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Impacts of barrage flushing and flooding in operations on upstream total suspended solids

[1*]*P. L. Law*, [1]*I. N. Law*, [2]*H. H. Lau*, [1]*F. W. L. Kho*

[1]*Department of Civil Engineering, University of Malaysia Sarawak (UNIMAS), Kota Samarahan, Sarawak, Malaysia*
[2]*School of Engineering and Science, Curtin University of Technology (Sarawak Campus), Sarawak, Malaysia*

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ABSTRACT: This study looks into the impacts of Sarawak Barrage (located in Kuching City, State of Sarawak, Malaysia) flushing and flooding-in operations on upstream total suspended solids (TSS). Water samples were collected from three upstream stations on 17th, 18th and 19th of August 2000. During flushing, it was observed that TSS levels increased over a distance of 11 km upstream. Maximum TSS recorded 250 mg/L at 1.5 km, 120 mg/L at 6 km, and 85 mg/L at 11 km upstream. During flushing, TSS levels increased with depth, and upstream turbulence intensities were indirectly proportional to distance from barrage. During flooding-in operation, TSS decreased from 249 to 155 mg/L at 1.5 km near the bottom, while surface TSS decreased from 86 to 58 mg/L. Generally, during flooding-in operation, TSS increased from 90 to 116 mg/L between 6 and 11 km. During flooding-in operation, maximum bottom TSS recorded 216 mg/L at 6 km upstream. Differences between bottom and mid-depth TSS levels were relatively minimal ranging from 19 to 45 mg/L, whilst the maximum difference between mid-depth and surface TSS was as high as 78 mg/L. After 9 hours of gate closure, a well-mixed regime prevailed from 6 to 11 km upstream with TSS ranged from 35 to 47 mg/L at all the monitoring points regardless of depths.

Key words: *Impact, barrage, flushing, flooding-in, upstream, total suspended solids*

INTRODUCTION

A barrage is a relatively low dam with controlling gates constructed across a river to raise the river level sufficiently to divert the flow in full, or in part, into a supply canal or conduit for the purposes of irrigation, power generation, domestic, and industrial uses, tidal control and so on (Novak, *et al.*, 1990; Sharp and Lim 2000). Sarawak River (Sg. Sarawak) flows through the City of Kuching dividing it approximately into two equal halves (Fig. 1). Kuching City is located in tidal influence zone with a tidal range of approximately 6 meters (DID 2001; Sharp and Lim 2000). To control upstream water level in Sarawak River, a barrage was constructed in 1988, i.e., Sarawak Barrage to regulate river water from draining out and to prevent seawater from flooding-in (Law, 2001). Thus, two causeways were constructed over Sg. Santubong and Sg. Sarawak (Figs. 1 and 2) (Law, 2001). The barrage structure consists of 5 radial gates (25 meters in width each) to prevent saline intrusion and to regulate water levels upstream of Sarawak River (Law, 2001). The general arrangement of Sarawak Barrage and discharge characteristics through barrage gates are illustrated in Figs. 3 and 4. A ship lock was constructed alongside of the barrage, which is exclusively reserved for river traffic (Fig. 4). During draining-out (flushing) and flooding-in operations, all the five gates are mechanically lifted up by 1.0 meter providing a total cross-sectional opening of 125 m^2 (125 m in width and 1 m in height (JKR 1994). The barrage serves as a "mini dam or weir" by holding additional amount of fresh water behind it during low tide, thus maintaining sufficient water volume for Batu Kitang Water Treatment Plant, located approximately 15 km from barrage (JKR 1994). Additionally, the construction of barrage was intended to enhance the aesthetic value of Kuching Water Front along Sarawak River, immediately upstream. A feasibility study favoured barrage construction over construction a dam upstream of Kuching City (LAK, Vol. I, 1996). The catchment of Sarawak River is the drinking water supply source for more than half a million of residents in Kuching City (LAK, Vol. II, 1996). Sarawak River Barrage Management (SSBM) commenced the operation of Sarawak Barrage

*Corresponding author, Email: *puonglaw@feng.unimas.my*
Tel.: +6082-672 317; Fax: +6082-672 317