ABSTRACT

The data on the concentration, distribution and fractionation of heavy metals in sediments, as well as in the aqueous phase for Yamuna riverine system are a requisite for the development of a comprehensive understanding of the impact of trace metals on water quality of Yamuna. Through the use of such additional data, it may be possible to begin to identify sources and sinks and the fate and potential effects of toxic or environmentally necessary metals. Similarly, sediment-chemical data are a requisite for transport modelling, for estimating geochemical cycles, and for inferring the availability of various trace metals in an ecological system.

Sediment is an important and dynamic part of the river catchments and basins. Heavy metals make way in to the aquatic environment are ultimately incorporated into the aquatic sediments. In the natural water systems, toxic metals are typically of high orders of magnitude in the sediments as compared to those in overlying rive waters. The total heavy metal load is more than 90 % in aquatic system is bound to the particulate matter and sediments. Many factors like geology, agricultural activity, industrialization, changes in land use pattern and biological productivity regulate the metal load in the river sediments. Recently, the heavy in sediments has received much attention due to the toxic and persistent characters.

Trace metals making way to natural water become part of the water-sediment system. Their distribution processes are controlled by a dynamic set of physical–chemical interactions and equilibria. The distribution of metals between the solid and liquid phase of the riverine system may be due to variety of processes including solubilization, competitive chelation, ion exchange, precipitation, sedimentation, adsorption and complexation phenomena. They are not permanently fixed by sediment. The metal solubility is principally controlled by pH,

concentration and type of ligands and chelating agents, oxidation-state of the mineral components and the redox environment of the system.

Most of earlier studies have been carried out mostly on total metal concentrations in water and sediments which generally does not provide significant indication of toxic potential of heavy metals. Very limited analysis has been performed on speciation/fractionation of heavy metals in the sediments of Indian rivers and therefore the need for intensive work/research in these areas being felt. In Indian context, the majority of studies are centred around the stretch of Yamuna river in Delhi and a few cities on other Indian rivers. This gives a bigger scope of studies for all Indian rivers at great length. Therefore, the scope of present study also includes fractionation analysis of heavy metals in sediments of Yamuna river throughout its stretch beginning from near Yamunotri, Uttarkashi district of Uttarakhand till near Sangam in Prayagraj district of Uttar Pradesh.

This study investigated different types of heavy metals namely, arsenic, cadmium, chromium, copper, lead, nickel, zinc and manganese found in water and sediments of Yamuna River along with their speciation studies. This Fractionation study helps in assessing bioavailability and potential toxicity due to heavy metal in the river water. The seasonal variation of the water quality and heavy metals concentration in Yamuna River water have also been covered under this study.

The study reveals that there is a considerable variation in the concentration of heavy metals in water and sediments of Yamuna River. This variation may be due to the change in the volume of industrial and sewage waste being added to river at different sampling stations. Both natural processes, such as precipitation inputs, erosion, weathering of rocks, and anthropogenic sources, viz. municipal wastewater, industrial effluents and agricultural runoff are identified to be the contributors of heavy metals to the Yamuna River system. Important among the natural sources is the weathering of rocks whereas agricultural runoff, municipal wastewater and

industrial effluents contribute heavy metal content to different degrees depending upon the quantum of load. Mining activities are not common in this stretch of the river. Municipal and industrial wastewater discharge constitutes a constant source of pollution, whereas surface run-off is a seasonal phenomenon, largely affected by climate in the basin. Seasonal variations in precipitation, surface run-off, interflow, and ground water flow have a strong effect on river discharge and subsequently on the concentration of pollutants in river water. Discharges of industrial, agricultural wastes and of municipal sewage water appear as the major sources for water quality deterioration in this study area. The elevated levels of these heavy metals could ultimately contaminate the cultivated crops, fish and thus making them toxic for human consumption.

The fractionation profile of heavy metals in sediments indicates bioavailability of associated metal in different fractions and hence different potential of toxicity. It seems the fractionation profile obtained for some metals in the study matches with some earlier reports, however for some metals like lead different results have been obtained.

Delhi is the major contributor of pollution in the Yamuna river, followed by Agra and Mathura. There is considerable enrichment of metals at Delhi and Agra due to massive population, haphazard urbanization and presence of huge number of small scale industrial units which discharge its untreated and partially treated wastewater into the Yamuna river. As a result, the Delhi segment of the river is considered as one of the intensely polluted rivers stretches of the world.

Finally, it may be recommended that regulatory steps should be taken by the government to check the heavy metal pollution of the Yamuna river system which is continuously being used for drinking, agriculture, religious and other industrial purposes.