Chapter 21
Water Quality Assessment at Various Levels of Depth at Sungai Manjung, Perak

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Abstract This study analyzes the quality of the water particularly at Sungai Manjung, Perak at various depth levels. In this research context, the water quality index is used to determine the quality of the water and water parameters are used as determinants. Environment Quality Report for Rivers in 2017 has shown that Sungai Manjung is categorized as a slightly polluted river. This study is conducted near the shipyard water area. The observations around the area are conducted and water samples are collected for 60 days in three different depth levels which include, 0.5, 1 and 1.5 m. The pH, temperature, salinity, dissolved oxygen (DO) and total dissolved solid (TDS) are measured. It is found that the pH for all samples is between the range of 7.4 to 8.4 whereas DO varied from 9.42 to 12.85 mg/L, TDS is 4002–9795 p.p.m, temperature ranged from 30 to 34.6 °C and salinity is revealed changeless at values between 23 and 24‰. Thus, the findings of this study have revealed that the water quality status in Sungai Manjung is moderately polluted in various depth levels due to several maritime activities in the surrounding area.

Keywords Water pollution · Water quality · Maritime activities

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21.1 Introduction

Water is an important element in any living thing. The main source of drinking water comes from rivers. River compromises the most important resources for domestics used, industry and other purposes in daily life. However, the water quality could be deteriorated by the threat of pollution. Pollution is one of the perils to the rivers as a result of human activities [1]. Therefore, preventing and controlling river pollution and conducting reliable evaluation of the water quality are both imperative for effective management [2]. The water quality can be characterized by a high level of heterogeneity in time and space and it could be identified in terms of its physical, chemical and biological parameters.

Industrial activities that are ongoing in the surrounding river area contribute to the quality of the river water and ultimately, it may lead to water pollution. The issue regarding the status of low water quality levels has arisen in which it could bring negative impact towards human life, sea life and environment [3]. Hence, it is necessary to identify the water condition and pollution sources. This would directly recognize the solution to control the pollution, in addition, to construct strategies to minimize the contamination resources. Sungai Manjung (see Fig. 21.1) is connected to Sungai Segari, Sungai Raja Hitam and Sungai Ayer Tawar at the upstream. Sungai Manjung is surrounded by maritime industries, where the Lumut port is the key industry. Most industrial areas are located near the river area. The green port concept is promoted by the International Maritime Organization (IMO) to sustain a healthier environment. This initiative is developed to create a condition for an efficient operation, low impact on environment and rational to economy [4]. In the near future, ports would become vital spots in the wide-ranging transportation system. This is a long-term major development for the future in which construction works, environment and natural resources could be affected as well as humans.

Sungai Manjung has become the main route for all the marine activities surrounding the area which have been operating for years. Some examples of marine activities include the operation of ports, shipyards, jetties, fishing and agricultural
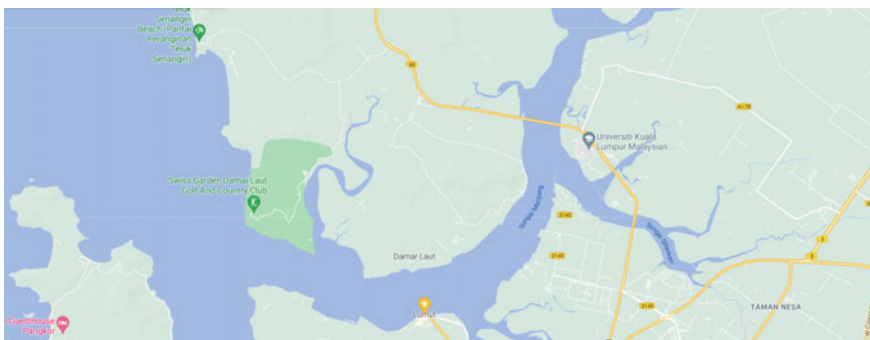

Fig. 21.1 Sungai Manjung, Perak

activities. These activities have been polluting the river water and ultimately, affect the water quality. Human activities particularly farming, live-stock and agriculture industry play a significant role in contributing to river water contamination compared to other pollutants.

The aim of this research is to determine the status of the water quality at three different depth levels whether it is in a good condition, moderately polluted or overly polluted specifically in Sungai Manjung, Perak.

21.2   Methodology

Sampling techniques were used by collecting the water samples. The water depth level was measured before sampling to choose a suitable location for the research. The measurement which has been done indicated that the maximum depth level at the sampling area was three metres during high tide and two metres during low tide. The water samples in Sungai Manjung have been collected daily for sixty days perpetually. The location of the sampling methods was fixed but it has been conducted at three different depth levels, 0.5, 1 and 1.5 m. The water samples were collected by using a steel syringe mechanism with a 2 m steel rod in length as shown in Figs. 21.2, 21.3, 21.4, 21.5 and 21.6.
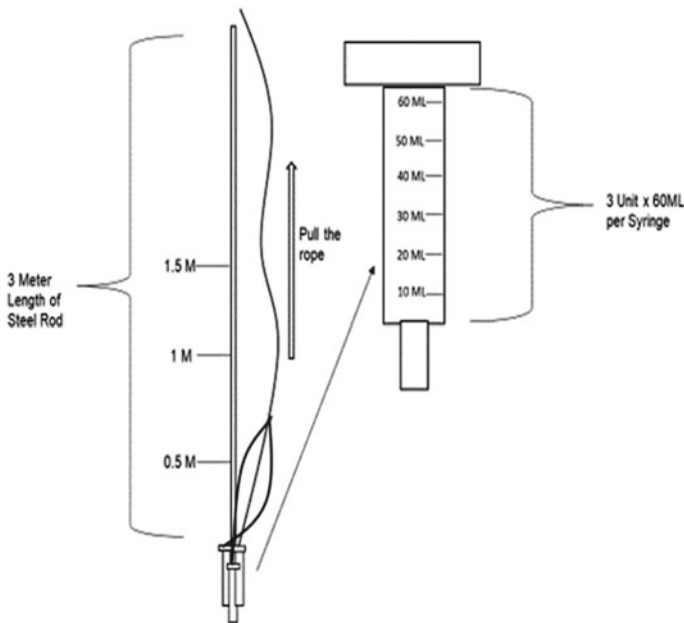

Fig. 21.2 Syringe mechanism for collecting data

Observation is one of the methods used for completing this research. The water surface was observed based on the colour, whether it is clear or dull. Based on the observation during the daily water sample collection, the water tended to be clear during high tides and clearer if it was raining before the data were collected. However, the water tended to be duller during low tides. This observation was made during the water sample collection. As a result, there are activities that contribute to the direct water discharge from the river to the sea such as small recreational boats and agricultural activities.

$$Pij = \sqrt{\frac{\left(\frac{Ci}{Lij}\right)^2 M + \left(\frac{Ci}{Lij}\right)^2 R}{2}}, \tag{21.1}$$

where, Pij is the pollution index for specified water quality, Ci is measure water quality parameters, Lij is a standard water quality parameter for each parameter at specified water quality purposes. While M is the maximum value from total Cij divide by Lij and R is average value for Cij divide by Lij.

Water samples that have been collected were tested based on the pH, dissolved oxygen (DO), salinity, temperature and total dissolved solid (TDS). The pollution index used to analyze the data using the function of Ci/Lj in which, Ci indicates the concentration of parameter i while Lj indicates the concentration permissible value of parameter based on the National Water Quality Standard of Malaysia (NWQS) as shown in Table 21.2. The pollution index is calculated by Eq. (21.1) to determine the status of pollution and water quality based on Table 21.1.

Table 21.1 Pollution index and water quality status criteria

Pollution index	Water quality status
$0 \leq Pij \leq 1.0$	Good condition
$1.0 < Pij \leq 5.0$	Slightly polluted
$5.0 < Pij \leq 10$	Moderately polluted
$Pij \geq 10$	Heavily polluted

Table 21.2 National water quality standard of Malaysia (NWQS)

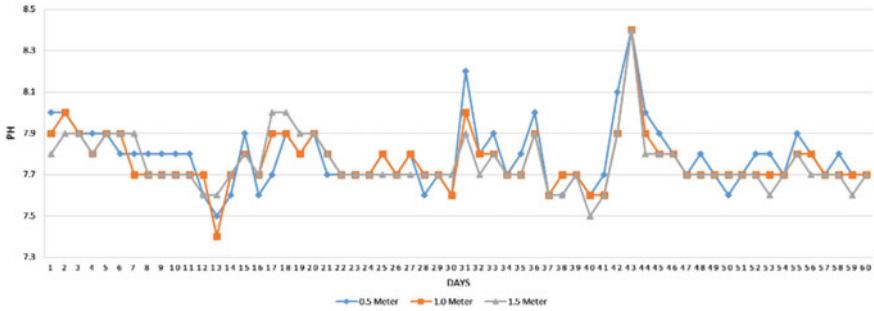| Parameters	Unit	Class					
		I	IIA	IIB	III	IV	V
pH	–	6.5–8.5	6–9	6–9	5–9	5–9	–
DO	Mg/L	7	5–7	5–7	3–5	< 3	< 1
TDS	Mg/L	500	1000	–	–	4000	–
Salinity	%	0.5	1	–	–	2	–
Temperature	°C	–	Normal + 2 °C	–	Normal + 2 °C	–	–

Fig. 21.3 pH over time

21.3 Result and Discussion

The total of data that has been collected is 288 in the duration of sixty days. The analysis consists of salinity, temperature, dissolved oxygen, total dissolved solid and pH in three different depths. Besides, the value of each data collected was within the same range due to the reading of parameters value which was quite similar. On the contrary, the differences in the parameter's value were affected by the surrounding activities such as ship repair, private yachts operation and docking of the ships as well as other activities in the surrounding area of Sungai Manjung.

21.3.1 pH

The highest pH value collected at Sungai Manjung was 8.4 and the lowest was 7.4. However, these values were almost similar to a study which has been conducted in Semenyih, Selangor. The study in Semenyih marked 8.4 as the highest pH value while 7.07 as the lowest. Overall, the range of pH from 6.5 to 9 is mainly appropriate for aquatic life [5]. Figure 21.3 shows the overall pH value at Sungai Manjung. As can be seen from Fig. 21.3, the pH value fluctuated and reached a higher value on day 43.

21.3.2 Temperature

The data collected for the temperature in this study has a range of 30–34.6 °C as in Fig. 21.4. One of the studies conducted in Semenyih, Selangor has found out that the water temperature value range is from 26 to 32 °C. Generally, many factors would affect the increment and the decrement of the temperature value. These factors include the weather condition, sampling time and location [5].
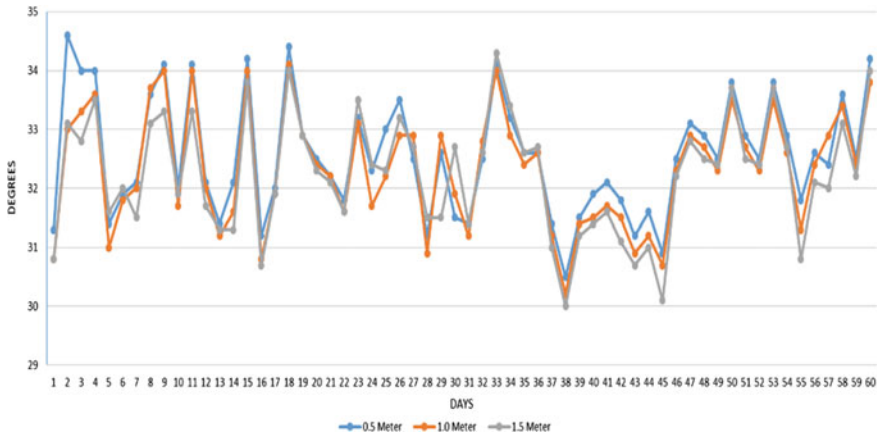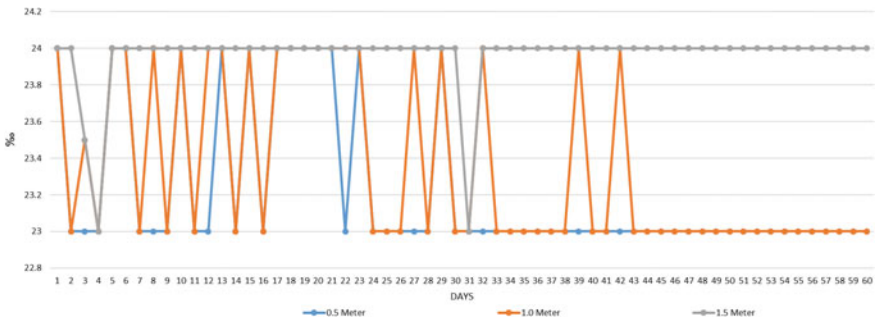
Fig. 21.4 Temperature over time

Fig. 21.5 Salinity over time

21.3.3 Salinity

The data recorded for salinity has a range of 23–24‰ as shows in Fig. 21.5, which is considered as a normal condition and an acceptable level of NWQS. Salinity is a significant contributor to conductivity. The higher the salinity level, the lower the dissolved oxygen concentration.

21.3.4 Total Dissolved Solid

The highest TDS value collected was 9795 p.p.m and the lowest value was 3377 p.p.m in which both, are considered above average in Fig. 21.6. A study conducted in Semenyih, Selangor has revealed that the value of TDS has a range of 108–504
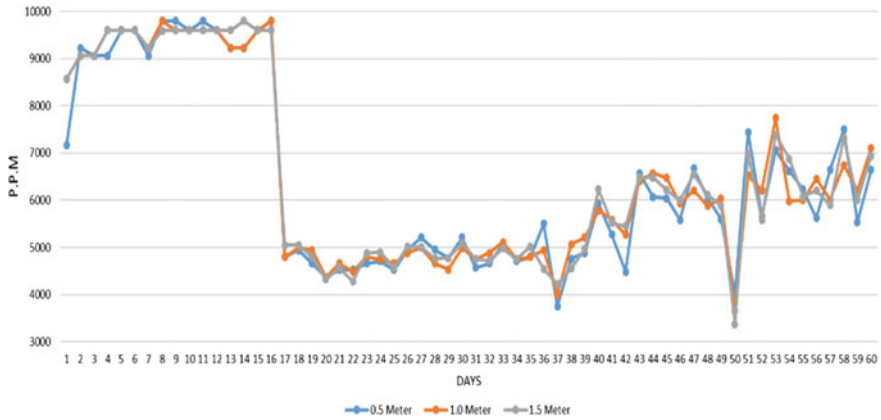
Fig. 21.6 Total dissolved solid over time

p.p.m [5]. The value range indicates that the level of pollution for TDS is heavily polluted.

21.3.5 Dissolved Oxygen

This study has revealed the value of DO which is considered high with the range of 9.42–12.85 mg/L. Meanwhile, the standard acceptable levels of NWQS for DO should not exceed 7 mg/L as shows in Fig. 21.7. Hence, the result shows that the level of pollution for DO is slightly polluted.

The pH value range at Sungai Manjung is between 7.4 and 8.4 which indicates that the water condition is neutral to alkaline. The water condition is due to its correlation to the sea, where there is an estuary and it is influenced by tides. The data was collected at a similar time every day. Based on the data collected, it is found that the
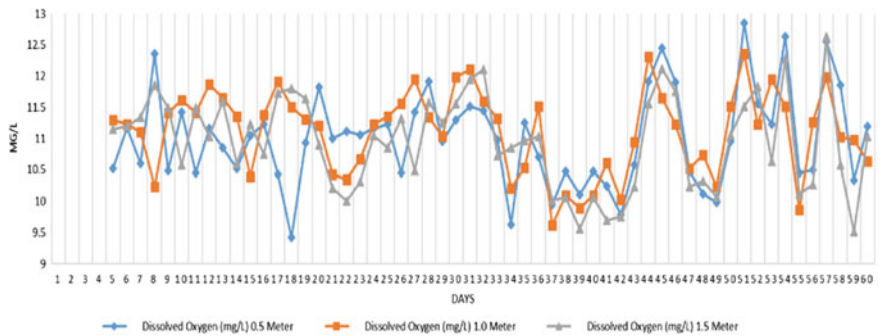

Fig. 21.7 Dissolve oxygen over time

Table 21.3 Summary
pollution level

Parameters	Result for each depth	Level of pollution
pH	0.5 m = 1.01 1.0 m = 1.01 1.5 m = 1.01	Good condition but almost lightly polluted
DO	0.5 m = 1.709 1.0 m = 1.68 1.5 m = 1.69	Slightly polluted
TDS	0.5 m = 16.57 1.0 m = 16.61 1.5 m = 16.63	Heavily polluted

pH value for every depth level is slightly high at 0.5 m compared to the value at the depth level of 1.0 and 1.5 m. The pH value at 1.0 and 1.5 m is slightly the same. The pH value at 0.5 m is high as it is near to the water surface where the heat is mostly received from the sun. Hence, based on the pH value, the water quality in the various depth levels is in a good condition. The marine ecosystem is not facing any risk of pollution. However, based on the DO amount in Sungai Manjung, the water surface area has the highest value. Nevertheless, the value is decreasing according to the increment of the water depth level. The pollution index measurement indicates it as slightly polluted. The dissolved oxygen decreases as temperature increases. Oxygen is generally dissolved in the water surface as a reaction from the atmosphere and photosynthesis process. Generally, dissolved oxygen is consumed by the degradation of organic matter in water [6].

The TDS value shows that, the deeper the water level, the higher the values. On day 16, the TDS value has drastically dropped at all depths of the water level. Through observation, drainage was coming directly from the agricultural activities periodically. The water from the agriculture activities produced substance or waste which results from the agricultural product. This indicates that, based on the TDS value, Sungai Manjung status in water quality is heavily polluted as shown in Table 21.3. Through the observation during the day, several hours before the samples were collected, there was heavy rain surrounding the area. This circumstance shows that there was an addition in the amount of fresh water to the river which influences the measurement of TDS.

21.4 Conclusion

The status of water quality in Sungai Manjung varies according to the depth level. In reference to the pollution index, it is determined that the water quality at Sungai Manjung is moderately polluted at all depth levels. The water quality at the research area was influenced by both, human activities and weather. Some examples of human activities would include, fisheries, docked barges and vessels, routes for private yachts and ship repairing and maintenance at the shipyard. However, there are many other

factors that need to be considered when choosing the sampling location. Tidal circulation, weather, current and waves could affect the value of some parameters, which later on could affect the status of water quality. A further assessment needs to be conducted to obtain a thorough and accurate result of the water quality. Therefore, the river water could be used for irrigation with precaution and for domestic purposes, but it requires treatment beforehand.

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