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Research Article

Effects of Opened and Closed Spillway Operations of a Large Tropical Hydroelectric Dam on the Water Quality of the Downstream River

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Water quality downstream of a hydroelectric dam is potentially affected by dam operations and other land uses in the river basin. Previous short-distance studies below the large Bakun Dam indicated poorer water quality during closed spillway. However, the extent of the impact is still unknown. Such knowledge is essential for mitigating the impact of the dam. Thus, the objectives of this study were to determine the water quality up to a distance of 210 km under two spillway operations, namely, closed and opened spillways, and also to determine the changes in water quality from the predam condition. Physicochemical parameters were measured at 15 stations along the Rajang River. Results of this preliminary study indicated that there were significant differences in eight out of nine water quality parameters between opened and closed spillway operations with opened spillway showing better water quality. During closed spillway, as we approached the dam, there was an increasing acidity and a decreasing oxygen content. Furthermore, as the water flows downstream, the unhealthy DO level (<5 mg/L) extended up to 165 km and the linear model showed an increasing DO rate of 0.09 mg/L per km. With opened spillway, DO decreased exponentially from 9.74 mg/L towards the downstream direction to 7.67 mg/L. The increasing turbidity and TSS in the downstream direction indicate contributions from erosion due to other land uses. The river is polluted with organics as indicated by COD of Class IV or V with sources from the dam and the activities in the river basin. Compared to the predam condition, the regulated river is less turbid but warmer and higher in ammonia. Closed spillway led to lower DO and acidic water. However, opened spillway water pH and DO were similar to those in the predam condition. Thus, it is recommended that DO be consistently high enough for the health of sensitive aquatic organisms downstream.

1. Introduction

Energy from hydroelectric dams is a beneficial alternative to fossil fuels as it is renewable. Abundance of rainfall in a tropical country such as Malaysia provides the water flow needed for hydropower generation. Thus, the largest dam in Malaysia, the Bakun Hydroelectric Dam, was constructed across the longest river, the Rajang River, providing an installed capacity of 2400 MW [1], which started operation in November 2011. Just like most rivers in the world, the Rajang River also functions as a means of transportation, source of food and water, and habitat to various floras and faunas. However, the building of dams has been reported to impact the agricultural land and wildlife habitats of the flooded area, and downstream from the dam, floodplain hydrology, movement of sediments, channel structure, ecology, and biodiversity have also been impacted [2–4]. In addition, the structural design and operation of a dam determine the flow regime and affect the downstream river in various ways including the water quality. In the Bakun