Local Communities Participation in Mangrove Management for Tsunami Disaster Mitigation at Palu City Coastal

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Abstract. In September 2018 there was an earthquake with a magnitude of 7.5 Mw in Palu Bay, which was followed by a tsunami. The impact of this disaster is the destruction of building infrastructure, the environment, and loss of life. 4,194 people died and damaged 8,107 buildings, 43 health facilities and 386 educational facilities. Mangroves as one of the ecosystems located on the coast can reduce the impact of the tsunami. This research aims to analyze the participation of local communities in mangrove management. The method used in this research is qualitative, and the analysis used in this research is descriptive and comparative method, and the data used in this research is the results of interviews obtained from several communities who live around the coast of Palu city. The importance of this research is to compare the participation of the community in three research locations. The results of the research show that communities at the research locations are starting to realize the importance of mangroves for reducing the impact of the tsunami, so that after 2018 many communities have started planting and managing mangroves.

1. Introduction

Disaster is one of the problems and challenges to sustainable development that can occur throughout the world [1]. One of the countries prone to disasters, especially natural disasters, is Indonesia, such as earthquakes, tsunamis, volcanoes, floods, drought, erosion, and abrasion [2]. As an archipelagic country that has a long coastline, coupled with climate change that causes sea level rise, natural disasters on the coast are a matter of concern [3]. Therefore, coastal areas should have good mitigation against natural disasters, such as tsunamis.

Tsunami is a disaster caused by natural factors. Tsunami waves are generated by impulsive disturbances such as underwater earthquakes, underwater landslides, and volcanic activity. Tsunamis can also cause damage to infrastructure, the environment, loss of livelihoods, trauma and loss of life [4]. In general, tsunamis occur due to earthquakes caused by shifting tectonic plates. In the world, there have been 202 tsunami events from 1966 to 2004 [5]. The 2004 tsunami was caused by a megathrust earthquake centered near Sumatra that killed around 150,000 people and caused enormous ecosystem damage [6].

The tsunami occurred in Palu in 2018 was caused by an earthquake causing severe damage with run-ups and puddles of about 4 m in many locations [7]. Tsunamis are most likely to occur in shallow water[8]. The impact of the tsunami disaster is so obvious so that it is important for local communities
and authorities to consider disaster risk reduction strategies [9]. Tsunami disaster mitigation can be done physically and non-physically [10]. Physical efforts include the construction of breakwaters, sea dikes, shelters, artificial hills, coastal vegetation, while non-physical efforts include education, training, zoning, implementation of integrated coastal management.

Disaster mitigation in coastal areas requires an ecosystem-based approach [11]. Because the coastal ecosystem is one that contains many natural resources. Mangroves are plants that can be found on tropical beaches that live in conditions of brackish water, high salinity, and muddy sand. The mangrove ecosystem has a role in reducing tsunami waves and the greenbelt becomes an important component [12]. The damage of tsunami can be reduced by tree species with large diameters, tree stands and also high crowns in coastal areas [13]. Coastal forest vegetation has the ability to reduce tsunami waves. Tree density, forest width and tree diameter are characteristics of vegetation that can reduce tsunami waves [14].

Mangrove forest is a very productive ecosystem to support ecosystem services, that can provide habitat for fish and wildlife, several functions of mangrove ecosystems can improve water quality, provide seafood, reduce coastal erosion, minimize the impact of flooding, and support high levels of carbon absorption [15]. In addition, the mangrove ecosystem can also be used as a source of livelihood for the surrounding community. The best plan is to develop natural tourism by utilizing existing potential and preserving environmental quality [16].

Coastal areas have potential resources, but also have natural hazards that can turn into disasters at any time, some coastal areas are in natural hazard zones so that they can become a threat to community, social and economic activities [17]. Mangrove conservation is very important for the sustainability of coastal ecosystems by involving the social and cultural aspects of local communities [18]. Efforts to improve the environment by planting mangroves along the coast can also reduce coastal damage caused by the tsunami [19]. Empowerment of coastal communities needs to be carried out to encourage active community participation so that they can increase income, preserve the environment and support the development and management of coastal areas.

Community-based coastal area development can be optimal if there is a synergy between the government, the community and local wisdom values so that it can create prosperity for coastal communities [20]. Empowerment in coastal areas not only provides a source of livelihood for the community but is also vulnerable to disaster hazards [21]. In various areas, mangrove ecosystems have changed their function to meet basic human needs such as firewood, agriculture and ponds, as a result, coastal areas are vulnerable to disaster risks such as storm surges, cyclones, and tsunamis [22]. Therefore, community participation is needed for environmental maintenance in coastal areas such as mangrove forests and coastal forests which are the front line in dealing with potential disasters on the coast.

Several previous researches concluded that the community has an important role in mangrove management, especially after the disaster. There was a change in the mangrove ecosystem after the disaster at Palu City coastal. However, the impact of the tsunami caused by several points of the research location was different, due to the existence of the mangrove ecosystem [23]. Thus, the debate about public awareness about the importance of mangrove ecosystem existence becomes a debate. This research wants to see the community participation in realizing the importance of mangroves as one of the coastal ecosystems that must be protected because mangroves can reduce the impact of the tsunami occurred in Palu in 2018. The importance of this research is to compare the participation of the community in three research locations, namely Kabonga Besar, Mamboro, and Lere. The three research locations were chosen because they had different impacts after the tsunami.

2. Method

The research used qualitative methods. Research method includes explanation about research location, data collection, and data analysis.
2.1. Study Area
The research was carried out at the coast of Palu Bay, Central Sulawesi. The tsunami in Palu Bay in September 2018 caused damage along the coastline. However, there are some areas that have had the greatest impact. The three areas that have the greatest impact are used as the focus of the research, namely the Sempadan Pantai Kabonga Besar, Sempadan Pantai Mamboro and Sempadan Pantai Lere. Sempadan Pantai Kabonga Besar was chosen because it has the largest mangrove ecosystem. Sempadan Pantai Mamboro was chosen because before the tsunami it had a small mangrove ecosystem, but after the tsunami the mangrove ecosystem was damaged. While Sempadan Pantai Lere was chosen because it does not have a mangrove ecosystem at all. Therefore, it is very interesting to conduct research at these three points because it can be found a comparison of how the local communities participation in mangrove management is.

![Figure 1 Research Location Map](image)

2.2. Data Collection and Analysis
Data collection was carried out using in-depth interviews with several informants who lived around the three research focus locations. The selection of sources was carried out by taking into account several criteria, such as communities who have lived in the area for more than 10 years and communities who have a livelihood such as: fishermen, traders, housewives, and entrepreneurs. Obtained 9 interviewees, interviews were conducted from August 29th to September 1st 2021. Questions in the interview consisted of how the condition of the coastline before and after the tsunami, how many lives were lost, what public facilities were damaged, and what the community had done in an effort to mitigate the impact of the tsunami. The method used in this research is qualitative, and the analysis used in this research is descriptive and comparative, by comparing the result of interviews from informants in three research location.
3. Results and discussion

3.1. Environmental Condition

Palu City is the capital of Central Sulawesi Province, which is located on the edge of Palu Bay. As the capital city of Palu is the center of various activities, especially government, education, and others. Palu City, Central Sulawesi is one of the seismically active areas in Indonesia because it is traversed by fault segmentation that has the potential to cause earthquakes, namely the Palu-Koro Fault which extends from Palu to the south and southeast. Thus, these activities make Palu City is an area that is vulnerable to disasters, especially earthquakes and tsunamis. The three research locations were chosen because they have different numbers of mangrove ecosystems along the coast. The three research locations are divided into two districts and cities. Kabonga Besar is located in Donggala Regency. While Lere and Mamboro are located in Palu City, so they have high mobility and density because they are the capital of Central Sulawesi Province.

Natural disasters don't happen very often in Kabonga Besar, but around the beginning of 2021 floods occurred due to a lot of rain. In Mamboro in 1938 the first tsunami occurred. While in Lere in 2005 there was an earthquake with a magnitude of 5.2 mw. And in 2018 there was an earthquake and tsunami that had a major impact on all community activities. Based on these findings, it is true that environmental conditions along Palu Bay are prone to disasters.

3.2. Socio-Economic Condition

The three research focus locations have different levels of socio-economic aspects, such as livelihood, religion, ethnicity, and education level. In Kabonga Besar the majority of the communities work as fishermen, farmers (corn, cassava, and coconut), State Civil Apparatus, and laborers outside the village area (Palu Town, Pantoloan, and other areas). The majority of the population in Kabonga Besar are Moslem, because 80% of the people come from the Kaili Tribe and the rest are immigrants such as Bugis, Mandar, and Chinese. In the education sector, the majority of communities are educated between junior high school and senior high school, while for undergraduates it is around 10%. Educational facilities such as schools are also available in this area ranging from elementary, junior high to high school/vocational school, but there are no traditional markets, supermarkets, or modern markets, so basic needs are sold in stalls that are managed independently by the community.

In Mamboro 20% of the communities work as fishermen, the rest are State Civil Apparatus, and construction laborers. The communities who live in Mamboro come from the Kaili and Bugis tribes who are immigrants, and the majority of the communities were Moslem. In the education sector, the majority of communities are educated between junior high school and senior high school, while only a few are undergraduates. Community life in the Mamboro village has a very good relationship between individuals and individuals, groups with groups, or groups with individuals. The community's sense of “Gotong Royong” has made this area more developed.

In Lere, the majority of the communities work as fishermen, 90% of them are shrimp fishermen. The communities who live in Mamboro come from the Kaili and Bugis tribes, the Kaili tribe is the original tribe in Lere so that the social system in Lere is regulated based on the Kaili tribe. The education sector is the majority of the community educated between junior high school to senior high school. The social system in Lere is carried out in mutual cooperation and with a family system. There is a respected community leader who is often addressed as Pak Safei Datu Palinggge, he is also a traditional leader in Lere.

3.3. Local Communities Participation

The earthquake and tsunami in 2018 caused many casualties, damaged buildings and public facilities, and lost their livelihoods. After the 2018 tsunami, there was damage to the coastal structure in Kabonga Besar due to the brunt of the wave, however, due to the position of the settlements being a bit far from the path of the waves dan there was also a mangrove ecosystem, so that the impact did not change the position of the coastline significantly. Changes in the coastline also occurred in Mamboro, the coastline
damage was about 5 meters. Apart from Kabonga and Mamboro, damage to coastal ecosystems has also occurred in Lere, a mangrove ecosystem that used to be abundantly found, but now it is lost due to the tsunami.

Many communities have lost their jobs due to damage to beaches, ponds, or lost equipment used for fishing for fish and shrimp, in addition, many communities are unable to work because the office where they work is also damaged. These losses change the mindset of the community towards the importance of maintaining the mangrove ecosystem. Because for example in Kabonga Besar there is a mangrove ecosystem that can reduce tsunami currents so that residential areas do not have severe damage. Figure 2 shows the condition of Palu Bay Coastal after tsunami at 2018.

![Figure 2 Condition of Palu Bay Coastal after Tsunami](image)

At this time the community is very aware of mangrove ecosystem benefits on the coast, and also because of the past tsunami experience, the community is aware of the importance of mangroves ecosystems in minimizing the impact of the tsunami. The community is more active in planting and caring for mangroves, many communities cooperate with organizations, student groups, Karang Taruna (youth organizations), and also Non-Governmental Organizations to plant mangroves around the coast. The participation of local communities in mangrove management was felt in the three research locations, namely Kabonga Besar, Mamboro, and Lere, plus respected community leaders also took part in managing mangroves on the coast. For example, in Kabonga Besar a religious figure named Alwan Kompulu took part in socializing the importance of mangroves, in Mamboro a religious figure named Ustadz Hasbi supported mangrove management, while in Lere a religious leader named Mr. Safei Datu Kapange realized the benefit of mangroves as a breakwater for sea water.

The community is very aware of the benefits of mangroves for the environment, which can reduce the impact of tsunami waves and can become a greenbelt that protects coastal ecosystems. In addition to having benefits for the environment, mangroves can also provide benefits to the economic aspects of the surrounding community, for example in Kabonga Besar there is mangrove ecotourism which can be a source of income for the community. Other research also stated that the mangrove ecosystem in addition to reducing the impact of the tsunami disaster, can also bring economic, educational and tourism benefits to coastal communities [24]. In addition, in order for mangrove conservation to run well, there needs communities participation on the coast [25]. The mangrove ecosystem can also attract more parties to collaborate in the development of mangrove ecosystems, such as cooperation with companies in the form of Corporate Social Responsibility and Community Development from students around Palu City.

4. Conclusion
As the capital of Central Sulawesi Province, Palu City is a city that has an important role, but on the other hand, Palu City is also vulnerable to disasters. In accordance with the previous explanation, many communities around the coast of Palu Bay do not really understand the importance of the mangrove ecosystem to the environment. However, after the 2018 tsunami, communities now know that mangroves can reduce the negative impacts caused by tsunami waves. So that at this time a lot of
planning and caring for mangroves around the coast of Palu Bay, for example in Kabonga Besar, Mamboro, and Lere. In addition to having benefits for the environment, mangroves can also bring benefits as a source of new jobs for the community. After the tsunami, community participation in mangrove management began to increase along with an understanding of mangrove benefits. After cooperation of various parties is needed to always maintain mangrove management as a tsunami disaster mitigation in Palu City, such as from the participation of the community, government, and also the private sector, in the form of policies. This research still needs further research, for further researchers can take the topic of community participation along with various sectors, and also community participation in mangrove management in other Palu City coastal.

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