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Vegetation analysis and level of damage to mangrove trees in the coastal of Labakkang district, Pangkep regency, Selatan Sulawesi province

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Abstract
The coastal area of Labakankang sub-district, Pangkep Regency has mangrove forests which are quite extensive and their sustainability is still maintained. As a coastal ecosystem, the existence of the mangrove ecosystem makes a very important contribution, both direct benefits (direct use value) and indirect benefits (indirect use value). In addition, the mangrove forest area in this sub-district, especially in Pundata Baji village, has been made into a tourist area. The purpose of this study was to analyze the diversity of mangrove species which includes species composition, density and IVI including: species composition, density, ecological index and distribution pattern. The method used in this study was the identification of mangrove species with quadratic transects, measurements of mangrove density and cover. Substrate and water quality are analyzed in the laboratory. In addition to knowing the distribution of mangroves by using GPS. The data obtained were analyzed to determine the ecological index and then analyzed descriptively and arranged in the form of tables and graphs. The results showed that mangrove species consisted of 3 families, namely Avicenniaceae (*Avicennia alba*, *Avicennia lanata* and *Avicennia marina*), Rhizophoraceae (*Bruguiera gymnorrhiza*, *Rhizophora apiculata* and *Rhizophora mucronata*) and Sonneratiacea (*Sonneratia alba*). The highest IVI values were found in *R. apculata* and *R. mucronata*. The existence of the types *R. apiculata* and *R. mucronata* have a very large role in the mangrove forest community on the coast of Labakkang which is also supported by muddy (clay) substrate conditions that are suitable for their growth.

Keywords: Mangroves, diversity, IVI

Introduction

Mangrove is a type of plant that is often found on muddy sloping beaches and river estuaries. The mangrove ecosystem is a unique form of coastal ecosystem because the physical, chemical and biological elements of land and sea are integrated in this area. This combination creates a complex ecosystem attachment between marine and terrestrial ecosystems. Besides being unique, mangroves also have ecological and economic functions that are very useful in coastal environments (Ulqodry, *et al*., 2010) [18].

Pangkep Regency is characterized by coastal and marine areas that have seagrass ecosystems, coral reefs, mangroves, tourism potential as well as various types of fish and other marine biota with high ecosystem productivity so that they can support economic activities (Dishubkominfo Pangkep Regency, 2012) [2].

The mangrove ecosystem grows along the coast of Labakkang, although there are some parts that have been converted into ponds, along with the importance of protecting the mangrove ecosystem, public awareness to plant mangroves is getting higher, even every house on the coast plants directly behind the house so that the condition of the mangroves is maintained. Found changes in the landscape from 1980 to 2010 on the coast of Labakkang as a result of the conversion of mangrove forests into ponds.

Furthermore, it is said that mangrove vegetation has decreased from 248.4 Ha to 49.0 Ha. Given the various functions and benefits of mangroves for the environment and humans, the mangrove ecosystem should be preserved so that it can continue to provide ecosystem services to the interests of mankind. Information on the vegetation status of the mangrove ecosystem, especially in the coastal area of Labakankang District, is still limited. The existence of mangrove forests on the coast of Labakkang is very important because local people use them to find various types of associated biota, so research is needed on the condition of mangrove vegetation. The purpose of this study was to analyze the diversity of mangrove species which included species composition, density and IVI.

Materials and Methods

Study Area

This research was carried out in the Labakkang Coastal Area, Labakkang District, Pangkep Regency from July to October 2021 (Figure 1). Identification of mangrove species in the Acoustics and Oceanography Laboratory, analysis of water quality was carried out at the Aquaculture Engineering Laboratory, Faculty of Fisheries and Marine Sciences, while substrate analysis was carried out at the Soil Laboratory, Faculty of Agriculture, UMI.

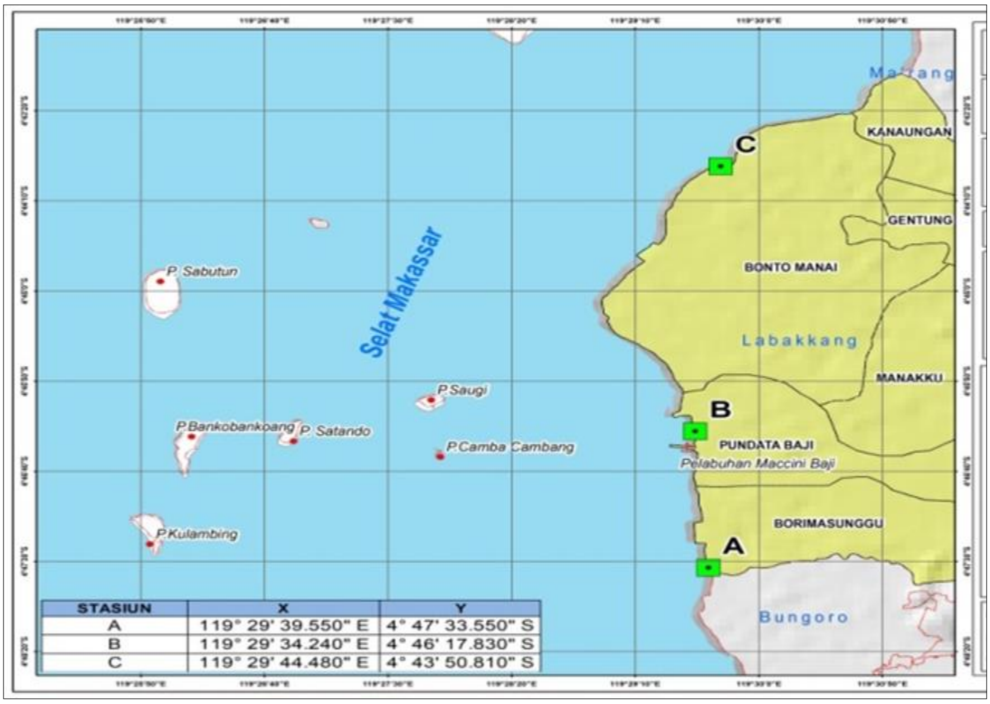

Fig 1: Map of Research Locations

Sampling and Laboratory Procedures

Observation of mangrove vegetation data is carried out in the following way:

1. Using a transect method specifically for trees (diameter > 4 cm (Bengen, 2001) [1].
2. Each research station has 3 sub-stations with a transect/plot size of 10 m x 10 m (trees)
3. Observation of mangrove vegetation data is carried out with a distance between transects of 50 m
4. The measurement data includes the diameter of the stem which is measured at 1.3 m from the top of the root (English, *et al*, 1994) [3], the number of stands and the types of mangroves. Mangrove species were identified based on Bengen's book (2001) [1] and Noor *et al*. (2006) [11]
5. Sampling of water and sediment when observing vegetation is carried out. In particular, temperature, salinity and dissolved oxygen were carried out in the field while pH, TSS and sediment were analyzed in the laboratory.

Data analysis

Data analysis included species composition, density, frequency, closure and IVI of mangroves as well as the damage status of mangroves based on the Minister of Environment Decree No. 201 of 2004 concerning Standard Criteria for Mangrove Damage (Table 1).

Table 1: Standard Criteria for Mangrove Damage

Criteria		Closure (%)	Density (tree/ha)
Fine	Very solid	≥75	≥1500
	currently	≥50-<75	≥ 1000-< 1500
Broken	seldom	<50	<1000

Source: Minister of Environment Decree No. 201 of 2004

Results and Discussion

Mangrove Vegetation Analysis

Type Composition

Based on the research results, it was found that mangrove species belong to 3 families (families), namely the families Avivenniaceae (*Avicennia Alba*, *Avicennia lanata* and *Avicennia marina*), Rhizophoraceae (*Bruguiera gymnorrhiza*, *Rhizophora apiculata* and *Rhizophora mucronata*) and Sonneratiacea (*Sonneratia Alba*). The types of mangroves found at all observation stations were *R. apiculata* and S Alba. This is presumably due to the substrate conditions that support the growth of these types, as well as the condition of the area which is heavily influenced by incoming river flow which can affect the condition of the substrate in these waters which very smooth. Lewerissa, *et al*. (2018) [9] stated that the zone closest to the sea was covered with *Sonneratia alba* with a mud substrate, while the middle zone towards the land was covered with *Rhizophora apiculata* and *Rhizophora stylosa* with a mud substrate.

Type Density and Relative Density

The highest density of species was *R. apiculata* which was found at all observation stations. This species grows quite well because the type of substrate at all stations is clay-textured which is suitable for its growth. The high relative density of *R. apiculata* is due to the fact that at station 3 it has a clay/mud substrate type, where this type of substrate is also one of the preferred substrate types for mangroves of the genus *Rizophora sp.* because in general mangroves from the genus *Rhizophora sp* can grow well on muddy soils (Bengen, 2001) [1].

Type Frequency and Relative Frequency

Fachrul (2007) [4] states that frequency is one of the vegetation parameters that can show the pattern of distribution or distribution of plant species in an ecosystem or show the pattern of plant distribution. The frequency value is influenced by the plot value where mangrove species are found. The more the number of quadrants found in mangrove species, the higher the frequency value of the presence of mangrove species. From the three research stations, the types of A. marina, *R. apiculata*, and *R. mucronta* were the species that had the highest frequency of occurrence, it was suspected that these three species were evenly distributed at each station. This condition occurs because this species likes muddy sand areas such as areas where research has a muddy sand substrate (Nybakken, 1992) [13].

Type Closure and Relative Closure

The highest closing value was found at station A of *R. apiculata*, 60.43% at station B, while at station C the highest was *R. apiculata*. The types of *R. apiculata* and S. Alba found in the fields have large trees that affect the trunk circumference. Haya, *et al*., (2015) [6] stated that the species closure value is closely related to the ring of mangrove tree trunks of each species where if the diameter of the tree is large it will have a large species closure value even though the number is small. In addition, factors that affect the low value of species closure due to the heterogeneous or diverse conditions of mangroves are found so that they affect the relative closure of mangroves. According to Raymond *et al*. (2010) [14] that the more heterogeneous the mangrove species in a community, the roles will be divided and the magnitude of the index will be more varied.

Important Value Index (IVI)

Important Value Index (IVI), is an index of importance that can be used to express the level of abundance and dominance of a type of vegetation in its ecosystem, starting from relative density (RD), relative frequency (RF), and relative dominance (RD) (Bengen, 2001) [1]. The results of the analysis are presented in Table 2.

Table 2: Significant Value Index (IVI) values at all observation stations

Station	Mangrove spesies	∑ stands (tree/100 m^2)	RD	RF	RP	IVI
A	*Avicennia alba*	1	3,571	8,327	4,963	16,862
	Avicennia lanata	2	7,143	8,327	3,729	19,199
	Avicennia marina	6	21,429	25,006	23,585	70,020
	Rhizophora apiculata	8	28,571	25,006	40,346	93,923
	Rhizophoa mucronata	8	28,571	25,006	8,016	61,593
	Sonneratia alba	3	10,714	8,327	19,364	38,405
Jumlah		28	100	100	100	300
B	*Rhizophora apiculata*	1	7,692	16,65	4,344	28,687
	Rhizophora mucronata	7	53,846	50	35,221	139,068
	Sonneratia alba	5	38,462	33,35	60,434	132,246
Jumlah		13	100	100	100	300
C	*Avicennia marina*	5	29,412	37,509	17,063	83,984
	Bruguriera Gymnorrhiza	2	11,765	12,491	12,201	36,456
	Rhizophora apiculata	8	47,059	37,509	44,930	129,498
	Sonneratia alba	2	11,765	12,491	25,806	50,062
Total		17	100	100	100	300

The results of the analysis in Table 2 show that the importance index value (IVI) at station A was the highest for the type *R. apiculata* and the lowest for the type A. alba, station B was the highest for the type *R. mucronta* and the lowest for *R. apiculata* while at station C the highest was for type *R. apiculata* and the lowest *B. gymnorrhiza*. Overall the highest important value index (INP) was for *R. mucronata* only at station B while *R. apiculata* was highest at stations A and C so that *Rhizophora sp* is the most important species in the Labakkang coastal area because it can grow well and adapt to the coastal environment. Labakkang sub-district, Pangkep Regency. The high IVI of *R. apiculata* and *R. mucronata* in this study was supported by a suitable type of substrate for their growth at all observation stations, namely a mud/clay substrate. Gamboa, *et al*., (2019) [5] also obtained the highest important index value for *Rhizophora sp*. This species is able to adapt to various types of substrates. According to Mullet *et al*. (2014) [10], the existence of each type of mangrove is strongly influenced by the quality of the substrate. Types of *Rhizophora apiculata* can grow on various types of substrates ranging from coarse to fine-sized substrates. The existence of the types of *R. apiculata* and *R. mucronata* have a very large role in the mangrove forest community in influencing the stability of the ecosystem compared to other types of vegetation that make up the mangrove forest area on the Labakang coast.

The Important Value Index (IVI) shows the range of indexes that describe the community structure and distribution patterns of mangroves. The difference in the importance value index of mangrove vegetation is due to competition for each type to get nutrients and sunlight at the study site. Apart from nutrients and sunlight, other factors that cause differences in the density of mangrove vegetation are the type of substrate and sea tides (Supriharyono, 2007) [15].

Mangrove Damage Rate

The level of damage to mangroves in the coastal area of Labbakang is based on the Minister of Environment Decree No. 201 of 2004 specifically for tree density. The results of observations made at each observation station obtained mangrove density based on trees can be seen in Table 3 while the standard criteria for mangrove damage are presented in Table 3.

Table 3: Density of mangroves at all observation stations

Station	Mangrove spesies	Stands (tree/100 m^2)	Stands (tree/ha)	Minister of Environment Decree No. 201 of 2004
A	*Avicennia alba*	1	100	Very solid/good
	Avicennia lanata	2	200	
	Avicennia marina	6	600	
	Rhizophora apiculata	8	800	
	Rhizophoa mucronata	8	800	
	Sonneratia alba	3	300	
Jumlah		28	2800	
B	*Rhizophora apiculata*	1	100	Moderate/good
	Rhizophora mucronata	7	700	
	Sonneratia alba	5	500	
Jumlah		13	1300	
C	*Avicennia marina*	5	500	Very solid/good
	Bruguriera Gymnorrhiza	2	200	
	Rhizophora apiculata	8	800	
	Sonneratia alba	2	200	
Total		17	1700	

Based on Tables 2 and 3, the highest density of mangroves was found at station A (2800 phn/ha) and station C (1700 phn/ha) showing a density of ≥ 1500 phn/ha while station B (1300 phn/ha) was in the range of ≥ 1000 - < 1500 phn/ha (Ministry of Environment Decree Number: 201 of 2004). Based on the standard criteria for mangrove damage, in general, the condition of mangroves in the coastal waters of Labakkang is in the good category. The low density of mangroves at station B is because it is a residential area where many mangroves are converted into settlements thereby reducing the density of mangroves. The low density of mangroves at station B is because this area is a residential area that converts a lot of mangrove forests into settlements as well as mangrove stems being used as firewood. Tolangara and Ahmad (2017) [17], the main cause of damage to mangrove forests is the conversion of mangrove forest land for aquaculture, settlements, agricultural land, highways, industry, cities, mining, sand excavation and so on and excessive logging of wood. Mangroves legally or illegally for the long-standing production of firewood, charcoal and chips. This excessive exploitation has caused damage and reduced the function and potential of mangrove forests.

Water Chemical Physical Parameters

The results of the analysis of the physical and chemical parameters of the waters are presented in Table 4.

Table 4: Average Physical-Chemical Parameters of Waters

No.	Parameters	Unit	Station A	Station B	Station C	Minister of Environment Decree No. 51 of 2004
physics						
1.	Temperature	°C	28,33	30	29,33	28-32
2.	TSS	mg/l	107,89	81,70	55,55	80
3.	sediment fraction	-	Clay	Clay	Clay	-
Chemical						
5.	pH	-	7,54	7,56	7,56	7 – 8.5
6.	Dissolved Oksygen	mg/L	4,13	4,23	5,17	> 5
7.	Salinity	°/oo	19	18	20	≤ 34

***Source*:** Primary Data

The results of temperature measurements during the study ranged from 28.33-30oC (Table 8). This range is still supportive for the life of aquatic organisms. Odum (1993), that the normal temperature of the life of organisms in seawater is around 26-32°C, but types of invertebrates can tolerate higher temperatures. While the Ministerial Decree. LH No. 51 yrs. 2004 the temperature range for marine biota (mangroves) was in the range of 28–32 oC.

Total Suspended Solid (TSS) ranges from 55.55 – 107.89 mg/l with an average of 81.71 mg/l which has exceeded the Ministerial Decree threshold. LH No. 51 yrs. 2004 which is about 80 mg/l. TSS levels are strongly influenced by the condition of the substrate. The results obtained for TSS levels in mangrove ecosystems by Kholifi, *et al*. (2021) [8] is much lower, ranging from 0.476 – 4.08 mg/l with sandy substrates. The sediment texture at all stations is included in the clay/mud category which still supports mangrove growth. The type of clay/mud found at all observation stations is suspected because the mangrove habitat is directly adjacent to the beach or sea. Nugroho and Basit (2014) [12] stated that the closer to the coast or the bay, the finer the grain size obtained.

The pH value of each research station ranged from 7.54-7.56. According to Nybakken (1992) [13], that generally the pH of seawater is slightly alkaline, varying from 7.5 to 8.4. While the Ministerial Decree. LH No. 51 yrs. 2004 the pH range for marine biota (mangrove) is in the range of 7–8.5.

The range of dissolved oxygen (DO) content ranged from 4.13–5.17. This range of values still supports the growth of mangroves and animal life. Kepmen. LH No. 51 yrs. 2004 oxygen level for marine life (mangroves) is greater than 5 (> 5).

The salinity range obtained during the study ranged from 18–20o/oo, this range was below the tolerance limit for survival. Kepmen. LH No. 51 yrs. 2004 salinity range ≤ 34o/oo. Meanwhile, the distribution of salinity in waters is influenced by evaporation, rainfall (season), river flow and the interaction between sea and land. Furthermore, it is said that plant n has a wide range of salinity, namely 10-40 o/oo. In general, the range of physical and chemical parameter values is still feasible to support mangrove life.

Conclusion

The structure of the mangrove vegetation on the Labakang coast includes:

1. The type of mangrove was found to consist of 3 families (families), namely the families Avivenniaceae (*Avicennia Alba*, *Avicennia lanata* and *Avicennia marina*), Rhizophoraceae (*Bruguiera gymnorrhiza*, *Rhizophora apiculata* and *Rhizophora mucronata*) and Sonneratiacea (*Sonneratia Alba*).
2. The highest IVI values were found for *R. apculata* and *R. mucronata*, meaning that these two species play a role in the mangrove ecosystem.
3. Water quality parameters still support the life of the mangrove ecosystem.

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