Analysis of suspended sediment distribution in Lamteng waters, Nasi Island, Aceh Besar District, Indonesia

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Abstract. The presence of sediment in the water column that moves without touching the bottom is known as suspended sediment. The distribution of suspended sediments in the coastal area is strongly influenced by river flows and ocean currents. Thus, this study aims to determine the distribution pattern and level of suspended sediment concentration in Lamteng waters, Nasi Island, Aceh Besar District. This research was conducted in October and December 2019. Samples were taken from 15 stations from the research location, each in October and December. Total suspended solids (TSS) samples were analysed using the Gravimetric method, in which the TSS value distribution was presented using the Natural Neighbour method. The results showed that the average TSS value in October was higher than in December. TSS in Lamteng waters shows a value that exceeds the quality standard value based on the Ministry of Environment.

1. Introduction
Sediment that enters a water body and moves without hitting the bottom of the water is called suspended sediment. The distribution of suspended sediments is influenced by climate, river discharge and ocean currents, among others. Hydro-oceanographic conditions such as currents, waves and tides are aspects that directly affect the distribution of TSS [1,2]. The velocity of the water flow can determine the grain size of suspended sediments, as well as affect the movement of the sediment grain size. The high current, the larger the grain size of the sediment and the smaller the current velocity, the smaller the size of the sediment that moves by the current. The currents will also carry sediment to the deposition site. To determine the amount and distribution of suspended sediments in a water area, TSS analysis was performed. Research on suspended sediment is important considering that the TSS value can indicate sedimentation conditions in seawaters, to minimize the adverse impacts that will occur [3]. The main cause of TSS in water is erosion that is carried into water bodies [4]. The study on TSS was carried out in Lamteng, Lamteng is one of the villages on Nasi Island, Aceh Besar District, there is a Lamteng port which is actively used as a sea transportation route to Banda Aceh and Nasi Island. Besides, Lamteng port is a bay port that can be affected by the offshore (Benggala Strait) from the impact of waves and currents resulting in sediment transport and changes in the morphology of the waters. Therefore, this study aims to determine the distribution and concentration level of TSS in Lamteng waters, Nasi Island, Aceh Besar District.
2. Materials and methods

2.1 Determination of research stations
The random sampling method was used in determining the location of the study, where precise location recording was carried out using the Global Positioning System (GPS). Each of the 15 research station location points was determined to represent the research location in October and September, as shown in Figure 1. Thus, the TSS concentration data taken was 30 samples.

2.2 Sediment data collection
Samples were taken temporally, namely in October and December with 15 sample points, respectively. Samples were taken from the surface of the water to a depth of ± 60 cm using a labeled bottle. The filtering treatment was carried out by the method [5]:
1. The blank filter paper is weighed using a digital scale.
2. Homogenize the sample by means shaken, samples strained used 500 ml.
3. Filter paper containing suspended sediment will be dried in an oven with a temperature of 103-105°C.
4. The oven filter paper will be dried for 5 mins.
5. Then the filter paper containing the sediment is weighed using a digital scale.

2.3 Data analysis
Analysis of TSS samples using the Gravimetric method, with the equations (1) based on the National Standardization Agency for Indonesia [6].

\[
\text{TSS (mg/L)} = \frac{(A-B) \times 1000}{V (\text{ml})}
\]  

(1)
Where A is the weight of filter paper + dry residue (mg), B is the weight of filter paper (mg), and V is the volume of water (ml).

2.4 Data Interpretation
The software used is ArcGis, which functions to process grid data and then interpolate it into a contour map that can show the concentration value of the waters using the Natural Neighbor method based on sampling data [7].

3. Results and Discussion
Sediment sample analysis has been carried out at the Laboratory of Marine Chemistry, Universitas Syiah Kuala, to obtain the value of TSS (Figure 2). Based on the monthly average value, it is known that the highest suspended sediment is found at station 2. The highest concentration of suspended sediment in October was at station 12, namely 221.8 mg/L, and the lowest concentration was at station 11, namely 109.8 mg/L. The concentration of suspended sediment that has accumulated a lot at station 12 is influenced by the direction of the west monsoon, according to National Oceanic and Atmosphere Administration (NOAA) data [8]. The current moves from the southwest to the northeast. In December, the highest suspended sediment concentration was at station 2, namely 239.2 mg/L, and the lowest concentration was at station 15, namely 135.9 mg/L. This is influenced by the direction of the east monsoon, NOAA data [8] shows that the current moves from the northeast to the southwest, which is the opposite of the west monsoon current. In accordance with Imanullah et al. [9] which states that in the west monsoon (June to September), the wind moves from the southwest to the northeast and in the east monsoon (December to February), the wind moves from the northeast to the southwest.

![Figure 2. Average Concentration of TSS (mg/L).](image)

Based on Figure 2, the concentration of TSS between October and December, the concentration in December was higher than that of October. One of the factors that influence the difference in suspended sediment concentration is the surface current caused by the wind blowing above it. Surface currents are influenced by climate and weather, the direction of the upper sea surface currents will follow the wind direction. There are differences in the direction of the west monsoon and the east monsoon so that it affects surface ocean currents and suspended sediments carried [10]. October is included in the west to east transitional season, and December is included in the east season. During the transitional season, both during the transition from the west monsoon to the east monsoon as well as during the transition from the east monsoon to the west monsoon the movement of the current is irregular and tends to be divided into two directions, but the average flow velocity is weak in almost all waters in Indonesia [11].
In addition, Lamteng waters which are Gulf waters can also cause differences in suspended sediment concentrations based on the location and direction of the bay opening. During the western transitional season in Figure 3, the wind moving from the west will be obstructed by the land so that it makes the current movement relatively small and the concentration of sediment carried is also small.

Meanwhile, during the eastern monsoon Figure 4, the wind moves from the open sea, namely the northeast to the west side of the land, the relatively large current movement triggers more suspended sediment concentrations. This agrees with Akhrianti et al. [12], that high current speeds can cause high TSS values. The current velocity is relatively large at the mouth of the bay because it is directly facing the sea which can be directly influenced by the sea. Alvarez et al. [13] said that the concentration of suspended sediments in the Gulf is influenced by the depth and currents that can trigger turbulence of the bottom sediments so that they are suspended in the water column.

The results of TSS distribution interpolation were carried out using the natural neighbor method [7] in Lamteng waters in Figures 5 and 6 show the distribution of sediment concentrations that vary according to the direction of the wind and currents that occur in Lamteng waters. Figure 5 during October, the dominance of TSS concentrations is in the north to the northeast and the high seas. In Figure 6, during December, the dominance of TSS concentrations is in the southwest coastline. The difference in the sediment pile is caused by the current that moves due to the wind, which causes the suspended sediment to be carried along with the current. Referring to the location of different sediment piles, it is suspected that there is a longshore current, that there is a current that occurs in the area between the breaking wave and the shoreline or it is called a longshore current which is caused by a breaking wave that forms an angle to the shoreline. The angle of the breaking of the wave varies, the higher the incoming wave, the greater the breaking of the wave, and the velocity of the longshore current is also higher. The flow of longshore currents can also transport the sediment and bring it to the beach or along with the so-called sediment transport [14]. The direction of the transport along the bay waters corresponds to the direction of the incident waves and the angle between the waves and the coastline [15]. Based on the distribution results and TSS value in Lamteng waters, it shows that the concentration value exceeds the quality standard value. According to the Decree of the State Minister for the Environment Number 51 of 2004, a good TSS value for marine biota is less than 80 mg/L. Davis and Cornwell [16], Razif et al. [17], and Basheer et al. [18] stated that the TSS value is one part that plays a role in determining the environmental quality of waters. If waters have a high value of turbidity or TSS,
the lower the productivity value of waters. This affects water conditions and indicates the level of pollution that can damage marine biota ecosystems.

Figure 5. Concentration Distribution of TSS (mg/L) in Lamteng Waters in October.

Figure 6. Concentration Distribution of TSS (mg/L) in Lamteng Waters in December.
Conclusion
Based on the research results, the highest TSS concentration in October was at station 12, namely 221.8 mg/L. In December, the highest TSS concentration was at station 2, namely 239.2 mg/L. The average TSS concentration obtained shows the dominant distribution of TSS at station 2. In October, the dominance of TSS concentrations occurred in the north to the northeast and the open seas. During December, the dominance of TSS concentrations occurred in the coastal areas of the southwest. The distribution results of TSS in Lamteng waters show a concentration value that exceeds the quality standard value, this shows the level of pollution that can damage the marine biota ecosystem.

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