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ANALYSIS OF SEDIMENTATION RATE AND CHARACTERISTICS OF SEABED SEDIMENT IN THE COASTAL WATERS OF TANETE RILAU DISTRICT, BARRU REGENCY

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ABSTRACT

The objective of this research is to ascertain the characteristics and sedimentation rates in the coastal waters of Tanete Rilau District. The study was conducted in March 2026 across three observation sites. Sediment data were collected utilizing the sediment trap method, which was deployed three times during the research period (at the beginning, middle, and end of the month), with each deployment lasting for two days. Seabed sediment samples were analyzed using the dry sieving method to determine the grain size distribution according to the Wentworth scale. The findings indicated that the average sedimentation rate during the observation period was 0.050 g/m²/day, with a maximum value recorded at Station 3 of 0.23 g/m²/day and a minimum value at Stations 1 and 2 of 0.01 g/m²/day. The sediment characteristics at the research site were predominantly composed of very fine sand to silt fractions, with the sediment type classified as sandy silt at Stations 1 and 2 and sand at Station 3.

Keywords: Sedimentation rate, Sediment characteristics, Sediment trap, Tanete Rilau, .

INTRODUCTION

Barru Regency, located in South Sulawesi Province, is an administrative region with significant coastal potential. Geographically, it extends from north to south and shares a direct border with the Makassar Strait to the west, featuring a coastline of approximately ±72 km, which constitutes about 22.4% of its total area. The coastal topography is relatively flat, with an elevation ranging from 0 to 25 meters above sea level (Hasriyanti, 2015). These geographical characteristics suggest a predominance of coastal areas susceptible to oceanographic dynamics, particularly sedimentation processes that may impact coastline stability. Furthermore, Barru Regency's strategic position along the primary transportation corridor between Makassar City and Parepare City exerts increasing pressure on coastal area utilization, including the expansion of the tourism sector (Falihin, 2025). A notable area of development focus is the Tanete Rilau District, which is being projected as a coastal ecotourism destination by BRIN.

Coastal regions function as transitional zones between terrestrial and marine environments, subject to the influences of tidal processes, waves, currents, and anthropogenic activities (Nuzullah et al., 2025). The interaction of these factors results in the dynamic movement of sediment materials, which can alter beach morphology through processes of abrasion and accretion. Unregulated sedimentation dynamics have the potential to induce shoreline instability, waterway shallowing, and damage to coastal infrastructure, ultimately diminishing environmental quality and the attractiveness of tourist areas (Harianti et al., 2025). Therefore, understanding the sedimentation rate is a crucial aspect of supporting the sustainable management of coastal areas.

Research conducted by Borang (2022) demonstrated that sedimentation rates in coastal regions exhibit considerable variability, influenced by hydrodynamic characteristics and terrestrial material supply. In the coastal waters of Juata Permai, Tarakan City, sedimentation rates were reported to range from 3.80 to 6.39 g/m²/day, with a sediment texture predominantly composed of clay, which poses a potential risk for the shallowing of marine transportation routes. Conversely, a study by Ruzlim et al. (2025) in the Sampara River Estuary, Konawe Regency, revealed even higher sedimentation rates, ranging from 262.7 to 1244.5 g/m²/day, characterized by a dominant mud fraction (>94%), alongside the influence of currents, salinity, and turbidity on sedimentation magnitude. This is corroborated by Adrianto et al. (2017) in the Karangsong River Estuary, Indramayu Regency, who also identified relatively high sedimentation rates in river channels and estuary areas, reaching

108.8 g/m²/day and 101.3 g/m²/day, respectively. These findings suggest that variations in sedimentation rates are significantly influenced by local oceanographic conditions and land-based activities, resulting in distinct sedimentation characteristics for each region.

While numerous studies have been conducted in various coastal regions of Indonesia, research on sedimentation rates in the coastal area of Barru Regency, particularly within the Tanete Rilau District, remains scarce and lacks sufficient quantitative data regarding the extent and characteristics of local sedimentation. This region holds potential for ecotourism development and is situated along a coastal transportation route vulnerable to silting processes. Given these conditions, further investigation is warranted to ascertain the characteristics and magnitude of sedimentation rates in the Coastal Waters of Tanete Rilau District. Such information is anticipated to provide a foundation for planning sustainable coastal area management, particularly to support environmentally friendly ecotourism development and mitigate the risk of damage caused by sedimentation.

This study was conducted to address scientific inquiries concerning the sedimentation rate in the coastal waters of Tanete Rilau District, as well as to examine the characteristics of seabed sediments based on grain size distribution and their variations across observation stations, which are influenced by oceanographic conditions and coastal activities. Accordingly, the objective of this research is to analyze the sedimentation rate and to identify the characteristics of seabed sediments based on grain size distribution and their spatial variations in the coastal waters of Tanete Rilau District.

MATERIALS AND METHODS

Time and Location of Research

The research was conducted in March 2026 in the coastal region of Tanete Rilau Subdistrict, Barru Regency, South Sulawesi Province. Data analysis was performed both in situ and ex situ at the Laboratory of Physical Oceanography and Coastal Geomorphology, University Hasanuddin. The study was carried out at three stations, selected based on variations in coastal physical characteristics and water dynamics: Station 1 (north, semi-enclosed area), Station 2 (center, high wave energy), and Station 3 (south, low wave energy). The locations of the research sites and station positions are depicted in Figure 1.

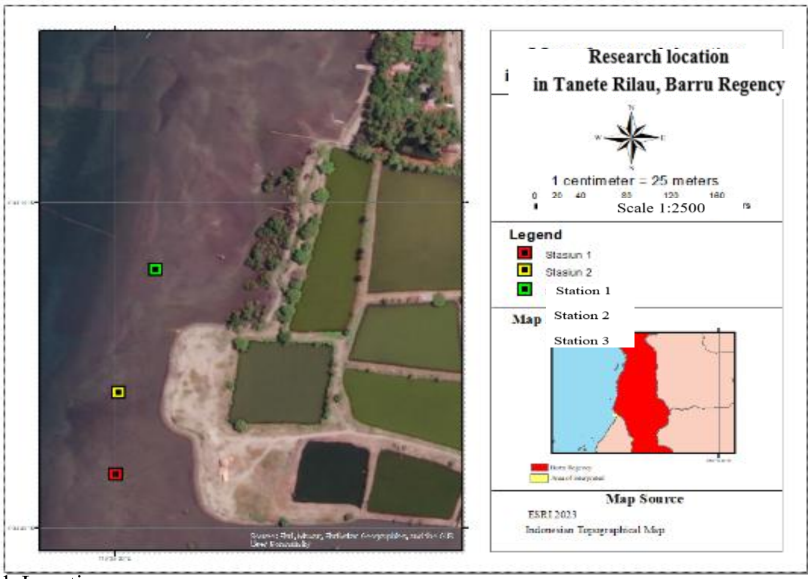

Figure 1. Research Location.

The selection of stations was executed using purposive sampling, a method characterized by the intentional selection of observation points based on specific criteria relevant to the research objectives. In this context, the selection of observation stations considered environmental conditions and various activities that could influence the characteristics of the field. Consequently, three observation stations were established to represent the variations in the water zones: Station 1 (North, semi-enclosed area), Station 2 (Center, high wave energy), and Station 3

(South, low wave energy). The coordinates of the research stations are provided in Table 1.

Data Collection

Seabed sediment sample

Seabed sediment samples were systematically collected at each station using a sediment core to a depth of approximately 20–30 cm, with three replicates obtained during the research period. The samples were subsequently placed in labeled plastic bags, indicating the station code, date, and time, and stored in a cold box prior to laboratory analysis to determine grain size (granulometry) and sediment type.

Table 1. Research Location Coordinates

Station	Coordinates		Characteristic
	Latitude (S)	Longitude (E)	
1	-4.555093	119.588893	Semi-enclosed Area
2	-4.554398	119.588909	High wave energy
3	-4.553346	119.589202	Low wave energy

Sedimentation rate

The sedimentation rate was evaluated using a sediment trap with a pipe diameter of 2 inches and a length of 30 cm. These sediment traps were installed vertically at each station, positioned at a depth of approximately 30 to 50 cm from the bottom of the water body. The traps were deployed three times throughout the research period, with each deployment lasting two days. Measurements were conducted at three observation stations, with four observation points at each station oriented according to the cardinal directions (East, West, North, and South) to capture spatial variation. Following each installation period, the accumulated sediment was collected, dried, and weighed to determine the sedimentation rate ($g/m^2/d$). Sampling of the trapped sediment occurred three times during the research period, specifically at the beginning, middle, and end of the month.

Current speed

Field measurements of current velocity were conducted using a flow watch device. The procedure involved positioning the sensor at a predetermined depth and aligning it parallel to the flow direction. Subsequently, the device was activated to record the current velocity over a specified duration until a stable reading was achieved. The data displayed by the flow watch were documented as the measurement results at the observation point. To ensure the representativeness

and accuracy of the data, measurements were repeated at each station. Environmental parameter

Aquatic environmental parameters encompassed temperature, beach slope, water transparency, and depth. Temperature was measured in situ using a calibrated thermometer at each observation station to ascertain the water temperature. The beach slope was determined by measuring the water depth at a specific point and the horizontal distance from the shoreline to that observation point. The measurement results were further validated using available bathymetry data. According to Kalay et al. (2018), the beach slope can be calculated using the following equation:

$$\boldsymbol{Tan\ \alpha = \frac{Y}{X}}$$

Where:
α = The angle formed (°)
Y = Depth (m)
X = Horizontal distance between the depth observation point and the shoreline (m)

Water transparency was evaluated using a Secchi disk, which was incrementally lowered until it became indiscernible from the surface, and then raised until it reappeared. As indicated by Yasser et al. (2021), water transparency can be quantified using the following equation:

$$\boldsymbol{WT\ (cm) = \frac{(DT + AD)}{2}}$$

Where:
WT= Water Transparency DT= disappearance distance
AD= appearance distance

Utilizing the Speedtech SM-5A portable sounder, depth measurements were performed at observation points positioned roughly 100 meters from the shoreline. These measurements accurately reflected the actual water depth at the specified locations and were subsequently verified against bathymetric data to improve the precision of the results.

Secondary data

Ocean current data were sourced from the Copernicus Marine Service reanalysis product, featuring a spatial resolution of approximately 1/12° (~8 km) and a daily temporal resolution. This dataset was employed to examine the movement patterns of water masses at the research site. The data utilized in this study were collected in March 2026. Tidal data were acquired from the Indonesian Geospatial Reference System (SRGI), managed by BIG, with an observation period spanning from March 1, 2026, to March 31, 2026, and a recording interval of every 60 minutes. The data were subsequently analyzed using the least squares method to derive the primary tidal parameters, namely High Water Level (HWL), Low Water Level (LWL), and Mean Sea Level (MSL) at the research location.

Following this, further computations were executed based on these values to derive the parameters, specifically the Highest High Water Level (HHWL), Mean Sea Level (MSL), Lowest Low Water Level (LLWL), and the Formzahl number, which serves to categorize the tide type. The derivation of these parameters follows the methodology outlined by Pradipta et al. (2025), employing the subsequent equations:

$$HHWL = A(S0) + (A(M2) + A(K1) + A(O0) + A(P1) + A(K2))$$

$$LLWL = A(S0) - (A(M2) + A(K1) + A(O0) + A(P1) + A(K2))$$

$$MSL = A \times S0$$

$$F = \frac{O1 + K1}{M2 + S2}$$

Where:
HHWL = Highest High Water Level
LLWL= Lowest Low Water Level
MSL = Mean Sea Level
F = Formzahl Number

Data Analysis

The analysis of data was undertaken to investigate the relationship between sedimentation dynamics and hydrodynamic conditions, serving as a foundation for identifying zones appropriate for development as ecotourism areas in Tanete Rilau District, Barru Regency. The data were analyzed using both quantitative and spatial methods..

Sedimentation rate analysis

The sedimentation rate was calculated from the weight of the sediment trapped in the sediment trap. According to Barus et al. (2018),

$$\boldsymbol{LS} = \frac{\boldsymbol{Bs}}{\boldsymbol{n} \times \pi \times \boldsymbol{r}^2}$$

Where:
LS = Sedimentation rate (g/m^2/day)
Bs = dry weight of sediment (g)
π = constant (3.14)
r = radius of the sediment trap circle (m)
n = sedimentation time (days)

Grain size and sediment texture analysis

Grain size analysis of sediment was conducted utilizing the dry sieving method. This procedure commenced with drying the sample at 105°C for approximately 16 hours until a constant weight was attained, followed by weighing approximately 100 grams. The sieving process adhered to the methodology outlined by Buchanan (1984) in Sagita et al. (2023), employing a sieve shaker with mesh sizes of 2, 0.5, 0.312, 0.125, and 0.063 mm for approximately 15 minutes. Each sediment fraction retained was weighed and labeled accordingly. The results of the analysis were organized in tabular form and calculated using formulas based on the Wentworth scale (1922) as referenced in Yusrifani (2025). Subsequently, the sediment was classified according to the Wentworth scale of 1922, as cited in Latief (2020), as follows:

$$\%\, \boldsymbol{SW} = \frac{\boldsymbol{SFW}}{\boldsymbol{TWSS}} \times \mathbf{100}$$

Where;
SW = Sediment Weight;
SIW= Sieved Fraction Weight;
TWSS = Total Weight of Sieve Sample

The classification of sediment types was conducted through the analysis of grain size data utilizing Gradistat software. This software is specifically designed to compute sediment statistical parameters, including mean size, sorting, skewness, and kurtosis.

Employing this software facilitates a systematic and precise classification of sediments based on grain size distribution, thereby enabling the results to quantitatively represent the sediment characteristics and support the interpretation of depositional environment conditions at the research site.

Table 2. Grain Size Classification Based on the Wentworth scale (1922)

	Grade Name	Particle Size (mm)
Gravel	Boulders	>256
	Cobbles	64 - 256
	Pebbles	4 - 64
	Granules	2 - 4
	Very coarse sand	1 - 2
	Coarse sand	0.5 - 1
Sand	Medium sand	0.25 - 0.5
	Fine sand	0.125 - 0.25
	Very fine sand	0.0625 - 0.125
Silt		0.0004 - 0.0625 (1/256 – 1/16
Clay		< 0.004 (< 1/256)

RESULTS AND DISCUSSION

Sedimentation refers to the deposition of materials transported by water, occurring when the water's energy is insufficient to maintain particle suspension (Ruzlim et al., 2025). In coastal systems, sediments are typically dispersed throughout the water column and accumulate on the seabed due to the interplay of hydrodynamic processes, material supply, and morphological conditions. This study specifically examines the sediments deposited on the coastal seabed of the Tanete Rilau Subdistrict; thus, the parameters analyzed reflect the actual deposition conditions in the benthic environment. Consequently, the findings are anticipated to offer a more detailed understanding of seabed sedimentation dynamics and the factors influencing them at the research site.

Sedimentation rate

The sedimentation rate quantifies the volume of sediment material deposited per unit area over a specified time interval (Rosyadewi & Hidayah, 2020). The deposition of sediment is influenced by the interplay of various physical factors, including current velocity, tidal dynamics, and other hydro-oceanographic conditions that govern particle transport and deposition. In this study, sedimentation rate measurements were conducted using a sediment trap device installed at three observation stations, each with four location points. The collected data were analyzed to characterize the sedimentation rate over the 30-day observation period, and the findings are presented in Table 3.

Table 3. Sedimentation Rate Analysis Results

No	Collection Date	Sedimentation Rate (g/m^2/day)											
		S1				S2				S3			
		E	W	S	N	E	W	S	N	E	W	S	N
1	05/03/2026	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
2	18/03/2026	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.03	0.04
3	27/03/2026	0.08	0.05	0.05	0.05	0.11	0.05	0.12	0.09	0.23	0.21	0.16	0.18

E: East, W: Weast, S: South, N: North

Analysis of the data presented in Table 3 reveals significant spatial and temporal variability across all stations. The highest sedimentation rate was observed at Station 3 (S3) to the east during the third sampling, measuring 0.23 g/m²/day, whereas the lowest rate of 0.01 g/m²/day was predominantly recorded at Stations 1 and 2 during the first and second sampling periods. Temporally, a marked increase in sediment flux was noted during the third sampling (March 27, 2026) at all sampling points, with values ranging from 0.05 to 0.23 g/m²/day. This increase suggests the influence of stronger external factors, such as heightened suspended load discharge or weather conditions during that period.

Despite the increase in the final period, all recorded sedimentation rates remained below 1 g/m²/day. According to the classification by Jawahir et al. (2019), the sedimentation rates at the research sites during the observation period are categorized as low to moderate, as the daily sediment accumulation did not exceed the threshold for the high category.

Tidal

Hydro-oceanographic parameters are critical components influencing the dynamics of physical processes in aquatic environments, including particle transport and sedimentation (Rahmat et al., 2017).

Among these parameters, tide level plays a pivotal role. Tidal variability significantly affects sediment distribution patterns, the rate of suspended particle deposition, and the characteristics of sediment accumulation in specific aquatic areas (Guo et al., 2018). Tides, in a physical context, are periodic oscillations of sea level resulting from the gravitational interactions among the Earth, Moon, and Sun, as well as the centrifugal force of the Earth-Moon system. These interactions generate hydrodynamic energy fluctuations that are instrumental in the resuspension, transport, and deposition of sediment within aquatic environments (Pambudi, 2026). The tidal graph for the research location is depicted in Figure 2.

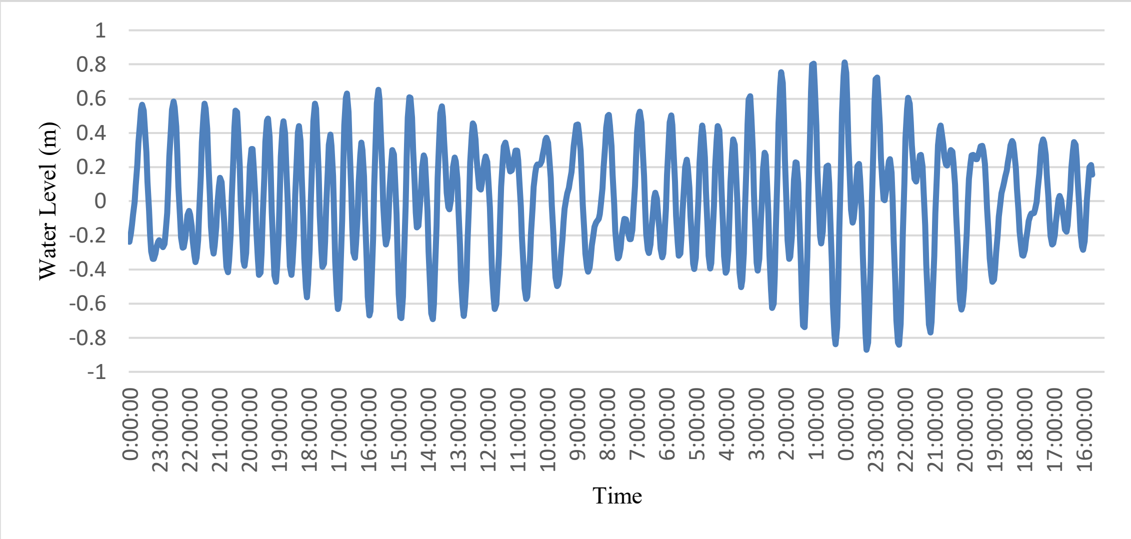

Figure 2. Tidal graph for March 2026.

Through the application of harmonic analysis to tidal data, a Formzahl value of 0.89 was determined, categorizing the tidal type at the study location as mixed, predominantly semi-diurnal. This value falls within the range of 0.25 < F < 1.5, as classified by Fitriana et al. (2022), indicating that within a 24-hour period, there are two high tides and two low tides with unequal water levels (asymmetric). This characteristic suggests relatively complex hydrodynamics, which may influence sediment transport and deposition patterns. In relation to the lunar phase, sedimentation rates observed on March 18, 2026, occurred under spring tide conditions, characterized by maximum tidal amplitude due to the alignment of the Earth, Moon, and Sun. On March 5, 2026, conditions exhibited a relatively small amplitude (approaching neap tide), and on March 27, 2026, when the sediment trap was installed for the third time, neap tide conditions prevailed, with minimum tidal amplitude resulting from the Earth, Moon, and Sun forming an angle that was nearly perpendicular.

The analysis revealed that tidal dynamics contributed to variations in sedimentation rates, although the relationship was not entirely linear. During spring tide conditions (18/03/2026), increases in hydrodynamic energy were not consistently accompanied by increases in sedimentation rates at all stations. Sedimentation values at Stations 1 and 2 were relatively low to moderate, approximately 0.01 g/m²/day, whereas a more significant increase was observed only at Station 3, ranging from 0.03-0.04 g/m²/day. This variation indicates that sedimentation response is spatially influenced by local conditions, such as water depth, substrate characteristics, and sediment source availability. Conversely, during conditions with smaller amplitudes (05/03/2026) up to neap tide (25/03/2026), sedimentation rates tended to be more homogeneous, ranging from 0.01-0.02 g/m²/day. These results suggest a weakening of hydrodynamic energy, resulting in more limited resuspension and sediment transport processes, and the distribution of suspended particles in the water column became relatively stable.

The findings suggest that an increase in tidal amplitude during spring tides does not invariably lead to a corresponding rise in sedimentation rates. Under high-energy conditions, intensified currents not only promote sediment resuspension from the seabed but also facilitate the expedited transport of sediment out of the observation area (sediment flushing), thereby preventing some material from settling. This observation aligns with the findings of Qarnain et al. (2014), who reported that increased current velocity during the spring tide phase can enhance both the resuspension and transport of sediment. Additionally, the predominantly mixed semidiurnal tidal type at the research site contributes to this spatial variability. The uneven current dynamics within a single tidal cycle complicate the distribution of sediment, as noted by Qhomariah and Yuwono (2016). Consequently, the sedimentation rate at the research location is influenced not only by the tidal phase but also by the interaction between hydrodynamic conditions, water morphology, and sediment characteristics.

Sea currents

Sea currents are hydro-oceanographic parameters that play a pivotal role in regulating sediment transport within aquatic environments. The movement of currents generates hydrodynamic energy, which facilitates the transport, relocation, and distribution of sediment across different locations. The magnitude of current speed and direction significantly influences the intensity of erosion, transport, and deposition processes, thereby directly impacting the dynamics of underwater morphological changes (Khadami et al., 2020). In coastal regions, sea currents serve not only as transport agents but also as primary regulators of the distribution patterns of both suspended and seabed sediments. High variations in current speed tend to enhance sediment transport capacity, whereas weaker currents are more conducive to deposition processes (Pawitra et al., 2022). The current distribution maps in the waters of Barru Regency are depicted in Figures 3 and 4, illustrating the patterns of current speed and direction during the observation period.

The pattern of sea currents during high and low tide conditions exhibited distinct movement characteristics. During high tide, the predominant current direction shifted from southeast to northwest, as depicted in the high tide current map (Figure 3), indicating the movement of water masses toward the coastal area. Conversely, during low tide, the current direction reversed from northwest to southeast (Figure 4), reflecting the flow of water masses away from the shore. This pattern suggests the presence of a reversing current system governed by tidal dynamics. The distribution of current vectors in both conditions demonstrated that the direction of flow tended to run parallel to the coastline with relatively consistent variation. Based on the spatial visualization results, the current speed in the waters showed a clear distinction between areas near the shore and offshore. In areas proximate to the coastline, particularly in the central to northern parts of the research site, zones with relatively higher current speeds were identified, indicated by yellow to red color gradients, ranging from approximately ±0.10–0.13 m/s. Meanwhile, in areas further from the shore, current speeds tended to be lower, ranging from approximately 0.03–0.07 m/s, as indicated by blue to green colors. In general, these current speed ranges fall within the weak-to-moderate current category. This condition indicates that the hydrodynamic energy of the water is relatively low; thus, the ability of the currents to transport sediment, particularly larger particles, is limited. Consequently, the sedimentation process is dominated by the deposition of fine particles, which are small and easily suspended. This distribution pattern suggests that areas with higher current speeds have the potential to experience more intensive sediment transport processes, whereas areas with weak currents tend to become zones of sediment accumulation. This is consistent with Setyanto et al. (2022), who stated that current speed significantly influences sediment transport capacity, where stronger currents can carry larger particles, whereas weak currents tend to cause the deposition of fine sediments. Thus, the characteristics of the currents at the research location play a crucial role in determining the distribution patterns and types of sediments deposited in these waters.

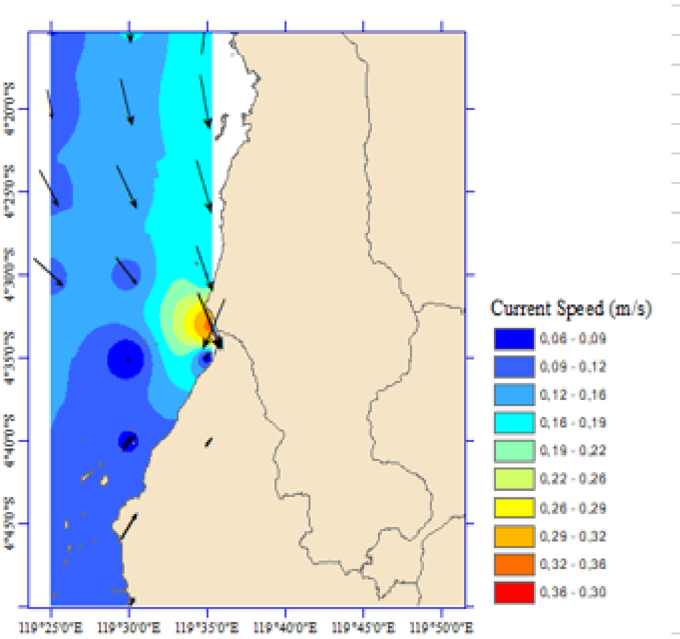

Figure 3. Current Circulation Patterns in the Waters of Barru Regency Under High Tide Conditions.

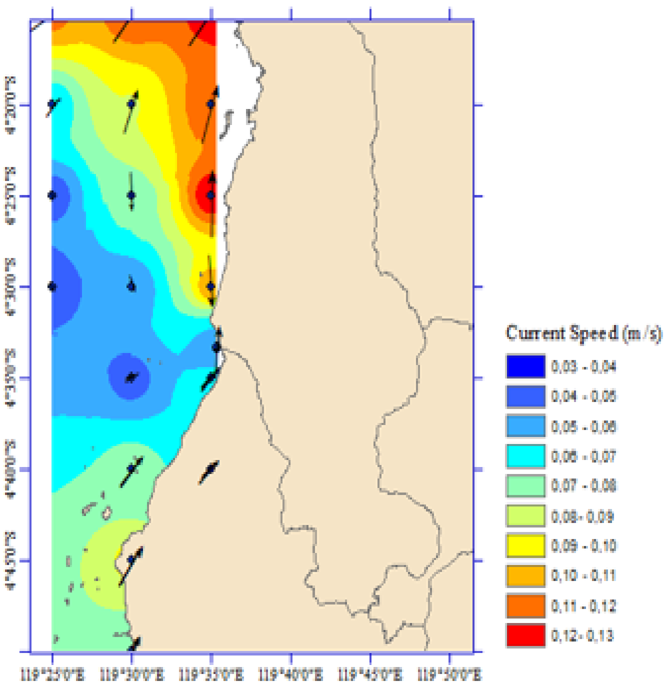

Figure 4. Current Circulation Patterns in Barru Regency Waters at Low Tide.

Sediment characteristics

Analysis of sediment grain size distribution at the three observation points (S1, S2, and S3) revealed a predominance of fine-sized fractions. As illustrated in Figure 5, the 125 µm fraction exhibited the highest percentage across all stations, with values of 54.28% at S1, 58.45% at S2, and 74.40% at S3. The 63 µm fraction also contributed significantly, accounting for 34.01% at S1, 39.32% at S2, and 20.31% at S3, whereas coarser fractions such as 2 mm, 1 mm, and 500 µm were present in relatively small percentages. According to Wentworth's grain size classification, the sediments at the research site are predominantly composed of very fine sand to silt. Elake et al. (2025) emphasize that sediment grain size distribution serves as a crucial indicator for interpreting the energy conditions of depositional environments. The dominance of fine-sized fractions suggests relatively low hydrodynamic conditions in the water. In environments characterized by weak current energy, the capacity of water to transport larger particles is limited, resulting in the deposition and accumulation of fine particles on the seabed. Such conditions are typically observed in sheltered coastal waters or areas influenced by the influx of suspended material from terrestrial sources. This observation aligns with the findings of Bila and Ardhani (2025), who noted that fine sediments, such as silt and clay, are generally deposited in low-energy environments.

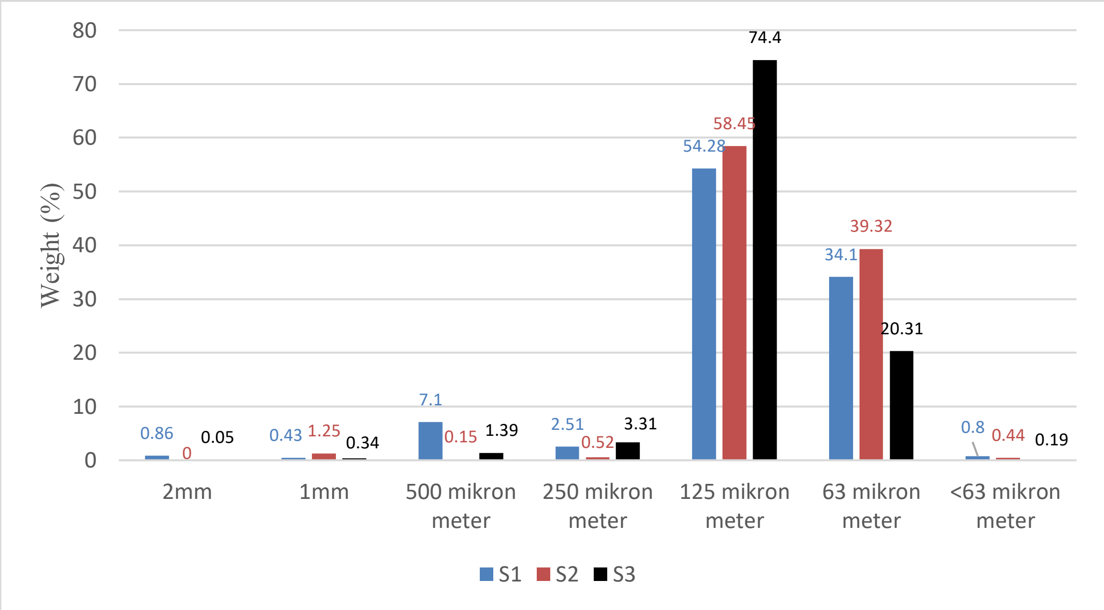

Figure 5. Sediment Grain Size Percentage Distribution Across Observation Stations.

Subsequent analysis, utilizing Shepard's classification to categorize sediment fractions into sand, silt, and clay components, revealed that the sediments at the research site were predominantly composed of sand, with a notable contribution from silt. The classification results, as presented in Table 4, indicate that stations S1 and S2 were classified as sandy silt, whereas Station S3 was classified as sand. This classification suggests that, despite the considerable presence of fine fractions, sand remains the principal component of the sediment composition at the research location. These sediment characteristics reflect the influence of a combination of current energy and the supply of sediment material from terrestrial sources. Fine-sized sediments exhibit higher mobility, rendering them easily transportable by river flows and tidal currents. Under conditions of weak currents, particles are subject to deposition. Conversely, the predominance of the sand fraction at certain stations suggests that, under specific conditions, there is adequate current energy to transport and deposit larger particles. According to Siregar et al. (2014), sediment distribution in coastal areas is significantly influenced by the interaction between currents, waves, and the influx of material from terrestrial sources. Consequently, the distribution of grain size and classification of sediment types at the research site indicate that sedimentation dynamics are affected by relatively low to moderate hydrodynamic conditions, as well as the contribution of sediment material from the land. The interplay of these factors contributes to the formation of sediment characteristics, which are predominantly composed of fine sand and silt in the study area.

Table 4. Sedimentary Fraction Composition and Shepard's Classification Across All Observation Stations.

Stations	Sand (%)	Silt (%)	Clay (%)	Classification
1	65.18	34.01	0.80	Sandy silt
2	60.47	39.32	0.44	Sandy silt
3	79.49	20.31	0.19	Sand

Water quality parameters

According to the measurements of water quality parameters at the research sites, as detailed in Table 5, the temperature at each station ranged from 26 to 27°C. In tropical regions, seawater temperatures typically range from 25 to 28°C in open waters and increase to approximately 28 to 30°C in shallow waters. These temperatures tend to be even higher in enclosed or semi-enclosed waters, such as lagoons or atolls. The relatively minor variation in temperature among the stations suggests that this parameter did not undergo significant fluctuations during the observation period. Analysis of sedimentation rate data indicates that temperature did not directly influence variations in sedimentation values; rather, differences in sedimentation rates were more affected by hydrodynamic factors such as currents and waves. This observation is consistent with the concept that sediment distribution and deposition are predominantly governed by water energy and current dynamics rather than temperature (Tanjung & Sinaga, 2025).

The results of water transparency measurements at each station, as detailed in Table 5, ranged from 60 to 90 cm. Station 3 exhibited the highest water transparency, while Station 1 recorded the lowest. Elevated water transparency values suggest minimal levels of suspended particles in the water, whereas reduced transparency indicates a higher concentration of such materials. This phenomenon is closely associated with sedimentation rates, where stations with diminished water transparency typically experience an increased influx of suspended sediments, thereby potentially elevating sedimentation rates. Conversely, stations with enhanced water transparency contain fewer suspended particles, leading to comparatively lower sediment deposition. This observation aligns with the findings of Hamuna et al. (2018), who asserted that reduced water transparency is attributable to the elevated presence of suspended particles derived from sediment or organic matter.

The data presented in Table 5 indicate that the slope of the seabed at the research sites varied between 0.58 and 0.74, with Stations 1 and 2 exhibiting relatively steeper slopes compared to Station 3. The seabed slope significantly influences sediment distribution and deposition processes. In regions characterized by gentler slopes, sediment accumulation is more pronounced due to the relatively lower energy of currents. Conversely, in areas with steeper slopes, sediments are more readily transported as a result of gravitational and current influences. Analysis of sedimentation rate data reveals that stations with gentler slopes tend to exhibit higher sedimentation values than those with steeper slopes. This observation aligns with the findings of Kalay et al. (2018), who asserted that seabed morphology plays a crucial role in determining sediment deposition patterns.

The measurements of water depth revealed variations ranging from 1.8 to 4 meters, with Station 1 exhibiting the greatest depth and Station 2 the shallowest. The depth of the water significantly influences the intensity of wave and current energy impacting the seabed. In shallower waters, wave energy is typically more intense, thereby increasing the likelihood of sediment resuspension, which results in lower sedimentation rates compared to deeper waters. Conversely, in deeper waters, hydrodynamic energy tends to diminish, allowing sediments to settle more stably. These observations align with the findings of Fernando et al. (2019), who asserted that water depth affects current velocity and sediment deposition.

Table 5. Results of Water Quality Parameter Measurements.

	Water Quality Parameter Measurements			
Station	water transparency (cm)	Slope (°)	Temperature(°C)	Depth (m)
1	60	0.74	27	4
2	79	0.72	26	1.8
3	91	0.58	26.5	3

CONCLUSION

Based on the research findings, it can be concluded that the sediment characteristics in the coastal waters of Tanete Rilau District are predominantly composed of fine fractions, such as very fine sand and silt. The sediment types are classified as sandy silt at Stations 1 and 2, and sand at Station 3. The average sedimentation rate during the observation period was 0.050 g/m²/day, with the highest rate observed at Station 3 (0.23 g/m²/day) and the lowest at Stations 1 and 2 (0.01 g/m²/day). This sedimentation dynamic is influenced by relatively low to moderate hydrodynamic conditions, a mixed predominantly semidiurnal tide type, and sediment supply from terrestrial sources. Practically, these findings suggest that the management of coastal ecotourism areas should incorporate sedimentation considerations by organizing the zoning of tourism activities to avoid areas with high sediment accumulation potential. This should be accompanied by mitigation efforts such as the rehabilitation of coastal vegetation (e.g., mangroves) to reduce sediment supply, as well as regular monitoring of changes in seabed conditions to support the sustainability of the coastal ecosystem.

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