The impact of marine sand mining on sea water quality in Pantai Labu, Deli Serdang Regency, Indonesia

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Abstract. Marine sand mining in Pantai Labu in 2008-2009 and 2017-2018 have drawn protests from the local community because they are detrimented. The impact of this marine sand mining results in environmental damage (degradation) of the coast such as abrasion and decreased productivity of marine fisheries due to declining water quality. This study aims to determine the current condition of sea water quality after sand mining in the area. From the results of research carried out it is known that the current condition of seawater quality decreases from before the presence of marine sand mining activities. This is known by looking at the results of water quality measurements that have been carried out by sand mining companies before sand mining activities are carried out. In this research, it is known that TSS contributes to the sea water pollution because the amount contained ranges from 169-186 mg/l and exceeds the quality standard stipulated in Minister of Environment Decree No. 51/2004 concerning Sea Water Quality Standards for Marine Biota, which is 80 mg/l. Seawaters quality parameter test results with the Storet Method concluded that the seawaters of Pantai Labu are now classified as good (lightly polluted). With the Shannon-Weaner analysis, the plankton diversity index in seawaters of Pantai Labu classified in medium diversity, the spread of the numbers of individuals of each type is medium.

1. Introduction
Sand mining is an attempt to take sand from the seabed and move it to another location. Marine sand mining improves beach abrasion damaging mangroves and other coastal ecosystems. Coastal abrasion and sedimentation can occur naturally by waves, currents, winds, river sedimentation, coastal vegetation, and tectonic / volcanic activities, and / or human factors such as port construction, sand mining, destruction of coastal vegetation, aquaculture, choice, and reclamation beach [1]. Sand mining by exploiting wastes mud at the bottom of the stir so that it increases turbidity and the number of TSS (Total Suspended Solids) in the mine area. By increasing the turbidity of benthic communities at the base also hampered, abundance and biodiversity can only be approved after 1 to 3 years but the recovery of biota requires a long time [2]. Correspondingly, [3] in their research on ecosystem damage due to marine sand mining in Korea can be seen in the following Figure 1.
According to Presidential Decree No. 33/2002 concerning Control and Supervision of Exploitation of Sea Sand, sea sand is a sand excavation material that is found in all coastal and marine waters of Indonesia which is not classified as Group A and / or B excavated material according to its economic aspect and sea sand is one of the natural resources which cannot be renewed. However, marine sand mining is still permissible according to the existing laws and regulations if it is carried out in accordance with the provisions and regulations of marine sand mining that have been determined.

Marine sand mining activities in Pantai Labu offshores began in 2008 and carried out by several sand mining companies to meet the needs of Belawan International Container Terminal (BICT) sand piles and Steam Power Plant (PLTU) in Belawan. The coordinates of the mining location and transport capacity differ according to the provisions of the Mining Business Permit Area in the RKL-RPL of the Sand Mining Activity Plan. Before this sand mining activity was carried out, the company had obtained permits and recommendations from the Department of the Environment and the Department of Mining and Energy of the Province of North Sumatera with the provisions stipulated in the RKL-RPL guided by Law No. 1 of 2014 concerning Constitution No. 27 of 2007 concerning Management of Coastal Area and Small Islands article 17 (1) which states that "the granting of location permits must consider the preservation of coastal and small island ecosystems, traditional fishing communities, national interests, and the right of peaceful crossing to foreign vessels".

Since the existence of sand mining activities in Pantai Labu, the community has begun to feel the impact of the decline in marine fisheries productivity and abrasion which has resulted in a reduction in the area of the beach to hundreds of square meters. According to data from the Marine and Fisheries Office of Deli Serdang Regency, the amount of marine fisheries production in 2017 decreased from 7,213.50 tons/year in 2016 to 6,974.03 tons/year. The decline in productivity of marine fisheries is caused by disruption of aquatic ecosystems since sand mining has been carried out. Up to 10 years the marine sand mining activities of the community increasingly feel the magnitude of the negative impacts that arise. This triggered protests from the community and fishermen to the company and the government that gave permission for sand mining even though until now there has been no solution to the problem. On this basis, the author is interested in conducting research to find out the current condition of sea water quality as a result of the existence of marine sand mining activities in Pantai Labu, Deli Serdang Regency, Indonesia.

2. Methods
The research method that used to measuring sea water quality is the Storet Method in accordance with Minister of Environment Decree No. 115 of 2003 concerning Guidelines for Determination of Water Quality Status. Water quality status is the level of water quality conditions that indicate polluted conditions or good conditions at a water source within a certain time by comparing with the specified
water quality standards. In principle, the Storet Method is to compare water quality data with water quality standards adjusted for their designation to determine water quality status.

The procedure for using the Storet Method is as follows:
1. Collecting sea water quality data so that it forms data over time (time series data).
2. Compare the measurement data from each water parameter with a quality standard value that is suitable for the water class.
3. If the measurement results meet the water quality standard value (measurement results < quality standard) then a score of 0 is given.
4. If the measurement results do not meet the water quality standard values (measurement results > quality standards), then a score is given according to Table 1.
5. The negative sum of all parameters is calculated and the quality status is determined from the total score obtained using the value system.

Table 1. Scores of each parameter in Storet Method

| Total Parameter | Value | Physics | Chemistry | Biology |
|-----------------|-------|---------|-----------|---------|
|                 | < 10  | Max     | -1        | -2      | -3      |
|                 |       | Min     | -1        | -2      | -3      |
|                 | Average | -3   | -6        | -9      |

Determination of the water quality status was conducted by using the US-EPA (Environmental Protection Agency) value system by classifying the air quality in fourth grade.

Table 2. Water quality status

| Group | Category | Total | Water Quality Status |
|-------|----------|-------|----------------------|
| A     | Very Good| 0     | Standard Quality     |
| B     | Good     | -1 s/d -10 | Lightly Polluted   |
| C     | Medium   | -11 s/d -30 | Medium Polluted    |
| D     | Bad      | > -30  | Heavily Polluted     |

Table 3. Parameter, analysis, and method

| Parameter | Unit | Analysis | Method Analysis |
|-----------|------|----------|-----------------|
| Physics   |      |          |                 |
| Temperature | °C   | In-situ  | SNI 06-6989.23-2005 |
| Turbidity | NTU  | In-situ  | Turbidymeter    |
| TSS       | mg/l | Lab Analysis | SNI 06-6989.3-2004 |

| Chemistry |      |          |                 |
| pH        | -    | In-situ  | SNI 06-6989.11-2004 |
| Salinity  | %o   | In-situ  | Refractometer   |
| DO        | mg/l | Lab Analysis | SNI 06-6989.23-2005 |
| BOD<sub>5</sub> | mg/l | Lab Analysis | SNI 6989.72-2009 |

| Biology  |      |          |                 |
| Plankton | cell/100ml | Lab Analysis | Plankton Net   |

Seawater sampling is carried out during the day at high tide. Measurements of temperature, pH, and turbidity, salinity is carried out in-situ while TSS, DO and BOD<sub>5</sub> measurements are carried out in the laboratory (ex-situ). Sampling for each parameter was done with two replications.
3. Results and discussion

3.1. Description of research location
Pantai Labu is one of the coastal districts in Deli Serdang Regency. Geographically, this district is located at 3°62' - 3°69' LU and 98°80' - 98°93' BT which is a low-lying area with an altitude of 0-1 m above sea level with an area of 81.85 km². The north is bordered with the Malacca Strait, the east is bordered by Pantai Cermin District, Serdang Bedagai Regency, the south is bordered with the Beringin District, and the west is bordered with Batang Kuis and Percut Sei Tuan Districts. Pantai Labu consists of 19 villages where there are 6 villages directly adjacent to the Malacca Strait, namely Denai Kuala, Paluh Sibaji, Pantai Labu Pekan, Rugemuk, Bagan Serdang and Sungai Tuan. This district is fed by 2 (two) rivers namely the Ular River and Belumai River.

The study was conducted in Pantai Labu waters and seawater quality tests were carried out at the Shafera Enviro Laboratory. The study was conducted for 3 months from May to July 2019.

![Figure 2. The map of research location](image1)

3.2. Seawater Quality
Seawater sampling is carried out 2 (two) times, namely on May 10, 2019 and May 25, 2019 at high tide, which is 2pm until 4pm. Sampling points are 4 locations around sand mining that represent villages directly affected by marine sand mining, namely waters of Rugemuk, Paluh Sibaji, Pantai Labu Pekan and Denai Kuala.

![Figure 3. Measurement of seawater quality in-situ](image2)
![Figure 4. Plankton sampling](image3)
After conducting the research, information on seawater quality was obtained as shown in the Table 4.

**Table 4. The average of parameter test results**

| No. | Parameter | Unit | Quality Standard | Sampling Points* | Method |
|-----|-----------|------|------------------|------------------|--------|
|     |           |      |                  | I    | II   | III  | IV   |                      |
| **Physics** |          |      |                  |      |      |      |      |                      |
| 1  | Temperature | °C  | 28-30            | 28   | 28   | 27.5 | 28   | SNI 06-6989.23-2005  |
| 2  | Turbidity  | NTU | <5               | 2.07 | 1.99 | 1.27 | 0.49 | Turbidymeter          |
| 3  | TSS        | mg/l | 80              | 169  | 179  | 179.5| 186  | SNI 06-6989.3-2004   |
| **Chemical** |          |      |                  |      |      |      |      |                      |
| 4  | pH         |      | 7-8.5            | 8.8  | 9.1  | 7.9  | 7.95 | SNI 06-6989.11-2004  |
| 5  | Salinity   | %   | 34               | 23.5 | 24   | 24.5 | 24   | Refraktometer         |
| 6  | DO         | mg/l | >5              | 8.52 | 8.575| 9.96 | 9.14 | SNI 6989.72-2009     |
| 7  | BOD₅       | mg/l | 20              | 0.755| 0.4  | 1.735| 0.52 | SNI 6989.72-2009     |

I : Rugemuk (03°41’39.99” U; 98°53’46.78” T and 03°42’18.30” U; 98°53’13.60” T)  
II : Paluh Sibaji (03°41’52.18” U; 98°54’24.34” T and 03°42’11.16” U; 98°57’41.07” T)  
III : Pantai Labu Pekan (03°41’40.22” U; 98°54’59.24” T and 03°42’11.34” U; 98°56’66” T)  
IV : Denai Kuala (03°41’29.29” U; 98°56’02.03” T and 03°42’44.71” U; 98°55’41.91” T)  

From the data above, it is known that the number of TSS in the waters of Pantai Labu has exceeded the quality standard stipulated by Minister of Environment Decree No. 51 of 2004 concerning Seawater Quality Standards for Marine Biota. Likewise, the pH value in the waters of the Rugemuk Village and Paluh Sibaji Village. Measurement results that do not meet water quality standards (measurement results > quality standards) are given a score as in Table 5.

**Table 5. Scores from each parameters**

| No. | Parameter | Scores |
|-----|-----------|--------|
|     |           | I     | II    | III   | IV    |
| **Physics** |          |       |       |       |       |
| 1   | Temperature | 0     | 0     | 0     | 0     |
| 2   | Turbidity   | 0     | 0     | 0     | 0     |
| 3   | TSS         | -3    | -3    | -3    | -3    |
| **Chemical** |          |       |       |       |       |
| 4   | pH          | -6    | -6    | 0     | 0     |
| 5   | Salinity    | 0     | 0     | 0     | 0     |
| 6   | DO          | 0     | 0     | 0     | 0     |
| 7   | BOD₅        | 0     | 0     | 0     | 0     |
| Total |           | -9    | -9    | -3    | -3    |

By using a value system from the US-EPA (Environmental Protection Agency) the quality status of Pantai Labu’s seawater is determined to fall into the category B (Good) or Lightly Polluted.

**3.3. Plankton**

Plankton is a water organism that lives floating or hovering in water whose movements are relatively passive (moving with the current) so that its distribution is strongly influenced by the power of water. Based on its size, plankton are distinguished above. 1) Ultra Plankton whose size is < 2 μm, 2) Nanoplankton whose size is between 2-20 μm, 3) Microplankton measuring 20-200 μm, 4)
Mesoplankton measuring 200-2000 μm, 5) Megaplankton whose size is above 2000 μm [10]. Plankton itself consists of phytoplankton and zooplankton. The existence of plankton in water becomes very important because plankton forms the basis of food webs in water. That is, plankton is an important food source for other aquatic organisms such as fish that live in fresh and marine waters. Zooplankton is a secondary producer where zooplankton feeds on phytoplankton. In the next process, zooplankton is a natural food for fishes [11]. The difference between phytoplankton and zooplankton is the ability to carry out photosynthesis with the availability of chlorophyll in the cells [12]. In the seawaters of Pantai Labu found phytoplankton consisting of 4 classes, 17 families, and 21 species such as Biddulphia sp, Tabellaria sp, Asterionella sp, Synendra sp, Cymbella sp, Navicula sp, Frustulia sp, Bacillaria sp, Nitzschia sp, Coscinodiscus sp, Chaetoceros sp, Melosira sp, Cocconeis sp, Rhizosolenia sp. Zooplankton belonging to 5 classes, 6 families, and 7 species such as Acartia sp, Calanus sp, Nauplius sp, Difflugia sp, Nebela sp, Ceratium sp, Branchionus sp.

Plankton diversity index value data where analysed descriptively to determine the high and the low diversity of plankton in the seawater of Pantai Labu. Plankton diversity is based on Shannon Weaner as below; [13].

| Index Diversity Plankton | Criteria |
|--------------------------|----------|
| < 2.3026                 | Low diversity, the spread of the numbers of individuals of each type is low |
| 2.3026 – 6.9076          | Medium diversity, the spread of the numbers of individuals of each type is medium |
| > 6.9076                 | High diversity, the spread of the numbers of individuals of each type is high |

From the Table 6, the plankton diversity index in seawater of Pantai Labu classified in medium diversity, the spread of the numbers of individuals of each type is medium.

![Index Diversity Plankton](image)

**Figure 5.** Diagram of Index Diversity Plankton

**4. Conclusion**

Marine sand mining activities have an impact on the decline in sea water quality, especially on TSS (Total Suspended Solid) parameters. The average value of TSS in Pantai Labu ranged from 169-186 mg / l. This number has exceeded the quality standard stipulated in Minister of Environment Decree No. 51 of 2004 concerning Seawater Quality Standards for Marine Biota that is equal to 80 mg/l. The high TSS content in the sand mining area might be caused by this mining activity stirring the bottom of the water and requires a long time to restore water conditions. With the Shannon-Weaner analysis, the plankton diversity index in seawater of Pantai Labu classified in medium diversity, the spread of the numbers of individuals of each type is medium.

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