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Method Article

Assessment of toxic elements in sediments of Linggi River using NAA and ICP-MS techniques

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A B S T R A C T

Fourteen sediment samples were collected along Linggi River, Malaysia. Neutron activation analysis (NAA) and inductively coupled plasma-mass spectrometry (ICP-MS) techniques were used in the determination of toxic element contents. The results showed that As, Cd and Sb concentrations were higher at all sampling stations, with enrichment factor values ranging from 17.7 to 75.0, 2.1 to 19.5 and 6.6 to 28.4, respectively. Elements of Pb and Zn) were also enriched at most of the sampling stations whilst Cu, Cr and Ni were shown as background levels. The sediment of Linggi River can be categorised as low (<8.0) to very high degree of contamination (>32.0). The mean concentrations of elements viz. Cd, Cr, Ni, Pb, Sb and Zn were lower than the threshold effect level (TEL) of FSQGs values except for As. The concentration of As (arsenic) was higher than PEL and PEC of FSQGs values.

A R T I C L E I N F O

Keywords: Linggi River, Enrichment factor, Degree of contamination, Freshwater sediment quality guidelines, NAA, ICP-MS
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Method details

Background

Heavy metals are considered as serious inorganic pollutants, that can be accumulated in sediments and aquatic food chain [1,2]. These can give adverse effects to the aquatic life [3,4]. Water, sediment and biota significantly play an important role in the assessment of the level of pollution, degree of contamination and toxicology effects [5–7].The major sources of inorganic pollution originated from anthropogenic sources are industrial, domestic, animal waste, mining, petroleum activities and agriculture activities, as well as industrial emissions [8,9].

Sediment Quality Guidelines (SQGs) were developed to assist regulator and enforcement to mitigate and dealing with the contaminated sediment [10]. Typically, the total concentrations of contaminants in the whole sediments are compared to the guideline values to determine whether there is a potential for benthic invertebrate community impairment [11]. SQGs can be used in environmental assessments in combination with other measures such as the water quality, the concentration level and the degree of contamination to evaluate the risk to aquatic ecosystems from the anthropogenic activities. In this study, consensus-FSQGs and Canadian-FSQGS concentration values were used as a reference to evaluate the risk of sediment concentration to the benthic and sediment-dwelling organisms.

Assessment of pollution level in water and sediment of the Linggi River is important since Linggi River supplies water to Seremban and Port Dickson area [12]. The Linggi River, was classified as class III by Department of Environment, Malaysia which has required extensive treatment for water resources [13]. The Linggi River pollution was reported on the elemental pollution in water and suspended sediment by Khan (1990). However, since then, there has been no recent work reported regarding heavy metal pollution in sediments collected from Linggi River. Study of heavy metal contents, degree of contamination and also compared with freshwater sediment quality guidelines (FSQGs) of the Linggi River are still limited. In the present study, toxic elements As, Cd, Cr, Cu, Ni, Pb, Sb and Zn in sediments were selected due to their importance with respect to public health concern and impact to the river ecosystem.

Materials and methods

Sampling locations

Fourteen sampling locations were selected along the Linggi River as shown in Fig. 1. The surface sediment samples were collected by using a Ponar grab sampler. Sediment samples were kept in polyethylene bottle and transported to the laboratory. Sediments were dried in an oven at 60 °C until constant weight, ground to a powder form with an agate mortar and then sieved through 63 μm mesh sieve and kept in polyethylene containers.

Preparation of mix standard solution, samples and standard reference material (SRM) prior irradiation

Single standard solutions of As, Sb, Cr, Zn and Fe were purchased from Merck brand. The mix standard solution was prepared in volume metric flask of 100 ml. The concentration of mix standard solution of As, Sb, Cr, Zn and Fe are 10, 10, 80, 100, and 1000 mg/L, respectively. Filter papers (Ø = diameter, 1 cm, Whatman brand) were inserted into small polyethylene vial (Ø 1 cm × 3 cm H). An aliquot of 0.2 mL (∼0.2 g) of mix standard solution was dropped onto filter papers and it was dried at 50°C in an oven for 24 h. Polyethylene vial containing of mix standard solution was sealed using heating solder. Wet sediment samples from Linggi River were dried in an oven at 60 °C until constant weight, ground to a powder form with an agate mortar and then sieved through 63 μm mesh sieve and kept in polyethylene containers. The standard reference material (SRM) (IAEA-soil-7) were purchased from IAEA. Approximately 0.15 to 0.20 g homogenised sediment samples and SRM-IAEA-Soil-7 were