

UNIVERSITI TEKNOLOGI MARA

**HEAVY METALS AND
RADIONUCLIDES LINKAGES AND
RISK ASSESSMENT IN SEAWATER,
SEDIMENT AND FISH OF KUALA
LANGAT COASTAL AREA**

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Thesis submitted in fulfillment
of the requirements for the degree of
**Doctor of Philosophy
(Science)**

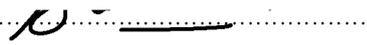
Faculty of Applied Sciences

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The Kuala Langat coastal areas are located within the vicinity of extensively developed areas which include agricultural and aquaculture, industries, as well as port and shipping activities. These anthropogenic activities may contribute major pollutants thus affecting the quality of the Kuala Langat coastal area ecosystems. This study focused on assessing concentration, source relationship, pollution levels of certain heavy metals and radionuclides as well as distribution linkages and risks of these pollutants in seawater, sediments and fish samples of the Kuala Langat coastal areas. The concentration of four heavy metal pollutants: [iron (^{56}Fe), copper (^{64}Cu), nickel (^{59}Ni), arsenic (^{75}As), lead (^{207}Pb) and zinc (^{65}Zn)] as well as three radionuclides: [uranium (^{238}U), thorium (^{232}Th) and potassium (^{40}K)] were determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF). In general, the concentration of heavy metals and radionuclides depend on the types of samples. Arsenic concentration in Pulau Indah and Pulau Carey seawater samples ranged from 73.51 to 109.36 $\mu\text{g/L}$ and 45.65 to 73.42 $\mu\text{g/L}$, respectively, which indicated both areas exceeded maximum concentration (20 $\mu\text{g/L}$) set by Malaysia Marine Water Quality Criteria Standard (MMWQCS) for arsenic. All heavy metals except arsenic were below the specified limit for fish tissue samples by Malaysian Food Act, 1983. Meanwhile, radionuclides concentrations in all types of samples were low and make only a small contribution to the total radiation dose to fish and, thus, to human consumers of seafood. Relationship of these pollutants in Kuala Langat coastal areas with their sources and with each other were obtained using principal component analysis (PCA) and cluster analysis (CA). The results identified anthropogenic activities as the main source of heavy metals and radionuclides pollutants in the study area. The pollution levels of this study area were determined based on Enrichment Factor (EF), Contamination Factor (CF), Pollution Index (PI) and Geological Pollution Index (I_{geo}), which revealed that the sediments were affected from arsenic and lead which originated through anthropogenic activities and other pollutants were mainly controlled by natural sources. In order to access the distributions linkages of metals from seawater and sediments to fishes, the Transfer Factor (TF) between these media were calculated, and it was found that, majority of the pollutants transferred to fishes from seawater. The daily intake levels and cancer risk assessments due to fish consumption were found to be dependent on the types of fish. However, the health risk of cancer due to fish consumption is still below the Malaysian Food Act, 1983. Daily intake levels of fish consumption values can be used to evaluate future safe daily fish consumption levels from this study area. Internal and external radiation level exposures (<1) were lower than the annual dose limit according to UNCEAR, 2002. The results of this study could be useful to authorities to carry out continuous environmental assessment so pollution levels can be monitored. Data from this study will also enable the formation of the first of its kind database on the spatial variations of radionuclide distribution in Kuala Langat coastal areas.

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