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Determination of Water Quality Status at Belawan Harbour Using STORET Method

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ABSTRACT

The operation and development of the harbour is closely related to pollutant sources in the waters, especially the waters of the Belawan Harbour in Medan. This study aims to assess the status of water quality and determine the index of pollution in the waters. The data used in this study are water quality data from the Medan Harbour's environmental management monitoring and reharbouring book in 4 (four) years during 2015 to 2018. Methods for determining the level of water quality status using the STORET method (Water Quality Data Retention and Retrieval System) and compared to the quality standards of Environmental Decree from Republic Indonesia Number 51 of 2004. Based on the analysis of the testing of 14 seawater sampling points around the waters of harbour, results of measurements of seawater quality in physics, chemistry and biology were varied. The level of pollution of the waters of Belawan Harbour shows the results of analysis that the waters of the Belawan Harbour are in the moderate polluting class with a value of -12 to -19, while 1 (one) station is in the light polluted class with a value of -10.

Keywords : Harbour Management, STORET, Water Quality

I. INTRODUCTION

Harbour of Belawan is the third largest (three) harbour in Indonesia after Tanjung Priok and Tanjung Perak Harbours in Surabaya. The geographical position of Belawan harbour is in the estuary of 2 (two) large rivers, namely the Belawan River and Deli River with coordinates 03º 47 '00 "LU and 98" 42 "BT, besides that it faces the Malacca Strait has a high potential as an operation center and regional economic development in particular.

Development and operation activities such as the construction of docks, caused changes in sediment trans harbour and pollution due to contaminant inputs from several polluted sources such as industrial activities around the harbour, liquid waste, domestic liquid waste, and the like and the use of antifouling paint as hull liners NRC (1997) Among the various activities, repairing and repainting ships and cruise ships around the harbour is a very dangerous activity Pourabadehei and Mulligan CN (2016). Over the years antifouling paint has been applied to the hull of the ship to protect ships from living organisms that are attached Turner (2010).

Other anthropogenic activities in harbour areas such as maritime, residential and maritime tourism and the development of aquaculture and fisheries. These activities will certainly affect the quality of the coastal region. A very dominant problem for coastal, coastal and marine areas is the occurrence of

pollution which results in a decrease in the quality and quantity of coastal and marine resources. Decreasing water quality will reduce the usability, yield, productivity, carrying capacity and capacity of aquatic resources which ultimately reduce natural resource wealth. According to Gholizadeh et al. (2016) that any changes in ecosystems are vulnerable due to anthropogenic activities that can endanger fish habitat and other aquatic organisms.

Harbour of Belawan as a meeting place for 2 (two) major river estuaries in Medan City, the load carried from upstream to downstream is also diverse. The load carried to the downstream then settles on the bottom of the water and this is a measure of water fertility, one of the determining factors is the quality of water. Therefore, to preserve coastal and marine functions in the Belawan Harbour area, an assessment of the quality status of the waters of Belawan Harbour in Medan is necessary to follow up on the quality management and control of water pollution in harbours to realize a sustainable harbour. This study aims to determine the value of water quality to get an overview of the level of water quality status, especially in the Harbour of Belawan.

II. METHODS AND MATERIAL

Determining the location of the sample is the point that is considered to represent an area that is reviewed includes the Area of Work Environment (DLKr) and the Imharbourant Environmental Area (DLKp) of the Belawan Harbour of Medan (**Figure 1**).

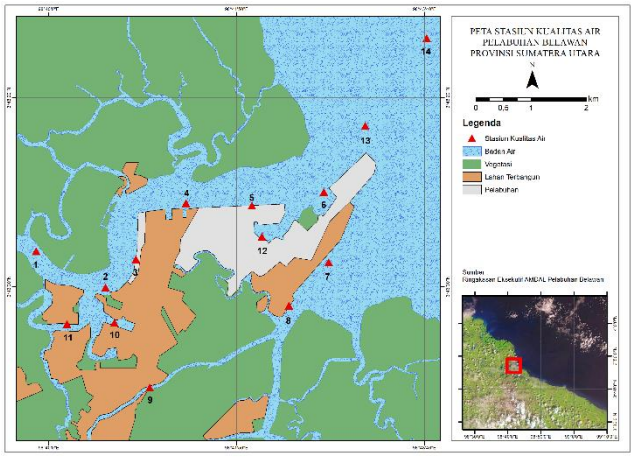


Figure 1. Water Monitoring Station of Belawan

Harbour waters is:

- St 1: 500 ml upstream of the Sicanang PLTU
- St 2: Plywood Factory PT. Tjipta Rimba
- St 3: LANTAMAL Pier
- St 4: Dredging dock
- St 5: Warehouse 107 Ujung Baru
- St 6: Jetty PT. Pertamina
- St 7: Fish auction pier (TPI)
- St 8: Bagan Deli
- St 9: Bridge of Deli River Kp. Syukur
- St 10: Kel. Belawan Bahagia
- St 11: Industrial Kel. Belawan Sicanang
- St 12: Shipyard of PT. Waruna Nusa S.
- St 13: Buoy VII
- St14: Dumping the sediment area

The data used in this study are secondary data including: water quality data from the harbour's environmental reharbouring and monitoring books from 2015 to 2018, and seawater quality standards for harbours from the Minister of Environment Decree from Republic Indonesia Number 51 of 2004.

Analysis of the status of seawater quality is carried out according to the first objective, namely by using the STORET method as one of the determinations of commonly used water quality as recommended in the Decree of the Minister of Environment No. 115 of 2003. With the STORET method, parameters can be met that have exceeded sea water quality

In principle, the STORET method is to compare the sea water quality data with seawater quality standards. From the results of the comparison, harbour waters can be categorized as water quality status. The way to determine the status of seawater quality is to use a value system from "US EPA (Environmental Protection Agency)", by classifying water quality into four, namely:

1. Class A : Very good, score = 0 meets is quality standards
2. Class B : Good, score = -10 mild polluted
3. Class C : Moderate, score = -11 to -30 is moderate polluted
4. Class D : Bad, score = -31 heavily is polluted.

Determination of water quality status using the STORET method is carried out by the following steps:

a. Presents a table of water quality analysis that contains all the values of the results of physical-chemical measurements of water.
b. Measurement data from each water parameter are compared with the quality standard values that are in accordance with the water class.
c. If the measurement results meet the water quality standard (measurement results ≤ quality standard) then given a score of 0.
d. If the measurement results do not meet the water quality standard (measurement results ≥ quality standard), then the score is given based on the following (Table 1).

TABLE 2.1

DETERMINATION OF VALUE SYSTEMS TO DETERMINE WATER QUALITY STATUS

Test Parameters	Value	Parameters		
		physics	Chemistry	Biology
<10	Max	-1	-2	-3
	Min	-1	-2	-3
	Average	-3	-6	-9
≥ 10	Max	-2	-4	-6
	Min	-2	-4	-6
	Average	-6	-12	-18

Source of KMLH 115/2003

Determine the negative score of all parameters calculated and determine the quality status of the number of scores obtained using the value system.

III.RESULTS AND DISCUSSION

3.1. Water Quality at Waters of Medan Belawan Harbour during 2015 to 2018

The quality of waters for habours should ideally meet standards both physically, chemically, and biologically. The value of harbour water quality that exceeds the threshold for seawater quality standards for established harbours will be classified as polluted waters. The results of observations obtained at each monitoring point are presented in graphical form and discussed physically, chemically, and biologically.

a. Physical parameters

Water quality observed physically includes turbidity, TSS, and temperature. After being compared with seawater quality standards for harbours from the Decree of the Minister of Environment Number 51 of 2004, the analysis results were seen when visualizing that turbidity level measurement data showed that in general the waters of Belawan Harbour had exceeded the specified quality standards (quality standard ≤ 3 meters). This is caused by the open waters of the Belawan Harbour so that there is influence from the land with the arrival of 2 (two) rivers in the harbour carrying sediments and pollutants which cause turbidity levels in high waters. According to Davis in Widiadmoko (2013), the ability of sunlight to penetrate to the bottom of the water is affected by turbidity of water. Therefore, the brightness and turbidity of seawater is very influential in the growth

of marine biota. Brightness levels of sea water greatly determine the level of photosynthesis of biota in marine waters.

The content of Total Suspended Solid (TSS) in general is still below the quality standard (< 80 mg / l) during 2015 to 2018 can be seen in (**Figure 2**). TSS consists of mud and sand as well as microorganisms, mainly due to soil erosion that enters the body of water (Rasyiid, 2015). This is presumably due to the influence of currents and tides which make the transharbour attracted to the bottom of the sediment.

Temperature in the waters of the Belawan Harbour in Medan generally tends to be stable from 2015 to 2018 and is still in the range of specified quality standards between 21.2° C to 29.2° C (Pelindo II, 2007) with a tolerance of ± 2° C. Water temperature plays a role in controlling the condition of aquatic ecosystems. Increased temperature causes an increase in decomposition of organic matter by microbes Effendi (2003).

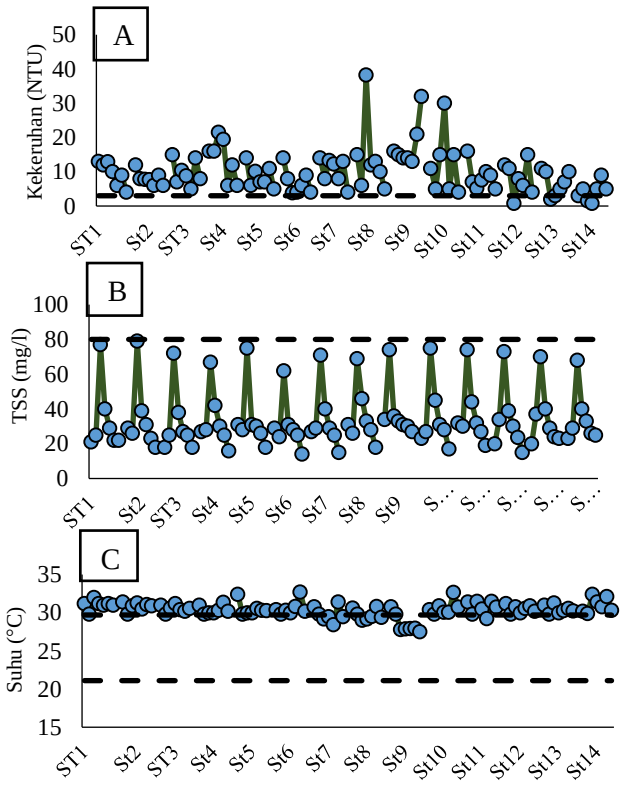


Figure 2. Physical Water Quality

A : Turbidity
B : Total suspended solid
C : Temperature

b. Chemical parameters

Measured physical quality includes pH, salinity, ammonia, sulfides, surfactants and fatty oils. pH value in all monitoring stations in the last 4 (four) years shows that they are still in accordance with the quality standard for harbour waters, which are between 7.5 to 8.13 (quality standard: 6.5 ≤ pH ≤ 8.5). The degree of acidity (pH) is a negative logarithm of the concentration of hydrogen ions released in a liquid and is an indicator of the deterioration of a waters. The pH of a waters is one of the imharbourant chemical parameters in monitoring water stability Simanjuntak (2009).

Sea water salinity can affect the saturation level of dissolved oxygen, where the higher the salinity capacity the oxygen saturation in water decreases. Salinity measured at each monitoring point. The results of monitoring clearly show that all salinity parameter monitoring stations are still in accordance with the designated Threshold Limit (NAV). The quality standard used is based on the assumption that sea water has a salinity range of 30 ‰ to 40 ‰ Effendi in Sunarwan (2006).

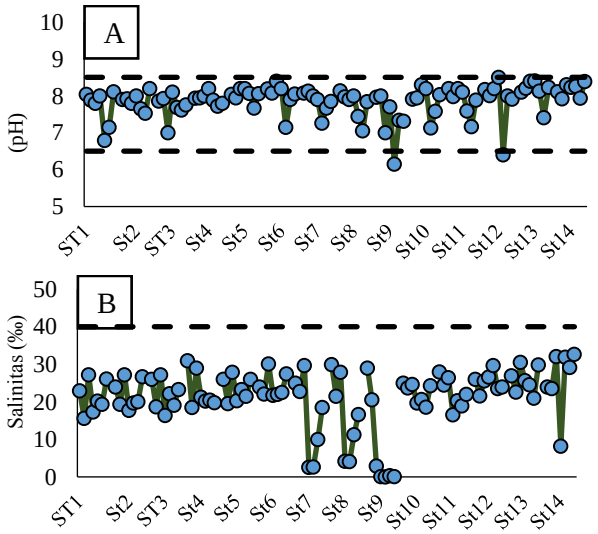
The ammonia content in 2015 showed that at stations 1, 7, 8, 11 and 14 exceeded the predetermined quality standard at station 1 at 0.51 mg/l, station 11 at 0.67 mg/l, station 14 is 0.53 mg/l, and the highest and very far value from the quality standard is station 7 of 2.07 mg/l and station 8 of 1.59 mg/l. The high ammonia value at the observation station, presumably as a result of the high organic matter from the waste entering and the garbage undergoing a degradation process is caused by station 8 in the densely populated settlement of Deli Bagan and station 7 at the pier Fish Auction Place (TPI). High levels of ammonia can be indicated by contamination of organic matter from

domestic waste, industrial waste, and agricultural fertilizer runoff Effendi (2003).

Observations for sulfide concentrations in 2017 phase I and in 2015 stage II were above the specified quality standard (quality standard <0.03 mg/l). This is allegedly due to the low decay process of organic materials containing sulfur by anaerobic bacteria and also as a result of reduction with anaerobic conditions against sulfate by microorganisms Triana in Apriliana (2014).

The surfactant content at each station is generally at a predetermined quality standard (quality standard <1 mg/l). Surfactants are a large number of organic molecules that are difficult to dissolve in water and cause foam in the waters. The presence of chemical waste in the form of excessive soap (detergent) in the water is characterized by the emergence of soap bubbles on the surface of the water Kamiswari (2013).

Overall, from the observation / monitoring results, the oil and fat content is still below the applicable quality standard of the applicable threshold value (quality standard <5 mg / l). The oil and fat content in the waters of Belawan Harbour can come from the fuel of ships and boats in the harbour itself. In addition, its presence can also come from domestic, industrial, fish washing, disposal of fish meat and special fish blood at fish auction docks.



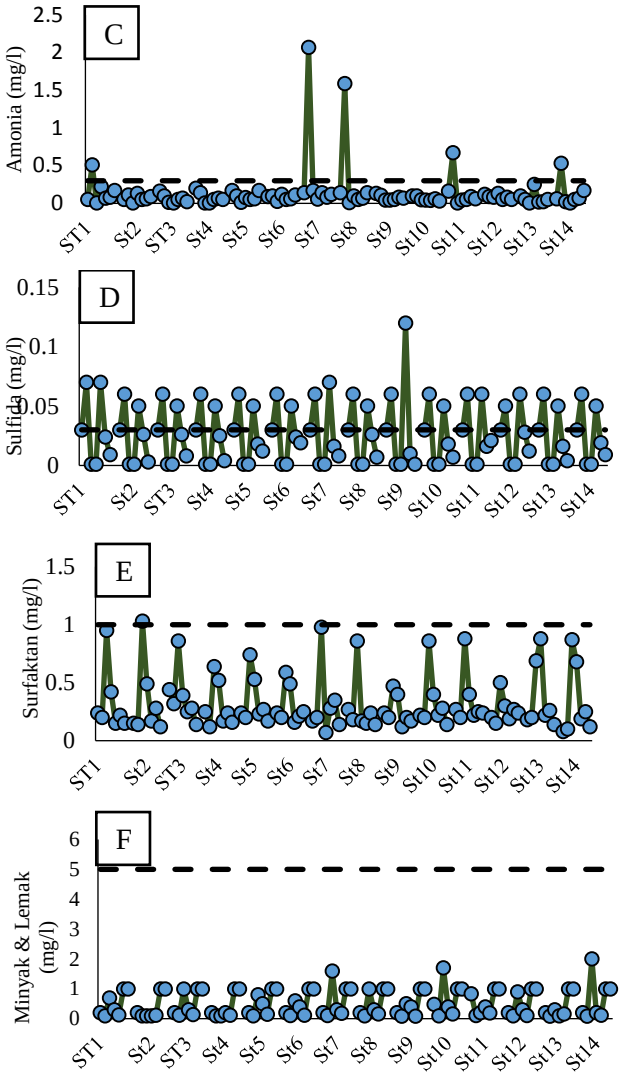


Figure 3. Chemical Water Quality

A : pH
B : Salinity
C : Ammonia
D : Sulfide
E : Surfactan
F : Oil and fat

c. Biology Parameters

Coliform is a class of intestinal bacteria that lives in the digestive tract of humans and animals. Coliform bacteria are used as an indicator of dirt pollution and bad conditions for water, food and drinks. The presence of bacteria in water shows a low level of sanitation Treyens (2009). The monitoring results show that there are still Coliform bacteria at several

monitoring stations. Even at station 1 (upstream Sicanang PLTU) and station 2 (PT Tjipta Rimba Jaya's plywood factory) is located right on the mouth of the Belawan river before harbour activity, in the 2015 phase II monitoring, the amount exceeds the applicable threshold value (quality standard <1000 ml) .

The cause of the high number of coliforms reflects the high level of pollution caused by human excrement and possibly due to the fact that many people who live on the banks of the Belawan river do not yet have the awareness to use septi tanks and remove stool directly into the body of the Belawan river which empties into Belawan Harbour waters.

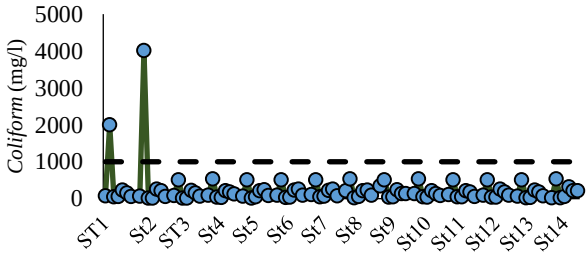


Figure 4. Coliform content in the water

2.2. Water Quality Status Based on STORET Method

To determine the pollutant level overall can be analyze using STORET (Storage and Retrieval of Water Quality Data System) method. STORET method can describe the parameters that fullfill or excess of water quality standard. STORET method principally is give comparation between water quality with the standard suitable with the function to determine the status. Based on the calculation using STORET method acquired water quality status water of Harbour Belawan from 2015 until 2018 that can be viewed in (**Table 3.1**) and graph of water quality status in (**Figure 5**).

TABLE 3.1

WATER QUALITY STATUS HARBOUR OF BELAWAN BETWEEN 2015-2018 USING STORET METHOD

St	Stations	Score	Water Quality Status
1	upstream PLTU Sicanang	-19	Moderate
2	Plywood Factory PT. Tjipta Rimba	-17	Moderate
3	Pier Belawan Lama	-12	Moderate
4	Dredging dock	-12	Moderate
5	Warehouse 107 Ujung Baru	-12	Moderate
6	Jetty PT. Pertamina	-12	Moderate
7	Fish auction pier (TPI)	-17	Moderate
8	Bagan Deli	-17	Moderate
9	Bridge of Deli River Kp. Syukur	-10	Good
10	Kel. Belawan Bahagia	-14	Moderate
11	Industrial Kel. Belawan Sicanang	-13	Moderate
12	Shipyard of PT. Waruna Nusa S.	-13	Moderate
13	Buoy VII	-12	Moderate
14	Dumping the sediment area	-14	Moderate

Information:

Kelas B : Good = mild polluted

Kelas C : Moderate = moderate polluted

This is because station 9 is the only station that is still in a river that has not been affected by tides. Whereas the other stations are at the mouth of the Belawan River and Sungai Deli to the sea or coastal areas. Coastal areas are affected by land activities such as industrial activities, settlements, hotels, tourism and marine activities such as shipping, sea dumping, aquaculture, and so on, which makes the increasingly complex sources of pollutants in the waters of Belawan Harbour.

According to Siahainenia in Damaianto and Masduqi (2014), there will be various types of garbage and pollutants in the sea, which of course can lead to environmental degradation in coastal areas and surrounding ecosystems. So that excessive influx of organic and inorganic substances into water bodies has a negative impact on marine waters and causes a decrease in the quality of sea water physically, chemically and biologically. If depressing the number of samples in 100%, it will be clear that 92.86% states the quality status of the water entering into the polluted is moderate, while classified as the light class is only 7.14% can be seen in **Figure 5**.

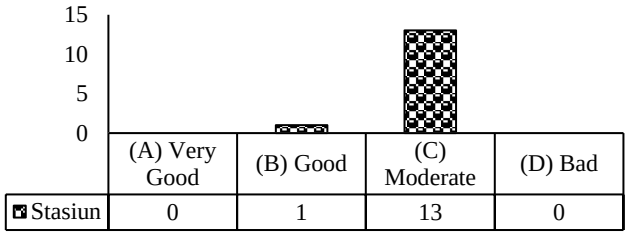


Figure 5. Graph of water quality at Belawan Harbour

IV.CONCLUSION

Based on data analysis using the STORET method and comparing with the Decree of the State Minister of Environment No. 51 of 2004 seawater quality standards for the harbour area, the conclusions from this study are:

1. The physical parameters of temperature and TSS indicate that Belawan Harbour waters are still in good quality while turbidity is above the quality standard.
2. The chemical parameters of water for pH, salinity, surfactant and fat oil are in good status while for ammonia and sulfide some are far above the quality standard.
3. The biological parameters of water, namely total coliform, show that Belawan Harbour waters are of good quality except at stations 1 and 2 in 2015.
4. Pollutant sources that cause a decrease in water quality around the harbour are from.
5. The level of pollution of the waters of Belawan Harbour in Medan is lightly polluted to moderate contamination, so the standard quality of the waters is included in class B (good) and class C (medium).

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