A New Cost-effective Adsorbent Device for Civic Remediation to Reduce Lead, Copper and Cadmium in Surface Water Runoff

Nagi, Kshemaahna (School: Vidyashilp Academy)

The number of annual lead-poisoning fatalities exceeds the combined annual fatalities from car accidents and malaria. Cadmium causes DNA damage. A leading heavy metal exposure source is surface water contamination, lethal to direct consumers and others through biomagnification. To combat this, I devised a 3-part framework. First, major contamination-pathways or ‘sources’ were identified as runoff from improper battery disposal sites, carwash and maintenance facilities. Composite water sampling of sources and depth-integrated sampling of sinks like lakes from 4 locations across India was conducted. QQQ-ICPMS was used to analyze samples for lead (> 0.01 mg/L), copper (>0.08 mg/L) and cadmium (>0.02mg/L) and grade them based on contaminant levels. Regression and spatiotemporal models enabled identifying sinks at risk. Based on this, I developed a mathematical model to predict lead, copper and cadmium levels in lakes without the expensive, cumbersome and time-consuming process of ICPMS samples testing. Then, potential cost-efficient adsorbents were evaluated on flow rates and coefficient of permittivity using Darcy’s Law. The flow volume/time was deduced for standard inlet drains. Adsorption experiments were performed and isotherms constructed. Finally, a layered-adsorbent was constructed using 0.1 M Caustic Soda-treated Rice Husk, kaolinite and Compressed Coconut Fiber structure along with a sensor and a coagulation layer. Carbon-negative rice-stubble biochar reinforced-casing provides structural integrity and increases detention time for adsorption. When placed in surface water inlets, the device reduces Pb and Cd by 95-98% and Cu by 72%. The device costs an average of 14 USD/surface water body (a heavy metal treatment plant costs on average 150000 USD).