HEAVY METAL DISTRIBUTION FOR AQUEOUS AND SOLID PHASES
IN URBAN RUNOFF, SNOWMELT AND SOILS

A Dissertation

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Abstract

At the start of the third millennium, over 50% of the world’s population lives in urban areas. Anthropogenic activities associated with urban development such as traffic generate significant particulate and heavy metal mass loadings. Ten urban highway sites located throughout the metropolitan area of Cincinnati, Ohio were studied. Storm water, snow and transportation land use soil/residual complexes (RSCs) were collected at each site. For the storm water, results are presented for a series of eight rainfall runoff events over a two-year period and included analyses between dissolved and particulate-bound fractions of heavy metals (Pb, Cu, Cd and Zn), and water quality characteristics such as hydrology, alkalinity, hardness and pH. For all sites, results are presented for a 460-mm snowfall in 1998 and included analyses between dissolved and particulate-bound fractions of heavy metals, particle size distributions (PSD), specific surface area (SSA), total surface area (SA), particle density ($\rho_p$), and water quality characteristics such as hardness, pH, conductivity, chloride, chemical oxygen demand (COD), and total suspended (TSS) and dissolved (TDS) solids. The role of climate and traffic were examined with respect to these results. For the RSCs, results included PSD, SSA, SA, $\rho_p$, particulate-bound fractions of heavy metals, mineralogical constituents and potentiometric titrations. Overall, partitioning analysis for storm water runoff indicated that heavy metals were predominately dissolved due to low pH, low alkalinity and short pavement residence times ($\tau_{sf}$). Snow however had a much greater capacity to accumulate and retain particulate-bound metals due to a neutral pH, increased hardness and longer $\tau_{sf}$ in terms of days instead of minutes. The RSCs which retain and export storm water and snow had decreased levels of heavy metals when compared to the reference site. Although similar in parent material, the RSCs had different mineralogical constituents than the reference and exhibited a greater buffering capacity and net
surface charge density. Heavy metal concentration at the undisturbed reference site indicated the potential of high atmospheric deposition from historical coal combustion. Characterization of partitioning, accretion and distribution of heavy metals is necessary for development of best management practices as source control in urban transportation land use areas.