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Planning of Vegetative Structures for Coastal Protection based on Analysis of the Results of Coastal Substrate in Palu Bay

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Abstract. An earthquake followed by a tsunami occurred on September 28, 2018 in Central Sulawesi. [8] recorded that 2.113 people died from the earthquake and tsunami, spread over 1.703 people in Palu City, 171 people in Donggala Regency, 223 people in Sigi Regency, 15 people in Parigi Moutong Regency, and Pairskayu Regency with a total of 15 people. 1 person. According to satellite imagery data obtained [2], damage to buildings that occurred in Palu City reached 2.403 buildings and caused the paralysis of Palu City from various aspects, around 70,000 people were accommodated in temporary shelters. Structural mitigation efforts to reduce the impact of damage from natural disasters can be done naturally or artificially. One of the natural structural mitigation efforts in the coastal area of Palu City is the creation of a coastal green belt or generally called a Greenbelt. Planting coastal vegetation and mangroves and maintaining existing coastal forest ecosystems is a disaster mitigation effort. Coastal forest ecosystems and mangroves have strong and sturdy root systems that can grip to the deepest soil layers. The canopy is flat and dense, and dense at all times, making coastal forests and mangroves an ideal natural protection against the threat of disasters in coastal areas. The purpose of this research is to plan the formation of coastal forest (Planning Vegetative Structure for Coastal Protection) in Palu City Bay. The method used in this research is descriptive method, namely by field observation, which is carried out to determine the existing condition of vegetation in the coastal area of Palu Bay.Based on the results of the analysis, at 23 measurement points, it was found that the thickness of the fine sediment at the bottom of the water ranged from 1-10 cm, while the results of the analysis of the thickness of the coarse sediment ranged from 1-26 cm. The sediment population in Palu City has the characteristics of Gravel (gravel) and Sand (sand). The potential content of TSS in the water column reaches 188 mg/l.

Keywords. Sediment, Vegetation, Community Development, Palu

I. INTRODUCTION

Indonesia is an archipelagic country with a very wide coastal area and has abundant natural resources, also has a very high potential for natural disasters such as earthquakes, tsunamis, tidal waves, floods, abrasion, accretion, sea water intrusion and strong winds. All of these natural disasters threaten the people who live and depend on the coast and have a bad impact on other coastal ecosystems. [7] Structural mitigation efforts to reduce the impact of damage from natural disasters can be done naturally or artificially. One of the natural structural mitigation efforts in coastal areas, especially beaches, is the creation of a coastal green belt or generally called a Greenbelt. The manufacture and rehabilitation of structural mitigation efforts naturally in the form of Greenbelt has several advantages, namely the manufacture tends to be more economical, has various environmental services and has ecological functions for the surrounding ecosystem.

Palu Bay is a bay in the waters of Central Sulawesi with a coastline of approximately 47 km whose existence is very important, both for residents living on the coast to those living in urban areas. This coastal area along Palu Bay is included in the administrative area of Palu City and Donggala Regency, Central Sulawesi Province. The city of Palu as the center of government and the heart of the economy in Central Sulawesi Province is located in the middle of the hammer valley and the center of the Palu-Koro plate fault which is an active fault so that it has quite

high tectonic activity. Communities living in coastal areas are very vulnerable to various kinds of disasters, such as hurricanes, storms, tsunamis, and heavy rains [3].

Figure 1. Research Location

Given the earthquake that was followed by the tsunami in Central Sulawesi, it is necessary to carry out integrated mitigation efforts to maintain the stability of the coastal area. Mitigation efforts are divided into two, namely structural and non-structural. Structural mitigation can be Soft Protection, namely making a green belt by planting mangroves or other vegetation in accordance with coastal characteristics.[5]

The vulnerability of coastal areas to natural disasters makes these areas require concepts in resilience. The community has an important role in making decisions for defend against disturbance, this refers to the system of social capital, response and capacity for adaptive action in survival [14]. Community resilience to disasters is increasing recognized as a powerful tool in providing support for decision-making in the field of disaster mitigation, risk assessment, and environmental, social, economic, or technological improvement [4].

II. RESEARCH METHODS

A. Research Time and Location

The method used in this research is descriptive method, namely by field observation, which is carried out to determine the existing condition of vegetation in the coastal area of Palu namely by ground checks at a number of points selected based on land cover from Google Earth satellite imagery of 23 survey points and Lansat TM 2019. The results of the classification of mangroves using the CART method are used to determine the distribution map of mangroves in Palu Bay

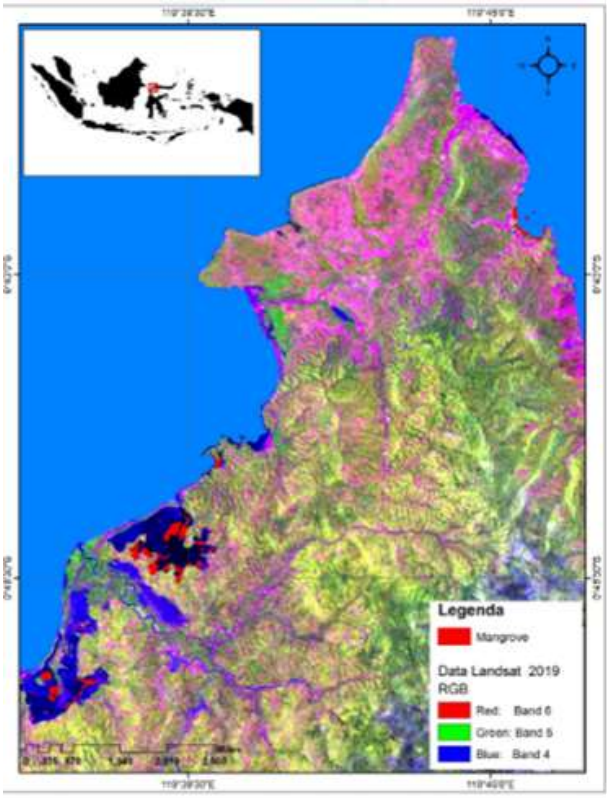

Figure 2. Map of Palu Bay Mangrove Area

B. Techical Sampling

Survey activities were carried out by observing the hue of the coastal environment and ecosystem characteristics including vegetation types, substrate types, beach characteristics and land use around the coast. Substrate characteristic data collection was on October 18, 2019 related to measurements of sediment carried out at 23 points while TSS (Total Suspended Sediment) 18 points were taken. Base sediment data collection was carried out using the Grab sampler tool. Prediction of water level using tidal data obtained from the results of tidal wave forecasting by the Geospatial Information Agency (BIG).

C. Research Data Analysis

This basic sediment sampling was carried out at several observation points, where then the sediment samples were analyzed in the laboratory. In the process of sample analysis in the laboratory, the methods used in testing and analyzing samples follow the procedures of the Indonesian National Standard (SNI) No. 06-6989.3-2004 on the method of gravimetric total suspended solids (TSS) test [12].

III. RESULTS AND DISCUSSION

The environmental hue and coastal conditions along Palu Bay are generally sandy and rocky beaches which are

dominated by coastal vegetation including Kekara Laut (Ipomoea pes-caprae), Spinifex littoreus, Crotalaria retusa, Calotropis gigantea on the coastal border which are influenced by tides; Various types of grasses and puzzles such as Cyperus pedunculatus, Cyperus stoloniferus; Types of trees such as Coconut (Cocos nucifera), Sea fir (Casuarina equisetifolia), Butun (Barringtonia asiatica), Nyamplung (Calophyllum inophyllum), Ketapang (Terminalia catappa), Chinese Kampis (Hemandia peltata), Waru (Hibiscus tilaceus). There are natural mangrove ecosystems in several locations located on the west coast including Palu City and the east coast including Donggala Regency with natural species such as Rhizophora apiculata, Avicennia lanata, Nypa fruticana, Rhizophora mucronata, Rhizophora stylosa, and Sonneratia alba.

Palu Bay as a natural landscape formation has estuaries in the form of semi-enclosed waters downstream river and has a reciprocal relationship with sea area. Therefore, the dissolved material from upstream to the downstream and empties into Palu Bay very affect the sustainability of the mangrove ecosystem. [9] The benefits of mangrove forests are to keep the coastline stable, protectbeaches and rivers from the dangers of erosion and abrasion, withstand storms/strong winds from the sea. [6].

Sediment is defined as materials derived from the breakdown of older rocks or materials derived from the weathering process of rocks and transported by water, air and ice, or materials deposited by naturally occurring processes such as chemical precipitation or secretion by organisms, then form a layer on the earth's surface [10].

Based on the results of the analysis, at 23 measurement points, it was found that the thickness of the fine sediment at the bottom of the water ranged from 1-10 cm while the results of the analysis of the thickness of the coarse sediment ranged from 1-26 cm. The sediment population in Palu City has the characteristics of Gravel (gravel) and Sand (sand). Texture is the appearance of sediments related to the size, shape, and arrangement of sediment grains. A sedimentary deposit is composed of various sizes of sediment particles originating from different sources, and this mixture of sizes is called the population. There are three groups of sediment populations, namely: 1. Gravel (gravel), consisting of individual particles: boulder, cobble and pebble. 2. Sand (sand), consisting of: very coarse, coarse, medium, fine and very fine sand. 3. Mud (mud), consisting of clay and silt [11]

The potential content of TSS in the water column reaches 188 mg/l, so an optimal layout design is needed to capture the sediment. Sediment deposition depends on the transport medium, where when the velocity is reduced the medium is unable to transport this sediment, resulting in accumulation [13]

Observation The highest and lowest tides reach 2 m, so it can be predicted that the value of tidal riding in 1 year can reach 3 m. Based on the results, the recommended mangrove species for planting are Rhizophora mucronata and Rhizophora apiculata, whose seeds come from the closest natural mangrove ecosystem. This species is very easy to breed and has a high survival rate if the environmental conditions are suitable.

Based on the results of the coastal substrate of Palu City after the Tsunami, it is to plan the formation of coastal forests in Palu City Bay. Coastal protection using vegetation (mangroves, sea pine, Ketapang, hibiscus, coconut, etc.) is a form of structural management known as soft protection. In addition to structural handling, there are non-structural measures, which include making laws and government regulations, regional regulations, law enforcement, establishing government and non-government organizations related to disaster management, providing disaster-friendly spatial planning concepts, providing databases and information systems. hazard and early warning, provision of tsunami hazard and risk maps, as well as making maps of evacuation routes and shelters (safe places), public education, and improvement of life support facilities.

Conceptually, [15] provides 7 cyclical steps in tsunami mitigation, namely: Involving relevant stakeholders, Determining the problem, Assessing available and required mitigation capacity, Identifying mitigation options, Evaluating these mitigation options and selecting actions, Implementing the implementation of mitigation actions, and Monitoring and evaluating the implementation of mitigation.

Based on the explanation above, the form of coastal protection with coastal forest (soft protection) can work well if it is supported by non-structural handling from both stakeholders and the community.

As for the rights and obligations of the community, as stated in Law [1] concerning Disaster Management, the community (everyone) has the right to:

(1) Obtain social protection and a sense of security, especially disaster-prone community groups,
(2) Obtain education, training, and skills,
(3) Obtain written and/or verbal information regarding PB policies,
(4) Participate in the planning, operation and maintenance of assistance provision programs,
(5) Participate in decision making, especially those related to themselves and their community,
(6) Supervise,
(7) Obtain assistance to fulfill basic needs (especially for those affected by disasters), and
(8) Obtain compensation due to disaster caused by construction failure.

Meanwhile, the community's obligations are:

1) Maintaining a harmonious social life of the community,
2) Maintaining balance, harmony, harmony and preservation of environmental functions,
3) Carry out disaster management activities, and
4) Provide correct information to the public about disaster management.

IV. CONCLUSION

Based on the results of the research on the characteristics of the coastal substrate of Palu City, it shows that the suitable coastal vegetation in this location is the dry vegetation type, namely the Rhizophora type of mangrove. The results of the analysis, at 23 measurement points, it was found that the thickness of the fine sediment at the bottom of the water ranged from 1-10 cm, while the results of the analysis of the thickness of the coarse sediment ranged from 1-26 cm.

The sediment population in Palu City has the characteristics of gravel (gravel) and sand (sand). The potential content of TSS in the air column reaches 188 mg/l, so an optimal layout design is needed to capture the sediment. In addition to handling construction, non-structural handling includes making laws and government regulations, regional regulations, law enforcement, forming government and non-government organizations related to disaster management.

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TABLE I
RESULTS OF MEASUREMENT OF SEDIMENT CHARACTERISTICS

No	Point	UTM 50N		Time (WITA)	Depth Water (cm)	Sediment Soft (cm)	Sediment Hard (cm)	Result
		X	Y					
1	PTS 20	817467	9902186	8:10:00 AM	68	2	2	
2	PTS 13	817481	9902243	8:22:00 AM	250	5	10	
3	PTS 11	817247	9902269	8:25:00 AM	201	12	17	
4	PTS 10	817012	9902289	8:30:00 AM	220	10	15	
5	PTS 9	816778	9902305	8:34:00 AM	240	3	17	
6	PTS 8	816546	9902346	8:39:00 AM	245	3	17	
7	PTS 7	816327	9902430	8:40:00 AM	280	2	3	
8	PTS 12	816110	9902519	8:50:00 AM	211	-	-	Stone
9	PTS 19	816107	9902503	8:53:00 AM	150	-	-	Stone
10	PTS 14	816320	9902402	8:56:00 AM	150	-	-	Stone
11	PTS 15	816535	9902307	9:00:00 AM	100	-	-	Stone
12	PTS 16	816766	9902270	9:03:00 AM	110	1	1	
13	PTS 17	817000	9902245	9:06:00 AM	150	10	5	
14	PTS 18	817234	9902217	9:10:00 AM	87	5	14	
15	PTS 6	817485	9902304	10:00:00 AM	271	1	15	
16	PTS 4	817255	9902331	10:03:00 AM	281	8	21	
17	PTS 3	817025	9902357	10:06:00 AM	255	5	20	
18	PTS 2	816794	9902378	10:08:00 AM	240	6	26	
19	PTS 1	816564	9902402	10:11:00 AM	255	5	35	
20	PTS	816339	9902456	10:14:00 AM	265	10	25	
21	PTS 5	816122	9902538	10:18:00 AM	119	-	-	Stone
22	310	817642	9902208	10:30:00 AM	145	5	0	
23	311	817619	9902175	10:33:00 AM	100	10	5	

TABLE II
RESULTS OF ANALYSIS OF TOTAL SUSPENDED SEDIMENT

No	Point	Easting	Northing	TSS (mg/L)
1	PTS 0	816339	9902456	74
2	PTS 1	816564	9902402	72
3	PTS 2	816794	9902378	63
4	PTS 3	817025	9902357	68
5	PTS 4	817255	9902331	84
6	PTS 6	817485	9902304	91
7	PTS 7	816327	9902430	68
8	PTS 8	816546	9902346	67
9	PTS 9	816778	9902305	58
10	PTS 10	817012	9902289	97
11	PTS 11	817247	9902269	76
12	PTS 13	817481	9902243	99
13	PTS 14	816320	9902402	122
14	PTS 15	816535	9902307	111
15	PTS 16	816766	9902270	188
16	PTS 17	817000	9902245	151
17	PTS 18	817234	9902217	147
18	PTS 20	817467	9902186	147