SUNGAI CHILING WATER QUALITY MODULE

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Abstract: During Mini Scientific Expedition of Sungai Chiling 2023, water quality of Sungai Chilling, Hulu Selangor was assessed to determine its quality status and also to determine whether this river is suitable for water-based recreation. The index of DOE-WQI Index and JPS River index were applied in determine the status of river quality. JRI employed four indicators which are turbidity, total suspended solids (TSS), total dissolved solids (TDS), and river specific flow to assess the water quality. Meanwhile, DOE-WQI Index used six indicators which are dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total suspended solid, ammoniacal nitrogen and water pH to assess the water quality. Two trails were chosen in this module with four water sampling stations. The first trail was from the base camp up to the waterfall while the second trail was from the confluence of a tributary after the third sampling point until further upstream where the last sampling poing was set. Several water quality indicators were analyzed in this study but as this study focused on in-site study, the indicators that being analyzed were in-situ indicators. As a result, in term of water quality based on DOE-WQI Index, it was found that only DO and pH measurement could be referred. By comparing the results of DO and pH, it was found that the quality of Sungai Chilling along the study area is consistently under Class II which means that the water needs minor purification if there is an intention to make the river as public water supply or to consume directly, but still suitable for recreation and certain aquatic lives. The flow rate of the river was high which was in the range of 29.08 m^3/s to 62.55 m^3/s. Based on JRI index, the water quality status of the river was mostly Class II A, meanings that the river condition is hydrologically in good condition.

INTRODUCTION

Surface water quality is determined by its physical, chemical, and biological characteristics. In this case, determination of physical water quality of water in the rivers is crucial especially the rivers in the forest as these rivers located in water catchment area which is the main source of clean water supply to the consumers. Besides that, some certain parts of the river had become the main water-based recreation area where the quality of the river is important to ensure a good health of the public.

The word “water quality” is used to indicate how well the water is suitable for a given purpose or applications. In the management of water resources, one of the key concerns is water quality. There are a variety of characteristics that can be used to categorize water quality into three major categories: physical, chemical, and biological and according to Alley (2000), these categories of characteristics play a major role in indicates the status of water quality based on the standards of its usage.

Water quality parameter are quantifiable traits that are used to evaluate the chemical, physical, and biological qualities of water. In assessing the health of the river water and ensure that it is safe to use for any purpose, including domestic and recreational usage, a variety of water quality indicators are examined involving the physical, chemical, and biological aspects. Physical properties of water are related to the appearance of water, namely, the color, temperature, turbidity, taste, and odor.

Water quality status is evaluated by a water quality index (WQI), a single unitless number distilled from a complex mathematical process from a large number of water quality parameters. According to Khan et al. (2003), the basis of the WQI concept is the comparison of the water quality parameter with the relevant regulatory norms. Water quality index provides the mechanism which can be used to evaluate the water quality status from various sources and determine the best way to utilize the water resource,

making decisions about public policy more objective and less arbitrary, describing the differences between the situation before and after the regulatory policy or piece of law being implement, and also provide a comprehensive picture of the overall water quality to make it user-friendly to technologically unskilled stakeholders.

Regarding with this situation, water quality of Chilling River in Hulu Selangor was being assessed to determine its quality status and also to determine whether this river is suitable for water-based recreation. The index of DOE-WQI Index and JPS River index were applied in determine the status of river quality. DOE-WQI Index was established by the Malaysian Department of Environment to assess the water quality comprehensively, covering the aspect of physical, chemical, and aggregate indicators and this index could determine the suitability of the river for certain kind of utilization. JPS River Index or in abbreviation denoted with JRI was established by the Department of Irrigation and Drainage to assess the water quality mostly on physical hydrology aspect and this index could determine the quality status of the river in term of physical and sediment content and the ability of the river to supply the water to downstream.

JRI employed four indicators which are turbidity, total suspended solids (TSS), total dissolved solids (TDS), and river specific flow to assess the water quality. The following Table 1 shows the parameters or indicators used to calculate JRI. Besides that, in the case of specific flow and turbidity, it was also shown the situation of the sampling whether it was conducted on rainy day or not. Table 1 also showed that JRI classified the water quality status into five classes that stands for clean, good, fair, poor, and very poor with their value of index range. (Hassan et al., 2015).

DOE-WQI Index used six indicators which are dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total suspended solid, ammoniacal nitrogen and water pH to assess the water quality. Table 2 shows the suitability of water based on the water quality status. While Table 3 shows the concentration or value range of the indicators for each class of water quality.

Table 1: JRI Water Quality Status Classification

Parameter	Unit	Class and Status of the River										
		Clean	Good			Fair			Poor			Very Poor
		I	II-A	II-B	II-C	III-A	III-B	III-C	IV-A	IV-B	IV-C	V
JRI	**-**	**>90**	**90-85**	**84-78**	**77-71**	**70-65**	**64-58**	**57-51**	**50-45**	**44-38**	**37-31**	**<30**
Specific Flow, Non-rainy Day (SF)	($m^3/s.km^2$)	>0.029	0.0261-0.0290	0.0231-0.0260	0.0201-0.0230	0.0181-0.020	0.0161-0.0180	0.0146-0.0160	0.0131-0.0145	0.0111-0.0130	0.009-0.0110	<0.009
Specific Flow, Rainy Day (SF)	($m^3/s.km^2$)	<0.37	0.370-0.534	0.535-0.784	0.785-1.034	1.035-1.274	1.275-1.564	1.565-1.874	1.875-2.184	2.185-2.584	2.585-3.050	<3.050
Turbidity, Non-rainy Day	NTU	<20	20-26	27-33	33-38	39-46	47-53	54-60	61-69	70-78	79-87	>87
Turbidity, Rainy Day	NTU	<55	55-71	72-188	189-107	108-128	129-149	150-169	170-194	195-218	219-243	>228
TSS	mg/L	<21	21-29	30-41	42-54	55-69	70-92	93-126	127-166	167-216	217-270	>270
TDS	mg/L	<66	66-95	96-144	145-192	193-230	231-290	291-346	346-396	397-466	467-539	>539

Source: Abdullah A. M (2009)

Table 2: Classes and Suitability of water under DOE-WQI Index

Class	Description of water suitability	Index value
I	No need treatment for public water supply	> 92.7
II	Needs minor purification for public water supply. Suitable for recreation	76.5 – 92.7
III	Needs an intensive treatment for public water supply. Suitable for certain aquatic life	51.9 – 76.5
IV	Suitable for drainage	31.0 – 51.9
V	Not suitable for any usage	< 31.0

Source: Department of Environment (2009)

Table 3: Concentration or value of indicators for each water quality Class under DOE-WQI

Indicator	Unit	Water Quality Class				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 – 25	25 – 50	50 - 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	---	7	6 – 7	5 – 6	3 - 5	< 3
Total Suspended Solid	mg/l	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index	---	> 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

Source: Department of Environment (2009)

METHODOLOGY

This module of study was carried out at Chilling River in Hulu Selangor. This river is one of the popular recreation spots in Selangor as this river has been chosen for *Ikan Kelah* fish breeding. Besides that, there is a waterfall where the clear water flows from further upstream.

As this module of study was carried out under the program named as Chilling River Biodiversity Scientific Expedition that happened for four days, this module was carried out for two days Two trails were chosen in this module with four water sampling stations. The first trail was from the base camp up to the waterfall while the second trail was from the confluence of a tributary after the third sampling point until further upstream where the last sampling poing was set. Several water quality indicators were analyzed in this study but as this study focused on in-site study, the indicators that being analyzed were in-situ indicators as in Table 4 below:

Table 4: List of water quality indicators being analyzed in the study

Analyzed using measurement meter	Analyzed using physical measurement equipment
Dissolved oxygen (DO)	River width
Water pH	River depth
Electrical conductivity (EC)	Water velocity
Total dissolved solid (TDS)	
Salinity	
Turbidity	
Water temperature	

In addition, the information of watershed area of each sampling point which is important to determine the river specific flow rate was also being recorded based on the topographic map while the amount of total suspended solid in the river was projected using the established log-linear regression model developed by Dickerman (2022) that relating this indicator with turbidity where the value of the coefficient of determination is 0.9374 which means that this regression model is quite strong enough to explain the actual relationship between total suspended solid and turbidity. The formula is as below:

$$\text{Ln TSS} = 0.979 \text{ Ln (Turbidity)} + 0.574$$

Where TSS = Total Suspended Solid

RESULTS AND DISCCUSION

After two days of study, it was found that for the water quality indicators that measured by measurement meter, the findings were as in Table 5 below.

Table 5: Concentration of the water quality indicators measured by measurement meter

Indicator	Station 1		Station 2		Station 3		Station 4	
	1st day	2nd day	1st day	2nd day	1st day	2nd day	1st day	2nd day
DO	5.94	5.92	6.16	5.91	5.78	5.89	5.82	5.84
pH	6.44	6.47	6.89	6.49	6.60	6.54	6.50	6.50
EC	32.09	31.7	31.64	31.66	31.67	31.27	27.04	29.58
TDS	10.56	10.44	10.42	10.42	10.43	10.30	9.57	10.35
Salinity	0.017	0.017	0.017	0.017	0.018	0.017	0.018	0.017
Turbidity	8.60	9.1	7.03	7.37	8.20	7.80	8.13	8.70
Temperature	22.5	22.6	22.5	22.4	24.2	22.4	23.5	22.5

From Table 5 above, it was found that in overall, not much different in term of the selected water quality indicators condition between all stations. Therefore, roughly it can be said that all stations has the same concentration or value of the indicators and therefore, it can be said that the condition along Chilling River from station 4 in upstream to station 1 in the downstream is homogenous.

From Table 5, in term of water quality based on DOE-WQI Index, it was found that only DO and pH measurement could be referred. By comparing the results of DO and pH with Table 3, it was found that the quality of Chilling River along the study area is consistently under Class II which means that the water needs minor purification if there is an intention to make the river as public water supply or to consume directly, but still suitable for recreation and certain aquatic lives.

In contradict, Table 6 below which shows the expected concentration of total suspended solids using equation, shows the different class of the river.

Table 6: The expected TSS concentration in the river

Station 1		Station 2		Station 3		Station 4	
1st day	2nd day	1st day	2nd day	1st day	2nd day	1st day	2nd day
14.59	15.42	11.98	12.55	13.93	13.26	13.81	14.76

By comparing this result with Table 3, it was found that the whole measurement of the concentrations in the findings were below 25mg/l which means that the water quality is under Class I that means the water can be consumed directly without any treatment.

Why is this happened? An officer from the Department of Environment named Jasrul Nizam had explained that in order to determine the actual water quality status using DOE-WQI Index, the status cannot be determined by just comparing the concentration of the certain water quality indicator, it could only determine by calculating the water quality index which considering six indicators (Jasrul Nizam, 2012). According to Jasrul (2012), the concentration or value for each indicator stated in the Table is just for describing in general whenever the quality status had been determined earlier.

Besides the determination of the water quality status using DOE-WQI Index, as stated earlier, study was also carried out to determine the quality status using JRI Index. This approach is physically assessing the quality of the river based on hydrological aspects. In this case, indirectly, the profile of the river at each sampling station could be examine. Figure 1 to 4 below shows the profile of the river at each sampling station.

Figure 1: River profile at Sampling Station 1

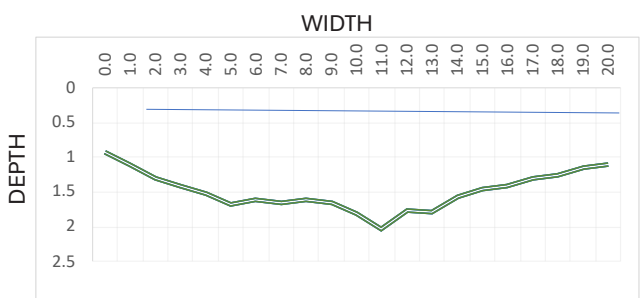


Figure 2: River profile at Sampling Station 2

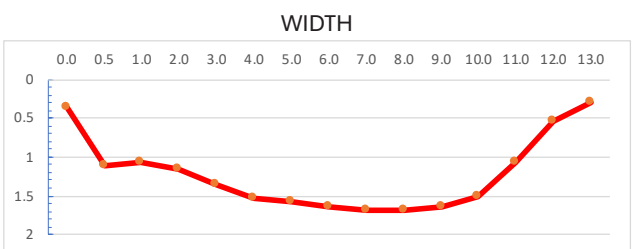


Figure 3: River profile at Sampling Station 3

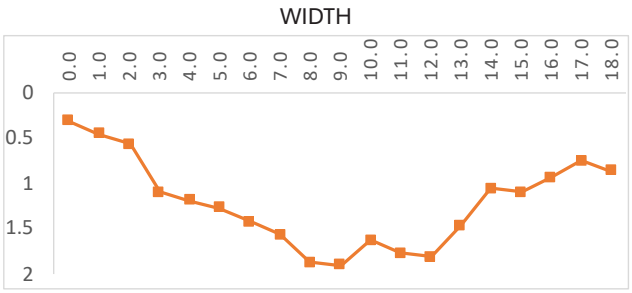
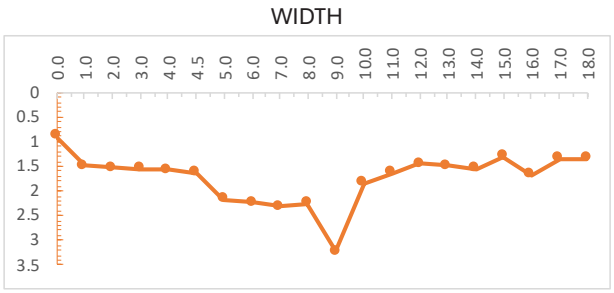


Figure 4: River profile at Sampling Station 4



From Figures 1 to 4 above, it was shown that the deepest section of the river at the sampling site was around 3m with the width of around 13 to 20 meters. It was also shown that the shape of the cross-sectional area of the river in each station are also similar with the deepest side of the river located at the middle, indicates that the tendency to lay down the sediment is not actively occurred along the study area.

After two days of study, it was also found that for the velocity and flow rate of the river, the findings were as in Table 7 below.

Table 7: The velocity and flow rate of the river

Hydrological Aspects	Station 1		Station 2		Station 3		Station 4	
	1st day	2nd day	1st day	2nd day	1st day	2nd day	1st day	2nd day
Velocity	1.82	1.88	2.07	1.94	1.28	1.31	1.88	1.88
Flow rate	55.75	57.58	34.30	32.15	29.08	29.76	62.55	62.55

It was found that the range of the water velocity in the river was around 1.28 to 2.07 m/s with the smallest velocity recorded at sampling station 3. As the river is quite width and deep at the study area, therefore, the flow rate of the river was high which was in the range of 29.08 m^3/s to 62.55 m^3/s. As this river flows into Selangor River, therefore this means that this river is able to provide Selangor river with that much amount of water for the water supply that could accumulated at Batu Dam further downstream. In assessing the water quality status using JRI Index, the results is shown in Table 8 below.

Table 8: Water Quality Status of Chilling River using JRI Index

	Station 1		Station 2		Station 3		Station 4	
	1st day	2nd day	1st day	2nd day	1st day	2nd day	1st day	2nd day
Value	87.67	87.24	86.30	87.05	91.42	91.31	87.38	87.30
Class	II A	II A	II A	II A	I	I	II A	II A

From Table 8 above, it was clearly shown that the water quality status of the river by assessing using JRI Index was mostly Class II A, meanings that the river condition is hydrologically in good condition and at the same time the river is under Class I that means the river could be classified as Clean at Station 3

CONCLUSION

Sungai Chilling has a high quality of water that flowing into Sungai Selangor, which is one of the main rivers used for clean water supply in Selangor. Therefore, the protection and conserving this high quality of water is important for the good well-being of the community. Moreover, as this river is marked as one of the fish breeding rivers, this is also another important factor in the steps taken to ensure the river is always in high quality.

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