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ASSESSMENT OF INDIVIDUAL WATER QUALITY INDEX PARAMETER IN TERENGGANU RIVER, MALAYSIA

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ABSTRACT

Water quality is a state of biological, physical, and chemical characteristics of water in collaboration with anticipated use and a set of standards. Samplings were taken in wet and dry seasons from twenty-nine stations within the river basin. Six parameters were used base on National Water Quality Standard (NWQS). Individual Water Quality Index (WQI) is used to compare the parameters with WQI table to show results on many impacts of natural and anthropogenic factors. Six parameters have been calculated to have the WQI which is wet season has a range of 62.10 to 75.46 with a mean of 72.81, while dry season ranging from 56.3 74.14 with an average of 70.47 which based on water quality classification is slightly polluted. It is suggested that monitoring and treatment should be appropriately carried out on measured parameters that fall in Class III and IV along with the river.

Keywords: water quality index; individual parameter; NWQS; Terengganu River.

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1. INTRODUCTION

Generally, water quality is a state of biological, physical and chemical characteristics of water in collaboration with anticipated use and a set of standards [1]. Moreover, surface waters are vulnerable and helpless to contamination resulting to the consequence of conventional techniques, which include, precipitation data, disintegration, weathering of crustal materials, sedimentation, erosion and anthropogenic exercises such as industrial, urban, horticultural activities and agriculture. Water quality is a primary ecological concern all over the world [2-3].

On the other hand, pollution is the major source of change in the water quality of a river which is defined as the infection of the environment either by natural or human exercises which can cause harms to the ecosystem at large. Water pollution is any chemical or physical changes of the surface water that can disrupt living life forms or makes water unhealthy for particular uses [4]. To evaluate the water quality status of any river water, the pollution causes that contaminate various constituents into the river need to be measured from its primary root. There are two main groups, these are point and non-point sources of pollution and are categorized by their chemical, physical, and biological attributes [5-6]. Moreover, the matter of water quality today is of grave concern to all water bodies in the world as a whole. Due to the rate of municipal, industrial wastewater and runoff from agricultural lands to the river as their vast drainage basin are vulnerable to water pollution. The water quality in any region is strongly determined by both natural processes which include precipitation rate, weathering processes and soil erosion while anthropogenic factors on the other hand include urban, industrial, agricultural and increasing exploitation of water resources [7].

However, in order to assess and monitor water quality in any river system, researchers have been using Water Quality Index (WQI) in other to have a full assessment of the biological, physical, and chemical characteristics of any river surface water such as [8-9] study. WQI is referred to as a numeric manifestation use to convert a great collection of water quality data into a solitary index number, which signifies the water quality level. A river with high WQI value means that the water body is in good condition and vice versa [10-11]. Furthermore, WQI can also be well-defined as a numerically summary of information from numerous water quality parameters into a single value that is evident and usable by the public. The information can be cast off to assess spatial and temporal variations in general water quality. However, these catalogs are time and region specific and may be subjective by local factors.

Additionally, Terengganu River has a history of water contamination by overflow effluents and flood, land recovery and environmental changes. Subsequently, water quality has been facing more threats from stable linkage with human prosperity [12]. According to World Health Organization (WHO) in 1983, about 80% of diseases in individuals are due to water-borne diseases. Also, the major threat of water pollution is not just treating human but the complete ecosystem of both aquatic and terrestrial, social prosperity and economic development like areas where productive fishing is carried out [13].

However, as a result of threats from natural and anthropogenic it is very important to understand the impact of different parameters on the water quality of the river. This study also aim in identifying major possible threats that need to be kept under check, for proper planning and decision making regarding the water quality of Terengganu River, Terengganu, Malaysia.

2. METHODOLOGY

2.1. Area of Study

Terengganu River and Terengganu River Basin is located on the East Coast Peninsular Malaysia, Malaysia (40 41'-50 20'N, 102 031'-103 0 9 ' E). its length is as long as 100km and an approximate of 500km^2 for the total catchment area of Terengganu River Basin where included Berang River, Telemong River, Pueh River and Nerus River. The river originates from Lake Kenyir in Northeast Malaysia (Hulu Terengganu), flows through Kuala Terengganu (the state capital), and empties out into South China Sea [7, 14].

In addition, the climate of this region is Tropical rainforest climate which has neither cold nor dry as it is consistently moist (all year round). The monthly average temperature 3^{0}C (5.40 F) and the average annual temperature is 26.7^{0}C (800 F). Total average rainfall per year is 2911mm (114.6 inches).

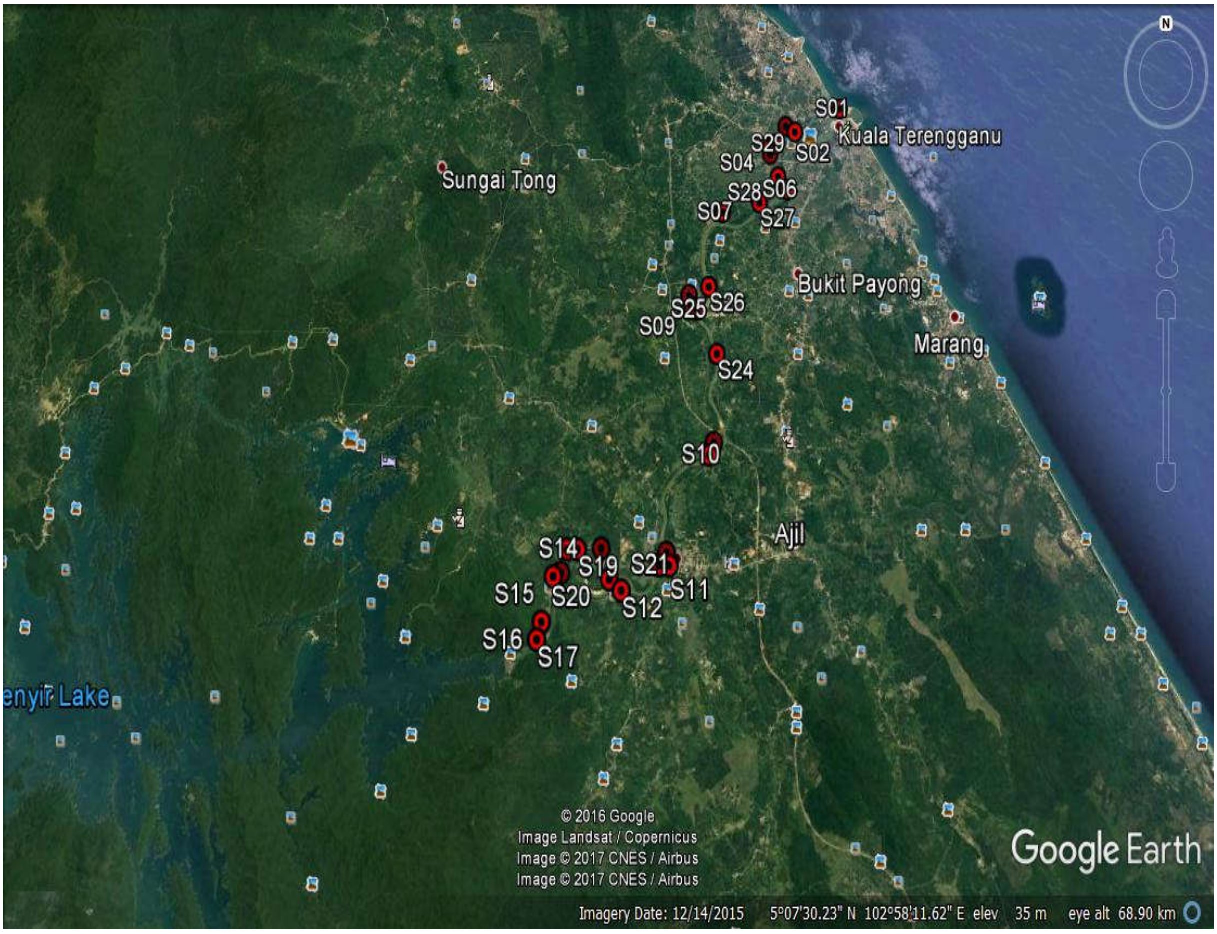


Fig.1. Study areas and sampling stations at Terengganu River, Malaysia

2.2. Method

In this study, the water quality of Terengganu River was measured and classified using the National Water Quality Standard (NWQS) and DOE-WQI for Malaysia which consist of six parameters DO, COD, BOD, AN, pH and SS [15]. Water samples were extracted from 29 random stations as shown in Fig. 1, which are ranging from the downstream to the upstream of Terengganu River. However, the process of collecting the samples was done using sterilized bottles that have been soaked and cleaned before usage. These samples have been duplicated thrice randomly at each station using these bottles and labeled according to the sampling area.

Sampling has been obtaining by directly filling a container with the surface water. The samples have been preserved right at the point of data collection by putting the samples in an icebox having an average temperature of 4^0C to avoid metabolism in the samples. After that, all the samples have been refrigerated at a temperature of approximately 6^0C with a cover layer to maintain dark condition [7].

Table 1. DOE-WQI calculation formula (DOE 2008) [16]

Subindex DO (SIDO)	x ≤ 8	SIDO = 0
(% saturated)	x ≥ 92	SIDO = 100
	8< × < 92	SIDO = -0.395 + 0.03×2 - 0.0002×3
Subindex BOD (SIBOD) (mg/L)	× ≤ 5	SIBOD = 100.4 – 4.23×
	× > 5	SIBOD = 108e-0.055× – 0.1×
Subindex COD (SICOD) (mg/L)	× ≤ 20	SICOD = -1.33x + 99.1
	× > 20	SICOD = 103e-0.0157× – 0.04×
Subindex AN (SIAN)	× ≤ 0.3	SIAN = 100.5 – 105×
(mg/L)	0.3 < × < 4	SIAN = 94e-0.573× – 5 ç×-2ç
	× ≥ 4	SIAN = 0
Subindex TSS (SITSS)	× ≤ 100	SITSS = 97.5e-0.00676× + 0.05×
(mg/L)	100 < × < 1000	SITSS = 71e-0.0016× – 0.015×
	× ≥ 1000	SITSS = 0
Subindex pH (SIpH)	× < 5.5	SIpH = 17.2 -17.2× + 5.02×2
	× ≤ × < 7	SIpH = -242 + 95.5× – 6.67×2
	7 ≤ × < 8.75	SIpH = -181 + 82.4× – 6.05×2
	× ≥ 8.75	SIpH = 536 – 77× + 2.76×2

Table 2. National Water Quality Standards (NWQS) [17]

Parameter		**Class**					
	Unit	**I**	**IIA**	**IIB**	**III**	**IV**	**V**
pH	mg/L	6.5-8.5	6-9	6-9	5-9	5-9	-
DO	mg/L	7	5-7	5-7	3-5	< 3	< 1
BOD	mg/L	1	3	3	6	12	>12
COD	mg/L	10	25	25	50	100	>100

TSS	mg/L N	25	50	50	150	300	300
AN		0.1	0.3	0.3	0.9	2.7	> 2.7

Class I: Conservation of natural environment. Water supply I-Practically no treatment necessary. Fishery I-Very sensitive aquatic species

Class IIA: Water Supply II-Conventional treatment required. Fishery II-Sensitive aquatic species

Class IIB: Recreational use with body contact

Class III: Water supply III-Extensive treatment required. Fishery III-Common of economic value and tolerant species; livestock drinking

Class IV: Irrigation

Class V: None of the above.

All the sample preparation and reservations conducted were following the standard procedures provided by American Public Health Association (APHA) and the United States Environmental Protection Agency (USEPA) methods [18]. Concisely, the BOD values determined from the DO metamorphosis before and after the sample have been kept in an incubator at 20^{o}C for five days. The DO concentrations for the BOD values were measured using the desktop DO meter. The COD levels are done using open reflux methods, which the samples were refluxed for two hours in an acidic medium using potassium dichromate as an oxidizing agent. To get the TSS water samples were filtered using a pre-weighted membrane filter and a pore size of 0.45μm, finally weighted the filter again after drying in an oven at 103-1050C to remove the water. However, to calculate all WQI parameters the DOE-WQI calculation formula was used as shown in Table 1. Thus, classification of the WQI parameters is done based on the NWQS which is also shown in Table 2.

3. RESULTS AND DISCUSSION

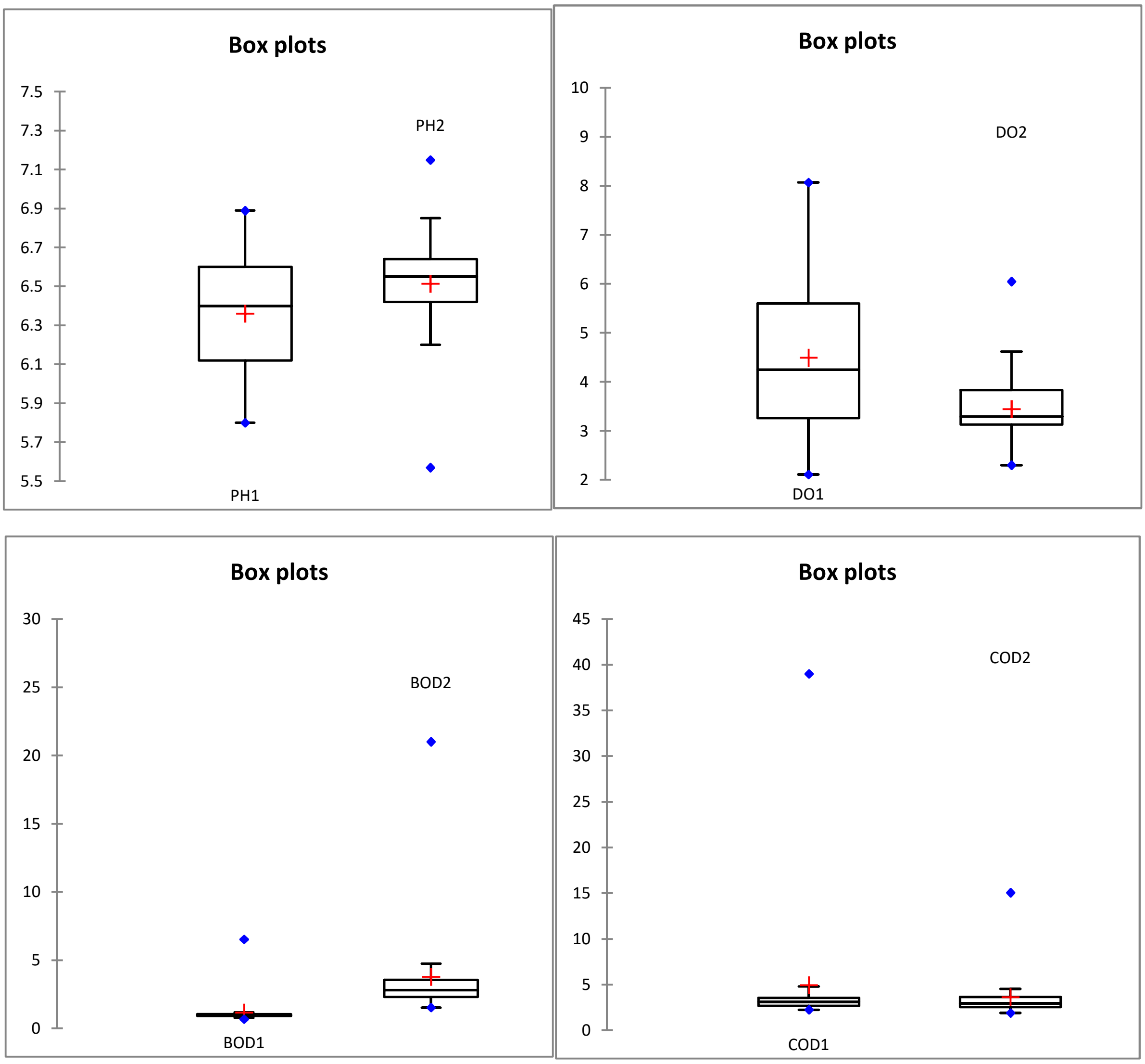
Fig. 2 shows a detailed data of different parameters of both dry and wet season for the present study. Firstly, the pH values of the rainy season (pH1) varied from 5.80mg/L to 6.89mg/L with a mean value of 6.36mg/L, while dry season ranged from 5.57mg/L to 7.15mg/L with a mean value of 6.52mg/L. With highest values recorded at stations WQ8 and lowest values at

WQ4 for wet season respectively, while for the dry season the highest value has been registered at WQ14 and most depressed at station WQ4. As classified based on the NWQS, the pH values for the wet season is categories into Class II and Class III which majority of the stations fall in Class II except stations WQ3, WQ4, WQ9 and WQ13 which were in Class III. In contrast, the dry season is divided into three classes WQ14 and WQ8 in Class I while stations WQ3 and WQ4 in Class III and the majority in Class II.

The DO concentration for wet season category ranges from 2.11mg/L to 8.07mg/L with a mean value of 4.49mg/L, while dry season ranges from 2.30mg/L to 6.05mg/L having a mean value of 3.45mg/L. Furthermore, the DO values according to NWQS for the wet season is categorized as Class I with WQ11 and WQ15. Class II having WQ12, WQ16, WQ19, WQ20, WQ22, WQ23 and WQ28; Class IV having stations WQ1, WQ2, WQ3, WQ5 and WQ7 while Class III contain the remaining high majority of 15 stations. The BOD awareness for wet season category ranges from 0.67mg/L to 6.52mg/L with a mean value of 1.15mg/L, while dry season ranges from 1.52mg/L to 21.00mg/L having a mean value of 3.77mg/L. Moreover, the DO values according to NWQS is classified as follows the wet season includes Class IV with WQ8; Class II having WQ6, WQ12, WQ15, WQ19, WQ24, WQ26 and WQ29 while Class I contain the remaining high majority of 21 stations. And dry season into Class V having WQ2; Class IV having WQ1; Class III with WQ7, WQ11, WQ12, WQ15, WQ16, WQ19, WQ20, WQ22, WQ23 and WQ28 and Class II having the majority of the remaining seventeen stations. Based on the mean, the wet season is classified to be in Class II and the dry season is set to be in Class III.

However, the COD analysis of Terengganu for the wet season is interpretation ranging from 2.24mg/L to 39.00mg/L with a calculated mean value of 4.94mg/L while the dry season has a range of 1.90mg/L to 15.10mg/L and a mean value of 3.62mg/L. Classifying COD stations according to NWQS for the wet season is as follows Class III having just station WQ2, Class II also just station WQ1 while the remaining stations all fall into Class I. In contrast, dry season has uniform positions of Class I. It shows that both dry and wet seasons have an overall majority classified under Class I. Also, both the mean value of wet and dry season having 4.94mg/L and 1.90mg/L they are categorized as Class I.

For AN, the concentration for rainy season varies from 0.010mg/L to 2.90mg/L and mean values of 0.23mg/L while dry season ranges from 0.010mg/L to 2.63mg/L with an average of 0.19mg/L. The stations for the wet season are categories into Class V having WQ9; Class IV having WQ1 and WQ15 while the overall majority of 26 stations falls under Class I. Moreover, dry season based on locations are categories into Class IV consisting of WQ1, WQ8 and 14 and the remaining 26 station fall under Class I. The class of AN based on the mean value, both wet season and dry season are classified under Class II.



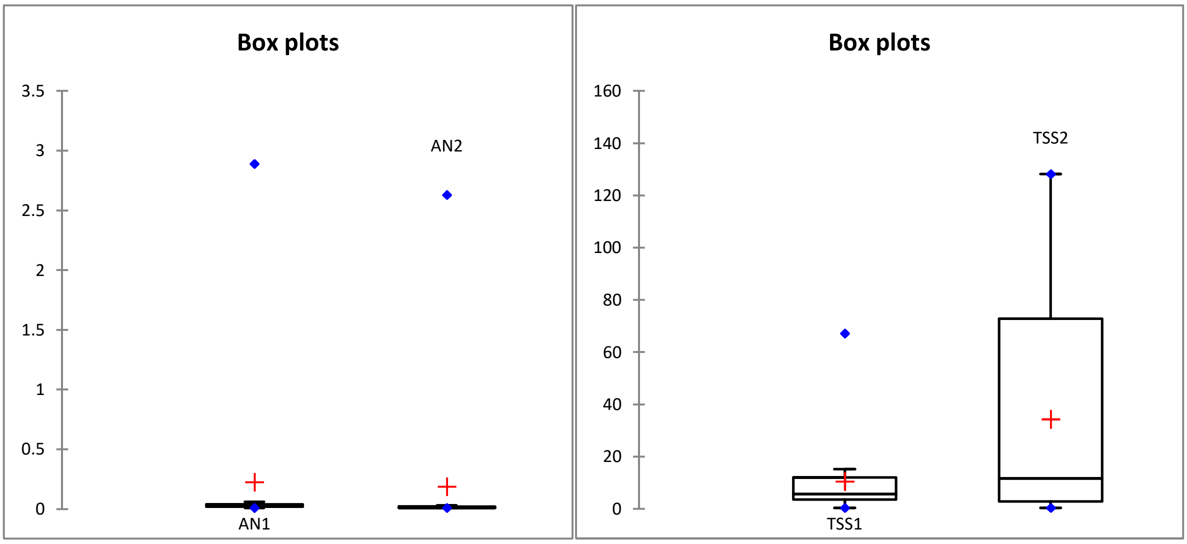


Fig.2. Description statistical of WQI parameters at Terengganu River

Moreover, TSS data for rainy season varies from 0.40mg/L to 67.20mg/L with a mean value of 10.52mg/L while the dry season is ranging from 0.40mg/L to 128.20mg/L and an average of 34.36mg/L. Classifying TSS stations according to NWQS for the wet season is as follows Class III having just station WQ6 and WQ7, while the remaining 27 stations all fall into Class I. Nevertheless, dry season having WQ1, WQ2, WQ3, WQ4, WQ5, WQ6, WQ7, WQ8 and WQ9 while the remaining majority of 20 stations fall under Class I. Narrowing down to conclude wet season based on the mean value to be in Class I and dry season to be in Class II.

All these parameters above have been calculated to produce the WQI for different stations. Fig. 3 shows the variations of DOE-WQI values based on various sampling stations of both wet and dry season. With results showing wet season ranging from 62.10mg/L to 75.46mg/L with a mean value of 72.81mg/L, and dry season ranging from 56.33mg/L to 74.14mg/L with a mean value of 70.47mg/L. Based on the mean values, both wet and dry season falls into Class III of the DOE Water Quality Index class.

Fig. 2 has shown the stand of Terengganu River from 6 different parameters with analysis of both wet and dry. However, Fig. 3 demonstrates a vivid WQI value for various stations of both wet and dry season which help in the classification of water quality standard. From this analysis, the WQI for the rainy season have all station in Class III and dry season also has all stations in Class III.

The primary purpose of this research is to assess the overall water quality of Terengganu

River. By using WQI, a wide range of different parameters have been evaluated and brought to our notice those that requires attention or are at a higher risk of pollution. Moreover, the study on Terengganu River is paramount because of the significant growths this basin is undergoing alongside rapid population growth and urbanization especially in Kuala Terengganu. These areas of vast population are located in the middle and downstream which are the major pollutants of the river via anthropogenic factors consisting of domestic waste, industrial discharge, agricultural runoff, etc.

Figure 3 shows the decline in water quality is highest in the downstream of the river especially at station WQ1, WQ2, WQ3, WQ4, WQ5, WQ6, WQ7 and WQ8. Studies have shown that wastes from anthropogenic waste bring about high organic content resulting to low DO, low pH and high AN values as a consequence of the decomposition processes [3-7].

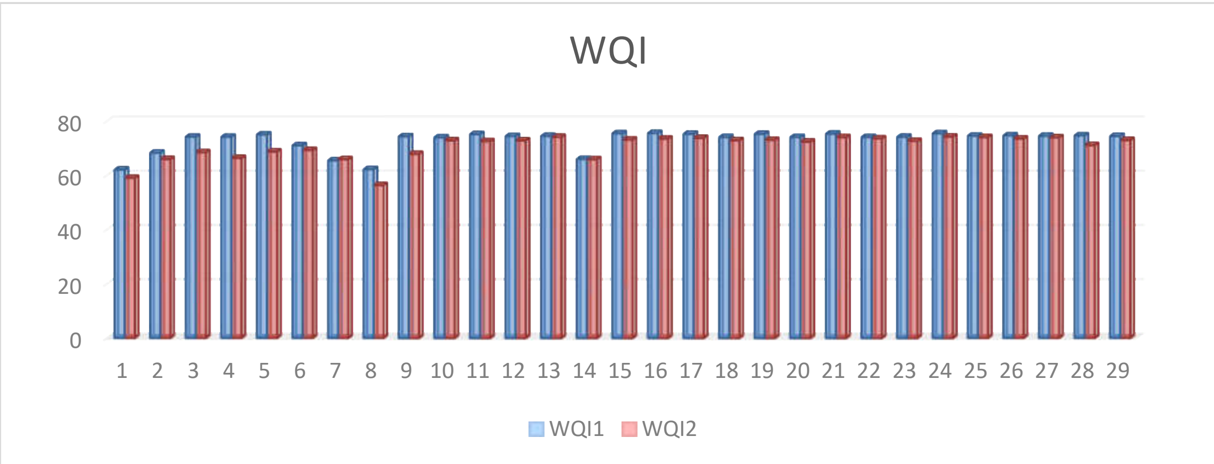


Fig.3. WQI variation between wet and dry season at Terengganu River

4. CONCLUSION

The assessment of Terengganu River basin water quality based on the DOE-WQI for both wet and dry season falls under the classification of slightly polluted to clean. The water quality of the river has declined from the upstream to downstream with evidence that most station of Class I are at the upstream, while the remaining classes are in the middle and downstream. According to NWQS, for wet season pH falls in Class II; DO falls in Class III; BOD in Class II; COD in Class I; AN in Class II and TSS in Class I. In contrast, for dry season pH falls in Class II; DO into Class III; BOD into Class III; COD into Class I; AN into Class II and TSS into Class II. Various anthropogenic activities have brought about changes in the water quality of Terengganu River basin. The result has brought update to the previous knowledge of the river water quality and created a foundation for further research.

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