

**Water quality in Malaysia: review Manik Urai, Durian and Geh rivers**

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Abstract

Water pollution issues and clean water needs have forced developing countries, such as Malaysia. Relating to clean water demand for covering human activities, water quality index determine several water parameter that presents pollution problem in water. As a water source, clean water in river is a critical concern. River water quality is according to natural process and anthropogenic activities. River water is potential to be contaminated by industrial, domestic and agricultural activities. Thus, in this study, water quality and availability in Manik Urai, Durian and Geh rivers were reviewed. Each pollutants was investigated, for instance BOD, COD, DO, SS, and pH. Range of river water flow was also examined. Total water demand was mentioned. In addition, the impacts of drought in 1990-2016 were assessed. However, review resulted that climate change has severe impact in water supply system.

Keyword :

River water, water quality index, water pollution, drought, climate change

1 Introduction

Rivers are the world's most vital source of water for human being related to local, agricultural, drainage and industrial uses (Abdulkareem et al., 2018). Apprehension about water scarcity to encounter future needs has enforced all developing countries to evaluate the current state of river water quality as well as water pollution (El-Zeiny and Elbeih, 2019).

River water quality is mainly influenced by natural processes and has related to anthropogenic activities (El-Zeiny and Elbeih, 2019). Studies in several countries have determined that river water quality is polluted by industrial, domestic and agricultural wastes (Mekonnen and Hoekstra, 2015). Industrial waste can pollute rivers with heavy metals that are not safe for human life (Tiwari et al., 2022). On the other hand, there are concerns that oil spills can cause a decrease in water quality on agricultural land, such as oil palm (López-Aguilar et al., 2022).

Malaysia has the main water needs that come from the agricultural, industrial, and domestic sectors (Yana et al., 2022). Several rivers in Malaysia were found to be polluted by industrial waste, agricultural activities, and residential activities along the rivers. Water pollution in Malaysia mostly comes from the manufacturing industry, agro-based industries, domestic waste, livestock, mining activities, as well as surface runoff from land clearing and earthworks (Evans et al., 2012).

The state of water quality is determined by the Water Quality Index (WQI) (Kachroud et al., 2019). It is a numerical index from 0 to 100 that combines selected physical, chemical and environmental parameters. Environmental parameter monitoring is becoming a top significance in evaluating the environmental status of water resources and protecting the environment. The main purposes of perceiving environmental parameters are (1) to assess water availability and quality, (2) to control and minimize the occurrence of pollution-related problems, and (3) to analyze various water is to provide the right water quality for the intended use. city. water supply and sewerage etc (Benameur et al., 2021). Malaysia uses WQI to determine river water quality according to the National Water Quality Standard (NWQS) (Abd Wahaba et al., 2019). In this study, Water quality status of Kelantan River was presented during both dry and rainy seasons using data in 2017 to 2018. To understand the WQI, six parameters were described: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrogen Ammonia (NH₃N), pH and Suspended Solids (SS). are selected. However, current study was arisen since it is related to river water quality monitoring programs that are becoming essential to protect valued freshwater resources and to provide water managers with the information for water quality and water resource management.

2 Water pollution

A severe flood was attack Kelantan in 2014 that affected water pollution especially in Kuala Krai River, Kelantan. According to WQI and Biological WQI (BWQI), the result found that the water quality in Kuala Krai River has decreased refer to DO and BOD values. The low DO value affects in deoxygenates to microbial population which impact limit the growth of aerobic aquatic microbial

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organisms. In addition, low BOD values affect an unpleasant odor in river water (Rafiuddin, 2016).

The average COD of data sampling show that a significant and fluctuating values, which influence the ability in reduce oxygen dissolved. In Suspended Solids parameter, the floods was erode the banks of the river which the highest 74,5 mg/L and the lowest 3 mg/L. The pH values change caused by floods. In terms of quality water index found that river water in Kuala Krai River in average of clean and slightly polluted. Therefore, the water river still safe to use and not dangerous for wildlife. (Rafiuddin, 2016)

Figure 1 Water quality index classification graph result

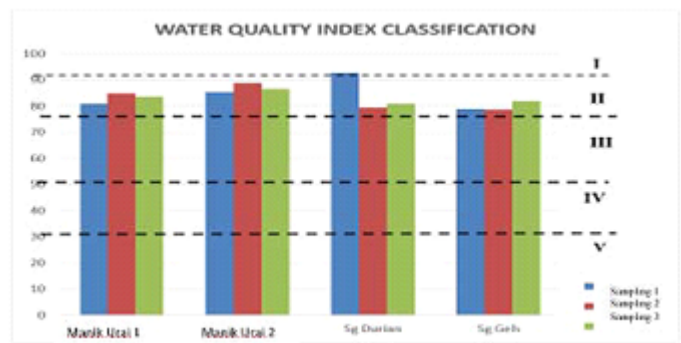


Table 1 Average DO of data sampling

Rivers	Sampling 1	Sampling 2	Sampling 3
Sg.. Manik Urai 1	9.15 ± 0.25	8.95 ± 0.45	7.25 ± 0.25
Sg. Manik Urai 2	9.15 ± 0.15	9.05 ± 0.05	7.05 ± 0.25
Sg. Durian	9.60 ± 0.10	9.40 ± 0.50	7.25 ± 0.35
Sg. Geh	9.15 ± 0.25	8.95 ± 0.45	7.25 ± 0.25

Table 2 Average BOD of data sampling

Rivers	Sampling 1	Sampling 2	Sampling 3
Sg.. Manik Urai 1	5.5 ± 0.5	7.5 ± 3.5	3.0 ± 1.0
Sg. Manik Urai 2	6.5 ± 0.5	4.5 ± 3.5	3.5 ± 1.5
Sg. Durian	4.0 ± 1.0	11.0 ± 1.0	11.0 ± 1.0
Sg. Geh 15.	0 ± 1.0	14.0 ± 0.0	13.0 ± 3.0

Table 3 Average COD of data sampling

Rivers	Sampling 1	Sampling 2	Sampling 3
Sg.. Manik Urai 1	10.0 ± 0.0	11.0 ± 5.0	4.0 ± 2.0
Sg. Manik Urai 2	10.0 ± 1.0	8.5 ± 5.5	6.5 ± 3.5
Sg. Durian	6.5 ± 2.5	17.0 ± 0.0	16.0 ± 2.0
Sg. Geh	21.0 ± 1.0	23.0 ± 1.0	18.0 ± 2.0

Table 4 Average SS of data sampling

Rivers	Sampling 1	Sampling 2	Sampling 3
Sg.. Manik Urai 1	75.0 ± 5.0	21.0 ± 1.0	74.5 ± 0.5
Sg. Manik Urai 2	30.0 ± 10.0	14.0 ± 6.0	67.0 ± 55.0
Sg. Durian	2.0 ± 1.0	28.0 ± 1.0	13.5 ± 0.5
Sg. Geh	7.0 ± 4.0	13.5 ± 2.5	3.0 ± 0.0

Table 5 Average pH of data sampling

Rivers	Sampling 1	Sampling 2	Sampling 3
Sg.. Manik Urai 1	6.72 ± 0.01	6.79 ± 0.00	6.83 ± 0.00
Sg. Manik Urai 2	6.74 ± 0.01	6.78 ± 0.00	6.82 ± 0.00
Sg. Durian	6.70 ± 0.00	6.78 ± 0.00	6.78 ± 0.01
Sg. Geh	6.72 ± 0.01	6.79 ± 0.00	6.83 ± 0.00

The Research has been conducted to measured the level of water pollution at Muar River, Johor that caused by floods. The WQI value of Muar River in 2006-2007 was under Class II category. The referenced data of rainfall in 22 stations rainfall over a 31-year period was used in observation. During flood in December 2006-January 2007, WQI values was 75.79 which in Class III or Polluted (Ching et al., 2015)

The average of DO values during first wave floods in November 2006 was 5.46 mg/L, that had decreased to 5.24 mg/L in December 2006 and 5.03 mg/L in January 2007. It possibly caused by water pollution obtained from nutrient and organics in floods. BOD values during floods was in slightly polluted category or under Class II. In Addition, COD values in Class III category or Polluted. In January 2007 the pH level was 3.2 which in Class IV category or dangerous to used. The total Suspended Solids during floods was 84.2 and 130 mg/L in December 2006-January 2007 which in Class III category or Polluted (Ching et al., 2015)

A severe floods affect contaminate water supply on river water and groundwater. Most of contaminated water sources contain sediment and suspended solids. Heavy metal was found contain in the groundwater (Hairom et al., 2021). Water pollution was happened in rivers across Malaysia. This causes shutdown the water treatment in 2008 and 2014. Floods contain mud result in river water contaminate (Srarfi et al., 2019).

The conductivity and Total Dissolved Solids (TDS) in Chini Lake, Pahang during flooded on October 2004 was contain ion such as sulphate and nutrient such as nitrate (Shuhaimi-Othman et al., 2007). The highest conductivity values on October 2004 was 27.29 µS/cm dan 17.5 mg/L. During floods the data shows lake water contain high ammonia nitrate concentration values. In addition, shows significant negative relationship with temperature, DO and chlorophyll-a concentration. The turbidity levels during the lake flooded was over 30 NTU, which contain high suspended solids. COD values was low during flooded (Shuhaimi-Othman et al., 2007).

Langat River basin in Selangor was polluted by floods (Ahmed et al., 2016). Pollution was contained from the air that falls with rainwater. Rainfall contains Perfluorinated Compounds (PFC), which are bio accumulative and toxic. (Zainuddin et al., 2012). The contaminated river water also possibly came from contaminated floods in Thailand and Singapore that cross the border (Chan, 2015).

3 Water Supply

97% Malaysia's water supply provided from the river. Clean and sufficient water supply has become water resource management's main problem during flood disaster. Floods affect water resource turned murky caused by sediment and suspended solids and contain toxic. (See, Nayan et al. 2017).

Irrigation water source for agriculture in Malaysia are from rainwater and river. The main problem of irrigation arises during dry season. (May to August) caused by scarcity and limited water source. Scarcity of water causes irrigation operational performance's technical to rice farming change in direct seeding to control the amount and timing of water delivery. Irrigation in Malaysia uses 40-50% of total water consumption for agriculture (68%), it caused inefficiency agriculture water use. (Ahmed et al., 2014)

Drought proved disrupt water supply domestic and irrigated agriculture problem. The scarcity of water causes crop failures that affect in oil pulm production. Several areas in Malaysia experiences southwest monsoon (dry season) in May to August. Recently in Kuala Lumpur, Selangor, and Putrajaya areas are facing water shortage. El Nino-Southern Oscillation (ENSO) phenomenon and Indian Ocean Dipole (IOD) are largely affect climate in Malaysia. Mainly drought in Malaysia influenced by El Nino phenomena that impact disruption in water supply sector and residents (Isa et al.,

2018).

In 2015, total consumption of daily drinking water reaches 1259 MLD in Johor state which 64% by domestic and 34% by non-domestic consumption (Chuah et al.,2018). The drought impact in Johor was happen in the Linggiu reservoir, Kota Tinggi, Johor. This affects water treatment disruption. During severe drought the amount of water imported to Singapore's local reservoir reaches 114 MLD of recycled NEWater (10% of water imported) (Chuah et al., 2018).

Another impact from drought in Johor was water rationing that occurred several hours in almost all district of Johor. The cessation of Waterworks operation at Kota Tinggi because of limited water supply that several residents collected water from swamps for household water needs, the residents complain received murky water, some district in Johor such as Kluang, Mersing, Kota Tinggi, Johor Bahru City, Pasir Gudang and Kulai Jaya experiences water rationing schedule (Tan et al., 2019).

Table 6 Range of flows for very dry, dry, average, and wet conditions in Kelantan and Johor, Malaysia

Area	Flood event (year)	Issues	Source
Kelantan, Malaysia	2014	Contaminated water resources-high sediment content in water	Shaharudin, Nik Ab Rahman, Syakir, Tajul Arifin, and Ab. Kadir (2017)
Johor	2006/2007	Contaminated water bodies with high conductivity and suspended solids Outbreak of Leptospirosis diseases	Lee, Salmijah, Liew, and Tanggang (2012)

Table 7 Range of flows for very dry, dry, average, and wet conditions in Johor

Johor		Drought
Impact		
Water rationing, where supply was limited to a few hours daily, was implemented within nearly all of Johor districts, including Batu Pahat, Kluang, Mersing and Muar		1990
Waterworks at Kota Tinggi ceased operations due to inadequate raw water supplies from rivers. Several residents collected water from nearby swamps for domestic use e.g.cooking, bathing and washing		1997
Water rationing occurred in Kluang and Batu Pahat districts. Supply was only available every alternate day. Residents also complained of receiving murky water		2005
During this prolonged period, water supply in most parts of the state was disrupted For example, in 2014, Kluang, Mersing, Kota Tinggi and Kulai Jaya districts underwent several months of scheduled water rationing		2014-2016
In 2015, many districts including the city of Johor Bahru and the industrial area of Pasir Gudang were subjected to water rationing		

Table 8 Percentage decline in future oil palm yield

Year	Johor expected decline (%)	Pahang expected decline (%)
2020	-0.58 %	-1.43 %
2030	-1.55 %	-3.81 %
2040	-2.52 %	-6.19 %
2050	3.48 %	-8.57 %
2060	-4.45 %	-10.95 %

Table 9 Total water availability in selangor (mm rainfall per year) projected from 2010-2015 Based on national water resources study (2000-2050)

Year	Runoff	Estimate % available (15%)	Total comsumptive water demand	Deficit
2010	760	114	266.6	(152.6)
2020	760	114	296.6	(182.6)
2030	760	114	306.0	(192.0)
2040	760	114	328.7	(214.7)
2050	760	114	348.0	(234.0)

Malaysia predicted in availability of water resources in 50 years (2010-2060) ahead such as increases temperature between 1.5-2°C, water crisis because of high evapotranspiration rate, high intensity in extreme storms, decreased of rainfall water, prolonged drought and arise of sea water level. The scarcity of water supply causing reduce in future oil palm production as seen in Table 8 (Merten et al., 2016).

In 2014, the southern area in Johor occurred water rationing caused by dry condition and high temperature. Low rainfall intensity impacts low water level in all Selangor's reservoir. Kuala Lumpur was shared water supply with Selangor state, that caused water availability decrease by 50%. In that moment Negeri Sembilan state was declare having water crisis for the needs of thousand households.

Climate change in Malaysia has serious affect the water supply system. One form of climate change in Malaysia was El Nino phenomena (1997/1998). El Nino lead worsening drought, intensifying floods, and changing hurricane patterns. In Malaysia, this phenomena result in severe drought, aggravated water planning Malaysia was not optimal on facing climate change.

Table 9 presents total water availability in Selangor that projected from 2010-2015 according to national water resources study (2000-2050). An increase in water demand if it is not proportional to the availability of water can cause a water crisis. Generally, water crisis in Malaysia caused by prolonged drought, this causes reduction in water supply for domestic and non-domestic. During drought, several dams in Malaysia reaches danger level, especially Selangor dams.

Water crisis also result in water rationing, that occurred lessen in water supply by 10% of total demand (Qin et al., 2019). Selangor experiences limited water supply caused by dry and hot weather, especially in 2014. Selangor dams that contribute 60% water supply for Klang Valley reaches critical water level (Koki et al., 2018). Table 10 describes total water demand in all sector in Selangor that projected from 2010-2015 according to national water resources study (2000-2050). All sectors that contributed on water demand in Selangor were portable water demand, irrigated paddy, non paddy crops, livestock, and fisheries. The demand for water should be adjusted to the availability of water and managed properly in order to prevent a water crisis.

Table 10 Total water demand in all sector in selangor (mm rainfall per year) projected from 2010-2015 based on national water resources study (2000-2050)

sectors	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
	Water demand MCM per year					Water demand mm rainfall per year				
portable water demad	1.474	1.787	1.960	2.181	2.364	175.5	212.8	233.5	259.8	281.6
irrigated paddy	750	655	555	516	482	85.8	78.0	66.1	61.5	57.4
non paddy crops	36.0	37.0	39.0	43.0	48.0	4.3	4.4	4.6	5.1	5.7
livestock	8.6	11.3	14.9	20.2	27.9	1.0	1.3	1.8	2.4	3.3
total comsumtive water demand	2.238	2.490	2.569	2.760	2.922	266.6	296.6	306.0	328.7	348.0
fhseries	159.2	194.1	236.6	288.4	351.5	19.0	23.1	28.2	34.3	41.9
total demand	2.397	2.684	2.806	3.408	3.274	285.5	319.7	334.2	363.1	389.9

4 Conclusion

Clean river water needs an attention in developing countries, such as Malaysia. Relating to clean water demand for covering human activities and preventing the serious effect of climate change in water supply, water quality index was presented. It shows a level of water quality and indicates pollution problem in water. River water is able to be polluted by industrial, domestic and agricultural activities. Thus, water quality and availability in Manik Urai, Durian and Geh rivers were reviewed. Results reflected that Climate change in Malaysia has serious affect the water supply system.

Declaration of competing interest

The authors declare no known competing interests that could have influenced the work reported in this paper.

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