Spatial Distributions of Heavy Metal Concentrations in Surface Soils of Quezon City, Philippines Using Geospatial Information and Regression Models

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ABSTRACT

Heavy metal pollution in soils is a ubiquitous and largely unmonitored environmental problem in urban areas where a growing majority of the human population resides. In Quezon City, Philippines, soils have exceeded critical threshold levels, thereby posing risks to surrounding communities and ecosystems. Using a digital soil mapping (DSM) framework that leverages soil point-survey observations (Navarrete et al. 2017) and available geospatial information, heavy metal concentrations (Cr, Ni, Cu, Zn, and Pb) in surface soils of Quezon City are mapped using multiple linear regression (MLR) and partial least squares regression (PLSR) to infer on important soil-landscape factors that drive the spatial distributions of heavy metals in urban environments. Approximately 50 percent of the observed variability in heavy metal concentrations can be statistically explained using urban landscape factors and a predictive linear function. While both MLR and PLSR returned weak to moderately predictive soil models ($R^2 < 0.70$), PLSR consistently outperformed MLR in terms of overall spatial accuracy. Ni (MLR and PLSR), Cr (PLSR) and Cu (PLSR) estimates have the highest correlation to soil measurements as well as the smallest prediction errors, making them the most accurate models in this study. Land-use, landcover, elevation, industries, population density, and solid waste are important factors that determine heavy metal abundance patterns in the study area. Anthropogenic factors are dominant predictors in the regression models, which suggests that heavy metal enrichment in soils is largely influenced by anthropogenic activities. Pollution hotspots are associated with dense residential areas, rangeland, metropolitan commercial zones, and heavily industrialized districts. As global trajectories accelerate towards urban land expansion and soil degradation, timely and reliable soil information has never been more important in strategic and sustainable land resource management. DSM is an effective methodology that supports and broadens the reach of soil inferences derived using point soil-survey by introducing a spatial and environmentally nuanced perspective on soil-landscape variability that can be applied to coupled human-natural systems.

Keywords: Digital Soil Mapping, MLR, PLSR, GIS, Heavy Metals, Urban Soils