evacuation, logistic distribution, and addressing both material and psychological recovery aspects. Despite the existence of Emergency Action Plan and Standard Operating Procedures, there are lack of clear guidance on disseminating emergency information during a disaster (Saleh & Yusmanizar, 2019). Furthermore, lack of coordination among stakeholders exacerbates flood-prone conditions, especially for communities. Communities are compelled to adapt and create their own mitigation systems, often employing collective efforts (gotong royong) (Marfai et al., 2015). This shows that effective disaster mitigition requires not only planning but seamless implementation and communication to reduce the impact of floods. Government success in mitigation hinges on adaptation to flood factors and adopt management to prevent these disasters (Ghozali et al., 2016).

4. Conclusion

The findings of this study underscore the complexity of flooding as a multifaceted issue, particularly demanding in urban settings. The findings demonstrate that the government's approach to disaster prevention is still far from achieving the anticipated goals. As a result, the author suggests that, to reduce the instances of flooding, the government should adopt a strategic and a tactical approach. However, even though the review's focus on flooding in urban areas, the steps derived from this governance approach can also be applied to flooding in other vulnerable areas, such as coasts and watersheds. Since the research's scope is restricted to a literature review, the authors have not been able to investigate a wider urban area or locus. Thus, further research could develop and compare policy makers in different regions of Indonesia consider distinct approaches to flood mitigation in various landforms.

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