ABSTRACT

The National Capital Territory (NCT) of Delhi is situated along the Yamuna river, a major tributary of the river Ganges. It has a population of over 11 million people, and it hosts one of the largest clusters of small-scale industries in India, generating waste of varying characteristics and quantities. It is estimated that the city generates 2270 million litres of wastewater and 6500 tonnes of solid waste daily. The raw and partially treated wastewater is often discharged into open drains, which link-up with others before emptying their contents into the Yamuna river, thus, resulting in the deterioration of its water quality. In this study, wastewater, suspended matter, bed residues and solid waste samples were obtained from selected industrial sites (Jhilmil, Patparganj, Naraina and Mayapuri) within the NCT of Delhi representing the lateral spread of the industrial zones on either side of the Yamuna river. Bulk estimation of heavy metals (Ni, Cu, Zn, Pb, Cr, Cd, Co, Mn, Fe and Hg) was carried out using GBC model 902 atomic absorption spectrophotometer. In addition, sequential extraction was used to fractionate heavy metals (Ni, Cu, Zn, Pb, Cr, Cd, Co, Mn and Fe) in solid waste and bed residues into six operationally defined phases: water-soluble, exchangeable, carbonate-bound, Fe-Mn oxides, organic-bound and residual. Also, fractionation of phosphorus was carried out on solid waste and bed residues in order to estimate its potential mobility and availability.

The results obtained show that the pH of the wastewater and solid waste varied from highly acidic to moderately basic. Wastewater samples with low pH levels had relatively high metal contents. In general, Jhilmil industrial site had higher levels of Ni, Cu, Zn, Pb, Mn, Cd, Co and Fe in the wastewater compared with the other sites. As well, suspended matter had higher levels of metals compared with the bed residues. The spatial distribution of heavy metals in solid waste showed that Jhilmil had higher levels of Cu and Hg, while Naraina had Pb, Ni, Cr, Co and Fe compared with the other sites. Sequential extraction revealed that while most of the heavy metals were held in the residual phase, there were significant portions in the non-residual phase i.e. in the potentially mobile and bioavailable fractions. The mean levels of phosphorus were high and ranged from 2286 to 2958 mg Kg\(^{-1}\) in solid waste and 2157 to 4292 mg Kg\(^{-1}\). The authigenic carbonate fluorapatite fraction was the single most dominant form in the solid waste (39.8 – 57.8%) and in the bed residues (32.6 – 46.6%). The exchangeable phosphorus contents ranged from 53 to 201 mg Kg\(^{-1}\) and 157 to 606 mg Kg\(^{-1}\) in solid waste and bed residues respectively. These high levels were indicative of anthropogenic input from urban, industrial and agricultural sources. The general trend of phosphorus distribution was: Acet-P > Det-P > Exch-P > Org-P > Fe-P.