Saprobic analysis to Marina coastal, Semarang city

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Abstract. Semarang city is one of coastal city in Indonesia, that antropogenic activities have impact to coastal of Semarang, including Marina beach. Therefore, it is important to study the quality of seawater related with antropogenic activities. The research purpose was to analyze the saprobic level of Marina beach as an indicator of marine pollution. This case study research used survey method. Purposive method was used for sampling the seawater at five stations at the beach. This research can be concluded that TSI (Tropic Saprobic Index) higher than standard that indicated the Marina Beach Seawaters polution at level of $\beta$ – Mesosaprobic.

1. Introduction
Semarang city is one of coastal city in Indonesia, where is located in north coastal of Java, with coastal area of Semarang city is 37.376 ha [1]. Semarang city is the capital city of Central Java Province, and become the centre of trade and industry in Central Java Province. Coastal areas are central to human activities, including centre of trade, industry, aquaculture, capture fisheries, tourism and houses. So, coastal areas are susceptible to pollution, including Pantai Marina Semarang as one of the coastal tourism sites in Semarang City.

The quality of the waters at Marina Semarang Beach is influenced by anthropogenic activity in the surrounding environment. Some of these anthropogenic activities are related to settlements, industries, and fisheries, both along the West Flood Canal River, as well as the waters east and west of Marina Beach. In this study, pollution estimation due to tourism activities in the coast of Marina Semarang beach is done by approaching saprobic level. The purpose of this research was to analyze the saprobic level of Marina beach as an indicator of marine pollution.

2. Research Methods
This research was conducted in March-April 2017. There were 5 observed stations, i.e.:
\begin{itemize}
  \item Station 1 (located at 6°56'44.29.5"S and 110°23'35.0"E) is at the estuary of ‘Banjir Kanal Barat’ river. The activities of households and industries that are located around ‘Banjir Kanal Barat’ river give an impact to river and coastal pollution.
  \item Station 2 (located at 6°56'44.0"S and 110°23'33.7"E) is on the open coastal at Marina Beach where there are several the tourism activity, including fishing, jogging and culinary.
\end{itemize}
c. Station 3 (located at 6°57′00.1″S and 110°23′23.6″E) is located on artificial lagoon. This location is relatively protected seawaters and there are several tourism activities, including culinary, public toilets, and boat base.

d. Station 4 (located at 6°56′57.1″S and 110°23′11.6″E) is near the new reclamation site of Marina Beach.

e. Station 5 (located at 6°56′44.1″S and 110°23′03.0″E) is in open seawaters at the new reclamation site of Marina Beach.

Determination of seawater pollution level used saprobic index (SI) and tropical saprobic index (TSI), using the following formula [2,3]:

\[
\text{SI} = \frac{l(nC) + 3(nD) + l(nB) - 3(nA)}{l(nA) + l(nB) + l(nC) + l(nD)} \\
\text{TSI} = \frac{l(nC) + 3(nD) + l(nB) - 3(nA)}{l(nA) + l(nB) + l(nC) + l(nD)} \times \frac{nA + nB + nC + nD + nE}{nA + nB + nC + nD}
\]

That ‘n’ is the number of individual organisms in each group of saprobic, ‘nA’ is the number of individual organisms of the polysaprobic group, ‘nB’ is the number of individual organisms of the alpha-mesosaprobic group, ‘nC’ is the number of individual organisms of the beta-mesosaprobic group, ‘nD’ is the number of individual organisms of the oligosaprobic group and ‘nE’ is the number of individual out of A, B, C, and D groups.

3. Results and Discussions

Marina Beach is an artificial lagoon and one of coastal tourism location in Semarang City. According to Miththapala [4], the lagoon is a shallow coast, that separated from the sea by barriers. According to Satriadi [5], Marina Beach has a depth of 0 to 9 m with a slope of 0.178 percent to 0.200 percent. The distribution of sediments of Marina Beach consists of 3 types, i.e. sand 28.125% of where is located on the beach, especially the western part, silty sand of 56.25 percent where on the deeper sea and sandy silt where on more deeper sea with a depth of 5 to 9 m.

3.1. Anthropogenic activities

There are several anthropogenic activities that give pollution in Marina Beach seawaters. The several of the anthropogenic activities is include:

a. Housing at located in the river zone of ‘Banjir Kanal Barat’ have the potential to become a source of household, agricultural and industrial waste pollution.

b. Tourism activities at Marina Beach. There are several activities that can be a source of pollutants, including the food and beverages waste, and activity of boat tours. Marina Beach is also used as a place to throw the ashes and flowers for Chinese ethnic.

c. Port of ‘Tanjung Mas’. ‘Tanjung Mas’ Port is a large-scale port with a vessels visit of 2 413 ship per year, with goods of 3 023 416 tons and passengers of 7 379 978 persons [6]. Passenger activity, and loading and unloading of goods contributes to pollutants in the seawaters.

d. Aquaculture. There are aquaculture activities at around of the west of Marina beach, including at ‘Mangkang Kulon’ village. The brackish-water ponds in ‘Mangkang Kulon’ village is dominated by milkfish culture and a small portion of shrimp culture. There are several pollutant source in aquaculture, including fertilizer, artificial feed and fish feces.

e. Capture fisheries. There are several fishing bases and fishing grounds in Semarang coastal. Capture fisheries in Semarang City is dominated by small scale fisheries that use boat under 30 GT. The fishing bases are found in District of North-Semarang and District of Genuk (east of Marina Beach) and District of Tugu (west of Marina Beach). There are also lift net on the eastern waters of Marina Beach. Capture fisheries activities can contribute to pollution, including oil and fuel spills, feed and waste of fish caught in the seawaters.
f. Industries. Industrial activities located in the port area, and industrial areas, both District of Tugu and Genuk can contribute to pollution in the seawaters of Marina Beach through the ocean currents. There are also several industries in the river of ‘Banjir Kanal Barat’. According to Maslukah [7], the ‘Banjir Kanal Barat’ river is a potentially polluted by several industries, including industries of textile, metal and machinery, chemical, and ceramics.

g. Office, education, trade and services. The activities of office, education, trade and services can also provide pollutants in the seawaters of Marina Beach. It is several types of pollutants from offices, education, trade and services, including organic waste, and packaging materials (plastic).

3.2. Homogenity dan diversity of plankton
Plankton could become as indicator of water pollution. If the value of diversity is less than 2.3026, so it is mean that the seawater have a small diversity and low stability of community [2]. This research proved that the level of plankton diversity have the value less than 2.3026, that is in the range of 0.902-2.110. That is means if the diversity of plankton in Marina Beach seawaters is relatively small and the community stability is low. Human activities are the main factor (including plastic debris) that reduce the biodiversity, including the biodiversity in the marine environment [8, 9, 10]

If the value of diversity of 2.0 or less indicates that a seawater has been polluted [3]. The smaller the value of diversity so the level of pollution tends to increase. The findings of this research indicate that seawaters of Marina Beach have been polluted, given the average value of plankton diversity in each station less than 2.0.

Several types of plankton that found in the seawaters of Marina Beach are including Skeletonema sp., Rhizosolenia sp., Synedra sp., Chaetoceros sp., Planktoniella sp., Pleurosygma sp., Dictyocha sp., Nitzschia sp., Bacteriastrum sp., Guinardia sp., Coscinodiscus sp., Ceratium sp., Thalassiothrix sp., Peridinium sp., Cyclotella sp., Trichodesmium sp., Eucampia sp. Biddulphia sp. and Dinophysis sp.

There are several factors that influence the biomass of plankton, including nitrogen, phosphor, silica, and eutrofication. The booming of toxic dinoflagellate is one of indicator if the aquatic environment is the bad condition, including Nitzschia sp and Dinophysis sp [11].

| Table 1. Homogenity and diversity of plankton |
|---------------------------------------------|
| Stations | 1 | 2 | 3 | 4 | 5 |
| March 2017 Sampling 1 |
| Species (S) | 12 | 12 | 12 | 10 | 15 |
| H Max     | 2.485 | 2.485 | 2.485 | 2.303 | 2.708 |
| Diversity (H’) | 1.481 | 1.150 | 1.085 | 1.350 | 1.125 |
| Homogenity (E) | 0.596 | 0.463 | 0.436 | 0.586 | 0.415 |
| Sampling 2 |
| Species (S) | 9 | 10 | 10 | 12 | 15 |
| H Max     | 2.197 | 2.303 | 2.303 | 2.485 | 2.708 |
| Diversity (H’) | 1.440 | 1.623 | 2.007 | 1.089 | 1.128 |
| Homogenity (E) | 0.656 | 0.705 | 0.808 | 0.438 | 0.417 |
| April 2017 Sampling 1 |
| Species (S) | 14 | 13 | 14 | 13 | 12 |
| H Max     | 2.639 | 2.565 | 2.639 | 2.708 | 2.485 |
| Diversity (H’) | 1.944 | 1.429 | 1.430 | 0.902 | 1.717 |
| Homogenity (E) | 0.737 | 0.557 | 0.542 | 0.333 | 0.691 |
| Sampling 2 |
3.3. Saprobic Index and Tropic Saprobic Index

The results of research on saprobic index and tropical saprobic index indicate that seawaters of Marina Beach have been polluted. If the value of TSI in the range of 0.5 to 1.5, then a seawater has a level of β-Mesosaprobic, that means there are low to moderate levels of pollution [2, 3]. While if the value of TSI ≥ 1.5, then seawaters are at the level of Oligosaprobic, that is classified as low-contamination to uncontaminated. The research results showed that the research sites were dominated by β-Mesosaprobic, and a small part has categories of Oligosaprobic.

| Stations | 1    | 2    | 3    | 4    | 5    |
|----------|------|------|------|------|------|
| Species (S) | 11   | 12   | 13   | 14   | 10   |
| H Max    | 2.398| 2.485| 2.565| 2.639| 2.303|
| Diversity (H’) | 1.779| 1.875| 1.625| 0.956| 1.652|
| Homogeneity (E) | 0.742| 0.747| 0.634| 0.362| 0.718|

If the value of SI is in the range of 1.0 - 1.5, then a seawaters could be categorized of β-Mesosaprobic to Oligosaprobic, that is means if the seawaters are polluted by organic and inorganic materials [2]. The research results showed that all research stations had a range of 1.0-1.5 (β - Mesosaprobic to Oligosaprobic). The findings of this research indicate that the seawaters of Marina Beach have been polluted. Therefore, it is important to pollution control to reduce the level of pollution.

Table 2. Saprobic index and tropic saprobic index of plankton

| Stations | 1    | 2    | 3    | 4    | 5    |
|----------|------|------|------|------|------|
| March 2017-Sampling 1
| SI      | 1.26 | 1.15 | 1.13 | 1.20 | 1.18 |
| TSI     | 1.47 | 1.21 | 1.30 | 1.48 | 1.29 |
| March 2017-Sampling 2
| SI      | 1.31 | 1.21 | 1.45 | 1.16 | 1.15 |
| TSI     | 1.48 | 1.50 | 2.50 | 1.33 | 1.18 |
| April 2017-Sampling 1
| SI      | 1.22 | 1.04 | 1.04 | 1.03 | 1.07 |
| TSI     | 1.62 | 1.20 | 1.21 | 1.10 | 1.44 |
| April 2017-Sampling 2
| SI      | 1.20 | 1.24 | 1.02 | 1.02 | 1.12 |
| TSI     | 1.60 | 1.55 | 1.23 | 1.13 | 1.33 |

3.4. Pollution control

Several studies showed that the waters of the rivers and coastal of Semarang city have been polluted. According to Suhartono [12], The BOD level of Banjir Kanal Barat-Semarang river reached of 24 mg per L, while in its estuary reached of 45 mg per L. Whereas the BOD limit for class IV waters is 12 mg per L based on Government Regulation No. 82 of 2001 about ‘Water Quality Management and Water Pollution Control’. Class IV is a water that designation could be used for irrigation, and farming. BOD could be used to measure natural biodegradation process. Hight content of organic waste in the water, so BOD is more high. The COD in the ‘Banjir Kanal Barat’ River-Semarang reached of 36 mg per L, while in the estuary reached of 236.5 mg per L. While the COD threshold for class IV waters is 100 mg per L. According to Yusuf [13] at study on the estuary of ‘Babon’ River-Semarang also indicate that this river has been contaminated, and there were several parameters have exceeded the quality standards, including: total suspended solids (TSS), dissolved oxygen, BOD₅, COD, ammonia, detergents, Cr⁶⁺ and Cd. The research of Pratama et al [14] showed that the metal content of Pb in ‘Tapak’ River-Semarang exceeded the quality standard (more than 0.03 ppm).
The above description shows that the waters in Semarang city have experienced pollution. Each of these polluted rivers brings pollutants to the coastal and is aggravated by anthropogenic activity on the coast. This research also proved that the Semarang coastal, including Marina Beach, has been polluted, so it is important to push the pollution control.

The marine pollution is one of major challenge to marine tourism. In case of Geoje Island, marine pollution (debris) made revenue lost in tourism about USD 29 millions and USD 37 millions in 2010 and 2011, and also decreased the tourist from 890 435 person in 2010 to 330 207 person in 2011 [15]. The water pollution is also can reduce the human health relate with the growth of pathogenic-resistent bacteria [16].

There are several efforts that can be done to control pollution in the coastal of Semarang city. This several efforts are including environmental waste management, WWTP (wastewater treatment plant), campaigns of clean river and coastal, periodic water quality monitoring, installation of water quality monitoring boards, extension and enforcement of regulations. WWTP can become a key driver of water pollution control. WWTP is not only an obligation for the company or factory, but it is necessary for households and brackish-water ponds with different specifications. For households, it can push to have a communal WWTP. While WWTP in brackish-water ponds can utilize biofilter by using shellfish, seaweed, fish and mangrove, that before the water output will be discharged to the river or coastal need to be checked first the quality.

According to Prameswari and Purnomo [17], communal WWTP can use Anaerobic Baffled Reactor (ABR) technology, that investment costs of IDR. 518 888 444 and it can be used to serve 672 HHs. The result of the calculation for maintenance and operation, the cost of maintenance and operation of communal WWTP was IDR 5 493 per month per house hold. The management of Marina Beach should also set and operate the WWTP and waste management.

4. Conclusion

The research results proved that the seawaters of Marina Beach have been polluted, both base on SI and TSI values. Based on TSI, seawaters of Marina Beach have category of β-Mesosaprobic (low to moderate contamination). Meanwhile, based on SI, the seawaters of the Marina Beach is classified as β–Mesosaprobic or Oligosaprobic, that it is mean the seawaters are low-polluted by organic and inorganic materials. Therefore, it is proven that the seawaters of Marina Beach has been polluted with tendency on β-Mesosaprobic

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