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Hydrology Properties at Sembrong Dam Reservoir in Johor

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Dam reservoir required a proper management that all components of the water resource system be known. This study focused on soil condition, rainfall and evaporation by Sembrong dam in Johor. The available data from soil loss estimation by environment impact assessment (EIA) and average of year from 1984 to 2009 daily rainfall and evaporation data across the Sembrong dam catchment by the Water Resources Management and Hydrology Division, Department Of Irrigation and Drainage, Malaysia. Result indicated that soil loss about 487.12 kg/km^2/day, for rainfall and evaporation records are 1862 mm and 1098 mm. This result effect on the water quality of water in Sembrong dam reservoir in Johor by those hydrology charateristics..

Introduction

Water is fresh potable water where is not always available at the right time or the right place for human or ecosystem use [1]. Water impoundments constructed by damming rivers are called dam reservoirs. Under the Malaysian Western Johore Agricultural Development Project, the main function of the Sembrong dam is flood mitigation. The secondary function of the dam was to provide a clean water supply to 240,000 consumers in Kluang district area where used for daily activities [2]. Water from the Sembrong dam reservoir is treated at the West Sembrong Water Treatment Plant before the distribution. Daily reservoir inflow data were extracted by applying the water balance model to the Sembrong dam reservoir. Developing hydrologic hazard curves for risk assessment uses the length of record and type of data to determine the extrapolation limits for flood frequency analysis [3]. Extrapolation beyond the data is often necessary to provide information needed for dam safety risk assessments [4]. The sources of information used for flood hazard analyses include stream flow, precipitation records and flood data.

Methodology

Study Area and Sampling Methods

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 (Figure 1).

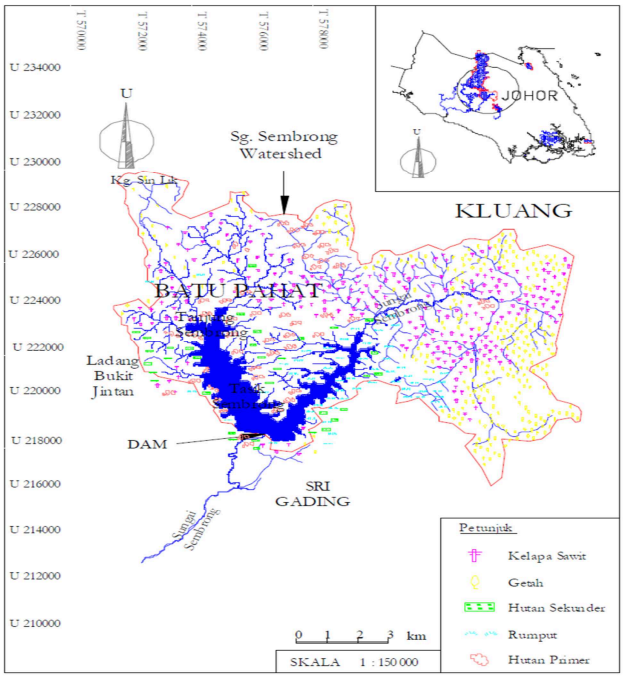

Figure 1. Sembrong dam reservoir 130 km^2 catchment area.

The rainfall data were sourced from the Environment 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 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 Empangan Sg. Sembrong, Air Hitam, Johor	Rainfall	October 1982 to December 2009
2033301 Stor JPS, Kluang, Johor	Evaporation	October 1982 to December 2009

Results and discussions

Soil characteristics

Sembrong dam is provided with two flood regulating structures to control floods with 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. 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 [5].

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.

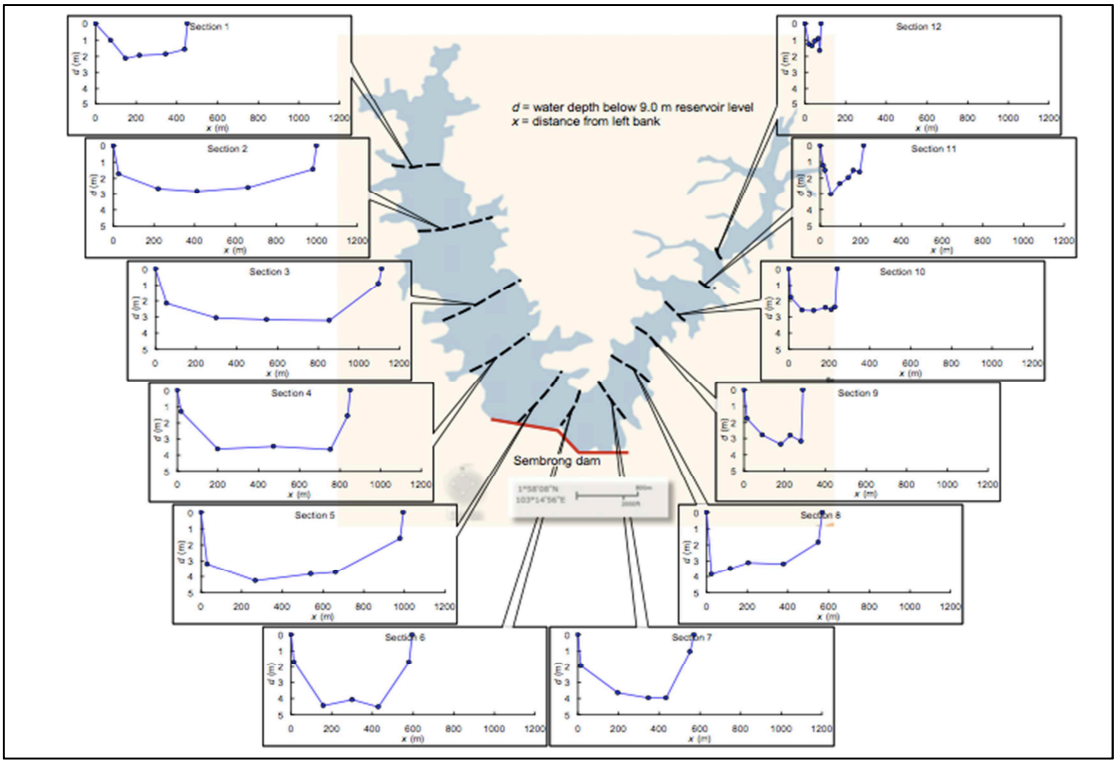

Figure 2. Water depth across Sembrong dam reservoir at 12 measuring cross-section.

According to the Environment Impact Assessment (EIA) report produced for the Modern Agriculture Project, Kluang, the soil loss was estimated at a rate of 487 kg/km^2/day (equivalent to 1.8 tons/ha/year) with an extreme rate of 48712 kg/km^2/day for bare soil. In terms of sedimentation into Sembrong dam reservoir, the estimated generated sediments were approximately 130 kg/km^2/day (equivalent to 0.19 ton/ac/year) with an extreme rate of 12998 kg/km2/day if the soil was bared. Sembrong dam reservoir was affected by the modern agriculture project like new farm for agriculture plant besides the dam, which is total of 5.6% from the catchment area [6].

Rainfall and evaporation pattern

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 Figure 3, 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 Figure 5 [7].

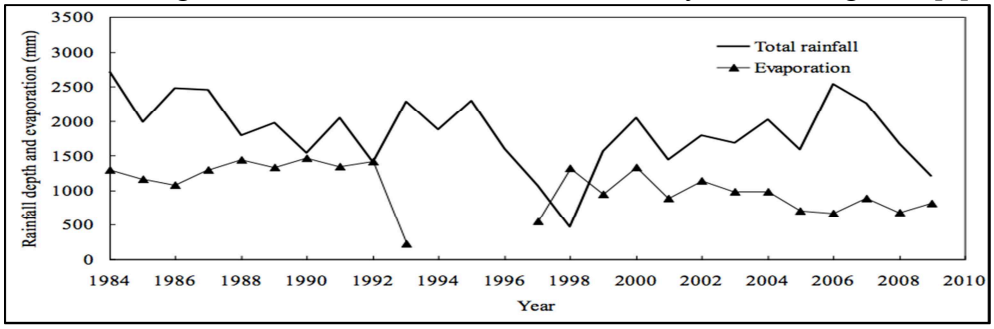

Figure 3. Annual rainfall depth and evaporation depth between years 1984 to 2009.

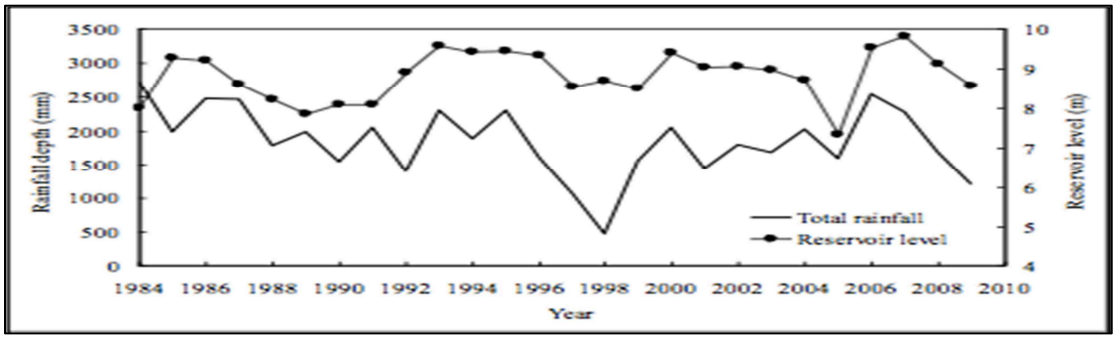

Figure 4. Annual rainfall depth and Sembrong reservoir level from year 1984 to 2009.

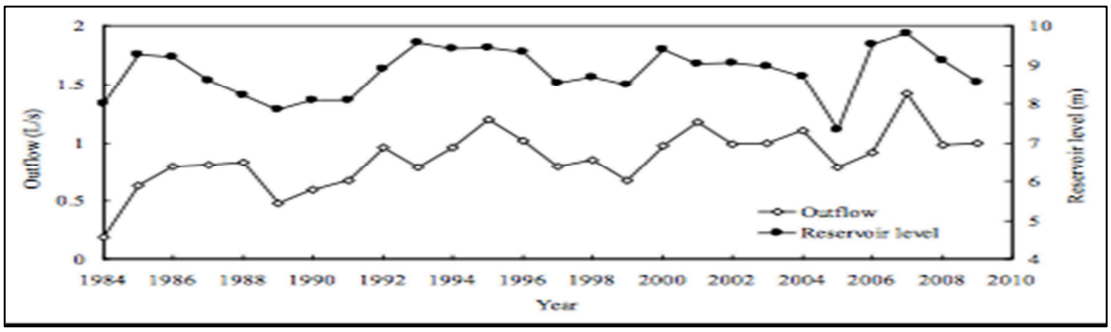

Figure 5. Annual outflow and Sembrong reservoir level from year 1984 to 2009.

Theoretical filling time

This theoretical from Table 2 value shows the average recurrence interval of flood event [8].

Table 2. Theoretical filling time.

10-year ARI flood event	100-year ARI flood event	Maximum flood event
Infilling rate = $\frac{\text{Volume flake } (m^3)}{\text{Inflow rate } (m^3 day^{-1})}$ =23.59 days	Infilling rate = $\frac{\text{Volume flake } (m^3)}{\text{Inflow rate } (m^3 day^{-1})}$ =1.72 days	Infilling rate = $\frac{\text{Volume flake } (m^3)}{\text{Inflow rate } (m^3 day^{-1})}$ =1.24 days

*ARI: The long-term average number of years between the occurrences of a flood.

Theoretical retention time

Retention time is also known as water residence time, hydraulic detention time, and retention rate or flushing rate [9]. Retention time should be calculated for each year or each appropriate shorter time period should the actual reservoir volume vary substantially during the considered period. The retention time of Sembrong dam reservoir during normal storage with water level at 8.5 M.O.D.

Conclusions

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. This study shows high rainfall and evaporation between years that had been study. This study also would relate to the development of water quality on Sembrong dam reservoir.

Acknowledgments

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