Water Quality and Its Relationship to Tides and Ebbs on the Sail River, Pekanbaru City, Riau Province, Indonesia

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Abstract. The Sail River flows through the Pekanbaru City area which functions as a hydrological reservoir and main drainage channel. This river is affected by tides. Development along the Sail River Basin may affect the aquatic ecosystems. The research was conducted to determine the quality of the Sail River water and how it relates to the tides. Sampling was carried out two times during June-July 2021 in high and low tide conditions. The water quality parameters measured were temperature, TSS, pH, dissolved oxygen, BOD, COD, oil and fat, and Pb metal. Results showed that the temperature, COD, and Pb were significantly different at high tide and low tide conditions. On the other hand, during low and high tide conditions, the value of TSS, pH, dissolved oxygen, BOD, oil, and fat were not significantly different. Dissolved oxygen levels during high and low tide ranged from 2.00 - 3.00 mg/l and 1.00 - 1.70 mg/l respectively. The Pb content during high and low tides ranged from 0.12 - 0.16 mg/l. In the present study, the values of dissolved oxygen and Pb content do not meet the water quality standards of Government Regulation No. 22/2021 (Class III).

1. Introduction

The Sail River is one of the tributaries of the Siak River in the Pekanbaru City area. The Sail River is affected by the tidal that goes from the Siak River, which is the semi-mixed tidal type, as in one day there are two high tides and two low tides with different tide heights [1]. The Sail River flows through four sub-districts in Pekanbaru City, namely Lima Puluh, Sail, Tenayan Raya and Bukit Raya Districts. The area of the Sail Watershed (DAS) is 109,011 Ha with the main river length of 24,799 km².

The Sail River flows in densely populated areas, markets, offices, hospitals, as well as industry areas and it plays as a main drainage channel in Pekanbaru City. Furthermore, various activities around the Sail sub-watershed certainly produce waste which then enters the Sail River. The Sail sub-watershed is in critical condition because it has a river channel with rapid rising flood water level. Moreover, the Sail sub-watershed is the widest channel in the Pekanbaru, with the longest tributaries of the sub-watershed, which is 53,938 km [3]. The greatest amount of waste that enter the river, however, produced by activities conducted around the watershed. The condition of the sail river which is influenced by the tides certainly has an influence on the distribution of pollutants in the river. Tides in the rivers affect the distribution pattern of pollutants [2]. Even the tides cause almost no pollutants to be discharged into the sea [4].
Study on the surface water pollution of the river is essential due to effluents from industries, municipal sewage, livestock wastewater, agricultural activities, and urban runoff which were discharged into the river and resulting great variations in water quality [5]. Several studies that have been carried out in the Sail River mainly only observed the physicochemical parameters of water [6]|7]|8]. However, none of these studies specifically explained the quality of the Sail River in high and low tide conditions. Therefore, research on the analysis of the water quality of the Sail River and its relation to tides is needed to be done to provide basic information for the efforts of improving the water quality of the Sail River.

2. Methodology

2.1 Sampling Methods

The research was conducted the Sail River of Riau Province, Indonesia. Samples were taken two times in June-July 2021. A total of three (3) observation stations were used, starting from the river mouth (km 0) to 4 km to the upstream of the river. The distance of each sampling point can be seen in Table 1. By using a Global Positioning System (GPS), sampling points of the study areas were as follows: 0°51'38.63''N - 101°46'98.10''E to 0°54'53.81''N -101°46'82.61''E (table 1). The water quality parameters measured included temperature, TSS, pH, dissolved oxygen, BOD, COD, Pb metal, and oil and grease. Water samples were taken using water sampler before being kept in a polyethylene bottle and added with concentrated H2SO4 preservative until the sample’s pH was < 2. Furthermore, the samples were kept in an ice box filled with crushed ice at 4 °C and they were analyzed in the laboratory [9].

2.2 Parameters measured and Laboratory Analysis

Several parameters such as temperature, DO, and pH were measured directly on the study sites. Dissolved oxygen was measured using Winkler method. Water quality analysis such as TSS, BOD, COD, Pb, oil and grease were analyzed following standard method analysis [9].

| Sampling Point                  | Coordinate       | Distance from river mouth (km) |
|---------------------------------|------------------|---------------------------------|
| Station 1 Sail district         | 0° 30' 51,923* N | 101° 28' 9,959* E               | 76.70                                        |
| Station 2 District fifty cities | 0° 31' 59,012* N | 101° 28' 4,602* E               | 28.24                                        |
| Station 3 River mouth (the confluence of the sail and siak rivers) | 0° 32' 44,080* N | 101° 28' 5,570* E               | 0                                             |

2.3. Data analysis

The results of the analysis of the water quality of the Sail River at the tides conditions are compared with water quality standards according to the Indonesian Republic Government Regulation (GR) (22/2021 Class III) concerning the Implementation of Environmental Protection and Management. Statistical analysis to measure the difference in mean water quality of the Sail River at high tide and low tide using the T-test.

3. Result and Discussion

The data of Sail River water quality based on tides were presented in Figure 1-8. Temperature were ranged from 30-31°C at high tide and 28-29 °C at low tide (Figure 1). The highest temperature was present in Station 1 during the high tide (31 °C). Results of the t-test shown that the temperatures at the high tide and low tide were significantly different (p < 0.05). The difference in that temperature values might be due to the difference of measurement time. The biggest source of surface water heating comes from solar radiation [10]. Generally, many factors such as sampling time, location, and
weather conditions influence the rise or decline of temperature by which its role impacts the number of dissolved oxygen and other parameters [11]. The lower temperature may be caused by the time of measurement, which was in the morning when the intensity of the sun's light is not optimal. On the other hand, the high temperature might be obtained as the measurement was conducted in the daytime when the intensity of sunlight was high. Even though the water temperature is different, but the temperature of the Sail River waters in general is suitable for the life of aquatic organisms.

Total Suspended Solid (TSS) of the Sail River ranged between 24 and 180 mg/l (Figure 2). TSS values varied from 24 mg/l to 170 mg/l at the high tide, and from 40 mg/l to 73 mg/l at low tide. The highest TSS was recorded at station 2 (170 mg/l) at high tide while the lower value was at station 3 (24 mg/l) high tide. These results are within the standard allowable limit of GR 22/2021 class III, which was 100 mg/l except station 1 at high tide. Furthermore, the t-test result indicates that there is no significant difference (P > 0.05) in Total Suspended Solids between high tide and low tide.

The pH value is an indicator of water quality parameters because it affects the biological and chemical processes in the river’s water. The pH of the Sail River during high and low tides were similar, ranged from 5-5.5 (Figure 3). The highest pH was obtained in station 2 at low tide (5.5). The pH values of the Sail River was no significant different statistically during the high and ebb tides (t-test, > 0.05). This pH value was not different from the results of [5] who stated that the water of the Sail River is acidic [5].

The DO in the Sail River during high and low tides are presented in Figure 4. There was no significant different of DO values, 2.00-3.00 mg/l and 1.00-1.7 mg/l during the high and low tides respectively (t-test shown that p > 0.05). However, there was a tendency that the DO value was higher during the high tide than that of the low tide. The highness of DO concentration during the high tide might be caused by the increase of the amount of water mass as well as diluted organic matter during the high tide [12]. The concentration of oxygen in the waters is an indicator of the health of a river [4]. In general, the dissolved oxygen concentration in the Sail River does not meet the water quality standards of Government Regulation No. 22 of 2021 (> 3 mg/l) and it indicates that the water condition of the Sail River should be improved.

BOD content varied between 8-13 mg/l at high tide and 9-10 mg/l at low tide. Station 3 at high tide recorded the high BOD (13 mg/l), while the lowest value (8 mg/l) was recorded in station 2 at low tide (Figure 5). However, there were no significant differences in BOD value between high tide and low tide (t-test, P > 0.05). In addition, the BOD values in this research were exceeded the permissible limit by Government Regulation Indonesia (GR 22/2021, class III), which is 6 mg/L. A high BOD value indicates that the water quality was poor and it may due to rapid decomposition of organic material present in the rivers, thereby reducing the dissolved oxygen content in the waters [13]. The high BOD content in the Sail River comes from domestic and industrial waste, as these wastes contain high BOD and it may causes water pollution. In the domestic wastewater, he BOD concentration may be ranged from 120 to 1000 mg/L [14].

The COD value in the Sail River ranged from 24.65-34.98 mg/l, it was 27.92-34.98 mg/l during high tide and 24.65-25.75 mg/l during low tide (Figure 6). The highest concentrations of COD at high tide were shown in station 1, whereas the lowest was in the station 3. On the other hand, the highest value of COD at low tide was showed at station 1, while the lowest was showed at station 2. However, COD content at high tide was higher than at low tide. The statistical analysis recorded that there was a significant difference between high tide and low tide (t-test, P < 0.05). Additionally, the COD concentration in the Sail River was within the suggested permissible limit by Government Regulation class III, which is 40 mg/l. The lower level of COD indicates a low degree of pollution, while the high COD level points out the high degree of contamination of the water in the research area [15].

The concentration of Pb in the Sail River varied from 0.12-0.16 mg/l at high tide and 0.15-0.16 at low tide (Figure 7). The maximum value of Pb in station 2 was recorded at high tide, while the minimum was showed in station one at low tide was recorded. There was significance difference in Pb between tides (t-test, P < 0.05). Furthermore, the Pb concentration in this research was exceeded the
recommended maximum allowable limit by Government Regulation (GR 22/2021, class III) for Indonesia rivers which is 0.03 mg/l.
Figure 8 shown the concentration of oil and grease in the Sail River based on tidal conditions. They ranged from 0.01-0.04 mg/l. The concentrations of oil and grease during the high tide was 0.01-0.03 mg/l, while that of the low tide was 0.03-0.04 mg/l. Oil and grease concentration during high tide and low tide not varied from 1.46 to 5.81 mg/L. The lowest value was recorded at station 1, while the highest was at station 5, but there was no significant different in oil and grease content during the high and low tides. Figure 8 shown that the concentration of oil and grease in the Sail River at high and low tide is relatively the same but at low tide tends to be higher. The high content of oil and grease at low tide is due to the lower volume of water mass so that the oil and grease is more concentrated. The concentration of oil and fat in the Sail River at high and low tide at all observation stations still meets the quality standard < 1 mg/l (GR 22/2021).

4. Conclusion
Sail River water quality varies based on the tide and sampling area. The values of temperature, COD, and Pb in the waters of the Sail River were significantly different at high and low tide. Temperature and Cd metal values are higher at high tide than at low tide. On the other hand, the COD value is higher at low tide than at high tide. Temperature values, TSS, COD, oils, and grease still meet the quality standards (PP 22/2021, class III). The dissolved oxygen, BOD, Pb value in this study was exceeded the recommended maximum permitted limit by Government Regulation Indonesia (GR 22/2021, class III).

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