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Vegetative Mitigation as an Alternative for Reducing Disaster Risk on The Calanimmur Coast, Pandeglang Regency, Indonesia

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Abstract. Structural mitigation at Carita beach, Labuan beach, Panimbang beach, and Sumur beach (Calanimmur) such as the installation of breakwaters, could not withstand the tidal waves and tsunami disaster. Therefore, it is necessary to apply mitigation in other ways that can withstand tidal waves of seawater and prevent the negative impact of the tsunami. This study aims to analyze the management of vegetative mitigation of mangrove forests on the Calanimmur coast, Pandeglang Regency to reduce disaster risk. The research method uses a qualitative method with a descriptive design that uses primary data from direct research in the field, and secondary to the results of previous studies, national journals, related books, and regulations related to mangrove forest mitigation, disaster risk reduction, and tsunami disasters. The results show that vegetative management of mangrove forest mitigation is expected to: 1) Carita beach, Labuan beach, and Panimbang beach can prevent or reduce tidal waves and tsunami so as not to directly damage the coast or land, and maintain tourism activities and aquaculture; 2) Sumur coast to prevent tidal waves and tsunamis from directly damaging the coast or land, and being developed as a pilot in Indonesia for combining new tourism and aquaculture. This study concludes that the development of physical mitigation as mangrove forest vegetation can reduce disaster risk such as preventing tidal waves and tsunami disasters from reaching the coast directly.

Keywords. Vegetative Mitigation, Reducing Disaster Risk, Calanimmur Beach, Pandeglang Regency

1. Introduction

The vision of Pandeglang Regency, Banten Province in the medium-term development plan is to establish an independent region in agribusiness and tourism based on rural development. Although the economic structure of Pandeglang Regency is mostly dominated by the agricultural sector, the economic structure of Pandeglang Regency is dominated by the agricultural sector, or about 80% of the land area is used for agricultural land (Central Bureau of Statistics of Pandeglang Regency, 2018). The location of land for fish farming is not only on the mainland but also on the shores of the Sunda Strait. There are 4 sub-districts on the edge of the Sunda Strait, namely Carita, Labuan, Panimbang, and Sumur or called Calanimmur Beach.

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The length of the Calanimmur coast from Sukanegara village in Carita sub-district to Sumur sub-district is 47.2 kilometers (Banten Province Marine and Fisheries Service, 2019).

Along the coastal area of Calanimmur Beach, most of it (80%) is used for the recreation and cultivation of caged fish. To mitigate management of the tidal wave and tsunami disasters, it is still not in line with expectations. This is evidenced that the program implemented along the coasts of Panimbang and Labuan will install a breakwater of about 15 kilometers. This program is a national program from the Ministry of Maritime Affairs and Fisheries for 2019-2020. If we remember again, the tsunami that occurred on December 22, 2018, the beaches that were most badly affected by the number of casualties and property and environmental damage were Carita beach, Tanjung Lesung beach, and Sumur beach. One reason is that proper mitigation methods have not been implemented along the Calanimmur coast. Thus, it is necessary to carry out disaster risk reduction activities in the coastal area of Calanimmur, especially the tsunami disaster.

Implementing disaster risk reduction with structural mitigation on the coast can be done by installing embankments, installing breakwaters (breakwaters, seawalls), and mangrove vegetation (Prasetyo, 2016), mitigation in the form of the breakwater. The existing breakwaters in Labuan and Panimbang sub-districts, when the 2018 tsunami disaster occurred, were heavily damaged, so the tsunami-damaged seawater entered residents' houses. While Carita beach, Tanjung Lesung beach, and Sumur have not been carried out structural mitigation The inability of the seawall to withstand high tides causing damage, also occurred on the north coast of Jakarta (Rujak Center for Urban Studies, 2020). The results of Hidayatullah et al. (2016) research, show that the installation of embankments on the coast of Muara Gembong by the Regency Government Bekasi, apparently cannot withstand the tidal wave sea water causing abrasion and tidal flooding. The installation of breakwaters in North, West, and East Semarang could not withstand land subsidence (Shidik et al., 2019). Thus, there are still doubts about the effectiveness of mitigation by using seawalls, breakwaters, and embankments. For this reason, it is necessary to consider the use of other mitigations that are following the conditions and needs of the Pandeglang district government and its people.

According to the results of interviews with the head of the Local Disaster Management Agency (LDMA) and the Sub-district head of Calanimmur, it is necessary to maintain the income of the local government and the people who have been depending on their lives on the Calanimmur beach. The income in question results from tourism and the results of aquaculture which so far can be enjoyed, including there is a traditional fish port. From the above conditions, the researchers would like to propose that the entire Calanimmur coast be developed by mangrove forest plants so that they are still able to maintain as a location for tourism and aquaculture. With the hope, Calanimmur beach mitigation activities by planting mangrove forests to withstand coastal abrasion and withstand tidal waves and tsunami waves.

The central government has determined that Tanjung Lesung beach is a special economic zone, so its management is automatically in the tourism company appointed by the central government. This further shows the similarities between the central government and the Pandeglang district as a location for tourism and agribusiness. Thus, it is necessary to think about new ways of implementing disaster mitigation outside of breakwaters or seawalls which have proven to be less effective. According to Setyawan and Kusumo (2006), to restore the characteristics and functions of damaged coastal ecosystems, it is necessary to heal by planting mangrove forests. Although the development of mangrove forests until the benefits can be felt takes 15 - 30 years, the benefits are very much needed for the Calanimmur beach such as holding back the tidal waves of seawater, where fish lay eggs and grow, holding sediment and

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suspension material brought from river water will settle and be used. to resist erosion, as well as a CO2 absorber that can withstand global warming. Therefore, physical mitigation measures on the Calanimmur coast by planting mangrove forests are expected to prevent coastal abrasion and withstand tidal waves, as well as tsunami disaster waves.

2. The purpose

The purpose of this research is was to analyze the management of vegetative mitigation of mangrove forest planting along the Calanimmur coast of Pandeglang Regency to reduce the risk of disasters.

3. Method

The research method used is a qualitative method with a descriptive design (Creswell, 2016). The data analysis used is a descriptive analysis using primary data as research results in the field and secondary data as literature reviews that evaluate the results of previous research findings (Triandini et al, 2019). To strengthen secondary data, sources of books and national journals published from 2000 to 2022 are also used, as well as regulations related to mangrove forest mitigation, disaster risk reduction, and tsunami disasters. Findings from primary and secondary data in the form of facts will be analyzed to understand and provide explanations or criticisms according to the topic under study (Cooper, 2010). The results were organized to get ideas, then analyzed and synthesized the data findings into an interrelated unit, identifying important issues of tsunami risk reduction. Then it is discussed and analyzed and synthesized to get conclusions and finally make an interesting article about the management of vegetative mitigation of mangrove forests on the Calanimmur coast which is needed by the Pandeglang Regency Government to support the prevention of negative impacts from the tsunami disaster.

4. Result and Discussion

The bad impact of the 2018 tsunami disaster was the loss of life, damage to hotels and villas, and environmental damage. There are efforts to overcome tidal waves by installing breakwater walls on the beaches of Panimbang and Labuan. However, during the tsunami disaster, there was heavy damage so the tsunami waves reached the mainland. The condition of the Calanimmur beach according to the regional government policy of Pandeglang Regency must be maintained as a tourism and aquaculture area. One alternative suggested by researchers is to mitigate with mangrove forests. One goal of developing mangrove forests is to withstand tidal waves so that they do not directly damage the coast (Rahman, 2013; Kariada & Andin, 2014; Djohan, 2007). The reality on the ground on the Pandeglang beach is that there are 1,761.39 hectares of mangrove plants on the north side of Genting Land, along the coast to the Cikalong River and Legon Lentah Panaitan Island (Palembang online, 2016). However, the condition of the Calanimmur beach, only mangrove forests on the Panimbang beach, are still under-appreciated.

The first step from the Pandeglang regional government is to make a zoning plan for protected areas and economic areas. Considering that the Calanimmur beach area has become a tourist attraction, there must be an effort to establish a protected forest area of at least 30% or 2,085.55 hectares on the coast. This protected forest area will be created as a mangrove forest development (President Decree No. 73 / 2012). The priority of mangrove forest planting management is according to the characteristics of the coast in each sub-district, for example, there are watersheds, estuaries, land that is far from high tide or closest to receding from the coast (Kurniadi et al., 2019). Aquaculture usually uses estuarine areas which are the confluence

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of watersheds and seawater. This location is indeed allowed for certain activities that are beneficial to the community following Law No. 27 of 2007. This shows that the people of Pandeglang Regency have a life of dependence on the coastal area (Ginting et al., 2017).

Based on this zoning, the proposed development of vegetative mitigation as planting mangrove forests is also adjusted to the conditions and needs of the community and measures to reduce the risk of tsunami disasters around the coast of the Calanimmur sub-district, including:

4.1 Carita Beach

Along the Carita coastline, which is a tourism location, the distance between hotel and inn buildings is attached to the beach. As a result, during the tsunami, almost 90% of the buildings were damaged and their condition has not yet been reconstructed. Carita Beach has no aquaculture activities, tourism sites, there is sand mud, there are watersheds and estuaries. Mangrove forest planting will be effective if planted about 100 meters from the beach and made 100 meters thick or wide. However, Carita beach is made flexible, namely, the location for the use of water tourism games is given an open space of 30 m – 50 m not planted with mangrove forests. The utilization of the beach can reach 300 meters into the sea. For that, it is necessary to make special boxes of mangrove plants that are 50 meters from the beach with a thickness of 100 meters. Mangrove plants are prioritized in locations in watersheds that have estuaries. The plant thickness of 100 meters allows tourists to enjoy water sports beyond 100 meters.

The main purpose of developing mangrove forests on the Carita coast is to maintain them as a tourist location. For this reason, the planting of mangrove forests must be maintained according to its objectives by maintaining about 10-20 years. During that time, the development of the mangrove forest will reach a root height of 30 cm to 100 cm. In this situation, the mangrove forest will withstand and reduce tsunami waves by up to 90% so that when it reaches the coast it will weaken so that it will not damage buildings and villas (sindo news.com, 2019; Rahman, 2013).

The real condition is that Carta beach as a tourist attraction will be more attractive if a mangrove ecosystem grows which is arranged in such a way that it can be combined between water tourism and maintaining the benefits of mangrove forests as ecotourism (Sudiarta, 2006). If necessary, one day it can be used as a new type of tourism as floating tuna and snapper cultivation for fishing (Kariadi & Andin, 2014). In the long term, the expected benefit in this research is the development of mangrove forests as an appropriate physical mitigation activity for Carita beach to withstand tidal waves or the tsunami disaster so as not to damage tourist buildings that are scattered almost covering Carita beach.

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4.2 Labuan Beach

Labuan Beach is a beach where there is no tourism activity unless there is a beach for tourism, there is a fish auction pier, and a location that is used as the honor of the ancestors. The condition of Labuan's sandy beach is the same as Carita's, there are watersheds and estuaries. Structural or physical mitigation activities, for example, are the installation of breakwaters about 1 kilometer near the auction site and 1 kilometer on the tourism beach, with installations located 50 meters from the beach. However, at the time of the tsunami disaster, the breakwater was not capable of tsunami waves and some were damaged. The depth of the beach is not the same where at the location of the fish auction dock, the depth is about 15-35 meters along 2 kilometers, a breakwater is installed, while on the other beaches it is 1-1,5 meters.

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Planting of mangrove forests on Labuan beach should still be planted on all Labuan beaches which are 50-100 meters from the beach. The mangrove forest planting system is in the form of a U plot with a distance between mangrove forest groups of 50 meters, with a thickness of 50-100 meters. Especially for the fish auction dock, it can be planted 200 meters from the pier so as not to interfere with the entry and exit of fishing boats to the dock. The benefit of the mangrove forest around the jetty is to provide the growth of estuarine ecosystems to become fish breeding around the dock for use as recreational fishing activities. Meanwhile, in areas where breakwaters have been installed, the distance for planting mangrove debt is parallel to the breakwater with a distance of 100 holes for fishers to enter and exit for fish. The main aim of developing mangrove forests on the Labuan coast is to withstand and break up tidal waves and tsunami waves (Kusmana, 2007; Wahyudi et al., 2009).

4.2 Panimbang Beach

Panimbang Beach is a beach that already has the largest aquaculture on the Calanimmur coast. Aquaculture has an area of almost 20 hectares, the distance from the beach is about 100 meters by using the length from the coast to the sea about 1,500 meters. Panimbang Beach has a breakwater of about 2000 meters installed, mangrove forest plants with a coastal area of about 300 meters from the beach, and growing well jutting towards the river which reaches 5 hectares. However, the location of mangrove plants is about 3 kilometers from the location of aquaculture. Tourism activities on the Panimbang beach are on the Tanjung Lesung beach about 500 hectares. In addition, the condition of the coast of Panimbang has watersheds and estuaries, containing mud. The advantage of the aquaculture location on the Panimbang beach is that it is not directly affected by the tsunami waves because a beach that juts out to the sea at Tanjung Lesung covers it.

The main objective of developing mangrove forests is to maintain fish farming. Panimbang Beach has many watersheds so the development of mangrove forests is prioritized around the location of aquaculture. The planting of mangrove forests can be started from the beach in front of the sub-district office to close to 50 meters of aquaculture area. Planting can start 50 meters from the beach to 100 meters from the Tanjung Lesung tourism location. At the Tanjung Lesung location, it is also arranged so that there is a 100-meter hole for the entry and exit of ships for water tourism activities. For planting in the cultivation location, it must be arranged by planting alternately so that there is a hole of about 100 meters in and out of fishing boats that enter and exit to collect fish harvests.

Another benefit from the development of mangrove forest plants on the Panimbang beach which is highly expected by aquaculture fish farmers is to become a source of energy for the spawning and breeding of skipjack and tuna, although not optimal (Palembang Online, 2016). In addition, the selection of mangrove forest planting in river basins and estuaries around the aquaculture location is expected to increase the income of aquaculture farmers. Mangrove forests will grow a new estuarine ecosystem so that it will become a place for spawning and development in addition to fish that are cultivated by farmers such as shrimp, crabs, and squid (sindo news.com, 2019). Therefore, the existence of mangrove forests as physical disaster mitigation will support the characteristics of the Panimbang beach as permanent aquaculture to maintain regional and community income.

4.3 Sumur Beach

Sumur Beach has a beach that directly faces the Indian Ocean and also faces Mount of Anak Krakatau. This position makes Sumur beach always suffer a bad impact first compared to

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other Calanimmur beaches. Sumur Beach also has watersheds and estuaries, along the coast, there are no mitigation activities such as breakwater, and the sand is muddy. Sumur Beach is used by fishers to get in and out of small boats looking for fish to and from the sea. The position of land that is parallel to or even lower than the beach is wider than the other Calanimmur beaches. As a result, if there is a tidal wave, an earthquake at sea, a tsunami or Mount Anak Krakatau erupts, the number of victims of property and the environment is greater than that of other beaches.

These characteristics require the development of mangrove forests as an alternative to physical mitigation to be carried out. The beach is wide so that they can use the spacing of mangroves parallel to the coast with variations. Beaches that are not used for fishers to come in and out, planting mangrove debt from 100 m off the coast to touching the beach. As for the location of entry and exit facing directly to the child of Mount Krakatau, a 100-meter hole can be given. The thickness of the mangrove forest in 10-15 years is expected to reach 10 m x 10 m per plot, with a tree diameter of at least 10 cm and a minimum height of 1.5 meters. Considering that this beach is the most affected, the distance between plots should be 10-15 meters (Fahrul, 2012).

If the benefits of mangroves are under the above conditions, it is hoped that a mangrove forest will protect the coast of the well from coastal abrasion, control intrusion of land water into the sea, will withstand strong sea breezes, reduce and break up the speed of tidal waves. , 2007; Wahyudi et al., 2009). In addition, it directly related the position to the Indian Ocean and Mount of Anak Krakatau which has a great potential for a tsunami disaster. The high potential for a tsunami disaster because of the eruption of Mount Anak Krakatau as stated by SuaraBanten.id (2022), that on March 25, 2022, there have been four eruptions of Anak Krakatau Mount. Therefore, the mangrove forest on the Sumur coast will withstand the waves of tsunami disasters from Mount of Anak Krakatau such as the 2018 tsunami.

The Pandeglang Regency Government sees increasing regional income and community income, so the existence of this mangrove forest can provide a source of food for fish, shrimp, and crabs or another biota, as well as being a supporter of coastal ecosystems (Kariadi & Andin, 2014; Djohan, 2007; Kusmana, 2007). , 2007). To support the objectives of the local government, the mangrove forest along the Sumur coast will be made into a water tourism site, as already owned by Carita beach and Tanjung Lesung beach (Sudiarto, 2006). Therefore, the existence of mangrove forests on the Sumur coast must be maintained (Kusmana, 2007).

From these results and discussion, according to Oudenhoven (2015), the management of the beaches of Carita, Labuan, and Panimbang is a sustainable type because it aims to maintain the characteristics of the coast as it is through tourism activities, aquaculture, and restraining the speed of tidal waves and tsunami disasters. Meanwhile, the management of Sumur beach according to Oudenhoven (2015) includes the management of high-intensity species to be a place for tourism, aquaculture, research, and education, as well as preventing tidal waves and tsunami waves from directly reaching the coast and land.

As for supporting the goal of effective mangrove forest management on the Calanimmur coast, the activities that must be carried out by the Pandeglang Regency Government and the community in developing physical mitigation of mangrove forests are planting by choosing the type of mangrove debt that is suitable for the Calanimmur beach. Activities that require priority according to Sari & Dewi (2014) are monitoring the development of mangrove forests until they grow solid and strong. There must be a special team to monitor

the growth of mangrove forests whose task is to measure the parameters of the mangrove environment and calculate the success rate of mangrove life. Every week you have to know and assess the condition of the nursery whether it is alive or dead, the condition is good or uneven with the group, and how to plant the dead so that it is balanced with the existing ones. In order to monitor the development of mangrove forests more effectively, it is necessary to form a special institution at the district level. The existence of this management agency will show better results than those without an institution (Syahrial & Ramdhan, 2019; Ginting et al, 2017). This is an embodiment of Law No. 24 of 2007 where countermeasures are not only the task of the government but must also involve many parties.

5. Conclusion

The conclusion of this study are;

Using the Calanimmur coastal area to support people's lives is still high, therefore the implementation of physical mitigation must pay attention to these needs. If the development of mangrove forests is as expected, the results of this study are: 1) Carita beaches, Labuan beaches, and Panimbang beaches are developed into tourism and aquaculture locations and are able to prevent the arrival of tsunami waves directly hitting the coast and land; 2) Sumur beach will be the best model for other beaches in Indonesia if the development of mangrove forests can protect the coast from tidal waves and tsunami attacks and will also be used as a location for seawater tourism and aquaculture. This study concludes that the development of physical mitigation as mangrove forest vegetation can reduce disaster risk such as preventing tidal waves and tsunami disasters from reaching the coast directly.

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