IDRiM (2024) 14 (1) ISSN: 2185-8322
DOI10.5595/001c.115826

Journal of Integrated Disaster Risk Management

Original paper

Assessment and Comparison of Community Resilience to Floods and Tsunamis in Padang, Indonesia

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Received: 21/03/2023 / Accepted: 05/03/2024 / Published online: 11/04/2024

Abstract Community disaster resilience is very important for the City of Padang, where floods occur almost every year. The city is also now at the peak of the Sunda Megathrust cycle, which could cause a tsunami in the near future. This study aims to assess and compare community resilience to different types of natural disasters that cause either shocks or stresses. Data were collected through the distribution of questionnaires to 150 respondents and field observations. The analysis employed a quantitative approach to assess community disaster resilience based on social, community capacity, economic, and infrastructure indices. The highest values for the social dimension were found in both floods and tsunamis, scoring equally at 0.73, indicating high resilience. In contrast, the lowest values for the economic dimension were observed in floods (0.35) and tsunamis (0.32), indicating low resilience. A significant difference was noted in the community capacity dimension, with a resilience value of 0.50 for floods and 0.34 for tsunamis, indicating moderate and low resilience, respectively. The results of this analysis suggest that the community is more prepared to face floods, as evidenced by higher values in the community capacity and economic dimensions compared to tsunamis. Therefore, interventions to increase community resilience are needed. This study recommends the need for an integrative and comprehensive approach, beyond existing efforts, in increasing community resilience related to floods and tsunamis.

Keywords: Tsunami, Floods, Disaster Resilience, Community Resilience, Padang

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DOI10.5595/001c.115826

1. INTRODUCTION

The increasing frequency and intensity of natural disasters are a big threat to livelihood, community, and infrastructure (Khan et al., 2022). The primary focus of disaster risk reduction has shifted towards the development of community resilience, rather than mere vulnerability reduction (Mayunga, 2007). Disaster resilience is grouped based on the type of disaster (natural, non-natural, and social) and the type of disturbance caused (shocks and stresses) (Handayani et al., 2022). Shocks are defined as rapid, sudden, and unpredictable changes (Setiadi & Wulandari, 2016), while stresses are defined as cumulative and continuous occurrences (Jones et al., 2010). Floods are the most common type of disaster globally, with 3,254 cases that led to 104,614 deaths over the past 20 years (UNDRR, 2020). Some examples of relatively rare disasters are earthquakes and tsunamis, with 552 recorded cases (UNDRR, 2020). However, tsunamis are 16 times more deadly than earthquakes (Moreno et al., 2019). A tsunami in the Indian Ocean in 2004 caused 222,570 deaths, with the highest number of victims identified in Indonesia at 165,708 people (UNDRR, 2020). The trend of loss of human life and damage to property shows that our society is not sufficiently resilient to natural disasters. (Mayunga, 2007).

One way to deal with shocks and stresses caused by disasters is by building community resilience capacity (Javadpoor et al., 2021). As a global commitment, the Sendai Framework for Disaster Risk Reduction (SFDRR) states that building a disaster-resilient society is a key goal for 2015–2030 (Aksha & Emrich, 2020). In principle, building community resilience requires population groups that can better deal with shocks and pressures in a systematic way (Mavhura et al., 2021). Resilient communities will experience less damage and tend to recover quickly from disasters (Orencio & Fujii, 2013). The assessment of community resilience is a fundamental and important step to reduce disaster risk and facilitate better preparation for disaster resilience (Cutter, 2016; Sharifi, 2016; Javadpoor et al., 2021; Martin et al., 2021). This step will uncover weakness points in the community (Ali & George, 2022; Kirmayer et al., 2009), which is key information in the development of proper strategies and policies for a specific region (Moghadas et al., 2019). Local governments can play a key role and contribute to making an area disaster resilient in many ways because they are rooted at the area where disasters occur (Malalgoda et al., 2013). A more cooperative and inclusive planning practice should be established to enhance community resilience (Zhang et al., 2019). Indeed, the level of disaster risk knowledge at the household level is a critical factor to make the approach work at the ground level (Rahman et al., 2021)

Based on its geographical, geological, and demographical characteristics, Padang can be categorized as a disaster-prone area in Indonesia (Rachmawati et al., 2018). Floods are the most commonly occurring disaster in Padang. A total of 111 flood events, which account for 45% of total disaster events in the city, occurred in 2016-2021 (BPBD Kota Padang, 2021). Floods are caused by the high rainfall volume, the high number of rivers passing through the city, and tides (Ikhvan & Mera, 2021). In addition, frequent Megathrust earthquakes affect community livelihood. Padang is directly opposite the Mentawai segment of the Sunda subduction zone (Tanjung et al., 2018). An 8.9 Mw megathrust earthquake was reported in a Sumatran subduction zone in 1833 (Wilkinson et al., 2012), which further led to a tsunami in Padang that same year (BPBD Kota Padang, 2021). Paleoseismic data showed that major earthquakes reoccurred every 200 to 240 years along the adjacent parts of the Sunda Megathrust (Borrero et al., 2006), which means the peak of the cycle is happening at present. Almost 80% of buildings and infrastructures in Padang are located in the sloped center of the city (Oktiari & Manurung, 2010).

Researchers have attempted to assess the level of community resilience to various types of natural disasters belonging to the stress group, such as floods (S. Qasim et al., 2016 ; M. M. Haque et al., 2022) and hurricanes (Uddin et al., 2020), as well as those in the shock group, including tsunamis (Moreno et al., 2019) and drought (Amirzadeh & Barakpour, 2021). Even though methods to assess disaster resilience have been developed and they utilize relatively similar criteria, the sub-criteria and resilience indicators might need to be adjusted according to each country and disaster type (Kusumastuti et al., 2014). Resilience to a type of hazard does not indicate resilience to other types of disaster (Sharifi, 2016). In this study, we aim to assess and compare community resilience to different types of natural disasters that cause either shocks and stresses.

Particularly in Padang, there has never been any research on disaster resilience at the community level. Thus far, disaster-related research in the city has been focused more on studying tsunami evacuation sites (Muhammad et al., 2017; Tanjung et al., 2018), tsunami risks (Muhammad et al., 2016; Oktiari & Manurung, 2010), and flood evaluation in watersheds (Nurpasari & Febriamansyah, 2020; Driptufany et al., 2021). Therefore, we conducted this research to assess community resilience level in dealing with floods and tsunamis in Padang. We expect this research can assist local governments in formulating planning guidelines and policies and as a reference for other cities with similar geographic, disaster, and social characteristics.

2. RESILIENCE AND COMMUNITY DISASTER RESILIENCE

2.1 Resilience

The term resilience originates from the Latin verb “resilientem”, which means to rebound or recoil (Qasim et al., 2016). The concept of "resilience" was first introduced in the field of ecology by Holling (1973), and after comparing the differences between durability and stability, resilience was distinguished into engineering resilience and ecological resilience (Holling, 1996) in 1996 (You et al., 2022). After more than 40 years of development, the resilience concept has been extended from natural ecological contexts to human ecological contexts, and it has progressively evolved from engineering resilience and ecological resilience to social-ecological resilience (Holling, 1973; You et al., 2022). However, the social-ecological resilience concept has been criticized for relying too heavily on natural science-based behavioural assumptions that may not necessarily be true for the resilience of human systems (Amirzadeh & Barakpour, 2021; Hastrup, 2009). In the context of urban resilience, the ability to recover is not as simple as the ability to reclaim balance in overcoming disturbances (Handayani et al., 2019).

The concept of resilience is multi-scalar (regional, community, and individual) (Buikstra et al., 2010; Wilson, 2012; Zaman & Raihan, 2023), and has multiple facets (collaborative and cultural) (Matarrita-Cascante et al., 2017; Rotarangi & Stephenson, 2014; Zaman & Raihan, 2023). Therefore, it's crucial to formulate distinct characteristics within the literature in accordance with the nature and scope of the research (Zaman & Raihan, 2023). This study focuses on the community scale within the context of resilience. Communities are identified as key actors in shaping urban system resilience (Joerin et al., 2012). Although various definitions of communities exist in the literature, they are generally classified as entities within geographical boundaries and emerge through cooperation related to shock events or pressures. In this study, a community is defined as "a group of individuals with diverse characteristics, connected through social bonds, sharing similar views, engaged in collective actions, and within the same geographical boundaries (Tariq et al., 2021)". Community-level resilience is crucial as it can reduce the risk of disasters occurring (Ardinugroho & Handayani, 2020). Various disciplines such as environmental science, engineering, psychology, sociology, and economics incorporate various concepts, models, and theoretical frameworks into community resilience against natural disasters (Zaman & Raihan, 2023). Norris et al., (2008) proposed that the definition of resilience can be operationalized differently based on the level of analysis and the purpose of the resilience assessment process. In this study, resilience is viewed as the community's ability to face natural disasters.

2.2 Community Disaster Resilience

Community Disaster Resilience is an evolving sub-field of resilience (Javadpoor et al., 2021). The theoretical foundation of community resilience to natural disasters emerges from the broader literature on socio-ecological resilience (Zaman & Raihan, 2023). Various authors' work highlights the relevance of resilience within a socio-ecological system where the community responds to disturbances or disasters in the natural environment (Joerin et al., 2012). In this study, we adopt the definition of community disaster resilience according to Mayunga, 2007, which refers to the community's ability to anticipate, prepare for, respond to, and quickly recover from disaster impacts. This encompasses not only the speed of recovery but also the extent of their capacity to learn, cope, or adapt to disasters. Among disaster experts, there is consensus that the initial steps toward community disaster resilience should focus on understanding how it can be measured and operationalized (Asadzadeh et al., 2017).

Community Disaster Resilience can be seen as a complex multidimensional phenomenon with various perspectives (Tariq et al., 2021). Mayunga, 2007, proposed the Community

Disaster Resilience Index (CDRi) to assess community resilience. This approach consists of the social, economic, human, physical, and natural dimensions. Additionally, Cutter et al., 2008, developed the Disaster Resilience of Place Model (DROP), designed to enhance comparative disaster resilience assessment at the local or community level. This model incorporates ecological, social, economic, institutional, infrastructural, and community competence dimensions. Subsequently, Cutter et al., 2014, conceptualized the Baseline Resilience Index for Communities (BRIC) framework based on DROP, with the exception of the ecological dimension. Joerin et al., 2012, further employed the Climate-related Disaster Community Resilience Framework (CDCRF) to quantitatively understand whether disaster-affected households take adaptive actions to enhance their resilience in response to disasters. This framework includes physical, social, and economic dimensions. Furthermore, Kusumastuti et al., 2014, developed a disaster resilience framework by comparing preparedness and vulnerability (exposure to disasters) to maximize preparedness potential and minimize vulnerability. Previous research frameworks have generally highlighted similar dimensions of resilience, including social, economic, physical/infrastructure, and human/community competency dimensions.

Various frameworks have been developed, indicating a diverse range of components that can be employed (Tariq et al., 2021). One of these frameworks was developed by Kusumastuti et al., 2014, where assessing disaster resilience in Indonesia requires considering the dimensions of social, community capacity, economic, and infrastructure. Hence, these dimensions were incorporated into this study. First, the social dimension was selected due to its close connection to the community, encompassing both individuals and groups, with community members being directly impacted by disasters (Indrasari & Rudiarto, 2020). Second, in order to highlight its significance, the community capacity dimension was examined as a distinct component, although it maintains ties to the social dimension (Javadpoor et al., 2021). Community capacity is linked to the extent of the community's comprehension of disaster risks and management within the region (Kusumastuti et al., 2014). Third, the economic dimension pertains to a household's ability to generate sufficient income for sustenance (Qasim et al., 2016). A resilient community typically consists of individuals with stable employment and diverse income sources, contributing to a robust and consistent economic foundation (M. M. Haque et al., 2022). The fourth and final dimension explored in this study is infrastructure, which encompasses housing and crucial infrastructural elements.

Several studies have also developed methods for assessing community resilience. For instance, Orencio & Fujii (2013) proposed an approach to measure disaster resilience in the Philippines. They utilized the Analytic Hierarchy Process (AHP) to synthesize national-level disaster resilience components. On the other hand, Moreno et al., (2019) conducted qualitative research involving semi-structured interviews, observations, informal conversations, documentary and social media reviews, to explore community resilience capacity and resources for disaster response through an inductive thematic analysis approach. In contrast, Qiang et al., (2020) took a different approach by measuring community resilience using remote sensing technology through "night-time light" satellite imagery. Additionally, Niazi et al., (2022) introduced a psychological resilience index for children, where their framework incorporated three aspects to gauge psychological resilience in children: mental health, attitudes, and awareness. Hence, various studies have presented diverse approaches to measuring community resilience, ranging from quantitative and qualitative analysis methods to remote sensing technology. However, when it comes to identifying coastal disasters, the commonly employed methods are often quantitative in nature (Cai et al., 2018).

3. RESEARCH METHOD

3.1 Study Area

Padang consists of 11 sub-districts with a total area of 694.96 km2 (Figure 1). The population size of Padang was recorded at 919,145 people in 2022 (BPS, 2023). As the capital of the West Sumatera Province, Padang is the center of governmental, educational, social and economic activities, which are generally concentrated in the coastal area. In the past five years, the city has experienced natural disasters, such as floods, landslides, hurricanes, coastal abrasion, earthquakes, drought, abrasion and forest fires.

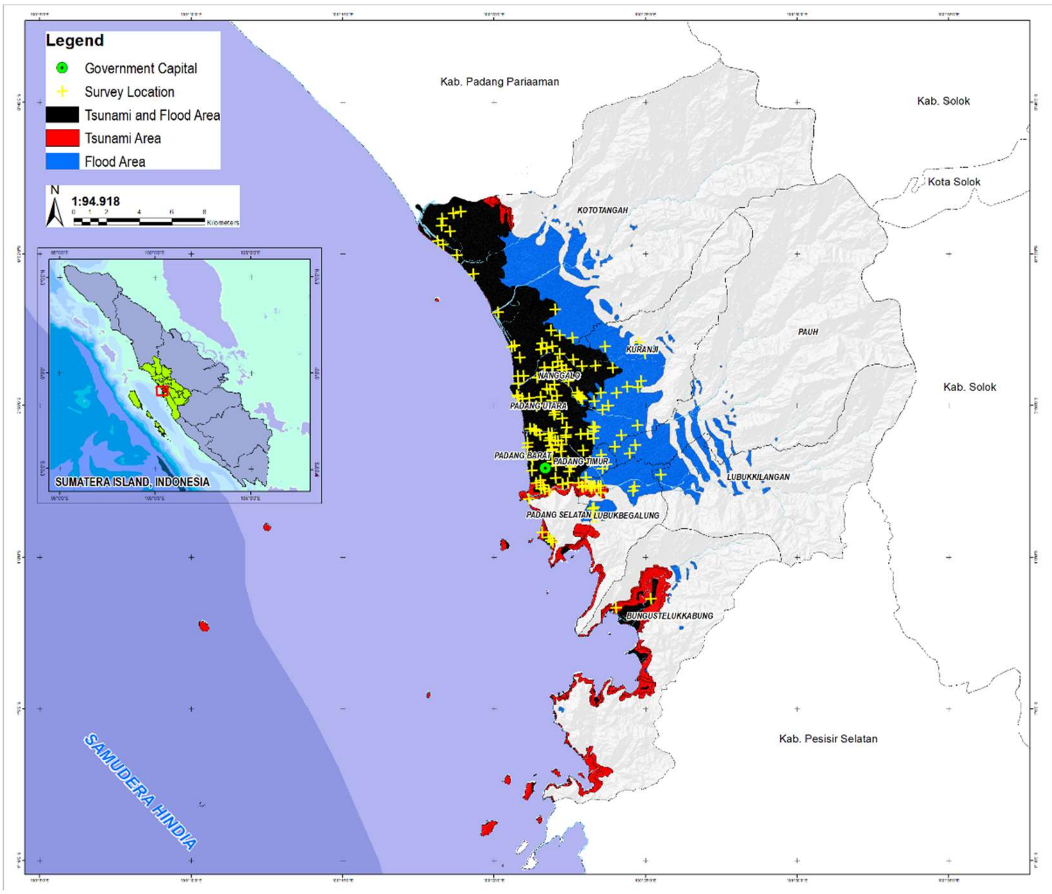

Figure 1. A Map of the Study Area

On September 30th, 2009, a 7.6 Mw earthquake occurred off the coast of Padang. The earthquake impacted 1,517 residents, with 2 missing person cases, 313 deaths, 431 severe injuries and 771 mild injuries, as well as caused damage to 116,469 buildings (BNPB, 2009). In addition, floods occur in Padang almost every year. Among these, the most significant damage was caused by a flash flood in the upper reaches of the Kuranji watershed in 2012, affecting 878 households (Utama & Yamin, 2017).

3.2 Sample Size and Data Collection

To understand community resilience in Padang, a survey was conducted from October to November 2022. The selected respondents were residents living in flood- and tsunami-prone areas. Based on Slovin's formula with 10% error tolerance , a minimum of 100 respondents was required to statistically represent the community perspective as a whole. However, due to the uneven spatial distribution of respondents when we achieved this number of responses, we increased the sample size to 150 people. Random sampling was used in respondent selection. Most participants in the interview were the head of the household. When the head of the household was not available, the wife or child in the family would take place in the survey instead.

The research data was collected through the distribution of questionnaires to the study's sample participants and field observations. We developed a closed-ended questionnaire consisting of 23 questions based on the research indicators, where each indicator was represented by a single question. For instance, we included a question regarding personal vehicle ownership with answer options "yes" or "no". However, there were questions specifically tailored to indicators that could indicate differing responses between flood and tsunami disasters. An example is the question about whether individuals had the initiative to provide voluntary support during critical disaster situations, with response options "yes" and "no" for both flood and tsunami scenarios. Field observations were conducted to validate or cross-check the accuracy of responses provided by the research participants.

3.3 Indicator Selection

No standard indicators are available for the assessment of community resilience, and therefore, multiple indicators are needed for the analysis (M. M. Haque et al., 2022). We included various indicators for these components in our study to assess community resilience (Table 1). These indicators were chosen based on prior research by different scholars concerning community resilience in the context of natural disasters, particularly those relevant to floods and tsunamis. There are 23 selected indicators, some of which are common for both flood and tsunami disasters. However, there are also several indicators that can indicate the differences between flood and tsunami disasters.

Table 1. Research Dimensions and Indicators

Dimensions	Indicators*	Description	References*
Social	Age [a]	Percentage of population who are 15 to 64 years of age	1,2,3
	Disability [a]	Percentage of residents without disabilities	1,2,3
	Education [a]	Percentage of residents who are high school educated	1,2,3
	Health insurance [a]	Percentage of residents who own a health insurance	1,2,3
	Vehicle ownership [a]	Percentage of households with vehicle ownership	1,2,3
	Household initiatives to provide voluntary support during critical situations [b]	Percentage of residents who proactively gave contributions or support during critical situations	1
	Disaster information dissemination [b]	Percentage of residents who share their disaster knowledge	1,4
Community capacity	Past disaster experience [b]	Percentage of households that have experienced a disaster	3,5,6
	Knowledge of potential disasters [b]	Percentage of residents who are aware of the risk of disasters	1,5
	Knowledge of the impact of disasters [b]	Percentage of residents who are aware of the impact of disasters	1,5
	Knowledge of action in the event of a disaster [b]	Percentage of residents who knows what to do in disaster events	1,5
	Knowledge of disaster information sources [b]	Percentage of residents who have obtained information about disasters	1,7
	Participation in disaster preparedness outreach [b]	Percentage of households that have been educated and trained to prepare for and protect themselves from floods	1,5,7
	Participation in self-rescue simulation [b]	Percentage of households that have been educated and trained to prepare for and protect themselves from floods	1,2,3,5
	Adaptation [b]	Percentage of households that implement disaster adaptation	1
Economy	Occupation [a]	Percentage of residents who have a job	1,2,3
	Various of sources of income [a]	Percentage of households with various sources of income	1,2,3
	Number of working family members [a]	Percentage of residents other than the head of household who work	1,2,3
	Availability of savings [b]	Percentage of households who own savings	1
Infrastructure	Location of residence [b]	Percentage of housing units not located in disaster-prone areas	2,3
	Building material [a]	Percentage of housing units that are completely made of bricks and concrete	2,3
	Availability of evacuation routes, evacuation signs, and temporary evacuation sites [b]	Percentage of residents who are aware of the evacuation routes, evacuation signs, and temporary evacuation sites	7
	Early Warning Systems [b]	Percentage of households who have received early warnings for disasters	2,3,5,7

*a. Indicators that can apply universally to flood and tsunami disasters; b. indicators that can indicate the differences between flood and tsunami disasters.
*1. Kusumastuti et al., 2014; 2. Qasim et al., 2016; 3. M. M. Haque et al., 2022; 4. Handayani

et al., 2019, 5. UNDRR, 2017; 6. Shah et al., 2018; 7. Rafdi, 2019

3.4 Data Analysis

The overall community resilience is influenced by four dimensions, each characterized by distinct indicators as outlined in Table 1. To avoid normalization, indicator values were captured in the form of percentages. Therefore, we have to assign weights to indicators to come up with resilience indices (M. M. Haque et al., 2022; Qasim et al., 2016). We opted for an index with equal weights at the indicator level because, according to Cutter et al., (2010) this simple aggregation method is transparent and easy to understand. Moreover, Cutter et al., (2010) found no theoretical or practical rationale for varying cross-indicator allocation. Despite alternative methods to determine subjective or data-dependent weights, such schemes often fail to accurately reflect decision-makers' priorities (Cutter et al., 2010; Esty et al., 2005). Calculating indicator values involved dividing the percentage responses obtained from household surveys by the assigned indicator weights (M. M. Haque et al., 2022; Qasim et al., 2016).

In the next step the Social Dimension Index, Community Dimension Index, Economic Dimension Index, and Infrastructure Dimension Index were calculated based on the sum of indicator scores divided by the number of indicators within each dimension. This calculation resulted in an index for each dimension, ranging from a minimum of 0 to a maximum of 1. Low resilience was characterized by values close to 0, while high resilience was indicated by values close to 1 (Table 2) (M. M. Haque et al., 2022). Each dimension was assessed separately, as recommended by Nhemachena et al., 2018, to avoid the use of a composite index that might convey non-robust policy messages and draw overly simplistic conclusions. Consequently, community disaster resilience was evaluated based on the values of each dimension. The entire analysis process for floods and tsunamis was similar. After obtaining the index results for each disaster, these values were placed in a single table for comparison. The final step involved using diagram to visualize the comparison results.

Table 2. Level of Resilience based on Resilience Index Score

Num	Index Score	Level of Resilience
1	0.00 - 0.20	Very Low Resilience
2	0.21 - 0.40	Low Resilience
3	0.41 - 0.60	Moderate Resilience
4	0.61 - 0.80	High Resilience
5	0.81 - 1.00	Very High Resilience

4. RESULTS

4.1 Respondent Characteristics

Respondent characteristics in this study are presented in Table 3. Based on gender, there are more female respondents (57%) than male (43%). Respondents' ages vary from 21 to 73 years old. The most common occupations among the respondents are entrepreneurs (40%) and housewives (29%). A majority of the respondents are senior high school-educated (71%).

Respondents are mostly long-term residents of Padang, with 39% of them having lived in the city for more than 20 years. The distribution of respondents in this study can be seen in Figure 1.

Table 3. Respondent Characteristics

Respondent Characteristics	Frequency (%)
Gender	
Male	43
Female	57
Occupation	
Freelance Day Laborer	5
Housewife	29
Private Sector Employee	11
University Student	3
Fisherman	2
Retired	3
Civil Servant	6
Enterpreneur	40
Education	
Elementary School	3
Junior High School	8
Senior High School	71
Associate's Degree (D3)	3
Bachelor of Applied Science (D4)	1
Undergraduate Degree	13
Duration of Residence	
≤ 5 Years	13
≤ 10 Years	23
≤ 15 Years	11
≤ 20 Years	14
> 20 Years	39

4.2 Resilience Index

The assessment of various dimensions of community disaster resilience illustrates differences between frequently occurring disasters, such as floods, and those never experienced, such as tsunamis (Table 4). The highest values for the social dimension were found in both types of disasters, floods, and tsunamis, with identical scores (0.73), indicating high resilience. Meanwhile, the lowest values for the economic dimension were observed in flood disasters (0.35) and tsunamis (0.32), signifying low resilience. A dimension showing a significant difference is the community capacity dimension, with a value of 0.50 for floods, indicating moderate resilience, and 0.34 for tsunamis, indicating low resilience. The results of this analysis suggest that communities are more prepared to face floods, as evidenced by higher values in the community capacity and economic dimensions compared to tsunamis (Figure 2). Further details on the assessment of each dimension are explained in the following section.

Table 4. Resilience Index

Dimension	Disaster	
	Flood	Tsunami
Social	0.73	0.73
Community Capacity	0.50	0.34
Economy	0.35	0.32
Infrastructure	0.37	0.40

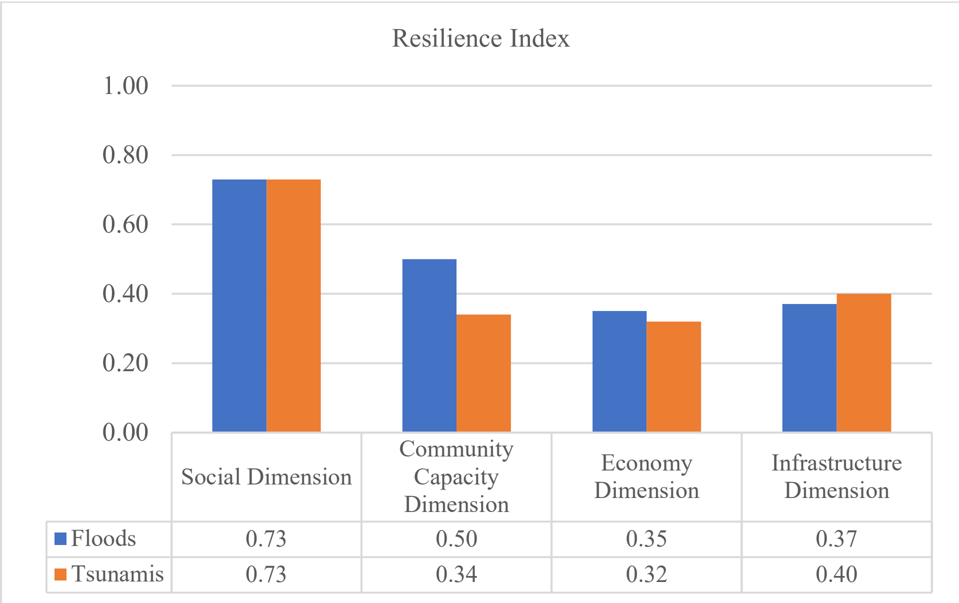

Figure 2. A Comparison Between Community Resilience Dimension for Flood and Tsunami

4.3 Social Dimension

In the social dimension, there is no difference between floods and tsunamis, as respondents consistently provided the same answers for both floods and tsunamis (Table 5). The social dimension index scores for both floods and tsunamis were 0.73, indicating high resilience (Figure 3). The score for the age indicator was 0.51, indicating that the population of productive age was slightly dominant than the non-productive age group. Conversely, the number of people without disabilities was significantly more dominant than the disabled population, resulting in a high resilience value of 0.99. This is attributed to the fact that physical and mental limitations among individuals with disabilities can create barriers during self-evacuation processes (M. M. Haque et al., 2022). Therefore, the low number of individuals with disabilities can mitigate the complexity of challenges that may arise when facing emergency situations. The scores for education and insurance ownership were 0.89 and 0.73. In addition, the willingness of household members to provide voluntary support during a crisis scored high at 0.93. This is in line with the findings of Gianisa & Le De, 2018, which showed that the community members in Padang often help others who are experiencing difficulties, such as in the event of a disaster, due to their beliefs and religious values (*syariah*) that people should help each other. On the contrary, the index score for disaster information dissemination was low, indicating that the community members are reluctant to share their disaster knowledge with others around them.

Table 5. Social Dimension Index

Social Dimension	Disaster	
	Flood	**Tsunami**
Age	0.51	0.51
Disability	0.99	0.99
Education	0.89	0.89
Health insurance	0.73	0.73
Vehicle ownership	1.00	1.00
Household initiatives to provide voluntary support during critical situations	0.93	0.93
Disaster information dissemination	0.04	0.04
Average	**0.73**	**0.73**

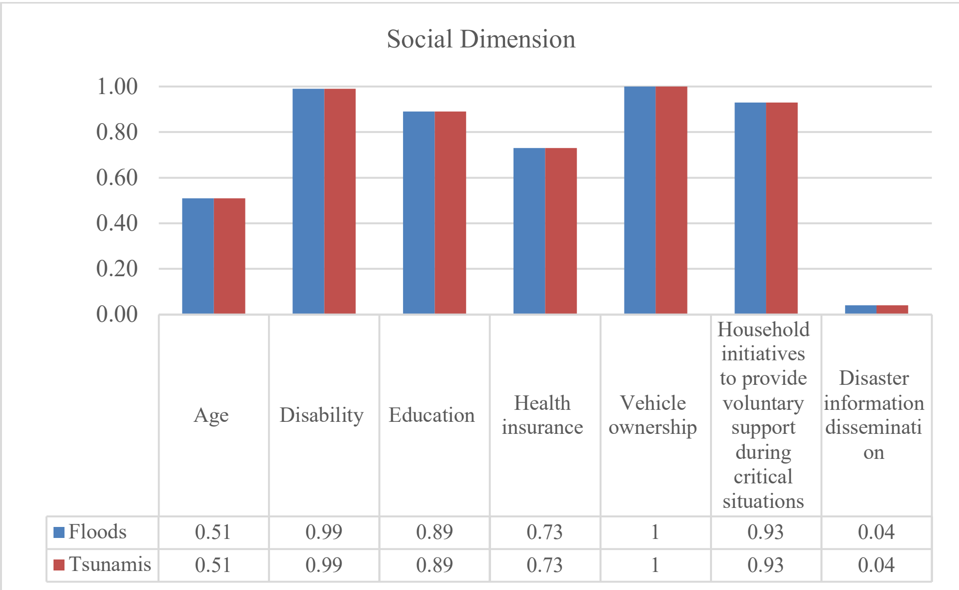

Figure 3. A Comparison Between Social Dimension for Flood and Tsunami

4.4 Community Capacity Dimension

The community capacity dimension index score for floods (0.50) indicated moderate resilience, which was higher than that for tsunamis (0.34), signifying low resilience (Table 6). A community that has experienced a disaster in the past tends to be more resilient to said disaster compared to one that has never experienced it (Figure 4). As shown in our analysis, due to past flood experience, the community were more aware of flood risks in their surroundings, the impact, and how to adapt to floods. These findings are similar to a study by Shah et al., 2018, where household heads with past flood experience were more aware of how to adapt to the situation. Meanwhile, the low number of participants in flood and tsunami simulations or disaster preparedness outreach would lead to a lack of public knowledge and consequently reduce community resilience.

From the lens of community capacity dimension, the community members are lack of relevant knowledge and participation in preparedness outreach and simulations. Some activities such as seminars, group discussions, and simulations for people living in disaster-prone areas are important to increase public awareness and knowledge. It is necessary to change the community's attitude regarding flood preparation and management. Meanwhile, for tsunami anticipation, government may organize disaster simulation training. Community members are expected to implement what they have learned through such training in the event of a tsunami. However, this program should be conducted regularly to prevent people from forgetting the key points and overlooking future risks.

Table 6. Community Capacity Dimension Index

Community Capacity Dimension	Disaster	
	Flood	Tsunami
Past disaster experience	0.41	0.00
Knowledge of potential disasters	0.51	0.27
Knowledge of the impact of disasters	0.83	0.72
Knowledge of action in the event of a disaster	0.90	0.82
Knowledge of disaster information sources	0.81	0.81
Participation in disaster preparedness outreach	0.05	0.07
Participation in self-rescue simulation	0.00	0.04
Adaptation	0.51	0.00
Average	**0.50**	**0.34**

DOI10.5595/001c.115826

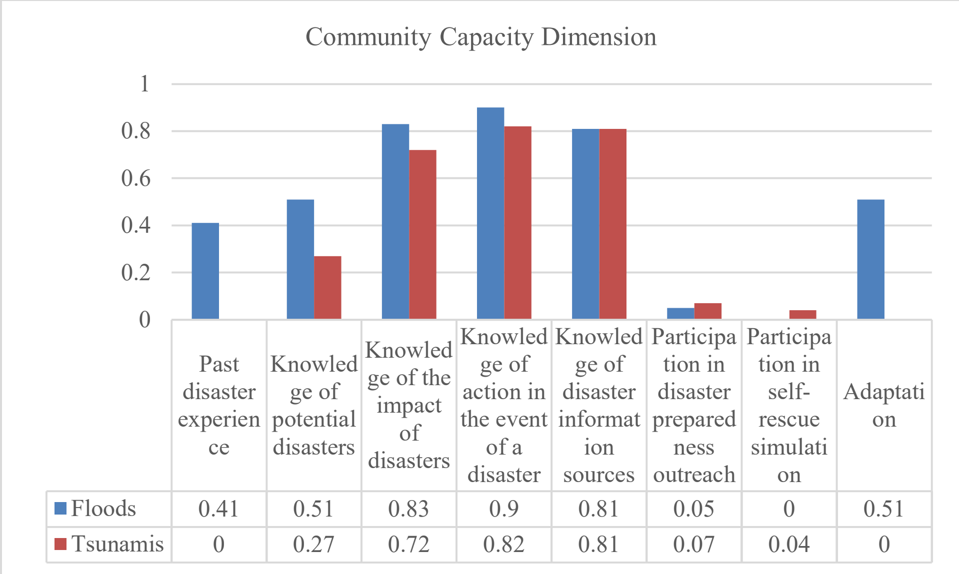

Figure 4. A Comparison Between Community Capacity Dimension for Flood and Tsunami

4.5 Economic Dimension

The economic dimension index scores indicated that the people of Padang have low economic resilience in dealing with floods 0.35 and tsunamis 0.32, indicating low resilience (Table 7). Employment-wise, the community members work as entrepreneurs, private employees, civil servants and casual daily laborers. These members of the community can support their family's economy, thereby increasing economic resilience. In addition, many households are also supported by other working family members, such as the wives and children. The problem is that the heads of households tend to rely on trading as their sole source of income. In the event of a flood or tsunami, their income will decrease and in turn affect the family's economic situation greatly. What distinguishes economic resilience to floods and tsunamis is the availability of savings (Figure 5). People generally do not designate specific savings funds to sustain themselves in case either disaster occurs. Their existing savings will be sufficient to recover from a flood but not a tsunami. To increase economic resilience in the community, it is necessary to prepare savings funds for disasters. Even though funding-wise the community is better prepared for floods, the possibility of disasters that can cause severe damage, such as tidal floods, should also be considered.

Table 7. Economic Dimension Index

Economic Dimension	Disaster	
	Flood	Tsunami
Occupation	0.64	0.64
Various of sources of income	0.02	0.02
Number of working family members	0.52	0.52
Availability of savings	0.21	0.08
Average	**0.35**	**0.32**

 ISSN: 2185-8322
DOI10.5595/001c.115826

Figure 5. A Comparison Between Community Economic Dimension for Flood and Tsunami

4.6 Infrastructure Dimension

The infrastructure dimension index score for tsunami 0.40 was higher than that for flood 0.37 (Table 8). This is because there are more residents who live in flood than in tsunami-prone areas (Figure 6). Many residential areas are near the rivers, making them vulnerable to floods. These houses would even experience floods more than once a year. Almost all houses are made of concrete, a material not easily damaged during a flood. This can increase infrastructure resilience but does not rule out the possibility that they could be destroyed by flash floods or tsunamis. The government should ban the construction of houses in these zones. Existing houses in flood- and tsunami-prone areas should be supported by an early warning system, evacuation routes, and adequate temporary evacuation sites. Currently, the early warning system coverage is quite limited, the majority of the respondents from the study sites did not receive an early warning system, and therefore, a community-based early warning system needs to be implemented.

Table 8. Infrastructure Dimension Index

Infrastructre Dimension	Disaster	
	Flood	Tsunami
Location of residence	0.09	0.24
Building material	0.88	0.88
Availability of evacuation routes, evacuation signs, and temporary evacuation sites	0.43	0.43
Early warning system	0.06	0.06
Average	**0.37**	**0.40**

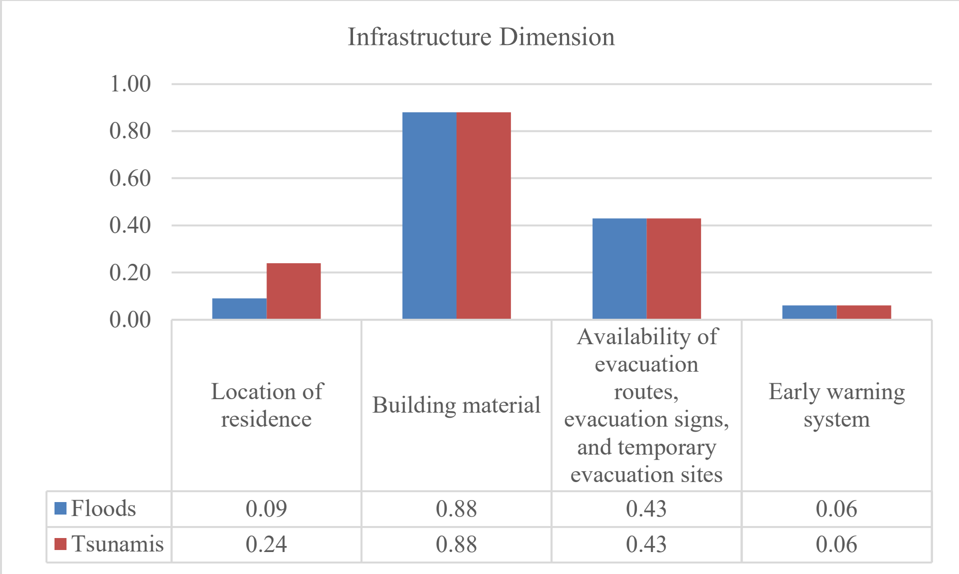

Figure 6. A Comparison Between Community Infrastructure Dimension for Flood and Tsunami

5. DISCUSSION

Our results showed that from the lens of dimension community capacity, economy and infrastructure, the Padang community responded differently to disasters that cause stresses or shocks. In general, people are more prepared to manage frequently occurring disasters, such as floods, compared to those they have never experienced, such as tsunamis. Frequently occurring disasters should be viewed as a learning experience (C. E. Haque et al., 2022). The community of Padang demonstrated this view by adapting to floods. For example, we observed that 39% of the residents raised the floor of their houses. Such a way to adapt to floods is commonly seen in developing countries like Indonesia (Marfai et al., 2015; Buchori et al., 2018; Nugraheni et al., 2022). This is consistent with the view of Kuang & Liao, 2020 that flood experience promoted learning and flood-related knowledge, which led to actions to mitigate the impact of future floods. On the contrary, Joerin et al., 2012 disagreed that households impacted by a disaster would learn and increase their resilience.

Following the tsunami in Palu in 2018, some residents chose to move to an area farther away from the danger of tsunamis (Yulianto et al., 2021). Similarly, the residents of Gobik Village in the Islands of Mentawai evacuated themselves and rebuilt an establishment on higher grounds (Esteban et al., 2013). Even though most respondents in this study have lived in Padang for a long time, Arimura et al., 2020 argued that the length of stay is not directly correlated to response to tsunamis.

Having adequate knowledge of the disaster faced is the essence of community resilience (Doğulu et al., 2016). Based on our analysis, the community members tend to know more about floods than tsunamis. The lack of knowledge was also an issue during the tsunami in Aceh in 2004. Surviving victims stated that they know very little about tsunamis and their hazards, and their response might have been different had they known what a dire situation they would have faced (Rahiem et al., 2021). Conversely, people know more about the risks and impact of floods. The respondents generally stated that floods usually emerged from heavy and continuous rainfall, and therefore they had plenty of time to prepare for one. This result demonstrated that it is important to educate the community members about the risks and impact of a disaster like a tsunami, as it will help translate awareness into preparedness (Dhellemmes et al., 2021).

Local governments are responsible in protecting communities from vulnerabilities and reducing the impact of disasters (Malalgoda et al., 2016). Mitigation efforts and programs usually focus on building infrastructure and sophisticated early warning systems (Syahputra, 2019). Padang has one evacuation route, four shelters and 58 potential buildings that can be transformed into shelters (BPBD Kota Padang, 2023). However, a study by Yosritzal et al., 2018 estimated that the city needed 37 additional shelters. An evacuation model by Imamura et al., 2012 showed that a majority of residents in Padang might not have enough time to evacuate from tsunami-inundated areas, and this would prompt vertical evacuation from such areas. Aside from the additional shelter requirement, many people in Padang are not aware of the location of existing shelters and evacuation route. Only 43% of the respondents could identify the evacuation routes and temporary evacuation sites. The provision of safe infrastructure and the development of an established and sophisticated early warning system are indeed important, but these steps must be integrated with the existing local wisdom of the community and involve the community actively (Syahputra, 2019). Community involvement is important because disaster risk understanding is not only a matter of expert perspective but also depends on community acceptance combined with local wisdom or community experience in disaster-prone areas (Sagala et al., 2021).

Finally, governments and practitioners responsible for building city resilience need support and guidance in the process (Hernantes et al., 2019). The operationalization of disaster resilience must be integrative and comprehensive, requiring actionable short-term initiatives as well as long-term transformative frameworks (Handayani et al., 2019). Short-term initiatives can focus on returning communities to normal in the event of a disaster, while long-term ones should focus on helping communities become more resilient so that they are less vulnerable and more able to cope with future disasters (Rouhanizadeh et al., 2020). Our findings reveal the importance of emphasizing community-focused resilience operations where communities can be the foundation for building regional resilience. Resilience operations need to apply a multi-hazard approach appropriately, considering that the community in this study has different responses in dealing with stress-and shock-causing disasters. If this effort is successfully implemented, the community and stakeholders will have the same views regarding disaster risk reduction, which will ultimately strengthen the implementation of each risk mitigation program and initiative (Syahputra, 2019).

6. CONCLUSION

In this article, we assessed and compared the level of community resilience in facing two types of disasters that cause stresses (floods) and shocks (tsunamis) in Padang. The resilience indices for social, community capacity, economic, and infrastructure dimensions were compared. The social dimension requires the same attention to increase community resilience to both floods and tsunamis. In contrast, for the community capacity, economic and infrastructure dimensions, a different approach is required to increase community resilience to either type of disaster. Not only is the government's role in efforts to increase community resilience, but also requires integrated and comprehensive resilience efforts that involve all stakeholders. Disaster management policymakers in Padang should consider the findings of this study in formulating policies that promote the effectiveness of community resilience interventions.

Community is likely to focused on frequent disasters such as flood. Consequently, government should put more efforts in increasing public awareness and vigilance towards potential disasters, such as a tsunami, that is rarely happens but creating tremendous loss. This research promotes an integrative and comprehensive approach to disaster management, which requires the participation of all stakeholders in a more proactive community-focused resilience-building effort. The community members may be able to deal with flooding individually, but during the tsunami emergency response, they had to rely on collective resources due to limited external assistance.

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