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Evaluation of heavy metals and environmental risk assessment in the Mangrove Forest of Kuala Selangor estuary, Malaysia

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ABSTRACT

This study was carried out to evaluate the distribution, enrichment and ecological risk of heavy metals (arsenic (As), zinc (Zn), manganese (Mn), copper (Cu) and lead (Pb)) concentration in Kuala Selangor estuary at the Kuala Selangor Nature Park. The results suggested that As and Pb in sediment were as high as the background value, suggesting the presence of anthropogenic contamination. The risk assessment of sediment I_{geo}, CD, and PERI, on the other hand, showed low risk of heavy metals in Kuala Selangor estuary. Meanwhile, risk assessment code (RAC) results showed that Mn, As and Zn presented medium to high level of environmental risk. The translocation factor and bioaccumulation factors of heavy metal concentration by mangrove vegetation showed a variety of trends, which indicates the different partitioning and uptake ability of heavy metal in the tissues of different mangrove species. Therefore, underscores the importance of preserving the high diversity of mangroves at securing the health and productivity of the coastal region. These results may play a critical role in facilitating decision makers in managing the sustainability of mangrove forests.

1. Introduction

Mangrove ecosystems are the most important intertidal zone in the protected estuarine shores in the tropical area (Tam and Wong, 2000). A mangrove forest consists of trees growing in zones such as estuaries or tidal swamps which are common features of the tropical and sub-tropical sheltered coasts (Hamdan et al., 2012; Peter, 1999). Besides its importance for the environment, these ecosystems also play an economic role, especially for the coastal dwellers, where various produces are obtained from mangrove forest. In addition, mangrove forests are very important to estuarine fisheries because of its function in supplying detritus and dissolved organic carbon within the food chain, and mangrove trees roots that provide shelter for fish and other faunal organisms (Holguin et al., 2001; Nagelkerken et al., 2008). Furthermore, the mangrove forests provide coastal buffer zone to safeguard coastal habitats from natural disaster (Tamin et al., 2011). The mangrove forests in Malaysia were estimated to cover 494,600 ha of areas in the year 2000 and subsequently reduced to 469,100 ha in 2014 (Hamilton and Casey, 2016). The destruction of mangrove forests has been partly due to climate change which resulted in the rise of sea level (Jusoff and Taha, 2008), as well as by anthropogenic activities such as changes of land use for coastal development, including aquaculture and agriculture activities (Jusoff and Taha, 2008).

Heavy metals pose a considerable level of danger to the aquatic environment due to its high toxicity and the possibility of accumulation in aquatic habitat and soil (Abuduwaili et al., 2015; Varol, 2011; Xu et al., 2016). Heavy metals have been generally used as environmental monitoring factors and their toxicity in humans, animals, and plants are well known (Xie et al., 2015). Likewise, heavy metal pollution has been determined to also be one of the major health causes, due to the indestructibility of metals and their impact on living organism in concentrations greater than the thresholds (Costa-Böddeker et al., 2016; Zhuang and Gao, 2015). Therefore, human and ecosystem health levels need to be assessed frequently by monitoring the concentration of heavy metals in the environment (Haris and Aris, 2015; Kennish, 2002). The total heavy metal concentration has always been used as a contamination indicator (Liu et al., 2016) while BCR (European Community Bureau of Reference, now known as the Standards Measurements and Testing Program) used to study mobility and bioavailability of heavy metals (Nemati et al., 2009, 2011; Rauret et al., 1999). In

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