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Research Article

Distribution of Major and Trace Elements in a Tropical Hydroelectric Reservoir in Sarawak, Malaysia

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This paper reports the metals content in water, sediment, macroalgae, aquatic plant, and fish of Batang Ai Hydroelectric Reservoir in Sarawak, Malaysia. The samples were acid digested and subjected to atomic absorption spectrometry analysis for Na, K, Mn, Cr, Ni, Zn, Mg, Fe, Sn, Al, Ca, As, Se, and Hg. The total Hg content was analysed on the mercury analyser. Results showed that metals in water, sediment, macroalgae, aquatic plant, and fish are distinguishable, with sediment and biota samples more susceptible to metal accumulation. The distributions of heavy metals in water specifically Se, Sn, and As could have associated with the input of fish feed, boating, and construction activities. The accumulation of heavy metals in sediment, macroalgae, and aquatic plant on the other hand might be largely influenced by the redox conditions in the aquatic environment. According to the contamination factor and the geoaccumulation index, sediment in Batang Ai Reservoir possesses low risk of contamination. The average metal contents in sediment and river water are consistently lower than the literature values reported and well below the limit of various guidelines. For fishes, trace element Hg was detected; however, the concentration was below the permissible level suggested by the Food and Agriculture Organization.

1. Introduction

Metals contamination has been a concern of hydroelectric development [1–5]. The process inevitably exposes rivers to the risk of metals contamination due to the alteration triggered in hydrological and sediment regime. The trace elements are often released into the aquatic environment from natural and/or anthropogenic sources where they are usually bound to sediment particles or soluble in water. These elements can then be taken up by aquatic organisms and transferred to human via food chain resulting in numerous adverse health effects; for example, methylmercury is a neurotoxin and exposure to arsenic increases the risk of skin cancer [6]. The bioaccumulation factor (BAF), expressed as the ratio of chemical concentrations in organisms over the concentrations in water [7], as high as 150–300 has been reported in fishes such as *Tilapia zilli*, *Tilapia guineensis*, *Clarias gariepinus,* and *Synodontis membranaceus* for various elements [8–12].

The construction of dam has been long challenged with the issue of elevated mercury (Hg). Upon impoundment of a dam, the naturally occurring inorganic Hg may be converted to bioavailable organic Hg by bacteria leading to bioaccumulation of Hg in fish [13]. The accumulation of Hg can be very persistent; for example, the methylmercury contamination reported in Canada and Finland took 20–30 years to be restored to the baseline level after impoundment [14]. Besides Hg, other elements were also reported to increase in sediment of Iron Gate, the largest dam and reservoir in Danube, 20 years after impoundment [15]. The potentials of metals contamination in dams and reservoirs have been revealed in numerous studies associating it with various anthropogenic inputs [16, 17].

Sarawak, a state in Malaysia on the island of Borneo, possesses high potential for hydroelectric development due to the abundant rainfall throughout the year [18]. A series of hydroelectric projects have been identified of which Batang Ai Hydroelectric Dam is the first dam impounded in 1985.