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Leveraging random forest and remote sensing techniques to map topsoil metals for site-specific pollution management

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The presence of heavy metals in topsoils remains a significant concern for sustainable environment and healthy food production. The study clustered 60 randomised topsoil (0-30 cm) samples to map Zinc (Zn), Cadmium (Cd), and Lead (Pb) concentrations for site-specific pollution management in soils around an industrial area in Papalantoro, Ogun State, Nigeria. Random forest (RF) algorithm and remotely sensed indices such as Normalised difference vegetation index (NDVI), Soil adjusted vegetation index (SAVI), and Digital elevation model (DEM) were utilized as environmental covariates, ranked according to significance performance using coefficient of determination (R^2), mean squared error (MSE) and mean absolute error (MAE). The average concentrations of soil heavy metals in the studied area were present in the order Cd > Zn > Pb. The single and nemerow composite soil pollution indices revealed slight, moderate, and heavy soil contamination extents for the area. RF algorithm showed satisfactory results for soil heavy metal distributions, yielding mapping accuracies for Cd (R^2 = 0.86), Pb (R^2 = 0.75), and Zn (R^2 = 0.71). The contamination extents provide a nuanced understanding of soil heavy metal pollution for the area, suggesting that adequate attention be directed to alert policymakers and stakeholders to reduce anthropogenic sources, particularly regions associated with increasing unchecked human actions and industrial developments for mitigating immediate and future control measures of soil management.







