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Baseline distribution and sources of linear alkyl benzenes (LABs) in surface sediments from Brunei Bay, Brunei

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ABSTRACT

Sewage pollution is one of major concerns of coastal and shoreline settlements in Southeast Asia, especially Brunei. The distribution and sources of LABs as sewage molecular markers were evaluated in surface sediments collected from Brunei Bay. The samples were extracted, fractionated and analyzed using gas chromatography-mass spectrometry (GC-MS). LABs concentrations ranged from 7.1 to 41.3 ng g^{-1} dry weight (dw) in surficial sediments from Brunei Bay. The study results showed LABs concentrations variably due to the LABs intensity and anthropogenic influence along Brunei Bay in recent years. The ratio of Internal to External isomers (I/E ratio) of LABs in sediment samples from Brunei Bay ranged from 0.56 to 2.17 along Brunei Bay stations, indicating that the study areas were receiving primary and secondary effluents. This is the first study carried out to assess the distribution and sources of LABs in surface sediments from Brunei Bay, Brunei.

Discharge and emission of sewage contamination are derived from human activities such as industrial development, urbanization, tourism, etc. The control of aquatic pollution has been identified as an immediate need for sustained management and conservation of the existing fisheries and aquatic resources (Islam and Tanaka, 2004). By far, sewage is the greatest volume of waste discharged to the marine environment. Highly populated cities generate huge loads of such wastes daily which are finally washed out by the drainage systems that generally release into nearby rivers or aquatic systems. Sewage contamination can be assessed by microbiological and chemical markers (Vivian, 1986; Takada and Eganhouse, 1998).

Linear alkylbenzenes (LABs) are one group of the chemical markers which have been successfully utilized as organic molecular markers for evaluating the source of sewage pollution (Eganhouse, 1997). Owing to their source specificity, resistance to degradation and persistence in marine sediments for a long time, molecular markers such as LABs have been important for studying anthropogenically derived organic matter input and its impact on aquatic environments (Takada and Eganhouse, 1998). Due to its improved biodegradability and cost-effectiveness, LABs have completely replaced the older branched alkylbenzene in the production of surfactants that have been used in household laundry detergents and dishwashing applications since the 1960s. LABs have isomers with different phenyl-substitution positions on the alkyl chains. It is easier to biodegrade external isomers (isomers whose phenyl substitution positions are close to the terminal end of the alkyl chain) than internal isomers (isomers whose substitution positions are close to the center of the alkyl chain). Thus, the distribution of LAB isomers indicates the level of LAB biodegradation (Takada and Ishiwatari, 1990). Furthermore, the isomeric structure and concentration of LABs reflect the magnitude and types of sewage discharged into the aquatic environment, such as raw sewage versus secondary effluents (Tsutsumi et al., 2002).

The I/E ratio (a ratio of the total of Internal to External isomers) has been proposed as an indicator of LAB degradation level in an aquatic environment (Takada and Ishiwatari, 1990). Because of these attributes, LABs are good indicators of human activities associated with sewage contamination in different regions around the world (Eganhouse et al., 1983; Takada et al., 1992; Isobe et al., 2004; Medeiros and Bícego, 2004; Luo et al., 2008; Martins et al., 2008; Ni et al., 2009; Venkatesan et al., 2010; Martins et al., 2012; Rinawati et al., 2012; Alkhadher et al., in press). All kinds of pollution stemming from human activities will ultimately settle down in surface sediments (Abdullah et al., 1999).

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