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RESEARCH ARTICLE

Quantitative assessment of soil metal pollution with principal component analysis, geo accumulation index and enrichment index

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SUMMARY: Total concentration of heavy metals such as Fe, Mn, Zn, Cu, Pb, Cd and Cr in the urban soil of Dindigul town was determined to evaluate the level of contamination. The mean concentration of these metals in the traffic and industrial area were found to be higher compared to residential area. The purpose of this research article was to apply three methods which were enrichment index (EI), geoaccumulation index (I_{geo}) and principal component analysis (PCA) to assess the heavy metals contamination levels in the studied area. Soil pollution assessment showed that the enrichment index for all the eighteen sampling sites were found to be greater than 1 (EI>1) indicating all the three sites were contaminated with heavy metals. The industrial sites showed the enrichment index greater than 2 (EI>2) indicating these sites were seriously affected by the contaminants. The Igeo values revealed that I geo for Cr>= 2 at the industrial sites indicating, these sites were accumulating more of chromium in the soil. I geo for Mn, Zn, Cu and Pb were found in between 0–1 for all the 18 sampling sites indicating these sites were moderately contaminated. Multivariate statistical analysis, principal component analysis and cluster analysis suggest that Mn, Zn, Cu, Cd and Cr were derived from anthropogenic sources, particularly road traffic and leather industrial activities and the extreme proximal parts were heavily contaminated with maximum heavy metals.

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The contamination of the biosphere has been increased as a result of the industrial revolution and urbanization of the landscape. The level of metals in soil may also be elevated by natural sources or by agricultural, industrial, mining and waste disposal practices. Further, soil and sediments are considered as sinks for metals, which are accumulated in high concentrations. The disposal of sewage and industrial sludge is becoming a severe problem in many countries including India. Heavy metal concentrations in past few years have reached to an increasing toxic level due to consequences of anthropogenic activities and urbanization. Now-a-days it is well-known that cities suffer from considerable pollution due to a wide array of substances that contaminate the air, water and soil (Rucandio *et al.*, 2010; Sarala and Prathipa, 2011 a and b). Metal persistence in soil for much longer periods than in other compartments of the biosphere is a matter of serious concern. International agency for research on cancer has classified heavy metals like arsenic, cadmium, chromium, nickel, lead to be carcinogenic to humans and wildlife. Over recent decades, the annual worldwide release of heavy metals reached 22,000t (metric ton) for cadmium, 939,000t for copper, 783,000t for lead and 1, 35,000t for zinc (Singh *et al.*, 2003 and Sarma, 2011).

Mining, industrial processing, pesticide and chemical fertilizer and automobile exhaust are the main sources of heavy metal contamination in the environment (Granero and Domingo, 2002; Lee *et al.*, 2005; Han *et al.*, 2006 and Sarala and Prathipa, 2012 a and b). These metals may accumulate to a toxic concentration level which can lead to