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Perceptions and adaptation strategies of the community against flood risk at the estuary riverbank of Bone River, Gorontalo Province

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Abstract. Indonesia is a country prone to natural disasters that are influenced by natural factors and human factors. Natural disasters that commonly occur in Indonesia are floods, sea tides, landslides, earthquakes, volcanic eruptions, hurricanes, and drought. Among these disasters, floods are the most frequent natural disasters in various parts of Indonesia. During 2015 there was 1732 incidence of disasters in Indonesia, 92.67% of the disasters are landslides, tornado, and flood (Indonesian National Disaster Management Agency – BNPB, (2016). Refer to BNPB (2018), during 2017, 979 incidences of flood disaster occurred in Indonesia where 2.518.578 people were affected by the flood disaster. Considering that flood is a common disaster in Indonesia, people should have flood preparedness. This research was conducted at the estuary of Bone River Gorontalo Province. The Bone River is one of the longest rivers in Gorontalo Province that cross Bone Bolango Regency and Gorontalo City. There are many communities are living in river estuaries that belong to densely populated areas, so this research is very important to understand perception and adaptation strategy of society to flood disaster. This research was conducted by distributing questionnaires to the community and analyzed quantitatively. The results show that most respondents know that they live in flood-prone areas, floods can cause various impacts, and floods can be prevented and minimized. The research result is expected to be useful in the decision-making process for decreasing flood disaster risk at the estuary of Bone River Gorontalo Province.

Keywords: Flood Disaster, Community Perception, Adaptation Strategy

1. Introduction

Indonesia is a country prone to natural disasters that are influenced by natural factors and human factors. Natural factors that affect the occurrence of natural disasters in Indonesia include the geographical location in the equator, climate and weather factors, and the location of Indonesia in The Pacific ring of fire. Human factors that can cause and trigger natural disasters are activities that are not implemented concerning the environment, deforestation, extreme landscape conversion, massive forest clearing, uncontrolled land use change and so on.

Natural disasters that commonly occur in Indonesia are floods, sea tides, landslides, earthquakes, volcanic eruptions, hurricanes, and drought. Among these disasters, floods are the most frequent natural disasters in various parts of Indonesia. Flood is a serious disaster in many countries, both developed and developing countries [1]. During 2015 there was 1732 incidence of disasters in Indonesia, 92.67% of the disasters are landslides, tornado, and flood [2]. Refer to Indonesian National Disaster Management Agency data, during 2017, 979 incidences of flood disaster occurred in Indonesia where 2.518.578 people were affected by the flood disaster [3]. A large number of victims affected by the floods indicates that flood has a wide impact on the community. Floods can cause impacts of dead and missing victims, injuries, damage to public infrastructure, loss of community property, disruption of socio-economic activities, and impacts on public health. The health impact can be divided into direct and indirect effect caused by other system damaged by flood disaster [4].

Considering that flood is a common disaster in Indonesia, people should have a flood preparedness and adaptation strategy in anticipation of frequent disasters. Flood preparedness is an important part of natural disaster management. In flood disaster management, it is important to understand the public perception and the community's level of awareness on flood disaster preparedness [5]-[8]. The public perception of flood risk is very important in the management of natural disasters because it can affect the design and operation of effective strategies in flood disaster management [7, 9]. Floods generally hit surrounding areas of the river or floodplains that should not be used as settlements. This is a serious problem in dealing with floods, and there are pros cons, especially in the floodplains that have occupied for a long time by the community [10].

The natural disaster management paradigm has shifted from handling the impact of natural disasters on disaster mitigation and disaster risk reduction. It is also supported by technological advances in the prediction of natural disasters such as remote sensing technology and various disaster prediction models [11]. At the community level, some communities have understood that disaster risk can be reduced through various actions. The government as a regulator plays a central and important role in the management of natural disasters. The Indonesian government has established institutions to deal with natural disaster namely Indonesian National Disaster Management Agency – BNPB. Regarding natural disaster management, the government has also regulated the Law of the Republic of Indonesia No 24 of 2018 concerning Disaster Management and several regulations of Head of Indonesian National Disaster Management Agency concerning disaster management and disaster risk reduction [12]-[16].

This research was conducted at the estuary of Bone River Gorontalo Province. The Bone River is one of the longest rivers in Gorontalo Province that cross Bone Bolango Regency and Gorontalo City. There are many communities are living in river estuaries that belong to densely populated areas, so this research is very important to understand perception and adaptation strategy of society to flood disaster. This research was conducted by distributing questionnaires to the community and was analyzed quantitatively. The research result is expected to be useful in decision-making process for reducing flood risk at the estuary of Bone River Gorontalo Province.

2. The study methods

2.1. Study Area

The study area is the estuary of Bone River Gorontalo Province which is located in Gorontalo City, Gorontalo Province, Indonesia. It covers two sub-districts of Kota Timur Sub District and Dumbo Raya Sub District. As can be seen in Figure 1, the research area is dominated by settlements, and there are several schools, mosques, offices and farm fields. Gorontalo city, as well as other areas in Gorontalo Province, has a tropical climate with two types of seasons namely the dry season and the rainy season. The climate condition of Gorontalo City in 2017 is minimum temperature of 24.1 °C, the maximum temperature of 32.4 °C, and average temperature 27.3 °C. The amount of precipitation ranges from 7 mm^3 in January and February – 323 mm^3 on October. Some rainy days range from 2 – 23 days [17].

Figure 1. Map of study area

2.2. Research Design

This research is a survey research category and survey results are analyzed quantitatively. Sources of data used in this study include primary data and secondary data. Primary data were obtained by distributing questionnaires to people living in the estuary of Bone River and field observations to determine the types and forms of adaptation strategies of communities in dealing with floods. The secondary data used in this study is statistical data relevant to the research.

This study examines three parameters:

1. Community knowledge about flood events,
2. Community perceptions of floods, and
3. Community adaptation strategies against flood disaster

3. Result and Discussion

3.1. Respondent Characteristics

As described in the research design, this study examines three parameters namely community knowledge about flood events, community perceptions of floods, and community adaptation strategies against flood disaster. The characteristic of the respondents is presented in Table 1.

Table 1. The characteristics of the respondents

Parameters		Value (%)
Sex	Male	37.74
	Female	62.26
Education	No Education	5.66
	Elementary school	22.64
	Junior high school	30.19
	Senior high school	37.74
	University	3.77
Occupation	Salesman	13.21
	Bentor Driver	7.55
	Entrepreneur	11.32
	Labour	9.43
	No	58.49
Family Size	1-3	18.87
	4-7	50.94
	>7	30.19
House Category	Permanent	47.17
	Semi-permanent	33.96
	Non-permanent	18.87

Table 1 shows that 37.74% respondents are male and 62.26% are female. Most of the respondent is an educated person that is considered able to provide perception and information adaptation strategy regarding flood risk. Based on the house category, 47.17% of respondents have a permanent house, and 33.96 % respondent has a semi-permanent house. The housing category which was dominated by permanent house shows that people want to stay for a long time or even permanently in flood-prone areas. The people stay in the research area as it is located in the center of Gorontalo city which is close to various socio-economic facilities and has a high business opportunity because it is close to the port, fish market, residential population center, and government offices.

The results showed that 92.45% of respondents know and understand that they live in a flood-prone area because they have experienced a flood disaster. Information about flood event includes flood height and flood duration is shown in Table 2. The flood height and flood duration are vary based on the proximity of the house to the river and the flood height. These flood parameters can be used as a reference for communities and governments to formulate appropriate adaptation strategies for flood disasters.

Table 2. Community knowledge on flood event

Parameters		Value (%)
Flood Height	<50 cm	13
	51 – 100	32
	100 – 200	17
	>200	38
Duration	2-6 hour	15
	6-12 hour	38
	>12 hour	47

3.2. Community Perception

Community perception on flood risk in this research was divided into three indicators includes perceptions of the flood caused, perception of flood impact, and perception of flood mitigation. Table 3 shows community perception on the flood caused. Based on Table 3, most of the respondent are agree with the flood caused. This shows that people know that natural factors and human factors can cause floods.

Table 3. Community perceptions on the flood cause

Statement	Strongly Agree (%)	Agree (%)	Disagree (%)
Flood can be caused by weather including extreme rainfall	62.26	37.74	0.00
Flood can be caused by damaged of upstream and central areas of the watershed	13.21	83.02	3.77
Flood can be caused by garbage disposal into the river	24.53	75.47	0.00
Flood can be caused by an improper drainage system	24.53	69.81	5.66
Flood can be caused by river sedimentation	16.98	75.47	7.55

The flood disaster caused various adverse impacts on society both physically and non-physically. In general, physical losses can be damage to residential buildings, hydrological infrastructure, and socio-economic facilities. Non-physical losses by the impact of floods can be economic losses, public health problems, disruption of community activities, and decreasing comfort level during floods. Community perceptions on flood impact are presented in Table 4. Based on Table 4, it can be seen that most of the respondent agree that flood disaster can cause several impacts both physical and non-physically. The public awareness of flood impact should be accompanied by various education and campaign programs to increase awareness and preparedness at the community level against flood

disasters. When the community flood awareness and flood preparedness has been formed the effects of a flood can be reduced and can be minimized.

Table 4. Community perceptions on flood impact

Statement	Strongly Agree (%)	Agree (%)	Disagree (%)
Flood can cause material / economic losses	26.42	73.58	0.00
Flood can cause physical damage to buildings	24.53	75.47	0.00
Flood can cause infrastructure damage	22.64	75.47	1.89
Flood can cause public health problems	20.75	77.36	1.89
Flood can inhibit the social, economic activity	26.42	64.15	9.43

The Indonesian government and specifically BNPB has implemented various programs and activities related to disaster mitigation. The government also has set various laws and regulations for disaster mitigation. However, the very vast of Indonesia area and considering that almost all areas of Indonesia are disaster-prone areas, the disaster mitigation requires participation from all parties in disaster risk reduction efforts including the community. As can be seen in Table 5, the community perception on flood mitigation varies widely. Based on Table 5, most of the community agree that flood can be prevented, the flood impact can be minimized, and the community can overcome the flood problem. However, based on community perception, government plays an important role in flood mitigation.

Table 5. Community perceptions of flood mitigation

Statement	Strongly Agree (%)	Agree (%)	Disagree (%)
Floods can be prevented	15.09	52.83	32.08
The impact of floods can be minimized	5.66	64.15	30.19
The community can overcome the flood problem	22.64	50.94	26.42
The government role is necessary for the prevention and flood mitigation	54.72	43.40	1.89

3.3. Adaptation Strategies

A public awareness motivates the community adaptation strategy to flood disaster that they live in flood-prone areas and the public awareness that floods can cause various impacts. The community adaptation strategies against flood risk in the study area are presented in Table 6. Table 6 shows that most of the community has determined the evacuation site and have prepared storage of valuable and important document. However, only a few communities have implemented a physical adaptation strategy include increase the floor level (5.66%), build a two-story house (7.55%), and build an additional barrier on the terrace (3.77%). Hence, it needs assistance from the government, especially the local government to increase public awareness in reducing the flood risk through various adaptation strategies.

Table 6. The community adaptation strategies against flood risk

Adaptation Strategy	Value (%)
Increase the floor level	5.66
Build two-story house	7.55
Additional barriers to the terrace	3.77
Determine the evacuation site	98.11
Prepare storage of valuables and important documents	98.11

4. Conclusions

Based on the research result, analysis and discussion, this study makes the following conclusions:

1. Communities of Estuary Riverbank of Bone River generally know and understand that flood can be caused by extreme weather, watershed damage, garbage disposal, improper drainage system, and river sedimentation.
2. Communities of Estuary Riverbank of Bone River generally know and understand that flood can cause economic losses, physical damage of building, infrastructure damage, public health problem, and inhibit social, economic activity.
3. Related to flood mitigation, some people have a perception that flood can be prevented, can be minimized and can be overcome by the community. Meanwhile, there is 32.08% of the respondent who disagrees if flood can be prevented and 30.19% of the respondent who disagrees if the impact of the flood can be minimized.
4. Almost all communities have a perception that the government plays a central role in flood mitigation.
5. The adaptation strategies against flood risk that have been applied by most of the communities include determining evacuation site and storage of important documents. Meanwhile, the small percentage of people implemented a physical adaptation strategy includes 5.66% increase the floor level, 7.55% build a two-stories house, and 3.77% build additional barriers on the terrace.
6. The research result is expected to be useful in the decision-making process for reducing flood risk at the estuary of Bone River Gorontalo Province.

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