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Research Article

Are Community Preparing for Coastal Hazards? A Case Study on a Small Island in Aceh, Indonesia

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ABSTRACT

Coastal areas are experiencing a high population density that is increasing the vulnerability of community to coastal hazards. Therefore, this study aimed to comprehensively evaluate the preparation level of community to confront coastal hazards. Disaster preparedness was recognized to play an essential role in reducing potential losses caused by flood. However, limited studies assessed community preparedness on small islands using face-to-face interviews with community. A household survey was also conducted on community living on Pusong Island. The results showed that community preparedness was still low (38.34% of 100). Even though tidal flood events were experienced, community were not forced to take preparedness actions and move from Pusong Island. The low level was due to socialization activities and community capacity building related to coastal hazards rarely performed by the government. This study also suggested the importance of increasing the preparedness on remote islands through integrated coastal area management.

Keywords : Coastal Hazards; Tidal Flood; Preparedness

INTRODUCTION

Coastal areas are characterized by high population density (Neumann et al., 2015) and the number of community has increased significantly (Oktari et al., 2021). According to data released by the United Nations, 10% of the global population lives in coastal areas (UNDP, 2018). The large population of community is caused by several reasons, namely rich in resources, trade access routes, sea transportation, and recreational facilities. These areas also offer various ecosystems used for human welfare and the trend is expected to increase in 2030 and 2060 (Neumann et al., 2015).

The large population of community in coastal areas increases the vulnerability to hazards (Hanson et al., 2011). This is caused by global climate change, which impacts sea-level rise and increases hazards such as tidal flood and storms (Neumann et al., 2015). Therefore, measuring community preparedness for coastal hazards is very important. Preparedness can increase community resilience in the face of disasters (Cope et al., 2018; Paton, 2003) and this reduces the vulnerability to coastal hazards (Aksa & Sinulingga, 2022).

In recent years, cities located in coastal areas of Aceh have experienced tidal hazards. The case of Banda Aceh City exemplifies the severity of the challenges posed by escalating sea levels,

with an annual increase of 7 mm. A substantial 11% of the city expanse could fall prey to inundation from tidal flood within the next century. Moreover, the area situated 4 km inland from the coastline remains exposed to the threat of tsunamis, compounding the array of hazards confronting Banda Aceh City (Oktari et al., 2020). The same thing also threatens coastal city of Langsa located at an altitude of 0 m – 25 m above sea level, and most of the southwestern area is a coastal alluvial lowland elevated 8 m above sea level (Aksa & Afrian, 2022). Therefore, it is important to know community preparedness on coastal areas against tidal flood hazards.

A community with disaster preparedness is the ability to mobilize knowledge, resources, and appropriate actions before, during, and after a disaster (Lindell & Perry, 2012; Oktari & Comfort, 2019). Knowledge plays an important role in disaster hazards reduction (Aksa, 2021; Bosschaart et al., 2013; Weichselgartner & Pigeon, 2015) to make informed decisions (Gaillard et al., 2019; Setten & Lein, 2019). Several studies proved that good knowledge of hazards improved individual and community capacities (Aksa et al., 2020; Gaillard & Mercer, 2013; Lauer, 2012). This is considered a cognitive element influencing a person to take preparedness actions (Fox-Rogers et al., 2016).

Limited studies assessed community preparedness for coastal hazards, specifically on small islands in coastal area of Langsa City. It is essential to measure community preparedness for coastal hazards on small islands. This is because small islands have received less attention in terms of disaster hazards reduction (Shultz et al., 2016). Small islands have remote characteristics, limited infrastructure, and have social and economic inequality compared to mainland areas or other big cities (Shultz et al., 2016). This causes community living on islands to be highly vulnerable to coastal hazards (Aksa & Afrian, 2022). In addition, community in small islands often experience delays in aid distribution and the low capacity of local governments in disaster hazards reduction (Rampengan et al., 2014). This study aims to examine community preparedness on coastal areas in facing coastal hazards. Disaster preparedness has been recognized as playing an essential role in reducing potential losses caused by flood.

METHODS

Study Area

. This study was conducted in a coastal community living on Pusong Island, West Langsa District. The island had the highest coastal disaster hazards index in Langsa City (Figure 1). Pusong Island is located in West Langsa District with 250 hectares and has a population of 1,797 (BPS, 2019) in the outermost area of Langsa City. The island consists of four hamlets, namely peaceful, Santosa, prosperous, and safe. It experiences tidal flood and the geographical condition is unfavorable due to tidal waves. Pusong Island also has limited infrastructure and a lack of clean water.

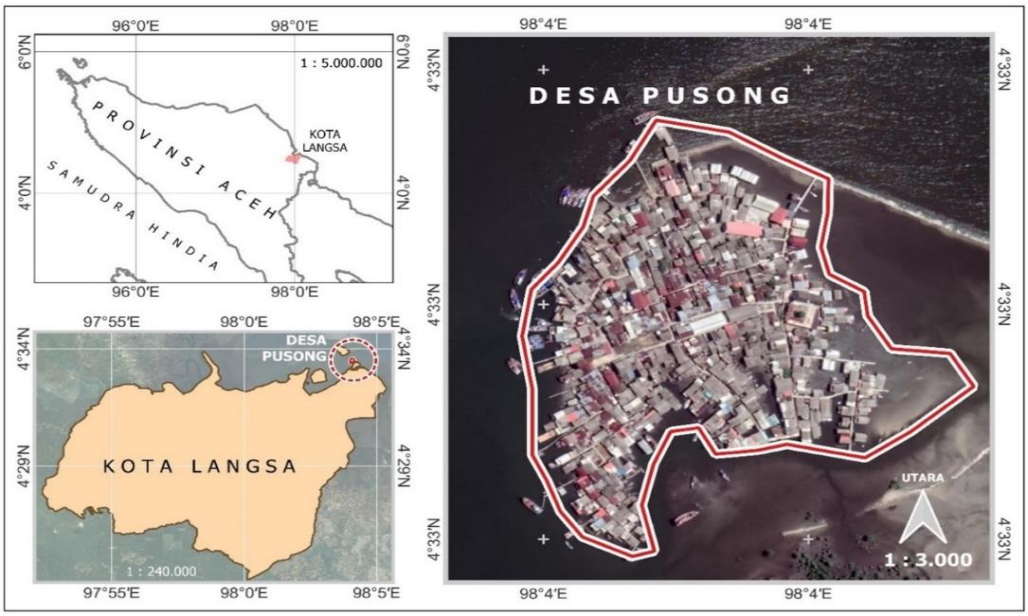

Figure 1. Study Area

Figure 2. Pusong Island

Data Analysis

This study uses face-to-face interviews with Pusong Island community. To measure community preparedness, this study uses an instrument developed by Oktari et al., (2021). The instrument consists of several indicators, namely (1) Knowledge of coastal hazards, (2) Emergency response, (3) Early Warning System, and (4) Resource Mobilization.

Knowledge of coastal hazards is measured by several indicators, namely the impact of sea-level rise and public knowledge related to tidal flood characteristics. Households with a good level of knowledge can be assumed to be more prepared to take anticipatory action against tidal flood hazards in the area. Knowledge is the main component of forming awareness to carry out emergency response plans, early warning, and resource mobilization (Oktari et al., 2020). Emergency response is measured by asking for steps or efforts to anticipate and adapt to individuals and households in a coastal flood disaster. This is also related to access to essential services such as clean water, electricity, and sanitation.

Early Warning System consists of a combination of technological capabilities and human capabilities to act on the results of these early warnings. Meanwhile, Resource Mobilization is related to community actions such as training programs, setting up savings, insurance, land/houses in areas with low hazard potential, and other livelihoods. Question items related to Resource Mobilization consist of several activities, such as participating in a training program/workshop on coastal hazards mitigation, first aid training, thawing, and rescuing victims, and clean water treatment. A total of 210 respondents representing households were selected using the purposive random sampling method.

RESULTS AND DISCUSSION

Characteristics of Respondents

The total respondents were 210 representing the date house on Pusong Island, West Langsa District. The sampling method used purposive sampling with criteria aged 20-60 years, living in a coastal area, and an official resident of the city of Langsa as evidenced by an ID card. Table 1 shows the characteristics of respondents.

Table 1. The characteristics of respondents

Variable	N	%
Age group		
Less than 20	5	2
20 – 29	15	7
30 – 39	98	47
40 – 49	62	30
More than 50	30	14
Gender		
Male	63	30
Female	147	70
Educational Background		
Not graduated from Elementary School	12	6
Elementary School	43	20
Junior High School	51	24
Senior High School	82	39
Higher Education	22	10
Employment Status		
Employee	12	6
Fisherman	120	57
Housewife	78	37

Most of respondents are 30-39 years old and 70% are housewives. A large number of female respondents was because most of the family heads were working as fishermen at the time of the interview.

Knowledge of Coastal Hazards

Community knowledge about coastal hazards is moderate with a percentage of 51.34%. Most Pusong Island community know that sea-level rise has an impact on coastal erosion, increased flood hazards , submerged coastal areas, and clean water crises. Respondents answered correctly above 70% in the question item and the high level of knowledge was because of tidal flood events. Community often experienced a clean water crisis when there was a tidal flood and different adaptation strategies to the hazards were conducted.

Community are not fully aware that sea-level rise also impacts infrastructure damage and a decrease in pond productivity. This is presumably because community in the area have not directly experienced the impact of rising sea levels on pond productivity. Furthermore, there exists limited understanding regarding the underlying factors of coastal erosion. Tides stand out as the primary catalyst behind the erosion phenomenon, attributing to an overwhelming 98% of the causal influence. Sand mining, polluting inorganic waste, and mining coral reefs can also cause beach erosion (Table 1). The lack of knowledge about the causes is because socialization activities and community capacity building related to coastal hazards in Langsa City are rarely carried out. This is evidenced by the questionnaire data, where most respondents obtain information on tidal flood hazards through television (Table 2). Only 13.7% obtained the information from government officials and Langsa City rarely conducts outreach activities in the area.

Other findings indicate that most respondents do not know the characteristics of tidal floods. Even though tidal flood was experienced regularly, the characteristics were not understood and community had good knowledge about tsunami signs related to hazards. This result corroborated previous studies conducted by Oktari et al. (2021), where community knowledge of fast-moving hazards proved to be better than knowledge of late-onset. Referring to the Protective Action Decision Model (PADM) theory developed by Lindell & Perry (2018), knowledge plays a role in influencing community during the decision-making process.

Table 2. Community knowledge of coastal hazards

	Question	N	%
1	What are the impacts of sea-level increases?		
a.	Coastal erosion	177	84.3
b.	Increased flood hazards	152	72.5
c.	Submerged coastal area	161	76.5
d.	Clean water crisis	148	70.6
e.	Damaged infrastructure	70	33.3
f.	Decreased farm productivity	78	37.3
g.	Protection of coastal ecosystems	21	9.8
h.	Loss of tourism appeal	82	39.2
2	What are the causes of coastal erosion?		
a.	Coastal tide	206	98
b.	Excessive extraction of groundwater	70	33.3
c.	Sand mining	37	17.6
d.	Inorganic waste pollution	123	58.8
e.	Mining of coral reefs	25	11.8
f.	Decrease in earth's temperature	119	56.9
3	What are the effects of coastal erosion?		
a.	Narrowing shore area	128	60.8
b.	Groundwater becomes salty	152	72.5
c.	Loss of livelihood	62	29.4
d.	Increasing population in coastal area	95	45.1
e.	Increased skin and digestive tract diseases	87	41.2
4	What are the characteristics of tidal flood?		
a	Occurs at high tide	123	58.8
b	The color of the water is not too murky	103	49
c	Occurs in the rainy season	107	51
d	Occurs in areas whose plains are lower than the sea	119	56.9
5	What are the signs of a tsunami?		
a	Earthquakes cause strong shaking, hence, people cannot stand up	202	96.1
b	Seawater suddenly receded	156	74.5
c	Big waves on the horizon	58	27.5
d	Loud sounds like an explosion	49	23.5
	Total		**51.34**

Note: N: Number of respondents who replied correctly
%: Percentage of respondents who replied correctly

This study also found that most respondents received information on coastal hazards from television (96.1%), relatives, relatives, friends, and neighbors (70.6%). Information obtained from government officials is very lacking (13.7%) and small islands have not received attention in disaster hazards reduction.

Table 3. Information related hazards

		Question	N	%
1		Where did you obtain information about coastal hazards??		
	a	Radio	8	3.9
	b	TV	202	96.1
	c	Newspapers, magazines, newsletters	12	5.9
	d	Internet, social media	33	15.7
	e	Pocketbooks, posters, *leaflet*, billboard	16	7.8
	f	Socialization and seminar	62	29.4
	g	Friends, neighbors	148	70.6
	h	Government officer	29	13.7
	i	Non-governmental organizations (NGOs) and others	16	7.8
2		What information do you still obtain a little bit?		
	a	Sea-level rise	128	60.8
	b	Tsunami	140	66.7
	c	Erosion	95	45.1
	d	Rob	107	51
	e	Tidal flood	107	51
3		To your knowledge, what events have occurred in this area?		
	a	Sea-level rise	173	82.4
	b	Tsunami	29	13.7
	c	Erosion	179	85
	d	Rob	201	95.7
	e	Tidal flood	207	98.7
4		Have you ever discussed/informed family members about:		
	a	Sea-level rise	148	70.6
	b	Tsunami	111	52.9
	c	Erosion	45	21.6
	d	Rob	111	52.9
	e	Tidal flood	103	49

Emergency Response Plan

The results show that most respondents are aware of coastal hazards in their area (62.7%). They have prepared clothes, cash, and emergency necessities (62.7%) and most respondents have also kept important documents of value (76.5%).

Community action to reduce the impact of coastal hazards, such as planting mangroves, is lacking. Only 9.8% of community reduced the impact of tidal flood hazards by planting mangroves. This is corroborated by the results of field observations, where the residential area built on Pusong Island is not planted with mangroves or other plants. Community on the island only build dams along the coastline, as shown in Figure 3.

Figure 3. Embankments built by community along the coastline

Community should be able to reduce tidal flood hazards by planting mangroves or sea pine. Mangroves play an important role in reducing the risk of abrasion, seawater intrusion, and tidal flood. The plants have supporting roots that can withstand the brunt of the waves (Tanaka et al., 2007). For example, the results of Tanaka et al., (2007) at 19 areas on the southern coast of Sri Lanka and 29 areas on the Andaman coast of Thailand worked after the Indian Ocean tsunami on December 26, 2004. The Mangrove Pandanus and trees on the coast have proven to be very effective in protecting from tsunami damage due to their complex root structure. The horizontal vegetation structure of small and large-diameter trees has also increased tsunami wave resistance. In addition, tributaries in the mangrove forest are considered effective in slowing tsunami waves.

The low level of community action to reduce the impact of coastal hazards is thought to be due to socio-economic factors. This can be seen from the condition of the houses in the area using the main structure of wood and increasing community vulnerability to coastal hazards (Arif et al., 2017).

Respondents do not have good access to clean water and sanitation facilities and solid waste. Field observations also show that the area has limited drainage, clean water, and garbage disposal infrastructure. In small islands in Indonesia, infrastructure gaps are often found, and the cost of basic needs is high. This causes community to have an economic dependence on the mainland (Syamsidik et al., 2020). The island is not suitable because most of community settlements are submerged in seawater during high tides.

Table 4. Emergency response plan

No	Question	N	%
1	To anticipate the occurrence of disasters due to coastal hazards, have you prepared the following things?		
a	Knowing the hazards around	132	62.7
b	Reducing the impact of hazards through mitigation actions (e.g., planting mangroves, etc.)	21	9.8
c	Knowing assembly point	115	54.9

No	Question	N	%
d	Prepare addresses/no. important telephones (hospitals, police, BPBD, PMI, etc.)	54	25.5
e	Prepare evacuation plans and places of refuge.	87	41.2
f	Identifying safe points in the house	66	31.4
g	Practicing evacuation plans with family	25	11.8
h	Prepare ready-to-eat food that lasts as long as necessary.	66	31.4
i	Storing essential and valuable documents	161	76.5
j	Prepare clothes, cash, and special needs/family emergencies.	132	62.7
k	Prepare a first aid kit and particular medicines for first aid.	58	27.5
2.	Do you have good access to:		
a	Electricity	206	98
b	Clean water	78	37
c	Sanitary facilities and solid waste	78	37.3
d	Public transportation	66	31.4
e	Information and communication	160	76.3
	Total		**44,71**

Note: N = Number of respondents who replied "YES"
% = Percentage of respondents who replied "Yes"

Early Warning System

The area has a flood early warning system developed by the Universitas Samudra. Early Flood Detection (EFDe) system is a flood hazard detection tool designed using the Internet of Things system with a data transmission speed of 10-15 seconds. EFDe system has an accuracy rate of up to 99.99% and the water level can be monitored in real-time using the website or Android. EFDe system is also equipped with a solar panel and control charger having an independent energy source from the sun which is stored in the battery. The tool does not function properly because Pusong Island does not have good internet and telecommunication network access.

Community do not apply traditional methods in dealing with these coastal hazards. This result corroborates a previous study, where small island areas have limited infrastructure for early warning system (Terry & Goff, 2012). Early warning system is an essential component in reducing tidal flood disasters. The absence of the system for flood hazards will increase the risk of the number of victims in a disaster.

The government needs a comprehensive effort to increase the capacity and preparedness of Pusong Island community. This is important for the government attention because the probability of tidal flood in coastal areas is expected to increase in the future. IPCC (2007) predicted that Indonesia sea level would rise 100 cm due to increased seawater temperature from 1.3 1C to 4.6 1C in 2100 (Harwitasari & Ast, 2011).

Most respondents living on Pusong Island adapt to tidal flood hazard autonomously (unmanaged without intervention from the government) (Aksa & Afrian, 2022). Socio-economic conditions strongly influence the adaptation strategy of community. Harwitasari & van Ast (2011) stated that community adaptation to hazards consisted of autonomous and planned adaptation. Autonomous adaptation is an action not managed without intervention from the government. Meanwhile, planned adaptation is a response strategy to climate change carried out in a planned manner (Harwitasari & Ast, 2011).

Table 5. Early warning system

No	Question	N	%
1.	Are you aware of the traditional method (passed down from generation to generation in Pusong Island community) for early warning of tidal flood?	0	0%
2.	Are you aware of local agreements for early warning of tidal flood?	0	0%
3.	Does Pusong Island have an early warning system for tidal flood?	126	60 %
	Total		**23.3%**

Note: N = Number of respondents who replied "Yes"
% = Percentage of respondents who replied "Yes"

According to Table 4, community do not have traditional ways passed down from previous generations regarding adaptation to tidal flood hazards. In addition, community are also not aware of local agreements for tidal flood early warning. This is worrying because early warning of tidal flood hazards is important to reduce the impact of losses when a disaster event.

Resource Mobilization

Resource mobilization was measured based on actions taken by community, such as training programs to increase resource capacity and access. The results showed that community had not prepared insurance, land for housing, and other livelihoods to reduce the impact of sea-level rise and tidal flood. Items from these questions were still below 50% on average.

The inhabitants of these areas do not consider relocating for residential purposes because of their proximity. This is because residing in coastal areas offers advantages for livelihood and community dwell in the small island area since the land prices are exorbitant elsewhere.

Respondents were constrained in their engagement with workshops and socialization events focused on coastal hazards mitigation, as well as in activities such as first aid training, victim evacuation, and clean water treatment guidance. The mean score for the questionnaire items continues to register below the 30% threshold. The survey indicates that local community involvement in the formulation, execution, finalization, and oversight of coastal protection initiatives remains limited, as shown in Table 6. The governmental initiatives targeting the resolution of challenges related to the protection of coastal areas exhibited a deficiency in adopting a participatory, transparent, and effective approach. Furthermore, the average score for the relevant question items persists below 40%.

Community had implemented several measures to enhance their awareness in the event of a disaster. Some of these measures included having relatives or friends ready to assist (76.5%), preparing communication tools for emergencies (70.6%), and arranging transportation means for evacuation (80.4%). In addition, respondents had access to communication tools, transportation for evacuation, and health facilities.

Table 6. Resource Mobilization

No	Question	N	%
1	For family awareness of the possibility of a disaster, has the family prepared the following things:		
	a. Saving	87	41.2
	b. Life/property/object insurance	49	23.5
	c. Land/house elsewhere	33	15.7
	d. Other livelihoods	54	25.5
	e. Relatives/friends who are ready to help	161	76.5
2	What activities have family members participated in?		
	a. Workshop/socialization on hazard mitigation	54	25.5
	b. First aid training	54	25.5

No	Question	N	%
	c. Evacuation training	54	25.5
	d. Clean water treatment training	29	13.7
3	Do you have easy access to the following?		
	a. Access to emergency preparedness	49	23.5
	b. Communication tools in an emergency	148	70.6
	c. Transportation for evacuation	169	80.4
	d. Medical Facility	136	64.7
4	Are you included in the decision-making process?		
	a. Coastal Protection Program planning	79	37.7
	b. Implementation of coastal protection program	54	25.5
	c. Troubleshooting in coastal area	70	33.3
	d. Coastal Protection Program monitoring	63	30
5	Have the government's efforts to solve the problem of coastal protection been carried out by:		
	a. Participatory	76	36
	a. Transparent	72	34.2
	b. Effective	74	35
6	Who are the actors who have been included in the protection of coastal areas?		
	a. Central government	42	20.1
	b. Provincial government	37	17.6
	c. City Government	119	56.9
	d. NGO	37	17.6
	e. Pers	37	17.6
	f. Collage	74	35.3
	g. Private sector	21	9.8
	Total	**34.02**	

Community Preparedness

The results of community preparedness index show that most of residents of Pusong Island are not ready to face coastal hazards. The item of this question indicates a score with a low category. Community preparedness index score is generated from the sum of all parameter scores divided by the number of parameters, as shown in Table 7.

Table 7. Community Preparedness Index

Parameter	Score Index	Category
Knowledge of Coastal Hazards	51.34	Moderate
Emergency Response Plan	44.71	Low
Early Warning System	23.3	Very low
Resource Mobilizations	34.02	Low
Total	**38.34**	Low

The results show that community preparedness index for tidal flood hazards is in a low category (38.34 out of 100). The knowledge parameter reports the medium category (51.34 %), emergency response plan (44.71%), resource mobilization (34.02 %), and early warning system (23.3 %). The results of this preparedness are worrying, considering that Pusong Village is an area with a high tidal flood disaster hazards index. A systematic and planned effort is needed to improve community preparedness in facing tidal flood hazards.

The low level of preparedness in Pusong Island is because tidal flood hazards are ignored. This result reinforces a previous study conducted by Adelekan & Asiyanbi (2016) on coastal community on Bonny Island, where the impact of tidal floods is not considered. Marfai et al (2015) reported that individuals in flood hazard areas in Jakarta City often underestimate the challenges. Even

though flood has become an annual disaster, community do not plan for evacuation areas or prepare food and medicine for emergencies.

CONCLUSION

In conclusion, community preparedness for coastal hazards was low at 38.34%. Respondents lacked awareness of the characteristics of tidal flood and the rising sea level, which contributed to the damage of infrastructure and the decline of pond productivity. Actions were not taken to reduce coastal hazards, such as planting mangroves. In addition, community did not apply traditional methods in dealing with these coastal hazards. The low level of community preparedness was very worrying because the frequency of tidal flood events was expected to increase during the mending period affected by global climate change and sea-level rise. Pusong Island residents were compelled to reside in a tidal flood hazard area due to the exorbitant price of land in urban areas. Future analyses should examine the relationship between hazards perceptions and disaster preparedness. Disaster hazards reduction in coastal areas also necessitated a comprehensive understanding of the psychological drivers of community in tidal hazard areas.

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DECLARATIONS

Conflict of Interest

The authors declared that they had no known competing interests.

Ethical Approval

The research has been approved by the Research Committee of Universitas Samudra. All research was carried out in accordance with Universitas Samudra research ethics guidelines applicable when human participants are involved.

Informed Consent

On behalf of all authors, the corresponding author states that all participants have been given informed consent and agreed to take part in this study.

DATA AVAILABILITY

Data used to support the findings of this study are available from the corresponding author upon request.

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