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Distribution and Ecological Risk Assessment of Trace Elements in Sediments along the Ganges River Estuary, India

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Abstract : The present study investigated the spatiotemporal distribution and ecological risk assessment of trace elements of surface sediments (top 0 - 5 cm; grain size ≤ 0.63 µm) in relevance to sediment quality characteristics along the Ganges River Estuary, India. Sediment samples were collected during ebb tide from intertidal regions covering seven sampling sites of diverse environmental stresses. The elements were analyzed with the help of ICPAES. This positive, mixohaline, macro-tidal estuary has global significance contributing ecological and economic services. Presence of fine-clayey particle (47.03%) enhances the adsorption as well as transportation of trace elements. There is a remarkable inter-metallic variation (mg kg-1 dry weight) in the distribution pattern in the following manner: Al (31801± 15943) > Fe (23337± 7584) > Mn (461±147) > S(381±235) > Zn(54 ±18) > V(43 ±14) > Cr(39 ±15) > As (34±15) > Cu(27 ±11) > Ni (24 ±9) > Se (17 ±8) > Co(11 ±3) > Mo(10 ± 2) > Hg(0.02 ±0.01). An overall trend of enrichment of majority of trace elements was very much pronounced at the site Lot 8, ~ 35km upstream of the estuarine mouth. In contrast, the minimum concentration was recorded at site Gangasagar, mouth of the estuary, with high energy profile. The prevalent variations in trace element distribution are being liable for a set of cumulative factors such as hydrodynamic conditions, sediment dispersion pattern and textural variations as well as non-homogenous input of contaminants from point and non-point sources. In order to gain insight into the trace elements distribution, accumulation, and their pollution status, geoaccumulation index (Igeo) and enrichment factor (EF) were used. The Igeo indicated that surface sediments were moderately polluted with As (0.60) and Mo (1.30) and strongly contaminated with Se (4.0). The EF indicated severe pollution of Se (53.82) and significant pollution of As (4.05) and Mo (6.0) and indicated the influx of As, Mo and Se in sediments from anthropogenic sources (such as industrial and municipal sewage, atmospheric deposition, agricultural run-off, etc.). The significant role of the megacity Calcutta in relevance to the untreated sewage discharge, atmospheric inputs and other anthropogenic activities is worthwhile to mention. The ecological risk for different trace elements was evaluated using sediment quality guidelines, effects range low (ERL), and effect range median (ERM). The concentration of As, Cu and Ni at 100%, 43% and 86% of the sampling sites has exceeded the ERL value while none of the element concentration exceeded ERM. The potential ecological risk index values revealed that As at 14.3% of the sampling sites would pose relatively moderate risk to benthic organisms. The effective role of finer clay particles for trace element distribution was revealed by multivariate analysis. The authors strongly recommend regular monitoring emphasizing on accurate appraisal of the potential risk of trace elements for effective and sustainable management of this estuarine environment.

Keywords : pollution assessment, sediment contamination, sediment quality, trace elements
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