



Regular Research Article

Mapping the Distribution of Sediment Types Using Core Sampling Methods on the Coast of Prancak Village, Bangkalan Regency, Indonesia

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Abstract: Prancak Village is a coastal village located in Sepulu Subdistrict, Bangkalan Regency, which has an important ecosystem in the form of coral reefs and seagrass beds. This study aims to map the distribution of bottom sediments and determine the influence of hydrodynamic conditions on sediment distribution. Data collection was conducted at 20 stations using a core sampler, and sediment samples were analyzed for granulometry in the laboratory. Supporting parameters such as currents, waves, tides, and bathymetry were also recorded. The results of this study show that bottom sediments in the coastal area of Prancak Village are dominated by sand with a sand content of 94.914-99.598% and silt and clay content ranging from 0.323-5.086%. The results of sediment classification showed that fine sand dominated at some points, while coarse mud dominated at other locations. The dominance of sandy sediments in the coastal area of Prancak Village creates substrate conditions that support seagrass growth and the sustainability of the coral reef ecosystem. This study provides information on the distribution of bottom sediments as a basis for coastal management and development planning, as well as erosion and sedimentation mitigation in the coastal area of Prancak Village, Bangkalan Regency.

Keywords: Sediment distribution; Coastline; Prancak Village; Bangkalan; Currents; Waves; Tides; Bathymetry.

1. Introduction

Coastal areas are important regions in the social, economic, and ecological life of communities. Coastal areas are used as locations for fishing, transportation, and tourism [1]. Various factors influence the dynamics of the coastal environment, such as oceanography, tides, and the supply of materials from human activities carried out around the coast [2]. One important factor in coastal areas is the distribution characteristics of bottom sediments. The distribution of bottom sediments can explain the condition of an ecosystem, its resource potential, and the vulnerability of an area to environmental change [3].

Bottom sediments in coastal waters serve as a storage place for organic and inorganic materials carried from land and sea, including pollutants that have the potential to contaminate the water [4]. The sediment deposition process is influenced by oceanographic factors such as currents, waves, tides, and human activities carried out around the coast [5]. Different types of bottom sediments in each water body will affect the habitat conditions of benthic organisms and the sustainability of the food chain in those waters. In this case, mapping the distribution of bottom sediments provides useful information regarding the distribution of sediments in the study location. The study location to be mapped is in the coastal area of Prancak Village,

Bangkalan Regency.

Prancak Village is one of the villages located on the coast of Sepulu District, Bangkalan Regency [6]. The coastal area of Prancak Village has important ecosystems such as coral reefs and seagrass beds. These ecosystems need to be protected from damage. When healthy, seagrass beds serve as spawning and nursery grounds for many marine organisms [7]. Coral reefs provide coastal protection against storms and waves [8].

The purpose of this study is to map the distribution of bottom sediments in the coastal area of Prancak Village, Bangkalan Regency, and analyze their impact on coral reef and seagrass ecosystems. The results of this study are expected to provide information on the distribution of bottom sediments that can be used as a basis for coastal zone management planning, particularly for coastal infrastructure development, as well as for the mitigation of erosion and sedimentation problems in the Prancak Village Coast, Bangkalan Regency.

2. Materials and Methods

This research was conducted on the coast

of Prancak Village, Bangkalan Regency, East Java Province. The research location was around the residents' houses in Prancak Village.

The materials used in this study consisted of primary and secondary data. The primary data used was bottom sediment data collected from the coastal waters of Prancak Village, Bangkalan Regency. Meanwhile, the secondary data used was tidal data, current data, and bathymetric data, which was then processed using software on a computer.

Sediment samples were taken from 20 observation points using purposive sampling, as shown in Figure 1. Sediment samples were collected using a core sampler or drill to obtain bottom sediments. Sediment samples were taken by inserting the core sampler vertically into the bottom of the water to a depth of ± 50 cm. The result of the insertion was a sediment core with a length of approximately 25 cm. Sediment samples were taken once at each observation point to represent the bottom sediment conditions at that location. The samples obtained were then placed in ziplock plastic bags and coded using a permanent marker.

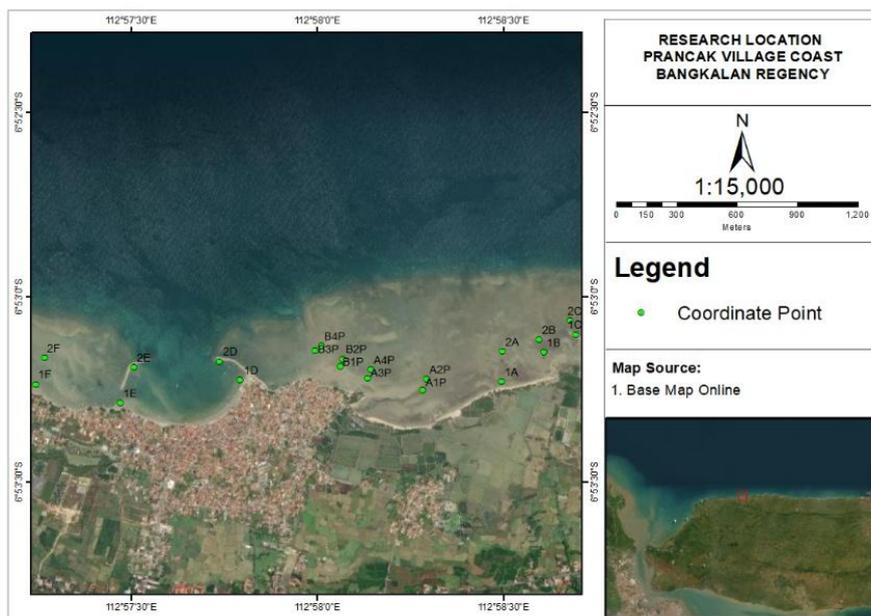


Figure 1. Sampling location map

2.1 Data Analysis Methods

2.1.1 Sediment Grain Analysis Methods

Sediment samples obtained from the

coastal waters of Prancak village, Bangkalan Regency, were then dried until dry. After the sediment samples were dry, they were ground

using a mortar and pestle, then weighed at 100 grams and sieved using a sieve shaker for 10 minutes. After that, the soil remained on the sieve was weighed to obtain its weight value. The sieve sizes used were 2 mm, 1 mm, 500 mm, 250 mm, 125 mm, 0.063 mm, and <0.063 mm. The sediment particles that passed through the 0.063 mm sieve were then subjected to wet pipette analysis and classified according to the Wentworth scale in Table 1.

Table 1. Sediment grain sizes were classified according to the Wentworth scale [9]

No	Name	Diameter (mm)
1	Rocks	>256
2	Round rocks	128
3	Large coral	64 – 32
4	Medium coral	32 – 16
5	Small coral	16 – 8
6	Very small coral	8 – 4
7	Grains	4 – 2
8	Very coarse sand	2 – 1
9	Coarse sand	1 – 0,5
10	Medium sand	0,5 – 0,25
11	Fine sand	0,25 – 0,125
12	Very fine sand	0,125 – 0,063
13	Coarse silt	0,063 – 0,031
14	Medium silt	0,031 - 0,015
15	Fine silt	0,015 – 0,0075
16	Very fine silt	0,0075 – 0,0037
17	Coarse clay	0,0037 – 0,0018
18	Medium clay	0,0018 - 0,0009
19	Fine clay	0,0009 – 0,0005
20	Very fine clay	0,0005 – 0,0003

2.1.2 Current Data Processing Method

Current data was downloaded from [Marine Copernicus](#) and then processed using Microsoft Excel software to determine the direction and speed of the currents. The direction and speed data obtained was then visualized using WRPLOT View software to view the direction and speed of the currents.

2.1.3 Current Data Processing Method

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2.1.4 Tidal Data Processing Method

The tidal data used was obtained from the [Badan Informasi Geospaial \(BIG\)](#) covering a 30-day period in September. The data was then processed using Microsoft Excel software with the Admiralty method to obtain the harmonic constant value and to obtain the Formzahl number. According to Pugh [10], the following formula is used to calculate the formzahl number:

$$F = \frac{A(K1)+A(O1)}{A(M2)+A(S2)} \quad (1)$$

The tidal characteristics are described using the Formzahl number (F), which is a dimensionless parameter used to classify tidal regimes based on the relative dominance of diurnal and semidiurnal tidal components. In this formulation, $O1$ represents the amplitude of the principal diurnal tidal component generated by the gravitational influence of the moon, while $K1$ denotes the amplitude of the principal diurnal tidal component induced by the gravitational influence of the sun. Meanwhile, $M2$ corresponds to the amplitude of the principal semidiurnal tidal component caused by the moon's gravitational pull, and $S2$ represents the amplitude of the principal semidiurnal tidal component generated by the sun. Together, these tidal constituents are used to evaluate tidal behavior and determine the prevailing tidal type at the study location.

2.1.5 Bathymetric Data Processing Method

Bathymetric data was obtained by downloading it from the [BATNAS geoportal](#). The bathymetric data was then processed using ArcGIS 10.3 software to display the sea depth contours on the coast of Prancak Village, Bakangkalan Regency.

3. Results

3.1 Sediment

The results obtained from the analysis of bottom sediments collected from the coast of Prancak Village, Bakangkalan Regency, showed sand, silt, and clay sediments. Sand dominated the sediment content at all sampling points. The sand content at each location ranged from 94.9140 to 99.598%, spread across all sampling points. Meanwhile, silt and clay only obtained a small percentage ranging from 0.323 to 5.086%, which was spread across all sample points, as can be seen in Table 2, and the sediment distribution map can be seen in Figure 2.

Table 2. Percentage distribution of sediment grain sizes

Point	Percentage %		Sediment Types
	Sand	Silt & Clay	
A1	98.707	1.293	Sand
A2	97.407	2.593	Sand

Point	Percentage %		Sediment Types
	Sand	Silt & Clay	
B1	95.307	4.693	Sand
B2	99.598	0.402	Sand
C1	98.806	1.194	Sand
C2	95.629	4.371	Sand
D1	99.677	0.323	Sand
D2	97.776	2.224	Sand
E1	98.911	1.089	Sand
E2	97.143	2.857	Sand
F1	99.170	0.830	Sand
F2	99.626	0.374	Sand
1AP	99.257	0.743	Sand
2AP	98.975	1.025	Sand
3AP	98.974	1.026	Sand
4AP	98.608	1.392	Sand
1BP	99.232	0.768	Sand
2BP	98.746	1.254	Sand
3BP	94.914	5.086	Sand
4BP	99.176	0.824	Sand

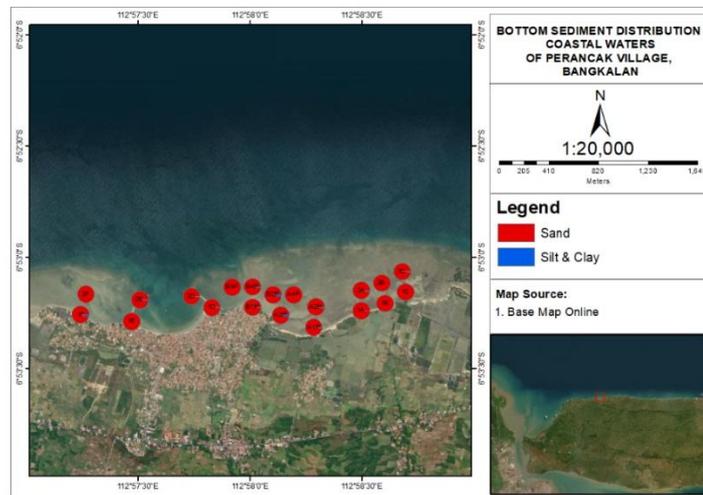


Figure 2. Map of coastal seabed sediment distribution in Prancak Village, Bangkalan Regency

The results of the sediment grain size classification analysis using the Wentworth scale can be seen in Figure 3. Points A1, A2, B2, C1, D2, E1, E2, F1, F2, 1AP, 2AP, 3AP, 4AP, 1BP, 2BP, 3BP, 4BP are dominated by very fine sand with other compositions such as very coarse sand, coarse sand, medium sand, fine sand, coarse silt, and medium silt. Points B1 and C2 are dominated by coarse silt with other compositions such as very coarse sand, coarse sand, medium sand, fine sand, coarse mud, and

medium mud. The dominance of coarse silt fractions at points B1 and C2 is due to the weak currents and waves at the research location and the relatively shallow depth, which causes fine particles such as silt to settle and accumulate more easily than larger sediments. Both points are also closer to mangrove areas, which causes the dominance of silt. Point D1 is dominated by fine sand with other compositions such as very coarse sand, coarse sand, medium sand, fine sand, coarse silt, and medium silt.

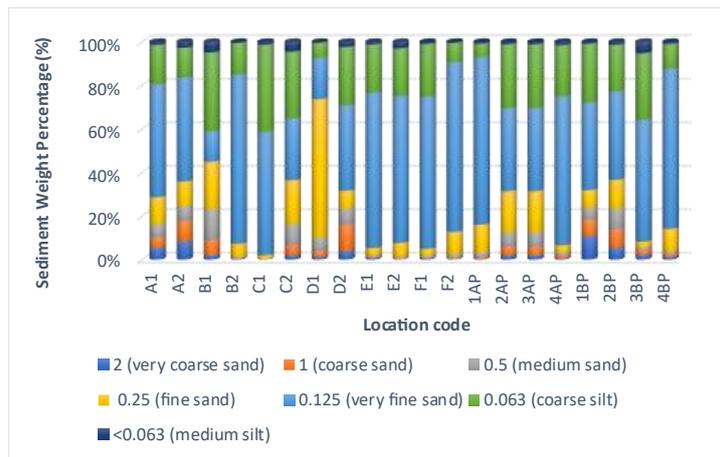


Figure 3. Composition of sediments

3.2 Currents

The speed and direction of currents on the coast of Prancak Village, Bakangkalan Regency in September can be seen in Figure 4, which shows the speed and direction of currents in September 2025. The current flows from east to west and from west to east, with a speed of

0.20-0.30 m/s 1 and 20% from east to west and a speed of 0.10-0.20 m/s 5% and 16%. Meanwhile, from east to west, the speed is 0.20-0.30 m/s 9% and 0.10-0.20 m/s 9%. The current speed in September is dominated by a speed of 0.10-0.20 m/s.

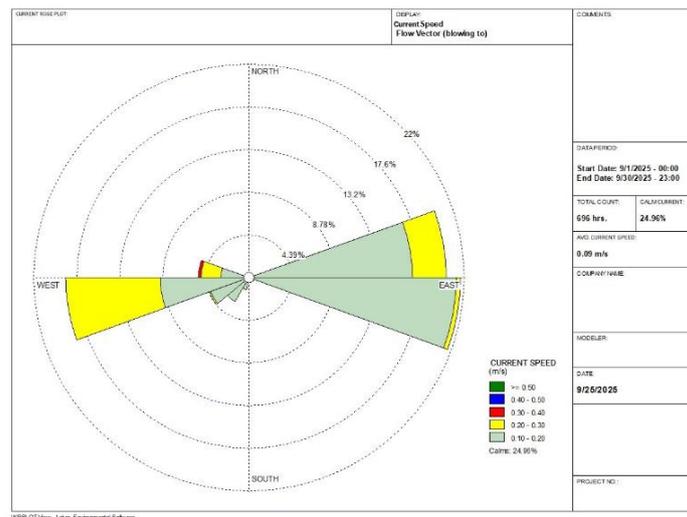


Figure 4. Current direction and velocity patterns

3.3 Waves

The direction and speed of waves on the coast of Prancak Village, Bakangkalan Regency in September 2025 can be seen in Figure 5. The dominant wave direction is from the west to the southwest, with waves from the southwest

reaching 18-22.3%, while waves from the west reach 5.5-9% and waves from other directions contribute less than 6%. The wave distribution pattern shows movement from the southwest to the northeast with a dominant wave speed of 0.90 m/s from all directions.

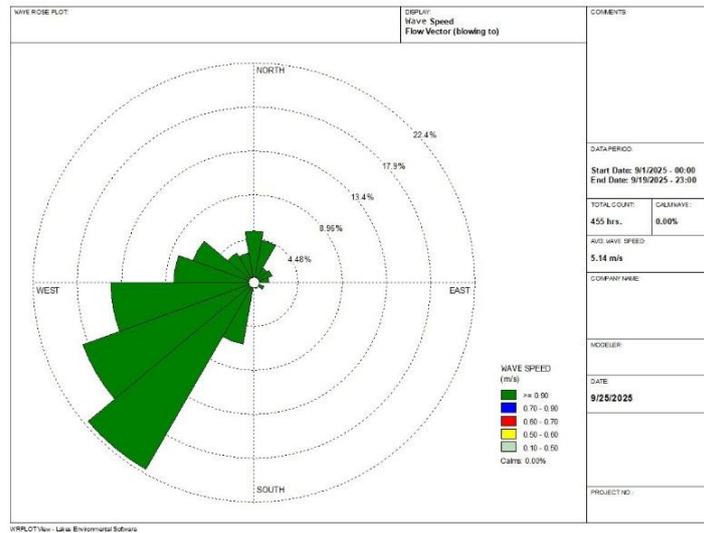


Figure 5. Wave height and direction patterns

3.4 Tides

Tidal data processing using the admiralty method obtained tidal component values in Table 3. Based on the results of the component values obtained, the coast of Prancak Village, Bakangkalan Regency has a diurnal tidal type or one high tide and one low tide with a formzahl of 5.224, MSL 0.087, HHWS 83.675, MHWS 13.517, LLWS -83.502, MLWS -13.343, HAT 99.132, and LAT -98.959 cm.

Table 3. Tidal constituents

No	Components	Amplitude (cm)
1	S0	0.087
2	M2	4.371
3	S2	9.059
4	N2	2.014
5	K2	2.084
6	K1	33.222
7	O1	36.937
8	P1	10.963
9	M4	0.143
10	MS4	0.254

Table 4. Sea surface level

F	MSL	HHWS	MHWS	LLWS	MLWS	HAT	LAT
5.224	0.087	83.675	13.517	-83.502	-13.343	99.132	-98.959

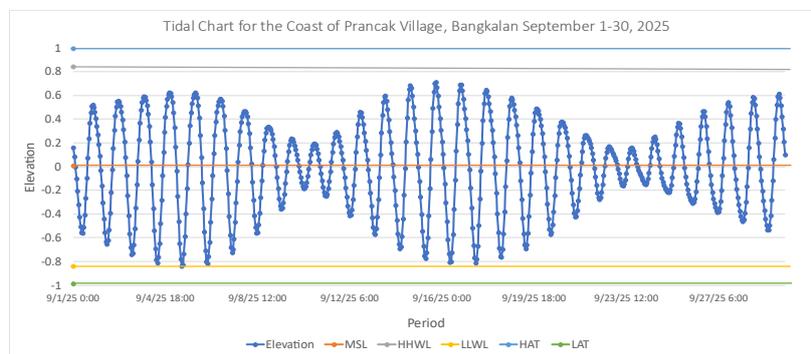


Figure 6. Tide graph

3.5 Bathymetry

The processing of bathymetry data yielded contour lines and sea depth elevation values for the coast of Prancak Village, Bakangkalan

Regency, using BATNAS data, which showed depths of 0-8 meters leading to the open sea, as shown in Figure 7.

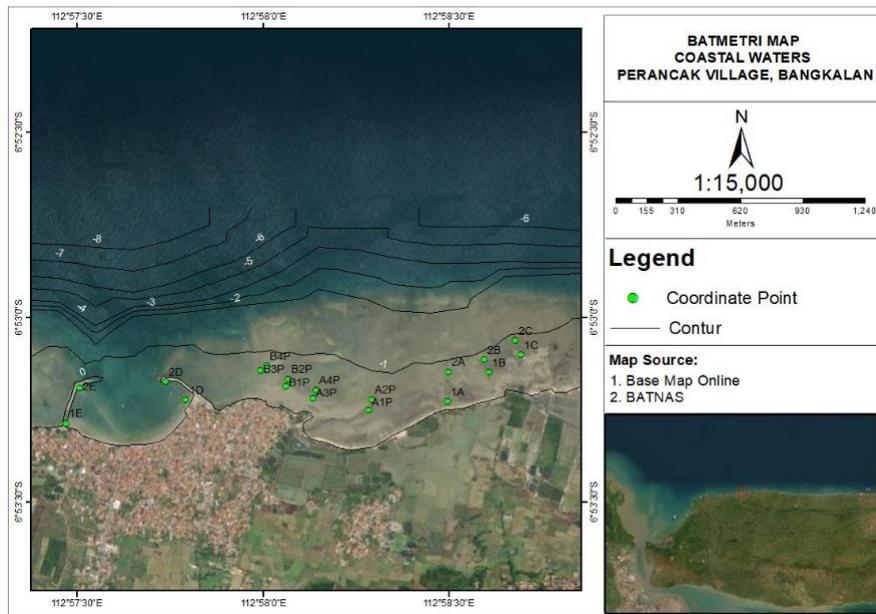


Figure 7. Bathymetric map

4. Discussion

The results of the bottom sediment analysis in the coastal area of Prancah Village, Bangkalan Regency, show that the types of sediment found consist of sand, silt, and clay. The sediment at this location is dominated by sand with a high percentage at almost all points, ranging from 94.9140% to 99.598%. Meanwhile, the silt and clay content is only small, ranging from 0.323% to 5.086%, and is spread thinly across all research points.

The results of the sediment grain analysis were then classified by grain size using the Wentworth scale at points A1, A2, B2, C1, D2, E1, E2, F1, F2, 1AP, 2AP, 3AP, 4AP, 1BP, 2BP, 3BP, 4BP were dominated by very fine sand with other compositions such as very coarse sand, coarse sand, medium sand, fine sand, coarse silt, medium silt, which remained present although in smaller amounts compared to the dominant fraction.

Points B1 and C2 were found to have the coarsest mud, which also contained other fractions in the form of very coarse sand, coarse sand, medium sand, fine sand, and medium mud with a smaller composition. Meanwhile, point D1 was dominated by fine sand, with other sediment compositions such as very coarse sand, coarse sand, medium sand, coarse mud,

and medium mud. The dominance of coarse mud fractions at points B1 and C2 was due to weak currents and waves at the research location and shallow depths, which caused fine particles such as mud to settle and accumulate more easily than larger sediments. Both points were also closer to mangrove areas, which caused the dominance of mud. According to Aini et. al. [11], mangrove roots can bind fine sediments such as mud. The mangrove areas at both points are not too far away, and mangrove trees were found next to points B1 and C2, which may explain why points B1 and C2 have a dominant mud type compared to other points.

The results of the analysis show that the ocean currents at the research site flow in two main directions, namely from east to west and from west to east. The speed of the east-to-west current is 0.20-0.30 m/s 1 and 20%, and the speed is 0.10-0.20 m/s 5% and 16%. Meanwhile, the east to west direction has a speed of 0.20-0.30 m/s 9% and a speed of 0.10-0.20 m/s 9%. The current speed in September is dominated by a speed of 0.10-0.20 m/s. The current speed in September is relatively low to moderate. The current velocity also influences the transport and sediment deposition processes at the research site. According to Pawitra et. al. [12], current velocities ranging from 0.001-0.2 m/s can cause the movement of sediments ranging

from fine-grained to coarse-grained sediments. The current velocity obtained in this study shows that the current velocity is not strong enough, with a velocity of 0.10-0.20 m/s. This flow velocity can only move fine-grained sediments, as the results obtained are dominated by fine to very fine sand (0.25–0.125 mm) and fine silt (0.063 mm).

These current conditions are closely related to the movement of waves that predominantly originate from the west to the southwest, where waves from the southwest contribute 18–22.3% and those from the west contribute 5.5–9%, while waves from other directions contribute less than 6%. Waves from the southwest move towards the northeast at a dominant speed of around 0.90 m/s, so that this considerable wave energy also influences the movement of water masses and determines the dynamics of bottom sediment distribution in the coastal area. The energy from the waves can transport and distribute fine to very fine sediments. These sediments include fine sand, very fine sand, and coarse mud. The fine sediments are then redeposited in lower energy zones.

Sediment distribution is directly influenced by the movement of water masses in an environment. The direction and speed of currents play a role in determining the content, composition, and distribution pattern of sediment material. Currents function as a medium for transporting and eroding sediments, while also playing an important role in the process of sediment mixing in the water. According to Rifardi in Nurainie and Wiyanto [9], the characteristics and distribution of sediments in an area are influenced by ocean currents. The composition of bottom sediment particles and grain size are influenced by variations in current strength, which cause differences. Areas with strong currents are generally dominated by fine particles, while areas with high current strength are generally dominated by coarse particles. The results obtained show that the bottom sediments in the waters of Prancak Village, Bakangkalan Regency, are dominated by sand. Based on the Hjulstrom diagram, for sandy sediments, a current velocity of 0.5–10 m/s is required to deposit sand sediments at the bottom of the waters.

The tidal analysis results show that the tidal type on the coast of Prancak Village is diurnal with a formzahl value of 5.224, indicating one high tide and one low tide. Tides affect sediment distribution patterns because they influence the movement of water masses that carry, deposit, or erode sediment material at the bottom of the water. During high tide, water masses carry fine sediments to coastal areas, and during low tide, they carry stable sediments back to the sea. Bathymetric data shows that the water depth is shallow, ranging from 0 to 8 meters towards the open sea, making it easier for currents, waves, and tides to affect the seabed. These conditions make it difficult for very fine sediments such as silt and clay to settle permanently. Conversely, sand fractions, especially fine sand, have a stable size and weight, making it easier to accumulate and dominate the bottom sediments. According to Hidayat et. al. [13], the slope of the seabed affects the size of sediment grains, where smaller sediment sizes result in gentler slopes, while larger sediment sizes result in steeper slopes. This condition is consistent with the distribution pattern of bottom sediments, which are dominated by fine sand fractions at each point.

The dominance of sand provides substrate conditions for seagrass growth. Fine sand has porosity and aeration that allow seagrass roots to anchor firmly. Smaller sediment particles can contain nutrients needed by seagrass, such as nitrate and phosphate, for productivity and sustainability of the seagrass ecosystem. According to Widiyanti et. al. [14], the smaller the sediment particle size, the greater the availability of nutrients in the sediment at a location. The presence of fine sand sediment provides conditions that are more conducive to coral reef growth and sustainability because sand acts as a stable substrate that is not easily stirred up. Sandy sediments are more suitable as a substrate for coral reefs than other types of sediments such as mud. Muddy substrates tend to be easily suspended, which can affect coral polyps and reduce light intensity, disrupting the photosynthesis process of zooxanthellae. The dominance of sand on the coast of Prancak Village indicates that the seabed conditions support the survival of coral reefs. According to

Prasetyo and Yuliadi [15], their research found three types of substrates, namely mud, coral fragments, and sand. Stable growth was found on coral fragment substrates, stable coral growth was found on sand substrates, while poor coral growth was found on mud substrates. According to Tuttle [16], high sedimentation in the form of suspended and deposited sediments can reduce the growth rate of seagrass and coral reefs by reducing light penetration, accumulating sediments that clog seagrass leaves, and inhibiting the development phase of coral larvae.

This study only took samples in one season, so the results do not yet describe seasonal variations, especially in hydrodynamic conditions that can affect the sediment distribution process. Supporting parameters such as currents, waves, tides, and bathymetry were not measured directly in this study, so it is recommended that future studies measure these supporting parameters directly to obtain more accurate results.

5. Conclusions

Sediment distribution in the coastal waters of Prancak Village, Bangkalan Regency, is dominated by sand sediment. The sand content at each location ranges from 94.9140 to 99.598%, which is distributed across all sampling points. Meanwhile, silt and clay only account for a small percentage, ranging from 0.323 to 5.086%, which is distributed across all sampling points. Most points, namely A1, A2, B2, C1, D2, E1, E2, F1, F2, 1AP, 2AP, 3AP, 4AP, 1BP, 2BP, 3BP, and 4BP, are dominated by fine sand, while points B1 and B2 are dominated by coarse mud. while point D1 is dominated by fine sand with other sediment variations. Sediment dominance can have a positive impact on seagrass and coral reef life if it does not cause turbidity that blocks light from entering and increases the rate of sedimentation. If this occurs, further management is required.

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