Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

Special Issue

WATER QUALITY INDEX ASSESMENT AROUND INDUSTRIAL AREA IN KUANTAN, PAHANG

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Published online: 08 August 2017

ABSTRACT

This study was conducted to determine water quality parameters and measure the Water Quality Index (WQI) based on Interim National Water Quality Standards, Malaysia (INWQS) classification. The sampling was carried out on February 2017 which are Balok River (S1), Pengorak River (S2) and Karang River (S3). The physical and chemical parameters were temperature, DO, pH, TDS, turbidity, BOD, COD, TSS and AN. Results show that base on Malaysian WQI, and the water of S1, S2 and S3 were 70.737, 66.127 and 73.098 respectively. Two-way ANOVA with replication test ($P < 0.05$) shows that all water quality parameters had significant differences between the sampling stations. In conclusion, S1, S2 and S3 were categorized as a slightly polluted river (WQI) and were classified as Class III.

Keyword: Gebeng industrial; water quality; Balok River; Pengorak River; Karang River.

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doi: http://dx.doi.org/10.4314/jfas.v9i2s.45

1. INTRODUCTION

Water is essential to all forms of life and makes up 50-97% of the weight of all plants and animals and about 70% of human body [2]. Freshwater is importance resource for agriculture, manufacturing, transportation and many other human activities. Despite its importance, water is the most poorly managed resource in the world. Research by (1980) supports the importance of water causes the demand of water increase drastically throughout the past year. They also explained in terms of physiology, water is essential for processes such as digestion, absorption, circulation, transportation and maintaining body temperature. Addition, in terms of civilization, a plentiful supply of water can be one of the most important factors in the development of modern societies [14].

Polluted water is one of agent for the spread of diseases. About 1.8 million people in developing countries, mostly children, die every year as a result of water-related diseases. Malaysia is one of developing countries in South East Asia and the major water demand comes from agriculture, the industry as well as a domestic sector [8]. Although the growth in these sectors has undoubtedly generated economic benefit to the society, it has led to deterioration in water quality and quantity [16]. As a result, the study and management of freshwater resources are becoming more challenging in this country. Therefore, water quality monitoring is important for contributing to the effectiveness of determining the status of the rivers water quality and the needed actions. Besides, evaluation of this water quality parameter will enhance the performance of an assessment operation and develop a better water resource management plan. This is a primary action and the measure to ensure sustainable water resources and environment in this area.

Water quality is a measure of the suitability of water for a particular use based on selected physical, chemical and biological characteristics. The water quality can be determined by specific analysis called Water Quality Index (WQI) using specific parameters. It is highly recommended that our water supply must be checked and tested continuously to make sure its quality follows the required and standard level of quality ensured by Malaysian Department of Environment (DOE). A good water quality represents higher index value. Therefore, in water quality assessment a numerical index is used as a management tool [5].

WQI has been developed to assess the suitability of water for a variety of uses. The index reflects the status of water quality in lakes, streams, rivers, and reservoirs. The concept of WQI is based on the comparison of the water quality parameter with respective regulatory standards [13]. WQI is calculated to identify the classes of water. The classes of water are determined according to National Water Quality Standard for Malaysia (INWQS). WQI relates a group of water quality determinants to common scale and combines them into a single number in accordance with a chosen method or model of computation. There are six basic parameters use in WQI calculations, namely Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia-Nitrogen (AN), pH and Total Suspended Solid (TSS). A higher index value represents good water quality [9].

This study focused on the assessment of the river water quality status of selected rivers at Kuantan, Pahang. This research determines the class of water by calculating WQI using water samples from different rivers at Kuantan, Pahang. Besides that, this research also focuses on classes of rivers at Kuantan, Pahang.

2. RESULTS AND DISCUSSION

The mean and range (maximum to minimum) for in situ and ex situ parameters for 3 sampling stations are shown in Tables 1. Statistical analysis (ANOVA) shows that all parameters measured in this study have significant differences ($P < 0.05$) between the sampling stations. Those variations in water quality parameters were mainly due to anthropogenic activities. Correlation analysis was also conducted to examine the relationship between different variables. The correlation coefficients of various water variables are tabulated in Table 2, 3 and 4.

Table 1. Min, max, mean and SD for water quality parameters for three sampling stations

	Parameter	Unit		S1	S2	S3
1.	Temperature	^{0}C	Min	28.00	29.00	29.00
			Max	29.50	32.00	30.70
			Mean	28.66	30.19	29.93
			SD	0.50	1.17	0.69

2.	pH		Min	6.23	6.59	6.14
			Max	6.82	7.09	6.35
			Mean	6.61	6.88	6.23
			SD	0.24	0.18	0.07
3.	TDS	mg/L	Min	10398.00	13478.00	1021.50
			Max	10946.50	20413.00	1231.40
			Mean	10672.66	17972.44	1126.81
			SD	156.54	2615.48	68.32
4.	DO	mg/L	Min	4.67	4.00	4.79
			Max	5.89	5.23	5.21
			Mean	5.35	4.59	5.06
			SD	0.47	0.37	0.16
5.	Turbidity	NTU	Min	17.00	20.00	15.00
			Max	13.00	24.00	22.00
			Mean	9.56	21.21	18.33
			SD	2.19	1.38	2.24
6.	TSS	mg/L	Min	49.70	48.90	48.90
			Max	55.30	55.00	55.00
			Mean	52.46	50.57	50.57
			SD	2.430	1.97	1.97
7.	BOD	mg/L	Min	0.47	0.48	0.47
			Max	0.62	0.65	0.56
			Mean	0.53	0.57	0.52
			SD	0.05	0.06	0.04
8.	COD	mg/L	Min	45.00	74.00	45.00
			Max	51.00	87.00	52.00
			Mean	47.89	79.11	49.00
			SD	2.20	4.73	2.24
9.	Ammonia-N	mg/L	Min	1.57	1.57	0.87

		Max	2.35	2.59	1.08
		Mean	1.88	2.03	0.99
		SD	0.28	0.38	0.08
10.	WQI	Min	67.90	60.52	71.44
		Max	73.07	70.44	74.40
		Mean[a]	70.74	66.13	73.10
		SD	1.76	3.47	0.85

SD: Standard deviation

[a] Class I => 92.7; Class II = 76.5-92.7; Class III = 51.9-76.5; Class IV = 31.0-51.9; Class V =< 31.0

Table 2. Correlation coefficient (r) between water quality parameters and WQI at Balok River

	Temperature	**TDS**	**DO**	**pH**	**Turbidity**	**TSS**	**BOD**	**COD**	**AN**	**WQI**
Temperature	1									
TDS	-0.132	1								
DO	-0.215	0.696***	1							
pH	0.260	-0.398	-0.170	1						
Turbidity	0.140	0.523*	-0.104	-0.276	1					
TSS	-0.031	-0.063	-0.582**	0.060	0.452*	1				
BOD	-0.508*	0.622**	0.451*	0.219	0.233	0.180	1			
COD	-0.764***	-0.360	0.097	0.044	-0.712***	-0.160	0.137	1		
AN	0.046	0.474*	0.048	-0.484*	0.498*	-0.178	0.060	-0.416	1	
WQI	-0.063	0.447*	0.905***	0.135	-0.264	-0.532*	0.356	0.123	-0.334	1

WQI: Water Quality Index

*Indicates a significant relationship ($P < 0.05$); **Indicates a significant relationship ($P < 0.01$) ***Indicates a significant relationship ($P < 0.001$)

Table 3. Correlation coefficient (r) between water quality parameters and WQI at Pengorak River

	Temperature	TDS	DO	pH	Turbidity	TSS	BOD	COD	AN	WQI
Temperature	1									
TDS	0.059	1								
DO	-0.047	-0.529*	1							
pH	-0.348	-0.170	0.108	1						
Turbidity	0.234	0.172	-0.045	-0.042	1					
TSS	-0.085	0.180	-0.229	-0.645**	0.010	1				
BOD	-0.124	0.042	0.357	0.396	0.214	-0.439	1			
COD	0.111	0.572**	0.148	-0.026	0.097	-0.443*	0.490*	1		
AN	0.049	0.171	-0.541*	0.177	-0.114	-0.501*	0.128	0.1971	1	
WQI	0.049	-0.836***	0.769***	0.016	0.027	0.046	-0.012	-0.428	-0.651**	1

WQI: Water Quality Index

*Indicates a significant relationship (P < 0.05); **Indicates a significant relationship (P < 0.01) ***Indicates a significant relationship (P < 0.001)

Table 4. Correlation coefficient (r) between water quality parameters and WQI at Karang River

	Temperature	TDS	DO	pH	Turbidity	TSS	BOD	COD	AN	WQI
Temperature	1									
TDS	-0.300	1								
DO	-0.259	0.348	1							
pH	-0.177	0.009	-0.304	1						
Turbidity	-0.299	0.079	-0.582*	0.320	1					
TSS	-0.202	-0.585**	-0.342	0.587**	0.153	1				
BOD	-0.091	0.070	-0.066	0.510*	0.133	-0.094	1			
COD	-0.105	-0.143	0.094	-0.759***	-0.125	-0.231	-0.702***	1		
AN	0.079	-0.121	-0.288	-0.219	0.443	-0.272	-0.022	0.299	1	
WQI	-0.114	0.544*	0.838***	0.002	-0.541*	-0.354	0.235	-0.334	-0.579**	1

WQI: Water Quality Index

*Indicates a significant relationship ($P < 0.05$); **Indicates a significant relationship ($P < 0.01$) ***Indicates a significant relationship ($P < 0.0$)

2.1. Temperature

The mean water temperature for Balok River, Pengorak River and Karang River are 28.66 ± 0.500^0C, 30.19 ± 1.17^0C and 29.93 ± 0.69^0C respectively. The temperatures recorded among stations were slightly high regardless of hot weather throughout the sampling periods. Based on Table 1, the highest temperature was recorded at stations two (S2) with a mean of temperature 30.19^0C ($\pm$ 1.17). As stated by [14], the influence of heat exchange with the earth surface also contributed to the river water circulation. In addition, Table 1 also showed the mean temperature for all stations within the normal range of water temperature for Malaysian lakes based on the National Water Quality Standard (NWQS) for Malaysia.

Correlation analysis at Balok River showed that temperature has a negative correlated with the BOD ($r= -0.508$, $p < 0.05$) and COD (-0.764, $p < 0.001$). These mean the value of BOD and COD decrease when temperature low. Temperature at Pengorak River and Karang River are not correlated with all water quality parameters.

2.2. pH

pH indicates contamination and acidification. Besides, they also explained low pH allows toxic elements and compounds to become mobile. They also argued the lower the pH, the higher the hydrogen ion (H+) activity and the more acidic is the water. The neutral pH is considered as 7.0. Theoretically, unpolluted streams normally show a near neutral or slightly alkaline pH [7]. Based on Table 1, the mean pH value in Balok River, Pengorak River and Karang River are 6.61 ± 0.24, 6.88 ± 0.18 and 6.23 ± 0.07 respectively. The results showed that most of the river water in different sampling station was slightly alkaline condition. This all value is in the normal range (6.5 to 8.0) for freshwater ecosystem. Thus, the rivers were classified as Class I based on NWQS classification. According to previous study from [16], the pH value of Tunggak River 6.77 which is around the pH value on this study (Table 1).

Correlation analysis at Balok River showed pH has negative correlated with ammonia nitrogen (-0.484, $p < 0.05$), while Pengorak River has negative correlated with turbidity (-0.645, $p < 0.01$). Karang River has negative correlated with COD (-0.759, $p < 0.001$) and positively correlated with TSS (0.587, $p < 0.01$) and BOD (0.510, $p < 0.05$).

2.3. Total Dissolved Solid (TDS)

The mean TDS in Balok River, Pengorak River and Karang River are 10672.66±156.54 mg/L, 17972.44±2615.48 mg/L and 1126.81±68.32 mg/L respectively. Based on Table 1, the average value TDS recorded in all station during this study is not in normal range (> 4000 mg/L) for a freshwater ecosystem and was classified as Class V based on the NWQS classification. This because the reactivation industrial area located near all stations was probably the main contributing the higher TDS value. Soil erosion is caused by disturbance of a land surface. Soil erosion caused near all stations might be another factor the TDS values are higher. The eroded soil particles may contain soluble components that can dissolve and be carried by stormwater to surface water. This was increased the TDS of the water body. The mean value of TDS at Tunggak River is lowest compare to all stations in Table 1 [17].

Balok River showed TDS have positive correlation with DO (0.696, $p < 0.001$), turbidity (0.523 $p < 0.05$), BOD (0.621, $p < 0.01$) and ammonia-N (0.474, $p < 0.05$). Pengorak River showed TDS have negative correlation with DO (-0.529, $p < 0.05$) and positive correlation with COD (0.572, $p< 0.01$). Karang River showed TDS have negative correlation with TSS (-0.585, $p < 0.01$).

2.4. Dissolved Oxygen (DO)

DO is an essential parameter for the survival of all aquatic organisms. Oxygen is the most well established indicator of water quality. DO test present the amount of oxygen is available in river water. The DO mean in Balok River, Pengorak River and Karang River are 5.35± 0.47 mg/L, 4.59±0.37 mg/L and 5.06±0.16 mg/L respectively. Tunggak River has lowest mean value of DO compare to Balok River, Pengarok River and Karang which is 2.24 mg/. This indicate that the Tunggak River was highly deoxygenated [17]. Based on the NWQS, the average DO value recorded at S1 and S3 were placed in Classes IIA and IIB (a range of 5–7 mg/L), while S2 was placed in Class III (a range of 3-5 mg/L). Concentrations of DO exhibit a daily cycle [6]. The lowest concentration of DO occur about dawn and during daylight, photosynthesis causes dissolved oxygen concentration increase and maximum DO concentrations are reached in the afternoon which agreed with the finding of [5]. These results indicate that the main contributing factors for low DO in all stations were photosynthetic activities and the decomposition rate of organic matter. Addition, waste discharge from the nearing industrial is another factor the low DO value at all stations.

Based on Table 2, Balok River showed DO have negative correlation with TSS (-0.582, $p < 0.001$) and positive correlation with BOD 90.451, $p < 0.05$). Pengorak River showed DO has negative correlation with ammonia-N (-0.541, $p < 0.05$). Karang River showed DO has negative correlation with turbidity (-0.582, $p < 0.01$).

2.5. Turbidity

Turbidity is an optical determination of water clarity [10]. Turbid water will appear cloudy, murky, or otherwise colored, affecting the physical look of the water. Turbidity also can come from suspended sediment such as silt or clay, inorganic materials or organic matter such as algae, plankton and decaying material. Turbidity in Balok River, Pengorak River and Karang River has a mean value of 9.56±2.19 NTU (Nephelometric Turbidity Unit), 21.21±1.38 NTU and 18.33±2.24 NTU respectively. The mean value of turbidity was detected at Tunggak River are 15.59, which are highest than Balok River and lowest than Pengorak and Karang River [17]. In general, the average turbidity values recorded in all station were classified as Classes IIA and IIB (5-50 NTU) of the NWQS classification.

The turbidity values of S2 are higher than the turbidity values of S1 and S3 (Table 1). Industrial activities near the S2 might be the possible factor that caused turbidity value at S2. Land development such as construction (house and factory), disturbs and loosens soil, increasing the opportunities for runoff and erosion. The loosened soils caused by these sites can then be carried away by wind and rain to a nearby body of water. This leads to an increase in runoff rates, causing erosion and increased turbidity in local streams and lakes. As stated by [3], turbidity is evident at dredging sites or washes water discharge points due to resuspension of sedimentation caused by stockpiling and dumping of excess mining materials.

Balok River showed turbidity have positive correlation with TSS (0.452, $p < 0.05$) and ammonia-N (0.498, $p < 0.05$) and has negative correlation with COD (-0.712, $p < 0.001$). Pengorak River and Karang River showed turbidity no correlation with any water quality parameters.

2.6. Total suspended solid (TSS)

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration. These solids include anything drifting or floating in the water, from sediment, silt, and sand to plankton and algae.

Based on Table 1, total suspended solids (TSS) recorded in the Balok River, Pengorak River and Karang River were 52.46±2.43 mg/L, 50.57±1.97mg/L and 50.57±1.97mg/L respectively. In general, the average TSS values recorded in all stations were classified as Classes II of the NWQS classification.

Based on correlation analysis, Balok River and Karang River showed TSS have no correlation with water quality parameters while Pengorak River have negative correlation with BOD (-0.443, $p < 0.05$) and COD (-0.502, $p < 0.05$).

2.7. Biochemical oxygen demand (BOD)

BOD is the amount of oxygen required by bacteria to stabilize organic matter under aerobic conditions. The BOD test involves the determination of oxygen uptake by bacteria under standard conditions. The concentration of BOD in water sample can determine the degree of pollution caused by microorganisms through biodegradation. BOD concentration is higher, and then the water is considered polluted. Based on Table 1, the mean BOD in Balok River, Pengorak River and Karang River were 0.53± 0.05 mg/L, 0.57± 0.06 mg/L and 0.52±0.04 mg/L respectively.

The average BOD concentrations in all stations were classified in class I based on NQWS classification. This is considered as not polluted and practically no treatment required. The low of BOD implies that no biodegradation process caused by microorganisms occurred in river water. However, prevention step and education program should be implemented to citizen before it becomes more serious. Prevention is an especially important strategy for controlling the pollutant

Based on correlation analysis, Balok River showed BOD has no correlation with any water quality parameter. Pengorak River has positive correlation with COD (0.490, $p < 0.05$) while

Karang River has negative correlation with COD (-0.702, $p < 0.001$).

2.8. Chemical Oxygen Demand (COD)

COD test predicts oxygen requirement during the decomposition of organic matter and the oxidation of inorganic chemicals. Normally, the value of COD is higher than that of the BOD. Theoretically, if COD concentration is higher, then the water considered polluted. The mean chemical oxygen demand (COD) in Balok River, Pengorak River and Karang River were 47.89±2.20 mg/L, 79.11±4.73 mg/L and 49.00±2.24 mg/L respectively. The mean COD value of Tunggak River is 45.55mg/L, which are around the value of Balok River and Karang River. The mean COD concentration in the S1 and S3 were class in class III, while S2 was class in class IV of the NQWS classification. In terms of COD, all rivers water is necessary extensive treatment. Weather condition, distance from discharge sources, accessibility, runoff factors and safety factor are contribute an increasing and decreasing COD concentration value during sampling time.

The higher concentration of COD at all stations due to higher decomposition of organic and inorganic contaminants, dissolved or suspended in water that came from the wet market and industrial near the stations. Besides that, improper sanitation in local villages, resort and camp near the stations might bring extra biological loading into the river, thus increase the BOD and COD values. Therefore, a pre-treatment is needed to treat the wastewater before being discharged as to reduce the concentration of COD.

Based on correlation analysis, Balok River, Pengorak River and Karang River have no correlation with any water quality parameters.

2.9. Ammonia Nitrogen (AN)

Ammonia nitrogen indicates nutrient status, organic enrichment and health of water body. It commonly forms as organic, ammonia, nitrate, nitrite and gaseous nitrogen. If higher value of ammonia nitrogen recorded, then the river water considered as polluted [11]. Based on Table 2, the mean ammonia nitrogen in Balok River, Pengorak River and Karang were 1.88±0.28, 2.03±0.38 and 0.99±0.08 respectively. The average ammonia nitrogen concentrations in all stations were classified as Class III of the NQWS classification.

Balok River (S1) is near the wet market while Pengorak River (S2) is near to industrial area.

Usually, wet market and industry discharge sullage that contained fresh composing materials. A high concentration of nutrients in sullage is critical issue which causes algal problems in the water bodies. Sullage can degrade the aquatic status of the urban stream where the assimilative capacity of the streams is low.

Based on correlation analysis, ammonia nitrogen at Balok River, Pengorak River and Karang River have no correlation with any water quality parameters.

2.10. Water Quality Index (WQI)

Based on the result finding, WQI calculation was carried out to determine the river WQI. Overall WQI for river basin is calculated by averaging WQI from all sampling points in each river basin. According to The Malaysian Water Quality Index (DOE-WQI), Balok River, Pengorak River and Karang River water are classified as class III with the mean of 70.74$\pm$1.76, 66.130$\pm$3.47 and 73.10$\pm$0.85 respectively where it class of classification in range of 51.9 to 76.5. At mid-stream of Tunggak River was categorized as class IV (highly polluted) while the lowest and upper stream were classified in class III (polluted) [17].

WQI at Balok River, Pengorak River and Karang River were be found to be correlated with DO (0.905, 0.769 and 0.838 respectively $p < 0.001$).

3. EXPERIMENTAL

3.1. Study Area Description

Kuantan District (2960 km^2) is the state capital of Pahang, which is located at latitude 3° 45′ 0″ N and longitude 102° 30′ 0″ E. Kuantan is considered a social, economic and commercial hub for the East Coast of Peninsular Malaysia due to its strategic location while rapid development has transformed and modernized the city All the samples were collected at Balok River, Pengorak River and Karang River which located close to the Gebeng industrial site and commercial beach area in Kuantan, eastern part of the Peninsular Malaysia. The river flows pass through the wide industrial facilities which include steel industries, palm oil mills and pipe coating and others. Besides that, these three rivers are located near the Kuantan Port. Kuantan port is temporary storage of bauxite mining prior to being exported to China for mineral processing.

3.2. Water Sampling

Three sampling stations were chosen within the study area (Fig. 1) with exact coordinate of sampling locations were recorded using a Global Positioning System (GPS) device (Table 1). The sampling was handled from 22 until 25 February 2017. It comprises of the Station One (S1) is situated at Balok River, Station Two (S2) is located at Pengorak River and Station Three (S3) is located at Karang River. Before sampling, 500mL polyethylene bottles was pre-cleaned with acid washed by soaking overnight in 5% (v/v) nitric acid before rinsing thoroughly with distilled water. This procedure is very crucial in order to ensure any contaminants and traces of cleaning reagent were removed before the analysis. During sampling, the polyethylene bottles were normalized rinse with river water and then filled up with running river water facing the direction of flow. The surface water sample was being collected about 10 cm below water. Moreover, samples were be labelled accordingly refers to the sampling location and date. Then, the samples were being brought to the laboratory for further analysis. All samples were stored in the cooler box at approximately 4°C to minimize the microbial activity in the water [3]. Each station was being taken at three points to obtain more accurate results during analysis. One measurement was being assessed with three replicates as in the experimental design.

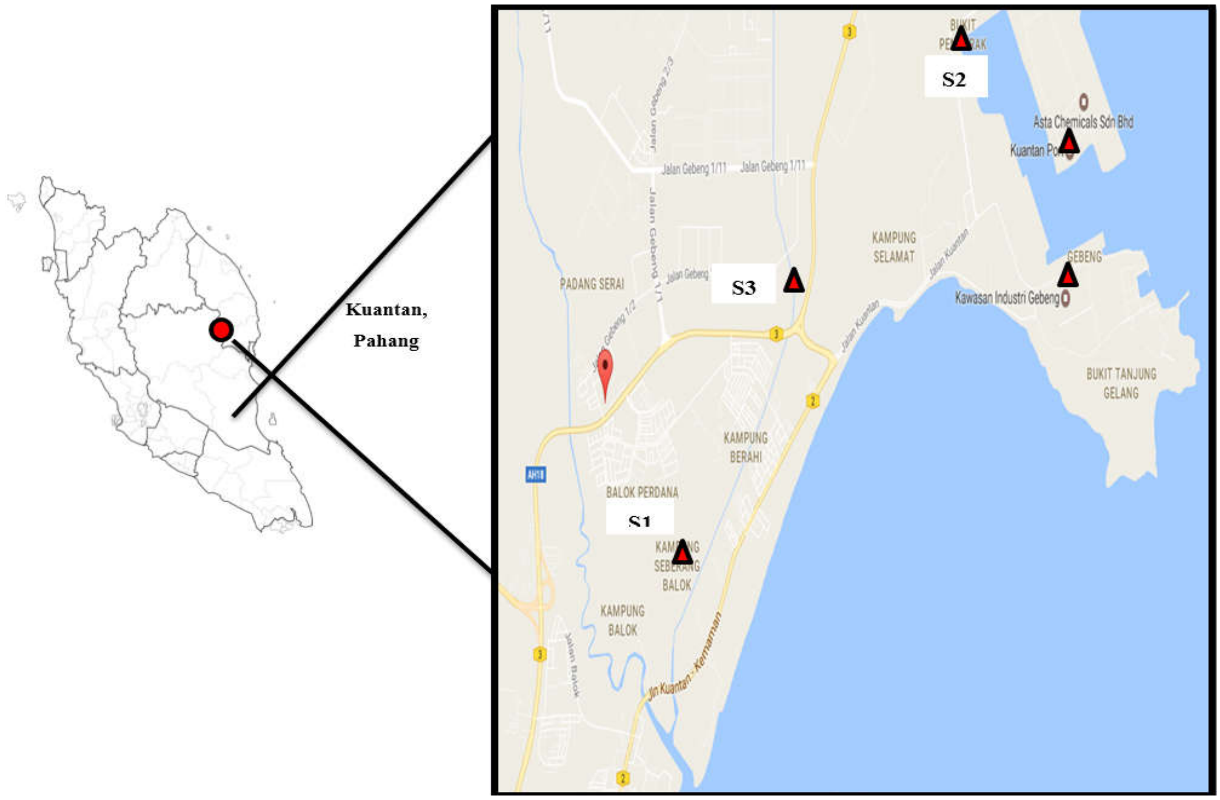

Fig.1. Maps of sampling station in Kuantan, Pahang

Table 5. The GPS coordination of the stations

Stations	Locations	Latitudes	Longitudes
S1	Balok River	03^{0} 56' 23.2" N	103^{0} 22' 32.2" E
S2	Pengorak River	03^{0} 58' 5.5" N	103^{0} 24' 36.3" E
S3	Karang River	03^{0} 58' 7.7" N	103^{0} 24' 36.9" E

3.3. Water Analysis

Basic water quality parameters included in situ parameters are temperature, Total Dissolved Solids (TDS), salinity, Dissolved Oxygen (DO) and pH, turbidity, Ammonia-Nitrogen (AN), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solid (TSS) were taken into account for measurement. The measurement of in situ parameters was done immediately during each fieldwork by using YSI multiparameters probe except the measurement of turbidity, which was carried out using a portable turbidity meter (2100 Q HACH) and BOD was be determined directly by using BODCheck WATERMODERN. This system can combine a sensor with a depth rating of 600m with either a wireless roamer. All apparatus was be calibrated before being used during field sampling. The measurement of TSS was be determined by using Multiparameter Handheld Colorimeter (HACH DR900) while COD was being measured by using two apparatus. First, 2 mL sample was added into vial that contains COD digestion reagent by using clean volumetric pipette. Then, DRB 200 Digital Reactor Block was be used for digestion procedure at 150 ^{0}C for two hours. Second, DRB2800 HACH was be used for colorimetric determinations.

3.4. Water Quality Index (WQI)

WQI was be measured based on six significant parameters which consist of pH, Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Suspended Solid (TSS), Chemical Oxygen Demand (COD), and Ammonia Nitrogen (AN). It was calculated by using below formula:

WQI = 0.22 SI DO + 0.19 SIBOD + 0.16 SI COD + 0.16 SI SS + 0.15 SI AN + 0.12

where WQI = Water quality index; SI DO = Sub-index of DO; SI BOD = Sub-index of BOD; SI COD = Sub-index of COD; SI AN = Sub-index of AN; SI SS = Sub-index of TSS; SI pH = Sub-index of pH the class of WQI of lakes was being determined based on Classes in Malaysian Water Quality Index.

3.5. Statistical Analysis

The data was statistically analyzed using Microsoft Excel 2010 Data to perform two-way ANOVA with replication. The significant differences water quality parameters between sampling station were showed. Correlation coefficient was applied in order to determine correlation between water quality parameters.

4. CONCLUSION

As a conclusion, the values of TDS (class V) and ammonia-N (class III) for all three rivers had exceeded the normal range for a freshwater. DO (class III) and COD (class IV) for Pengorak River (S2) also exceeded the normal range for a freshwater Water Quality Index of Balok River, Pengorak River and Karang River were 70.74, 66.13 and 73.10 respectively. The value of WQI for all rivers is in class III and indicate slightly polluted based on DOE Water Quality Index Classification. In general, most of the rivers in Kuantan are required extensive treatment before water supply.

The overall assessment from this study shows that 9 parameters were recorded in the all rivers are slightly influenced by the condition of the sampling station. Based on the results from statistical analysis of two-way ANOVA with replication, it was showed that there is a significant difference among all parameters and sampling stations. The study shows clearly that as the river flows from an undisturbed to a disturbed environment, chemical and physical as well as biological characteristics of the river water change and the status of the water quality degrades.

5. ACKNOWLEDGMENTS

The authors would like to thank Universiti Sultan Zainal Abidin and Ministry of Higher Education for support the FRGS grant (RR212).

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How to cite this article:
Yaakub N, Raoff MNA, Haris MN, Halim AAA, Kamarudin MKA.Water quality index assesment around industrial area in kuantan, pahang. J. Fundam. Appl. Sci., 2017, *9(2S), 731-749*.