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Port Dickson Surface Water Quality Status: A Year with COVID-19 Pandemic

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Abstract. The COVID-19 pandemic has become a planetary concern that affecting the sustenance of the human population all around the globe. The effective measured has been taken in Malaysia to control the virus transmission by limiting the human vitality which unsurprisingly propitious to the environment. A monitoring study was conducted to assess the water quality status of surface seawater along the Port Dickson coast based on the Malaysian Marine Water Quality Index (MMWQI) and Malaysian Marine Water Quality Standards (MMWQCS) with an interval period of a year (March 2020-March 2021). *In situ*, water quality parameters incorporate temperature, pH, salinity, conductivity, dissolved oxygen (DO), and total dissolved solids (TDS) were measured at 14 sampling sites to evaluate the biochemical characteristics of water. Surface water samples were collected from the same sites and transported back to Universiti Putra Malaysia for nitrate (NO₃⁻), ammonia (NH₃), phosphate (PO₄), biochemical oxygen demands (BOD), fecal coliform (*Escherichia coli*), and total suspended solids (TSS) analyses. The MMWQI showed the status of surface water from the Port Dickson coast was classified as moderate quality (50.41 - 64.05) for both sampling events. However, there are some indexes that showed significant decreases ($p < 0.05$) in the latter year. The concentration of nutrient pollution such as phosphate, nitrates, ammonia, fecal coliform as well as oil and grease, was decreased by 11.12%, 77.39%, 82.4%, 90.26%, and 99.9% respectively. The water parameters namely TDS, pH, and BOD levels were significantly decreased by 1.77%, 20.73%, and 77.16%. Certain parameters listed in the MMWQS such as temperature, pH, ammonia, fecal coliform, oil and grease were classified as Class 1 in March 2021. These occurrences recorded were greatly influenced by the reduction of the substantial human activities around the recreational beach of Port Dickson followed by the declaration of Movement Control Order (MCO) in Malaysia.



1. Introductions

COVID-19 pandemic or also known as severe acute respiratory syndrome corona-virus 2 (SARS-CoV-2) has been declare as a worldwide pandemic on 12 March 2020 by World Health Organization [1]. The Malaysian Governments had taken an immediate action on controlling the movements of citizen by implemented the Movement Control Order (MCO) to limit the spread of the virus. In Malaysia, the pandemic spread has been almost two years have highly impacted the daily life as well as the economic aspects. Economic crisis during this pandemic was predicted to be much more severe that the other previous pandemic outbreak [2]. According to International Momentary Fund (IMF), [3] almost 300 million full time jobs losses in second quarter of 2020 as a results of lower purchasing power and fuel price due to COVID-19 interventions.

The deaths and reduction force of the workers greatly impacts the global economic as certain sectors would be in demand in supplying stocks in manufacturer industries [4]. Also, according to [2], the global travel in the tourism industries have been decline by 25% as estimated by The World Travel and Tourism Council (WTTC). Both global economic and tourism activities were highly affected however it has positively impact on the natural environment and its ecosystem. The global pollution of the environments is mainly contributed by the anthropogenic activities through urbanization and industrialization in order to accommodate the growing of human population of over-consumption and over-exploitation [5].

The aquatic ecosystems in marine and freshwater were extremely disturbed by the various anthropogenic sources of pollutants from sewage, nutrients and terrigenous materials, crude oil, heavy metals and plastics [6]. A case study by [7] in Egypt the noise pollution was reduced by 75% during the lockdown period of COVID-19 as well as a study by [8], showed significant reduction on the sound level in Dublin, Ireland. Noise pollution have been recognized as third most hazardous pollution by World Health Organization (WHO) widely contributed by the road traffic in the city. The absorbing aerosol index (AAI), nitrogen dioxide (NO₂), carbon dioxide (CO₂), and greenhouse gases (GHG) were reported as reduced by 30%, 15-30%, 5% and 4% respectively in Egypt's air pollution level [7]. The main reason of the reduction in air pollution was the reduction in traffics, industrial activities as well as the less construction activities. They also emphasized on the positive effects of COVID-19 pandemic on the environmental aspects including the beaches, surface and groundwater pollution. Another study by [9], demonstrated that the global air quality was significantly reduced and showed the positive impacts of lockdown during pandemic.

This study evaluates the concentration of particulate matter (PM_{2.5} and PM₁₀) and nitrogen dioxide (NO₂) was reduced by 20% - 47% and 32% - 64% respectively as a result of reduced anthropogenic emissions sources during lockdown. Mumbai and Delhi are one of the vast populated cities also experienced the reduction in environmental pollution as the nitrogen dioxide (NO₂) were documented had significant decreases of 40% - 50% as compared before the lockdown period in India and its benefits coming from the reduced economic activities in the country [10];[11]. According to [12], the lockdown cause by the COVID-19 pandemic had positive impact towards the environment from the reduction of the anthropogenic activities especially towards aquatic environments. This study was conducted to quantify the level of surface water quality after a year with COVID-19 spread at one of the famous recreational beaches in Malaysia, Port Dickson. The objective of this study is to analyzes the status of the water pollution as well as the effects of the MCO on the coastal surface water quality.

2. Materials and Methods

2.1. Study Area and Sampling Stations

Port Dickson coastal areas has always been an attraction towards local and foreign tourists as one of the must visit areas located in the state of Negeri Sembilan, west coast of Peninsular Malaysia (Figure 1). Generally, the coastal water is shallow (20m), well mixed and the temperature are within 21 to 32 °C [13]. The long stretches of coastlines have important role in the economic and property market through the ports, shipping, industrial and tourism activities.

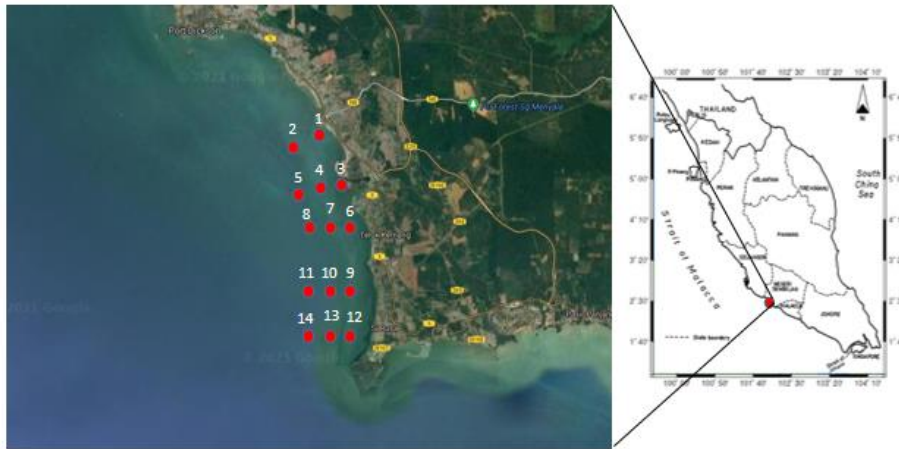


Figure 1. Sampling stations around the coastal area of Port Dickson, Negeri Sembilan, Malaysia.

2.2. Sampling Methods and Analytical Procedures

Water sampling has been carried out twice before the COVID-19 pandemic MCO in March 2020 and a year after the MCO in March 2021. The water samples were collected from each station with 50 cm of the surface seawater depth from one kilometer from the coastal beach. The water samples were collected in the specific bottles according to the samples using Van Dorn water sampler. Samples were stored in 500 ml acid-washed plastic bottles for nutrients analysis, amber glass for biochemical oxygen demand (BOD) analysis and 50 ml sterile centrifuged tube for fecal coliform analysis. The collected water samples were stored cooled, transported to the laboratory in Universiti Putra Malaysia and processed within 24 hours.

The *in-situ* water was measured including temperature, dissolved oxygen (DO), conductivity, pH and salinity using YSI meter, while BOD₅, TSS, PO₄, NO₃, NH₃-N, and fecal coliform (FC) were analysed in the laboratory. BOD₅ was analysed as described by 5-day test and TSS analysis was used total solid dried method [14]. Moreover, phosphate, nitrate, and ammonia nitrogen were assayed by acid ascorbic, cadmium reduction, and Nessler methods, respectively using Hach DR900 colorimeter. While, the fecal coliform specifically *Escherichia coli* was identified using Colilert 18 Test. The oil and greases method were using hexane extractable gravimetric method which also known as USEPA Method 10056. The equipment's were calibrated prior to use based on the manufacturer's instruction.

2.3. Statistical Analysis

Statistical analysis of the data was carried out using SPSS version 22. The analysis of the variance (ANOVA) was carried out to determine the significant differences between sampling stations.

2.4. Marine Water Quality Index Formula and Calculation

$$MWQI = SI DO^{0.2} \times SI NH_3^{0.16} \times SI FC^{0.14} \times SI TSS^{0.14} \times SI O\&G^{0.13} \times SI NO_3^{0.12} \times SI PO_4^{0.11}$$

where;

- SIDO = Subindex Dissolved Oxygen
 - SINH₃ = Subindex Unionized Ammonia
 - SIFC = Subindex Faecal Coliform
 - SITSS = Subindex Total Suspended Solids
 - SIO&G = Subindex Oil and Grease
 - SINO₃ = Subindex Nitrate
 - SIPO₄ = Subindex Phosphate
- 0 ≤ MWQI ≤ 100

Table 1. Marine Water Quality Index Classification [15].

Category	Index Value
Excellent	90 - 100
Good	80 - < 90
Moderate	50 - < 80
Poor	0 - < 50

3. Result and Discussion

3.1. The Concentration of Water Quality Parameters

3.1.1 Temperature

The temperature values ranged from 30.55 - 31.51°C in March 2020 and 29.40 - 30.25°C in March 2021. The temperature ranged were slightly decreases after a year of MCO in Malaysia and the results are within the standard acceptable level of the Malaysia Marine Water Quality Criteria and Standards (MMWQCS). Also, the temperature was statistically no significant difference between the sampling station in both sampling occasions ($p > 0.05$). The previous study also reported the similar trends of temperature along the coastal area of Port Dickson ranged between 28.55 to 29.00°C [16]; [17] (Table 2). The surface water temperature was greatly influenced by the weather, the sampling time and location [18].

Table 2. Previous record on the physio-chemical water parameters and nutrients along the coastline of Port Dickson and Straits of Malacca [19].

Location	Physio-chemical parameters	Water	References
Coastal water of Port Dickson	pH	7.87-8.10	[20]
	Temperature	29.5-31.0 °C	
	Salinity	28.0-31.0 ppt	
Teluk Kemang Batu Empat Batu Lapan Centre of Marine Science Blue Lagoon Teluk Kemang	Dissolved oxygen	5.75-6.35 mg/L	
	Dissolved oxygen	7.90-8.00 mg/L	[21]
	Dissolved oxygen	0.89 mg/L	
	Dissolved oxygen	0.59 mg/L	
Coastal water of Port Dickson	Dissolved oxygen	0.65 mg/L	
	Dissolved oxygen	0.52 mg/L	
	pH	8.10-8.20	[21]
	Temperature	29-32 °C	
Straits of Malacca	Salinity	30-31 ppt	
	Salinity	30.0 ppt	[22]
Coastline of Port Dickson	Temperature	29.0 °C	
	Dissolved oxygen	4.25 mg/L	
	Salinity	31.22 ppt	[23]
	Temperature	29.60°C	
	pH	7.84	
	Dissolved oxygen	5.28 mg/L	
	Biochemical Oxygen Demand (BOD)	0.604 mg/L	
Coastline of Port Dickson	pH	8.23-8.30	[17]

Dickson		
Temperature		28.55-28.88 °C
Dissolved oxygen		5.42- 6.66 mg/L
Salinity		29.98-30.00 ppt
Turbidity		1.34- 3.48
Ammonia		0.12-0.18 mg/L
Nitrate		0.01-0.05 mg/L
Phosphate		0.06-0.09 mg/L

Table 3. Physio-chemical water parameters before MCO of COVID-19 and a year after MCO its classification (mean \pm standard deviation).

Parameters	March 2020	March 2021	Classification MMWQS
Dissolved Oxygen (mg/L)	7.79 \pm 0.79	5.51 \pm 0.58	Class I - Preservation, Marine Protected Areas, Marine Parks
Temperature (°C)	29.78 \pm 0.08	29.48 \pm 0.14	
pH	8.69 \pm 0.06	6.86 \pm 0.21	Pristine
Salinity (ppt)	31.32 \pm 0.58	30.54 \pm 0.03	
Conductivity (mS/cm)	46.71 \pm 0.25	51.18 \pm 0.11	Pristine
Total dissolved solids (g/L)	31.22 \pm 0.17	30.67 \pm 0.06	-
Biochemical Oxygen Demand (BOD)	4.91 \pm 0.88	1.12 \pm 1.01	-
Total suspended solid (TSS)	475.92 \pm 30.01	594.64 \pm 48.38	Class III - Ports, Oil & Gas Fields

3.1.2. pH

The pH values showed significant differences ($p < 0.05$) between the two sampling occasions which higher in March 2020 before MCO with average of 8.65 than a year after which is much lower with the averaged value of 6.86 (Table 3). The percentages of the decreases were around 20.73% and yet showed the results are in the standard range and classified in the Class I based on the MMWQCS for Malaysian marine. On the other hand, there are no significant differences were showing between the sampling stations in both sampling occasions. The previous report on the pH values around the coastlines of Port Dickson reported the similar values around the 8.00-8.30 (Abu Hena et al., 2000; Preveena & Aris, 2013). The pH values decrease significantly as due to MCO, the domestic discharge and sewage effluent may eventually load into the aquatic ecosystem as well as the invisible pollutants sources that have been build up through bioaccumulation and biomagnification in the environment (Chuan et al., 2021). Another study by [24] concluded that the pH can becomes lower in the coastal area as the mangrove soils experienced decaying of the vegetation and acidification of the clays [25]. Generally, the decreases in the pH as a result of the ocean acidification from the absorption of the anthropogenic greenhouse gases and CO₂ by the ocean. However, overall, the range of pH from 6.5 to 9 is considered appropriate for aquatic organisms. Therefore, it is crucial to maintain the balance pH for the aquatic ecosystem as extreme pH changes can be detrimental.

3.1.3. Salinity

The salinity of the both sampling occasions were averaged of 31.33 ppt and 30.54 ppt in March 2020 and March 2021 respectively. There are no significant varied ($p > 0.05$) between sampling stations in both sampling occasions. The salinity around the coastlines area were in lines with the previous report ranged from 28.0 ppt - 31.00 ppt ([20]; [21]; [17]). The COVID-19 pandemic and MCO does not

greatly influenced the salinity in the Port Dickson coastlines. The salinity of the coastal water could be influenced by the heavy rainfall causing the large freshwater inflow into the sea. The ocean salinity is playing important roles in the world climate and its aquatic organism as well as the its habitability [26].

3.1.4. Dissolved Oxygen

The maximum dissolved oxygen recorded was in station 2 in March 2020 with averaged reading of 9.29 mg/L, while the other sampling stations recorded the mean value of 7.80 mg/L before the MCO. However, the dissolved oxygen in the coastal surface water of Port Dickson has significant decreases ($p < 0.05$) after a year with COVID-19 with average of 5.51 mg/L. According to the [12], these occasions may result from the urban runoff of the greywater as the product of greywater increased since the stay-at-home policy were implemented. The greywater domestic discharged were usually carried along the dissolved nutrient into the aquatic ecosystem through the stream that can caused the low dissolved oxygen in the coastal surface water of Port Dickson. Also, the lowered dissolved oxygen may due to the high decomposition of the organic matters in the coastal mangrove areas which also impacted the lowered pH values in this study. Despite the lower dissolved oxygen after a year with COVID-19, the results are within the standard acceptable levels of MMWQCS for Malaysian marine ecosystem which classified in Class II. The saturation level of dissolved oxygen > 5.00 mg/L is important for the growth of the marine fish and plankton as well for other aquatic organisms [27]. Previous study conducted by [17] also reported the similar ranged dissolved oxygen from 5.42- 6.66 mg/L.

3.1.5. Biochemical Oxygen Demand

The biochemical oxygen demand (BOD_5) of the coastal surface water was ranging from 3.99 to 6.33 mg/L in March 2020, before the MCO and showed significant decreases of 77.16% of the BOD in March 2021. The value of the BOD was averaged of 1.12 mg/L after a year of movement control order. This study showed that the regular influx of anthropogenic sources causing the BOD higher event though the dissolved oxygen in the surface water is highly concentrated before the MCO regulations. After a year with MCO, the BOD decreases significantly showed that the limited human activities give a positive impact towards the aquatic environments. According to [23], the average BOD in the surface water of the Straits of Malacca was 0.604 ± 0.077 mg/L, however he reported that the Port Dickson areas are susceptible to higher BOD. The BOD values might increase as the economic and tourism activities can be carried out after the movement control order lifted. Therefore, in order to maintain the good water quality of the Port Dickson coastlines, a good plan of environmental management program should be conducted by the authorities and supported by the local communities.

3.1.6. Total Suspended Solids

The coastal surface water of Port Dickson recorded high TSS in March 2020 before the MCO and recorded higher TSS in March 2021 with mean ranged between 475.93 mg/L and 594.64 mg/L respectively. in addition, ANOVA result showed there is no significant difference ($p > 0.05$) in TSS between the sampling stations. Based on the MMWQCS for Malaysia marine ecosystem, the TSS were classified in Class III of which the coastal water has directly exposed of the effluent discharged from the industry, commercial activities and coastal settlements. Port Dickson as an ecotourism site proved that high human activities around the coastlines area caused the high concentration of the suspended solids in the water body. Also, the rainy events happened before the sampling occasions could affect the suspended solids came along with the sediment's runoff from the terrestrial surrounding area. The high TSS also can be contributed by the high concentration of phytoplankton or the living microorganism as well as the non-living matters which suspended in the water body [28]. Besides, the strong ocean current during sampling occasions can affect the re-suspension of the sediments along the coastlines [29].

3.1.7. Total Dissolved Solids

The values of total dissolved solids (TDS) before MCO were recorded with average of 31.22 g/L and the value slightly decreases in March 2021 with average of 30.67 g/L. The values recorded between sampling stations did not show significant varied ($p > 0.05$) between them. The TDS values showed the typical seawater dissolved solids in the water body ranged up to 35.0 g/L. The high concentration of dissolved solids was attributed by the immense anthropogenic activities and sedimentation runoff with high contents of suspended matters [24].

3.1.8. Electrical Conductivity

In this study, the electrical conductivity ranged between 46.64 - 47.50 $\mu\text{S}/\text{cm}$ in March 2020 and increases in March 2021 ranged between 51.03 - 51.48 $\mu\text{S}/\text{cm}$. The conductivity in both sampling occasions showed there are no significant differences ($p > 0.05$) between sampling stations. Overall, the conductivity of the seawater can be up to 50.00 $\mu\text{S}/\text{cm}$ and affected by the inorganic dissolved solids such as sodium, magnesium, chloride, calcium and cations [30]. A part of inorganic dissolved solids, the organic compounds such as oil, and phenol can affect the water conductivity.

3.1.9. Nutrients Concentration

3.1.9.1 Nitrate

The nitrate (NO_3) concentration ranged from 1.4 - 3.5 mg/L in March 2020 and had significantly decreases ($p < 0.05$) in March 2021 with ranged between 0.369 - 0.776 mg/L. The highest concentration was recorded at station 8 in March 2020 which then decline to 0.46 mg/L with percentage of 86.86%. The nitrates values recorded at the both sampling stations in this study are within the permissible limit of Malaysia Marine Water Quality Criteria and Standards (MMWQCS) (> 0.1 mg/L) which classified as a Class III. The overall percentages of decrease are up to 77.39 % showed that the less human activities around the area decreases the nutrient pollution released into the water body. Generally, the values recorded in this study were higher than the previous study ranged between 0.01-0.05 mg/L [17]. The high concentration of nitrates could be attributed by the runoff of various water sources such as agricultural fertilizer as well as the natural events such as atmospheric and geological depositions [31]. The concentrations of the micro-nutrients in the coastal water of Port Dickson and its classification have been summarized in Table 4.

Table 4. Summary of the concentrations of micro-nutrients in the coastal water of Port Dickson and its classification (mean \pm standard deviation)

Parameters	Nutrient (mg/L)		Classification MMWQCS
	March 2020	March 2021	
Nitrate ($\text{NO}_3\text{-N}$)	2.3 ± 0.70	0.523 ± 0.11	Class III - Ports, Oil & Gas Fields
Phosphate (PO_4)	0.165 ± 0.04	0.146 ± 0.09	Class II - Marine Life, Fisheries, Coral Reefs, Recreational and Mariculture
Unionized Ammonia (NH_3)	$1.01 \times 10^{-4} \pm 0.002$	$1.78 \times 10^{-4} \pm 9 \times 10^{-5}$	Class I - Preservation, Marine Protected Areas, Marine Parks

3.1.9.2. Ammonia-Nitrogen

Unionized ammonia (NH₃-N) concentrations of the coastal water samples ranged between not detected to 0.003 mg/L with averaged of 0.001 mg/L in March 2020. Few stations showed increases in the readings recorded up to 0.0003 mg/L in March 2021. Overall, in average the ammonia concentration showed a significant decrease ($p < 0.05$) in March 2021 with percentages of 82.47% as compared from the March 2020 with ranged between 8×10^{-6} - 2.95×10^{-4} mg/L. Based on the Malaysia Marine Water Quality Criteria and Standards, the concentration of unionized ammonia was within the permissible limit of Class I (0.0035 mg/L). Previous study showed higher concentration of ammonia in water body ranged between 0.12 - 0.18 mg/L could be contributed by the sources of nutrients from inland discharged and freshwater runoff during rainy seasons [17]. The scale down in industrial and ecotourism activities due to COVID-19 pandemic positively impact the marine ecosystem along the Port Dickson coastlines from the overloading of the nutrient into the seawater that can eventually threaten the aquatic organisms.

3.1.9.3. Phosphate

The phosphate (PO₄) concentration was ranged between 0.10 - 0.22 mg/L in March 2020 and decreases up to 11.12% a year after in 2021. The concentration was decreases to range between 0.003 - 0.297 mg/L with averaged of 0.146 ± 0.01 mg/L. The phosphate concentrations were significantly varied ($p < 0.05$) between the sampling stations in both sampling sessions. The highest phosphate concentration recorded in station 11 with concentration of 0.22 mg/L and decreases in March 2021 down to 0.07 mg/L with percentages of 68.18% decline. The phosphate values recorded at the both sampling stations in this study are within the permissible limit of Malaysia Marine Water Quality Criteria and Standards (0.075 mg/L) which classified as a Class II. As mentioned before, the decline in the nutrient concentrations may due to the restricted movement control order during this pandemic and this events directly leave positive impact towards the environment as many sectors including industrial and tourism were not allowed to be operated. Previous study along the coastlines of Port Dickson showed lower concentration of phosphate ranged from 0.06-0.09 mg/L proved that there are intensive population and economic growth around the Port Dickson area over the past years. Overall, the high concentration of phosphate recorded were greatly contributed by the run off of the domestic effluent from detergent, fertilizers as well as the waste-water from the industrial activities [32].

3.1.10. Fecal Coliform

The fecal coliform concentration especially *E. coli* in March 2020 before the strict standards operation procedures of MCO was ranged between 26.5 - 203.0 MPN/100 mL while the concentration was recorded decreases significantly after a year in March 2021. The *E. coli* concentration decreases up to 90.26% to range within 1.0 - 15.0 MPN/100 mL after a year with MCO. There are significant differences ($p < 0.05$) in the mean concentration of the fecal coliform between the sampling stations in both sampling occasions. Stations 14 showed the highest *E. coli* concentration with 203 MPN/100 mL which later dropped to 11.1 MPN/100 mL after a year with MCO with 94.5% decreases recorded. The MMWQCS on fecal coliform parameters showed the increases in the water quality index as before MCO, there is one station with *E. coli* concentration higher than the standard in Class III (>200 MPN/100 mL) which then changed to Class I (<70 MPN/100 mL) after a year with strict movement order. The high concentration of the fecal coliform or *E. coli* along the sampling stations could be caused by the sewage discharged from the surrounding areas. According to [33], the increases of settlements in coastal population as well as the waste-water discharged of the treated and untreated sewage are the main factors contributing to the high number of fecal coliforms. In addition, along the Port Dickson beaches with hotels and houses, there are 82 pipelines that directly discharged the waste-water into the sea which negatively impact the surrounding water quality [34]. Table 5 showed the summary of the previous record of the fecal coliform study along the Port Dickson coastlines which shows the intense tourism activities and the growing population around the area. A year with strict order of any human activities during COVID-19 pandemic can clearly decreases the

concentration of fecal coliform in the water body. The fecal coliform concentration might increase as the tourism activities can be operated as previously.

Table 5. Summary on previous record of fecal coliform or *E. coli* concentration along the Port Dickson coastlines.

Sampling	<i>E. coli</i>	Classification MMWQCS
March 2020 (This study)	26.5 - 203.0 MPN/100 mL	Class III - Ports, Oil & Gas Fields
March 2021 (This study)	1.0 - 15.0 MPN/100 mL	Class I - Preservation, Marine Protected Areas, Marine Parks
[35]	N.D - 120.0 MPN/100 mL	Class II - Marine Life, Fisheries, Coral Reefs, Recreational and Mariculture
[36]	60.0 - 4113.0 MPN/100 g (Beach sand)	-
[33]	$1.5 \times 10^2 - 2 \times 10^4$ MPN/100 mL	Class II - Marine Life, Fisheries, Coral Reefs, Recreational and Mariculture
[34]	141.0 - 1950.0 MPN/100 mL	Class III - Ports, Oil & Gas Fields Class II - Marine Life, Fisheries, Coral Reefs, Recreational and Mariculture Class III - Ports, Oil & Gas Fields

3.1.11. Oil and Grease

Oil and grease (OG) values ranged between 0.6 - 3496.0 mg/L in March 2020 and the values decreases significantly ($p < 0.05$) drastic after a year in March 2021 with range between 0 - 0.038 mg/L. The decreases of the oil and greases was up to almost 99.9% as compared from the previous sampling in March 2020. In addition, oil and grease in station 8 showed significantly in high concentration with value of 3496.0 mg/L which then decreases to almost no detectable in range. The oil and greases concentration in this study decreases from the category of Class III (5.0 mg/L) to Class I (0.01 mg/L) in March 2021 sampling occasions based on the MMWQCS. Other parameters that have showed positive impact from the COVID-19 pandemic from the strict rule of movement control order implemented in Malaysia. Previous study along the coastal area of Negeri Sembilan showed lower concentration of oil and greases ranged between 0.10-0.60 mg/L (Class I- Class II) as compared to this study in March 2020 and almost similar values in March 2021 [37].

3.2. Marine Water Quality Index

Malaysia marine water quality index were calculated using seven crucial parameters to classify the marine water quality index into several categories from poor, moderate, good and excellent. In this study, the MWQI calculated in March 2020 were recorded as 50.41 ± 29.08 , while in March 2021 the MWQI were calculated with average of 64.05 ± 4.48 . Both MWQI recorded in March 2020 and March 2021 were classified in moderate class. However, there are significant increases in the water quality index up to 27.06% which incorporated with water parameters of dissolved oxygen, fecal coliform, nutrients of phosphate, nitrate and unionized ammonia, total suspended solids as well as oil and grease. There are no significant different of MWQI in March 2021 between the sampling stations, however significant different between sampling stations during sampling occasions in March 2020 in station 5 which is in poor category. After a year during the MCO, the MWQI were improved to

moderate class which showed a significant improvement of the coastal water quality along the Port Dickson coastlines.

There are many factors that contributed to the marine water quality index including the development and industrialization along the coastlines as well as the ecotourism activities as one of the main attractions. Previous record reported by the Malaysia Environmental Quality Report (2018), showed several areas with similar category of MWQI in moderate class around the area of Port Dickson city, Pantai Teluk Kemang, Port Dickson TNB, Port Dickson Batu 5, with reading of 68, 67, 68, 68 respectively. Maintaining the marine water quality are important in sustaining the aquatic ecosystem.

Conclusion

Water quality of the coastal area of Port Dickson based on several parameters showed positive improvement in the water quality a year after the movement control order in Malaysia. Strict movement control order (MCO) has been implemented in mid-March 2020 since the spread of the COVID-19 pandemic all over the world. Although this COVID-19 pandemic negatively impacts the global human health as well as the world economic sectors, we can see some positive impact towards the environmental pollution. The endless pollution from the anthropogenic activities is declining and natural environment in aquatic ecosystem are recovering by its own nature. Some positive impact reported in this study may be temporary and the pollution index may increase later after the economic and social activities are allowed back to be operated. Therefore, the effective aquatic managements of water quality assessment should be studied from this unfortunate event of COVID-19 to reduce the aquatic pollution for future to ensure the sustainability of the marine ecological functions and integrity.

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