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Hydrology Properties and Water Quality Assessment of the Sembrong Dam, Johor, Malaysia

Halizah Awang[a]*, Zawawi Daud[b], Mohd. Zainuri Mohd. Hatta[b]

[a]*Faculty of Technical and Vocational Education,Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia*
[b]*Faculty of Civil and Environmental Engineering,Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia*

Abstract

In recent years, monitoring quality of water body or reservoir has become a main concern for the determination of current condition and long-term pattern for future management. This study focused on hydrology properties and water quality of Sembrong Dam in Johor, Malaysia. The result indicated that soil loss about 487.12 kg/km^2/day, for rainfall and evaporation records are 1862 mm and 1098 mm for hydrology properties; Sembrong dam categorized as Class III according to NWQS. Sembrong dam need a treatment for further environmental technology in the future.

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Keywords: Hydrology; water quality; sembrong dam; environment.

1. Introduction

All living organisms need water. It plays an important role in many natural processes and is essential in countless physical and chemical reactions (Fang *et al,* 2005). Water is considered a renewable resource, renewable referring to that portion which circulates through the hydrological cycle. About 70% of the earth's surface is covered by water, only 2.5% of that water is fresh and only 0.3% of that water is available for human use (Ministry of Agriculture and Agro-base Industry

* Corresponding author. Tel. +600-07-4564223; fax: +600-07-4536588.
E-mail address: halizah@uthm.edu.my

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Malaysia, 2003). Furthermore, pressures on this resource are growing. Sembrong dam reservoir is constructed on large lowland rivers with gradually sloping banks; it can be characterized by inundation of large areas, extreme horizontal variability with extensive shallow riparian vegetation and shallow reservoir (Amneera *et al,* 2013). The secondary function of the dam was to provide a clean water supply to 240,000 consumers in Kluang district area were used for daily activities (Traskraba *et al,* 1999). Water from the Sembrong dam reservoir is treated at the West Sembrong Water Treatment Plant before the distribution. Extrapolation beyond the data is often necessary to provide information needed for dam safety risk assessments (Idris *et al,* 2004). Thus, quality of the water from Sembrong dam important for future.

2. Material and Method

2.1 Study area and sampling method

Hydrology properties sampling stations were selected based on criteria of utilization of water and effect nearby activities. Sembrong Lake was located in the districts of Air Hitam and Kluang, within the range of 2°01'35"N 1°58'29"N latitude and 103°09'32"E 103°12'57"E longitude (Fig. 1).

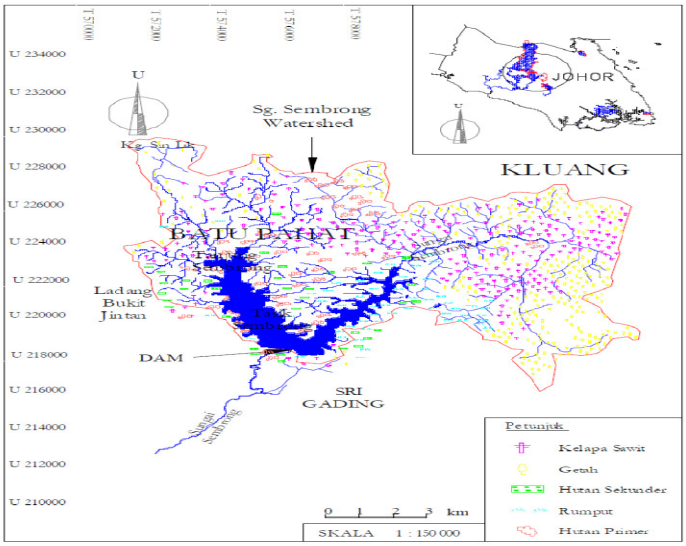

Fig.1 Sembrong dam reservoir 130 km^2 catchment area.

The rainfall data were sourced from the Environmental Impact Assessment (EIA) and the Department of Irrigation and Drainage, which was in charge of the reservoir operations whilst reservoir inflow data were extracted using a water balance equation for the reservoir in Tabe 1.

Table 1. Sembrong dam reservoir rainfall and evaporation station

Station no. and name	Type of data	Period of data obtained
1931003	Rainfall	October 1982 to
Empangan Sg. Sembrong, Air Hitam, Johor		December 2009
2033301	Evaporation	October 1982 to

Stor JPS, Kluang, Johor December 2009

For water quality study, there were a total of 17 water quality-sampling stations of the Sembrong dam reservoir as indicated in Fig.2. The surface water collected 10 cm below water in that river. Each sample station's water stored in one-liter polyethylene bottles. The water samples kept in ice for further analysis in the laboratory.

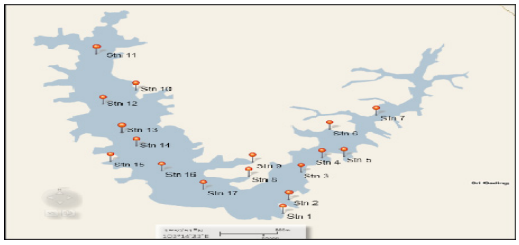

Fig. 2 Study area and sampling stations of Sembrong stations.

The water samples were kept in a refrigerator at temperature below 4^0C. The parameters involved are BOD, COD, N H $_3$ - N, TSS and turbidity while pH and DO will measure directly at the station by using in-situ method due to process of obtaining the sample might change the measurement. All the result of the laboratory analysis records on the appropriate table.

3. Result and discussion

3.1. Hydrology properties

Sembrong dam is provided with two flood regulating structures to control floods with a maximum outflow of 42 m^3/s. The normal water level of the reservoir is maintained at 9.0 m by maximum operating depth (M.O.D.) to meet the water supply demand from Fig. 3.

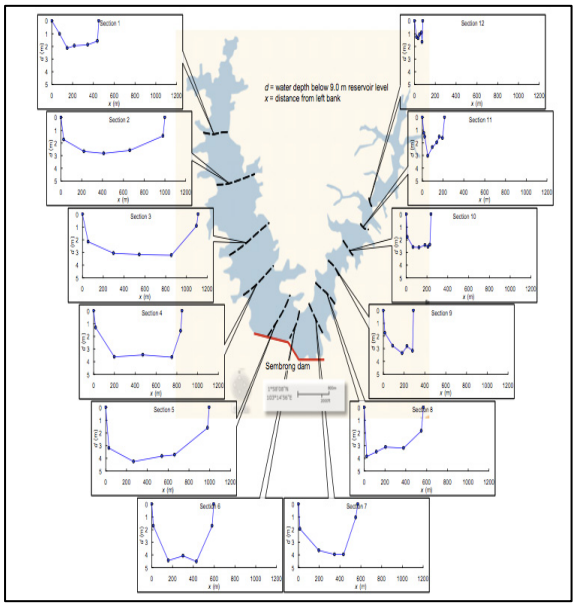

Fig. 3 Water depth across Sembrong dam reservoir at 12 measuring cross-section

Outlet for the water supply is provided in the upstream guide wall of the flood-regulating outlet. A maximum of 1.0 m^3/s of water can be drawn off through an 800 mm diameter pipe at the invert level of 2.870 m M.O.D. for water supply where this effect by the soil loss in dm. The compensation water draw-off is 1.2 m^3/s through a 900 mm pipe, built into the flood regulating outlet structure. The compensation draw-off is required to maintain water quality and to keep the river downstream in a viable condition (Caroline and Wardah, 2006). Figure 2 shows the water depths at 12 cross-sections of the Sembrong dam reservoir. The intervals of each cross-section are ranged between 500 m (along Sembrong River) to 1500 m (along Merpo River) intervals. Measurements of the water depths were made on 9th of November 2010 to 10th November 2010. The water levels in the reservoir are 9.0 m M.O.D. during both days. The reservoir bed slopes towards the dam outlet where it gives a depth with the maximum water depth recorded is 4.52 m, upstream of the dam.

The available rainfall and evaporation records, the average annual total rainfall and evaporation recorded at Sembrong dam rainfall station are 1862 mm and 1098 mm, respectively. The rainfall and evaporation records reported in this report are obtained in this study. Generally, heavy rainfall occurs during the months of October to January and again in March and April due to the climate changes of the monsoons by Figure 4. From Fig. 4 and Fig. 5, evaporation rate is quite uniform. The study made by Ministry of Agriculture between years 1964 to 1974, the mean annual evaporation for Sembrong dam reservoir catchment is 1800 mm/year from Fig. 6 (Said *et al,* 2004).

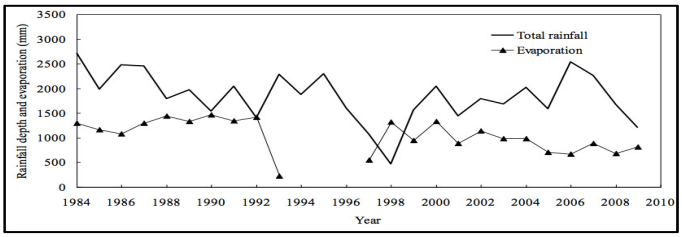

Fig. 4 Water depth across Sembrong dam reservoir at 12 measuring cross-section

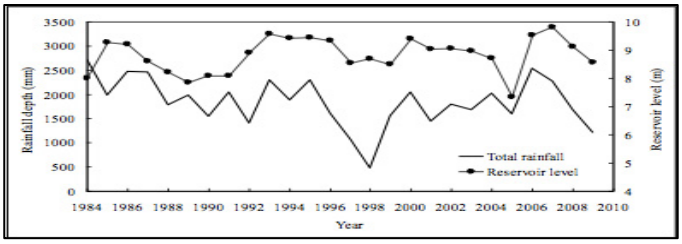

Fig. 5 Water depth across Sembrong dam reservoir at 12 measuring cross-section

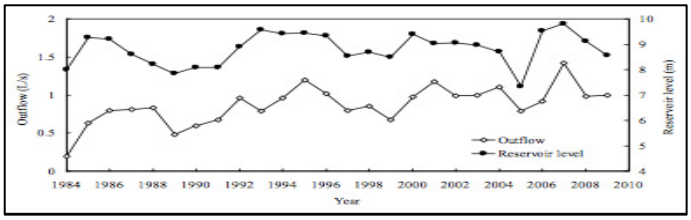

Fig. 6 Water depth across Sembrong dam reservoir at 12 measuring cross-section

3.2. Water quality assessement

Table 2 shows water sampled in Sembrong River contains higher total coliform counts. 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.

Table 2. Chemical parameter concentration

Zone	STN No.	Average Total Coliform {Cfu}	Average Total Faecal Coliform {Cfu}	pH	DO (mg/L)	TSS (mg)	NH_3-N (mg/L)	BOD (mg/L)
	1	97	-	6.71	4.95	20	0.16	2.5
	2	101	-	6.79	4.63	14	0.11	3.0
	3	145	-	6.79	2.25	16	0.08	2.0
	4	148	-	6.86	4.80	9	0.12	2.2
	5	175	-	6.89	4.81	12	0.17	4.8
A	6	97	<10 cfu	6.85	4.78	5	0.26	2.0
	7	120	<10 cfu	6.62	2.85	9	0.17	1.6
	8	28	-	6.82	4.88	59	0.25	1.3
	9	32	-	7.05	4.73	11	0.30	14.2
	Avrge	105	<10 cfu	6.82	4.3	17.2	0.18	3.73
	NWSQIIA/ B	500	100/400	6-9	5-7	50	150	3
	10	32	-	7.02	5.10	20	0.19	2.1
	11	13	<10 cfu	7.89	5.90	6	-	2.7
	12	37	-	7.02	5.69	6	-	2.0
	13	12	-	6.97	5.09	5	-	1.0
B	14	40	-	6.84	5.13	7	-	1.6
	15	33	-	6.81	5.42	26	-	3.2
	16	39	-	6.82	5.45	7	0.09	1.9
	17	57	-	6.75	5.81	6	0.08	0.8
	Avrge	33	<10 cfu	7.02	5.45	10.3	0.05	1.91
	NWSQIIA/ B	500	100/400	6-9	5-7	50	150	3

From Table 2, Sembrong River station shows an average of low BOD compared Merpoh river station. Hence, low DO, high BOD and COD rapidly decrease the oxygen content of the river making it difficult for the fish and other valuable aquatic fauna to survive. Oxygen concentrations vary with the volume and velocity of water flowing in a stream. The colder the water, the more oxygen it can hold (Davie, 2003). Suspended solid (SS) in water consist of inorganic and organic particles. Inorganic particles such as clay, silt and other soil constituent and organic material such as plant fibers and biological solids like algae, bacteria, plankton are found in water (Aggrawal and Arora, 2012). Sembrong River station shows a high of TSS compared Merpoh River station. Higher inorganic and organic particles in river contribute higher of TSS in river as well can effect turbidity in river water. Increasing the TSS value then increased the river to pollute. Result from Table 2 indicated that both river zones have a lower concentration of NH_3-N from this ammonical nitrogen analysis. Discharge of untreated sullage adds oxygen demanding substances, nutrients and toxic elements such as NH3-N into the water, which in turn make the streams unsuitable for aquatic flora and fauna (Davis and Storm, 2005). As such, like any other pollution source, sullage should also be treated effectively before discharged into the streams. The concentration of BOD in water sample can determine the degree of pollution caused by microorganisms through biodegradation. Table 2 shows the concentration of BOD in Sembrong and Merpoh River at 17 stations involved for every sampling. Sembrong River shows high of BOD concentration compared Merpoh River. Thus, this can be classified Sembrong River as polluted. BOD is also related to DO and they are inversely

proportional to each other (Akkoyunlu and Akiner, 2011).

Table 3. Water Quality Index

Zone	Parameters	Sub index and water quality index	Water quality classification based on water quality index
A	Biochemical Oxygen Demand (BOD)	84.6	Slightly polluted
	Ammonical Nitrogen (NH_3-N)	81.6	Slightly polluted
	Suspended Solids (SS)	87.6	Clean
	Water Quality Index (WQI)	**77.4**	**Slightly polluted**
B	Biochemical Oxygen Demand (BOD)	92.3	Clean
	Ammonical Nitrogen (NH_3-N)	95.2	Clean
	Suspended Solids (SS)	95.6	Clean
	Water Quality Index (WQI)	**86.9**	**Clean**

The classification of water quality of Zone A (Sembrong) and Zone B (Merpoh) followed the Water Quality Index (WQI). The DOE water quality classification based on water quality index refer on Table 4. The WQI of Sembrong River is 77.4, which is categorized as slightly polluted.

4. Conclusion

As conclusion, it can be conclude that Sembrong River Dam slightly shows high soil loss where is consist of soft fine grained silty clay material with organic matter, tree roots and decaying timber. For rainfall and evaporation records are 1862 mm and 1098 mm. Sembrong River (Zone A) generally slightly polluted compared Merpoh River (Zone B) where is clear from pollution in Sembrong Dam. Due to Biological parameter where is Sembrong River shows high of Total Coliform rather Merpoh River. Besides that, all of chemical parameter shows that Sembrong River was not a good condition. According of Water Quality Index, Sembrong River was truly slightly polluted compared Merpoh River in Sembrong Dam.

Acknowledgments

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