A Thesis for the Degree of Ph.D. in Engineering

Geochemical Partitioning and Assessment of Trace Metal Pollution in Urban Rivers: The Scenario of River Pollution in Developed and Developing Countries

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ABSTRACT

The study was conducted- i) to determine the spatial distribution, seasonal and temporal variation of different trace metal contents in the river water and sediments, ii) to measure the potential trace metal mobility, iii) to assess the pollution load in water and sediments, iv) to distinguish the probable sources of pollution, and v) to evaluate the effectiveness of existing urban river management and waste disposal systems in different socio-economic condition. Three urban rivers were selected as experimental sites, namely, Tsurumi & Tamagawa river of Japan and Buriganga river of Bangladesh. Total trace metal content in water and sediment samples were analyzed and compared with different standard and reference values. Sequential extraction procedure was employed in sediment samples for the geochemical partitioning of the trace metals. Major elements and mineralogy of sediments were also determined on bulk prior to extraction, which allowed qualitative correlation between the fractionation results obtained and the presence of defined geochemical phases. Water and sediments samples were collected from 20 sites of Tsurumi river in winter and summer 2009. Concentrations of different trace metals like, Zn, Cu, Pb, Cr and Cd in Tsurumi river sediments were three to four folds higher than that of reference values and downstream sediments possess much more trace metals than the upstream sites. Geochemical partitioning results suggest that the potential trace metal mobility in aquatic environment was in the order of: Cd > Zn > Pb > Cu > Co > Mo > Cr > Ni. About 80.2% Zn, 77.9% Mo, 75.3% Co, 63.7% Pb, 60.9% Cu, 55.1% Cr and 39.8% of total Ni in the sediment were presumed to be contributed through anthropogenic activities. Based on Intensity of pollution (I_{POLL}), Tsurumi river downstream sediments are strongly to extremely contaminated by Zn, Pb and Cd. Pollution load index (*PLI*) indicates Tsurumi river downstream sites possess higher pollution load than that of upstream sites. Area load index (*ALI*) value of the Tsurumi river was 7.77 in winter and 7.72 in summer; while values above one indicates progressive deterioration of the sites and estuarine quality. Afterwards, water and sediments samples were collected from 11 sites ot the downstream of Tamagawa river in summer 2010 and winter 2011. Downstream sediments of Tamagawa river contains relatively higher concentration of Zn and Cu. *ALI* values of the downstream of Tamagawa river is 3.7 in summer and 4.1 in winter season; which indicate that the river sediments are in a bit polluted condition. However, the situation of Tamagawa is much better than the downstream of Tsrumi river. On the other hand, water and

sediment samples were collected from the 20 sites of Buriganga river during summer and winter 2009. Concentrations of the all the trace metal analyzed in Buriganga river water samples were greatly exceeded the toxicity reference values (*TRV*). Concentrations of total Cr, Pb, Cu and Ni in sediment samples were mostly higher than that of severe effect level (*SEL*) values. On average 92% Pb, 88% Zn, 73% Cu, 72% Cr, 68% Co and 63% of total Ni were associated with the first three labile sequential extraction phases. According to Intensity of pollution (I_{POLL}), the Buriganga sediments in most of the sampling sites are strongly to extremely contaminate by Pb, Cd, Cr, Zn and Cu. *ALI* value was as high as 21.1 in summer and 24.6 in winter season. Magnitude of heavy metal pollution in the Buriganga river system implies that the condition is very alarming and may severely affect the aquatic ecology of the river. In order to minimize the severe impact on city dwellers and aquatic ecology of the Buriganga river, prompt action on pollution prevention and cleanup operation is highly recommended.