Modelling heavy metals build-up on urban road surfaces for stormwater reuse safety

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Abstract

Heavy metals on urban road surfaces are primarily sourced from vehicle emission and surrounding anthropogenic activities. Heavy metal pollutants accumulate on the roads during dry periods. When there are rainfall events, the runoff can wash off these heavy metal pollutants into the drainage network and eventually undermine receiving water bodies. However, there are few research studies focusing on the heavy metal pollutant accumulation processes, and the research on their modelling and prediction is even extremely limited. An in-depth understanding of heavy metal pollutants build-up on road surfaces modelling can provide useful insights to urban non-point source pollution control. In this context, this study selected sampling sites in Shenzhen, China. The samples were collected using a dry-wet vacuuming system and Pb, As, Cr, Mn Cu, Zn and Ni were measured using Inductively Coupled Plasma Optical Emission Spectrometer, and an artificial neural network (ANN) approach and two regression modelling approaches were compared in terms of estimating heavy metal build-up loads on road surface based on traffic activities and land use fractions. The results showed that Mn had the highest loads (0.57-34.85 mg/m^2), followed by Zn (3.05-21.99 mg/m^2), Cu (0.44-10.53 mg/m^2), Cr (0.24-7.21 mg/m^2), Pb (0.23-2.75 mg/m^2), Ni (0.13-2.38 mg/m^2), As (0.02-0.23 mg/m^2), the Relative Prediction Error, Standard Error of Cross-Validation and Cross-Validated Coefficient of Determination of ANN approach were ranged between 24.48% and 44.21%, 0.031 and 4.458, 0.551 and 0.774, respectively, which had a better performance than conventional regression modelling approaches. These research outcomes are expected to provide an effective approach for ensuring stormwater reuse safety and a useful guidance for decision-making for stormwater management and water environment protection related urban planning.