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Seasonal Variation of Water Quality at Sungai Chanteq and Sungai Dendong

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ABSTRACT

Water is important for all living things as water is one of the components build up in plant, animal and human. Rivers are an important source for domestic, industrial as well as agriculture sector. The aim of this study to assess the physicochemical and biological parameter from two rivers located at Pasir akar and Tembila. Water Quality Index (WQI) related to the quality status of the water. Two sampling stations in different rivers were sampled from December 2017 until March 2018. Eight water quality parameters were analyzed based on in-situ and ex-situ analysis at two different time. This experiment conducted according to HACH and American Public Health Association (APHA) methods. Based on the Malaysia WQI, the shows the classification water quality value for Sungai Dendong and Sungai Chanteq are 71.56 (class III) and 89.99 (class II), respectively. Based on the water class and guideline treatment of Malaysia, class II for water quality need conventional requirement to treat the water, while class III need extensive treatment to serve in the agricultural sector surround the area.

Keywords: Physicochemical, biological parameter, Water Quality Index, agricultural sector.

ABSTRAK

Air adalah penting untuk semua makhluk hidup kerana air adalah salah satu komponen penting dalam tumbuhan, haiwan dan manusia. Sungai merupakan sumber penting bagi sektor domestik, perindustrian dan pertanian. Tujuan kajian ini untuk menilai parameter fizikokimia dan biologi di dua sungai yang terletak di Pasir akar dan Tembila. Indeks Kualiti Air (IKA) berkait dengan status kualiti air. Data dari dua stesen pensampelan di sungai-sungai yang berbeza telah diambil dari Disember 2017 sehingga Mac 2018. Lapan parameter kualiti air dianalisis berdasarkan analisis in-situ dan ex-situ pada dua masa yang berlainan. Eksperimen ini dijalankan mengikut kaedah HACH dan Persatuan Kesihatan Awam Amerika (APHA). Berdasarkan Indeks Kualiti Air Malaysia (IKA), nilai kualiti air untuk Sungai Dendong dan Sungai Chanteq masing-masing adalah 71.56 (kelas III) dan 89.99 (kelas II). Berdasarkan kelas Air dan garis panduan rawatan Malaysia, kualiti air kelas II memerlukan rawatan konvensional, manakala kelas III memerlukan rawatan yang bersepadu bagi penggunaan di sektor pertanian yang terdapat disekeliling kawasan tersebut.

Kata Kunci: Parameter fizikokimia, parameter biologi, Indeks Kualiti Air, sektor pertanian.

INTRODUCTION

From 3% of fresh water, only 0.003% is available in the form of groundwater and surface water. Water is used for many activities such as drinking, irrigation, transportation, washing and waste disposal for industries. Therefore, rivers play important roles for water resources. However, many rivers are contaminating by industrial wastes and human activities. Water quality is a measurement of the status of the water based on the physical, chemical and biological characteristics. Water Quality Index (WQI) can determines the water quality status by specific analysis under specific parameter. It highly recommended to continuous checked of the water quality status under standard levels of quality based on Department of Environment (DOE).

WQI is calculated to identify the classes of water. According to National Water Quality Standard for Malaysia (NWQS), the class of water can be determined from Class I to Class 5. This study focusses on the determination of WQI at Sungai Dendong and Sungai Chanteq. There are six basic parameters used for WQI calculations, which are Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia-Nitrogen (NH_3-N), Potential Hydrogen (pH) and Total Suspended Solid (TSS). A higher index value indicates good water quality. In Malaysia, biological monitoring in water supplies involves a coliform count for detection count of fecal pollution. Besides, metal concentration also being evaluated either presence of it related to pollution occur around the area

Variation in the quality and quantity of river is widely studied by the many researcher especially examined the spatial - temporal variation in trace elements (Das et al., 2017). It is an important to determine the quality of the water by investigate it either the rate of pollution occurred will giving a bad impact to aquatic life and human. Based on the primary observation, there are mangrove trees around Sungai Dendong, thus it can be an indicator to help determine the water quality. For Sungai Chanteq, the metal concentration in the water need to be determined, either it is presences in high or low amount. There are still no WQI data for Sungai Dendong and carries the Sungai Chanteq, the current WQI only determine based on the physiochemical, inconsiderate for microbial indicator and metal concentration

The study objectives are to determine the physiochemical and biological parameters, the WQI status and the heavy metal contain in the rivers. This study significantly contributes to water quality status of the rivers and show if it needed for an action. This is a preliminary action to ensure the sustainability of water resource and environment for that particular area.

MATERIALS AND METHODS

Study area

There are two places for the study area, which are Sungai Dendong at Tembila and Sungai Chanteq at Pasir Akar. For Sungai Dendong, it is sub-institution for Sungai Kluang Besar. Sungai Dendong has 17.5 km² area. The river surrounded by mangrove tree. Thus it is one of the main reason to determine the water quality status and metal concentration in the water. For Sungai Chanteq, it is located at pasir akar farm, which act as main water supply throughout the farm. Both river surrounding with human activities that may cause the water quality status to be drop, thus it need to be determine if there has any pollution occurs.

Figure 1 Map of Sungai Dendong
Retrieve from Google Earth
Scale: 1000ft, 200m

Figure 2 Map of Sungai Chanteq
Retrieve from Google Earth
Scale: 1000ft, 200m

Sampling Collection

Two sampling stations were selected for this study. Station one (S1) situated at Sungai Dendong and station two (S2) located at Sungai Chanteq. The surface of the water sample being collected about 10 cm below water. Before sampling, polyethylene bottle need to pre-clean with acid wash by soaking overnight in 5% (v/v) nitric acid before rinsing thoroughly with distilled water. This procedure was done to ensure no contaminants and trace of cleaning agent remove before being analysis (APHA, 2005). Water samples were collected by using 500 mL steriled polyethylene clean bottle. The samples were labeled according to the sampling location and date. The samples then brought to the laboratory for analysis. All samples need to be kept in a cool box under 4ºC to minimize microbial activity (APHA, 2005). To determine BOD, the samples were collected using black bottle to avoid light penetration. There are three replicates for each sampling point comprise of the inlet, middle and outlet for both rivers. Sampling duration was within 4 months total.

Measurement of *In-situ* Parameter

There are two parameters for determining water quality that has been carried out as *in situ* measurement. The measurements are pH and dissolve oxygen (DO), that determined by using Handheld Multiparameter Water Meter YSI. All apparatus was calibrated before sampling.

Measurement of *Ex-situ* Parameter (Laboratory Analysis)

There are four parameters for determining water quality that has been carried out as *ex situ* measurement. The BOD is determined by using Horiba Laqua. TSS and COD are determined by DR900. All apparatus was calibrated before used for their analysis. Another parameter that need to be viewed are metal concentration which determined by using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). This analytical was used for detection of the chemical element in the water.

Biological Parameter

E.coli and coliform were determined by using two methods. First, by using 3M Petrifilm. A total of 2 ml of water sample was placed to petrifilm by using pipette in a laminar air flow. The spreader was placed on top of the film and gently applied pressure as well. The spreader lifted and waited for a minute for the gel to get solidified firmly. The petrifilm plate was incubated for 18 to 24 hours with the control temperature of 37 ºC. The colony on the petrifilm were count and recorded for the last procedure.

$$\text{Number of colonies} = \frac{\text{colonies counted}}{\text{mL sample x100}}$$

Water Quality Index

WQI is measure based on six basis significant parameters which are pH, DO, BOD, TSS, COD, and AN. They were calculated by using two methods which are mobile application, MY. Index Calculator and using the formula in Microsoft Excel 2010:

$$WQI=0.22\ SI\ DO +0.19\ SI\ BOD + 0.16\ SI\ COD + 0.15\ SI\ AN + 0.12\ SI\ pH$$

Where:

WQI = water quality index

SI DO = sub-index dissolve oxygen

SI BOD = sub-index biochemical oxygen demand

SI COD = sub-index chemical oxygen demand

SI AN = sub-index ammoniacal-Nitrogen

SI pH = sub-index pH

Statistical Analysis

The data were statically analyzed by using Microsoft excel 2010 data to perform one-way ANOVA.

RESULTS

Physical Parameter

There were six significant parameters which involved in the analysis. The parameters are pH, DO (conducted by *in-situ* measurement), BOD, TSS, COD, and AN analysis (conducted *ex-situ* measurement). The following are the result recorded during wet and dry season which began in December 2017 and ended in March 2018.

Total Suspended Solids

Figure 3 shows the increasing gradually of TSS of Sungai Dendong and unevenly reading for Sungai Chanteq for Wet and Dry Season through 4 months of sampling period.

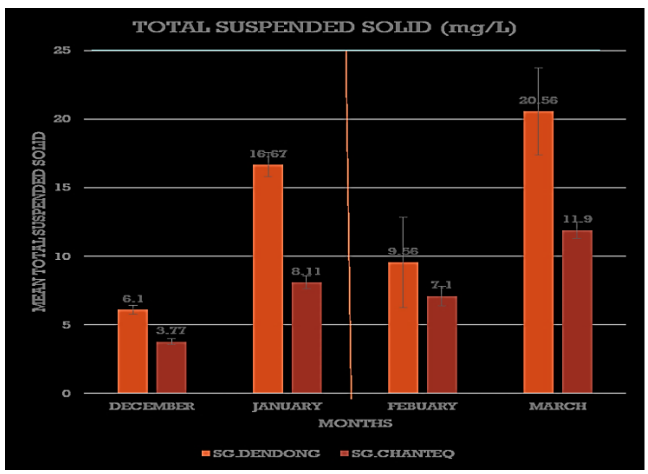


Figure 3 Mean of Total Suspended Solids in Sungai Dendong and Sungai Chanteq during Seasonal Periods

Chemical Parameter

Potential Hydrogen(pH)

Figure 4 shows the pH reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

Dissolve Oxygen (DO)

Figure 5 shows the DO reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

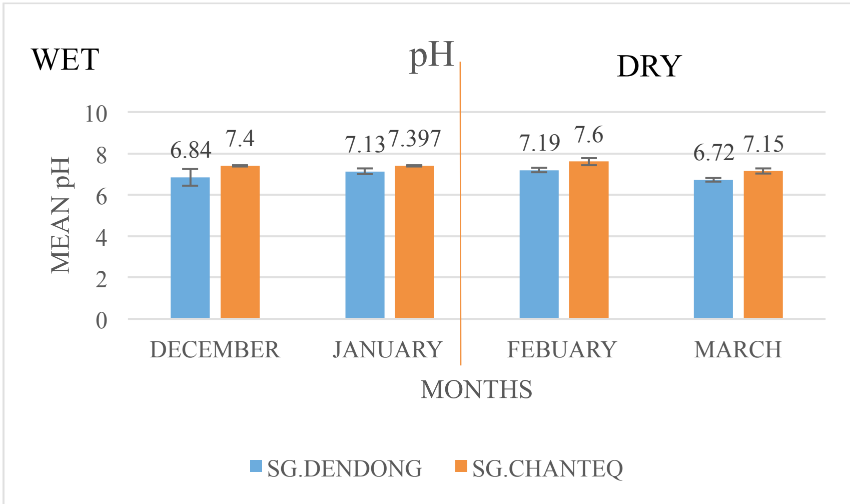


Figure 4 Mean of pH in Sungai Dendong and Sungai Chanteq during Seasonal Periods

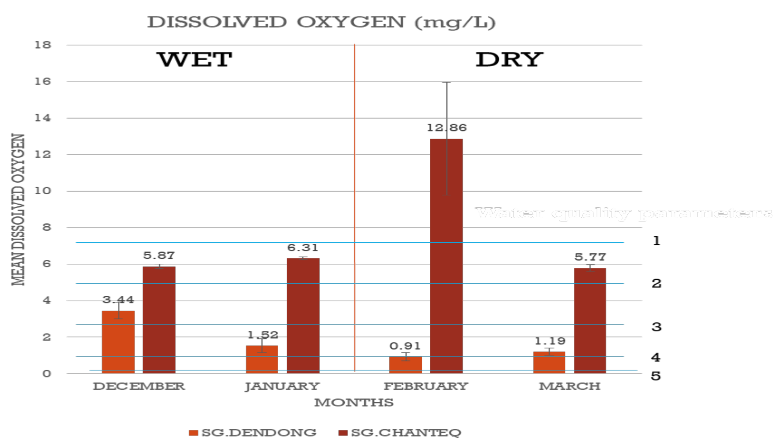


Figure 5 Mean of Dissolved Oxygen in Sungai Dendong and Sungai Chanteq during Seasonal Period

Biochemical Oxygen Demand (BOD)

Figure 6 shows the BOD reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

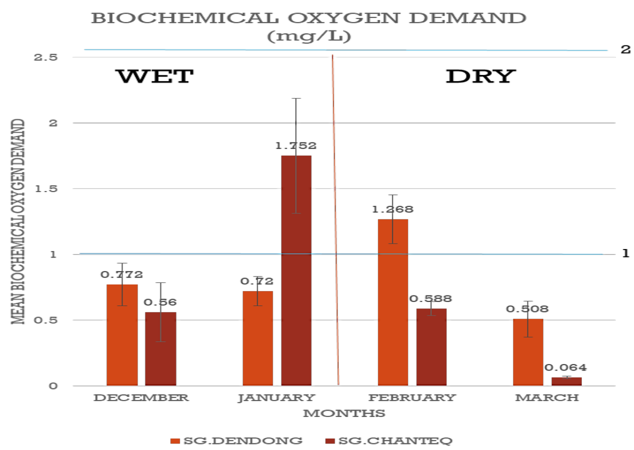


Figure 6 Mean of Biochemical Oxygen Demand in Sungai Dendong and Sungai Chanteq during Seasonal Periods

Chemical Oxygen Demand (COD)

Figure 7 shows the COD reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

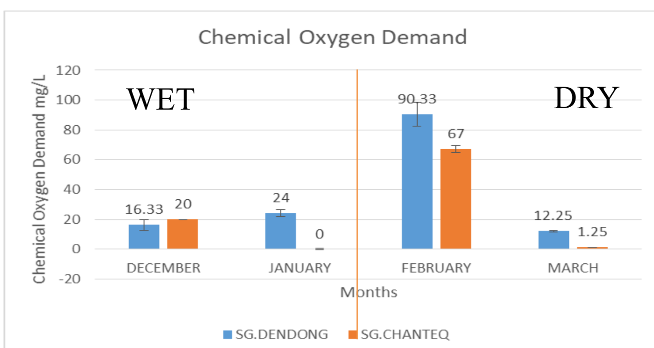


Figure 7 Mean of Chemical Oxygen Demand in Sungai Dendong and Sungai Chanteq during Seasonal Period

Ammoniacal Nitrogen (NH3-N)

Figure 8 shows AN reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

Heavy Metal Concentration

Figure 9 shows heavy metal concentration for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

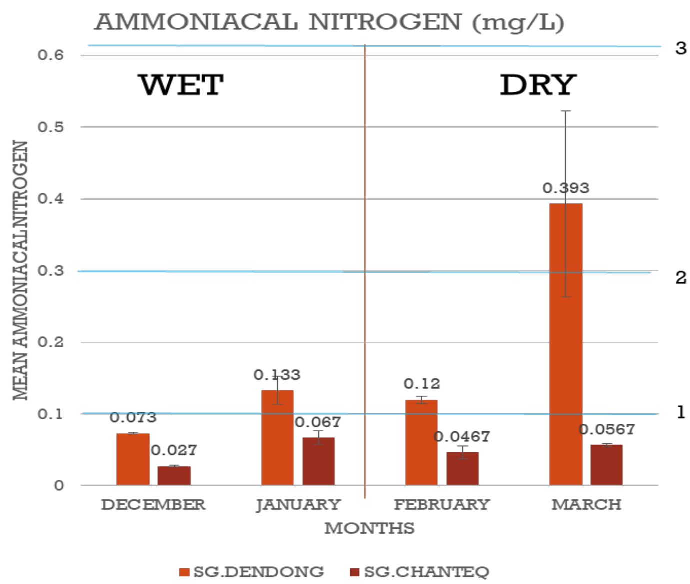
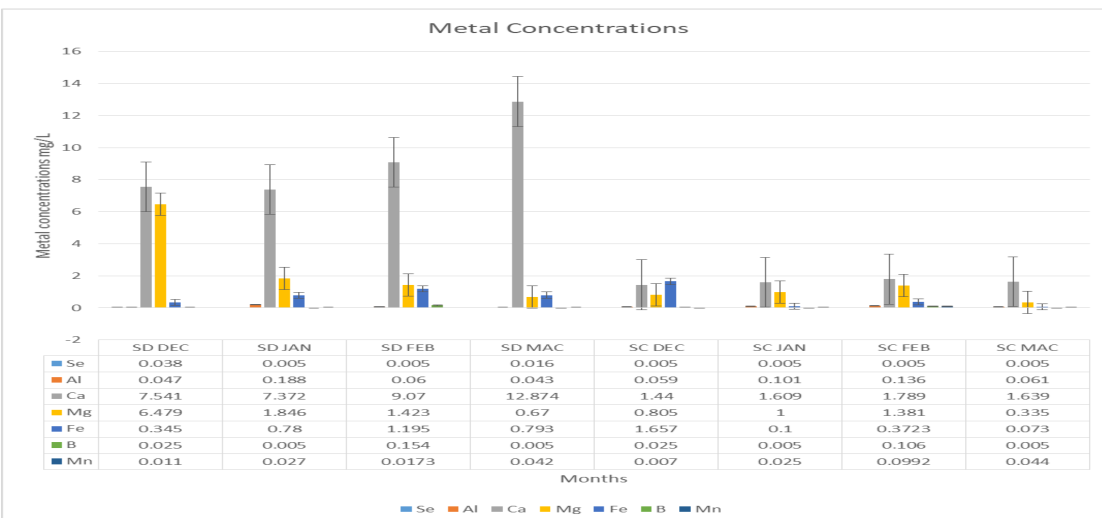


Figure 8 Mean of Ammoniacal Nitrogen in Sungai Dendong and Sungai Chanteq during Seasonal Periods



	SD DEC	SD JAN	SD FEB	SD MAC	SC DEC	SC JAN	SC FEB	SC MAC
Se	0.038	0.005	0.005	0.016	0.005	0.005	0.005	0.005
Al	0.047	0.188	0.06	0.043	0.059	0.101	0.136	0.061
Ca	7.541	7.372	9.07	12.874	1.44	1.609	1.789	1.639
Mg	6.479	1.846	1.423	0.67	0.805	1	1.381	0.335
Fe	0.345	0.78	1.195	0.793	1.657	0.1	0.3723	0.073
B	0.025	0.005	0.154	0.005	0.025	0.005	0.106	0.005
Mn	0.011	0.027	0.0173	0.042	0.007	0.025	0.0992	0.044

Figure 9: Mean of Metal Concentrations in Both Rivers During Seasonal Period

Biological Parameter

E.coli

Figure 10 shows the *E.coli* reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

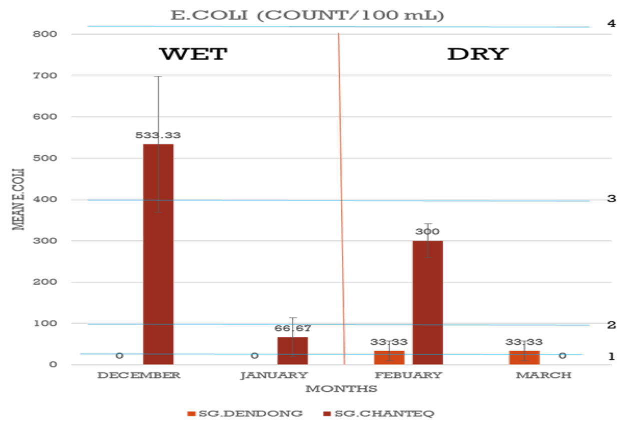


Figure 10: Mean of *E.Coli* in Sungai Dendong and Sungai Chanteq during Seasonal Periods.

Total Coliform

Figure 11 shows the Total Coliform reading for Sungai Dendong and Sungai Chanteq for 4 months of sampling due to the Wet and Dry Seasons.

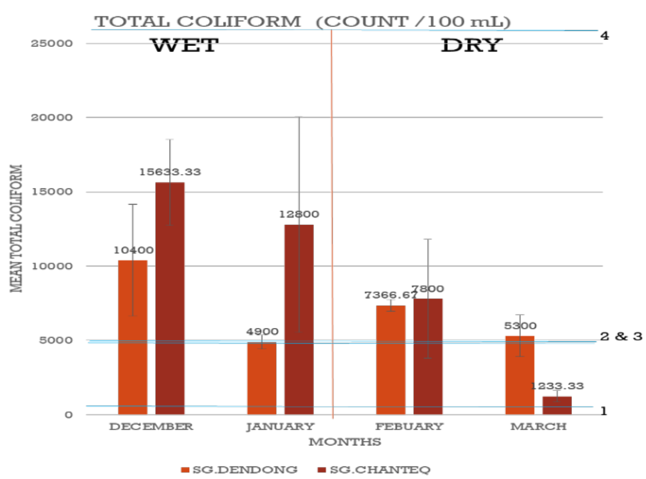


Figure 11 Mean of Total Coliform in Sungai Dendong and Sungai Chanteq during Seasonal Periods

Water Quality Index

Water quality index of Sungai Dendong and Sungai Chanteq shown in Table 1.

Table 1 The Water Quality Index of Sungai Dendong and Sungai Chanteq

	SG DENDONG	SG CHANTEQ
PHYSICAL PARAMETER	-	-
TSS mg/L	13.22 ± 8.84	7.72 ± 3.31
CHEMICAL PARAMETER	-	-
DO mg/L	1.76 ± 1.38	7.71 ± 5.37
AN mg/L	0.18 ± 0.23	0.05 ± 0.03
BOD mg/L	0.82 ± 0.52	0.74 ± 0.95
COD mg/L	17.94 ± 8.67	7.42 ±9.11
pH	6.97 ± 0.34	7.39 ± 0.36
Al mg/L	0.10 ± 0.08	0.10 ± 0.04
Ca mg/L	7.99 ± 0.09	1.61 ± 0.17
Mg mg/L	3.25 ± 2.80	1.06 ± 0.29
Fe mg/L	0.77 ± 0.43	0.71 ± 0.83
B mg/L	0.06 ± 0.08	0.05 ± 0.05
Mn mg/L	0.02 ± 0.001	0.04 ± 0.05
Se mg/L	0.02 ± 0.02	0.005 ± 0.00
BIOLOGICAL PARAMETER	-	-
E.Coli (count / 100 mL)	16.67 ± 38.92	225 ± 286.43
Total Coliform (count / 100 mL	6992.70 ± 4811.40	9366.70 ± 3119.04
WQI	71.56	89.99
Class	III	II

DISCUSSION

Based on Warner and Breon (2004), TSS particles that are between sizes larger and smaller than 2 microns are considered Total Disolved Solid (TDS). The TSS value for Dendong River is higher than the Chanteq River based on 4 months of sampling period (Figure 3). This may due to the turbidity (optical water clarity) of the rivers for Sungai Dendong is higher in dissolved organic matters than Sungai Chanteq. Besides, there are also algae fertilization in the Dendong River. According to Bilotta and Brazier (2008), the alteration of physical properties could causes decreasing of penetration of light, change of temperature, infilling of channels and reservoir when deposited of solids. There are no differences shows between wet and dry season for TSS parameter.

pH is an important factor to indicate the sustainability of water for the various purpose including toxicity to plants and animals (Venkatesharaju et al., 2010). Based on Figure 4, the results show a slightly different between both sampling stations. For Sungai Dendong, the result shows increased during the dry season from December to February and decreased in March. For Sungai Chanteq, the result shows increased and decreased throughout the 4 months. However, the range value for the pH most likely nears to the neutral that is 7.0. There were no differences between wet and dry seasons for pH parameter. This is because the accumulation of agricultural waste that goes to the river being flush out when raining, resulting in a neutral pH value was happen at the sampling point.

Dissolved oxygen (DO) is an important parameter to determine water quality and organic pollution in the sstream. Based on Figure 5, the DO value for Sungai Chanteq were higher than DO value for Sungai Dendong. According to Hallock (2002), Washington state department of ecology stated that DO concentration increase when the water flow becomes turbulence or rapid current. This brings the water more contact with the air which then increase the amount of dissolved oxygen into the water. Due to the topography of Sungai Chanteq, the river flow from the hilltop to the downstream of the river at high speed bring the higher concentration of DO compared to Sungai Dendong. There are differences shows between wet and dry season. As shown, during dry season has highest DO value for Sungai Chanteq than wet season. Due to smooth water flowed through the small quantity of residue.

BOD determines the strength of pollutant. The BOD test provides rough information on the biodegradable waste presence in water. Aquatic life can suffocate or die if the BOD in water is too high (Naubil et al., 2016). Based on the Figure 6, the BOD value for average BOD recorded shows that BOD was higher at Sungai Dendong than Sungai Chanteq. It may be contributed by the agricultural activities near the rivers which the application of pesticide, fertilizer and others. This is because the agricultural area was a bit far from Sungai Chanteq compare to Sungai Dendong. There also are no differences between dry and wet season for BOD values.

Department of Environment (2001) states that COD is a measure of oxygen that is required for oxidation of organic and inorganic matter in water. Based on Figure 7, the COD value showed an increasing value during

February than other months. This might be due to an increase of agricultural activities that occur after the wet seasons. However, based on overall months, the COD value in Sungai Dendong was higher than Sungai Chanteq. It might be because of distance of agricultural areas for Sungai Dendong discharge sources near than at Sungai Chanteq. There are differences between wet and dry season for COD values.

Based on Figure 8, the NH_3-N showed that the value at Sungai Dendong higher than Sungai Dendong. This might due to presence of higher number of algae in Sungai Dendong. These algae may use ammonia and nitrogen during nitrogen cycles which then increasing the ammoniacal nitrogen content in the water body. According to Corwin et al. (1999), the higher value of NH_3-N could be toxic to aquatic organisms such as fish. However, in low concentrations it could serve as nutrient for excessive growth for algae. There are differences between wet and dry season. As shown, at dry season in March there was the highest value recorded for ammoniacal nitrogen parameter.

Azaman et al., (2017) state that heavy metal is derived from a variety of natural and anthropogenic source that contribute to the aquatic environment. As long as it is in a small amount, there will not dangerous to the environment. Based on the Figure 9, the amount of metal concentrations observed in both rivers show the changes of every heavy metal from the 4 months of sampling which during the seasonal periods. There were different between wet and dry season. As shown, the heavy metal concentration increase from wet to dry seasons

Based on Figure 10, the amount for *E.coli* for Sungai Chanteq was higher than Sungai Dendong for almost overall Seasonal Periods. The *E.coli* could grows faster under certain condition which related to the temperature and surrounding environment. As according to Griffith et al. (2003) reported that *E.coli* could be washed out into the rivers, lakes, and groundwater from the land. Moreover, Sungai Chanteq near to area for livestock production such as cows, goats, and chicken. Therefore, the waste from the livestock runs through to the rivers. There are differences between dry and wet season. As shown, there are district decreasing and increasing of *E.coli* count from wet to dry season.

Based on the Figure 11, the amount of total coliform for Sungai Chanteq were higher than Sungai Dendong. The total coliform was similar to *E.Coli*. When there is a good condition or desirable condition for the bacteria to grows, the number of total coliform will be increased. There were no differences from dry and wet season. As shown, there are just slightly decrease of total coliform from wet to dry season.

Water quality index provided the indication for the quality of the water. Based on the Table 1, the total WQI that been calculated for considering the quality of the rivers which were Class 2 for Sungai Chanteq that needed conventional treatment, while for Sungai Dendong in class 3 which needed extensive treatment.

CONCLUSION

Water quality assessment is important due to water as the essential sources for daily life. Polluted water may be a threat and harmful to aquatic organism and public health. A total nine water quality parameter that measured were Total Suspended Solids(TSS) for physical parameter while for chemical parameter were Dissolved Oxygen (DO), Ammoniacal-Nitrogen (NH_3-N), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand(COD), Potential Hydrogen(pH), Heavy Metal Concentration (Aluminum (Al), Calcium (Ca), Iron (Fe), Boron (B), Magnesium(Mg), Manganese (Mn), Selenium(Se)), and also Biological Parameter which was E.Coli. From the results that were taken from the two different rivers, which had assessed during the wet and dry season, it shows that for every parameter reflect either causes effect due to changes of the seasonal periods. Measurement of WQI was determined for selected rivers. For Sungai Dendong, the WQI resulted 71.56 that can be classified as class 3, while for Sungai Chanteq, the WQI value indicated 89.99 in class 2. Although the classes for WQI in class 2 and class 3, it still need treatment either conventional or extensive.

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