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Phytoremediation of Zinc and Chromium in Partially Saturated Constructed Wetlands using *Typha angustifolia*

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Abstract

Heavy metals are persistent pollutants posing ecological and health risks when discharged into the environment. The study focused on the phytoremediation potential of *Typha angustifolia* for removing Zinc (Zn) and Chromium (Cr) in partially saturated constructed wetlands (PSCWs) treating municipal wastewater from the post-primary leachate treatment stage at the Dompe Sanitary Landfill, Sri Lanka. Three PSCW configurations with partial saturation (PS) layer heights of 70 cm, 50 cm, and 30 cm were operated in triplicate for four months to assess the effect of saturation depth on heavy metal retention and plant uptake. Systems were operated under vegetated and non-vegetated conditions with a hydraulic retention time of six days, using *T. angustifolia* as the planted treatment. Data were collected monthly, with influent and effluent concentrations monitored, and metal accumulation in plant roots and shoots analysed at the end of the experimental period. The influent contained around 0.518 mg/L of Cr and 0.173 mg/L of Zn. Across vegetated units, Zn and Cr removal ranged from 28.1% to 55.8%, with significantly higher accumulation of the heavy metals in roots (0.283 mg/L) than shoots (0.112 mg/L). Translocation factors (TF) were consistently below 1 for both metals, confirming that *T. angustifolia* primarily retained heavy metals within the root zone, characteristic of phytostabilisation. Among the PS configurations, the 70 cm system exhibited the highest root accumulation (0.283 mg/L), suggesting that greater saturation depth enhances contact time and promotes metal retention through root–biofilm interactions. While plant accumulation accounted for a substantial fraction of total removal, the contributions of sediment adsorption and precipitation were not measured and warrant further investigation to complete a full metal mass balance. MANOVA and Tukey's tests indicated significantly lower removal rates in non-vegetated systems ($p<0.05$), underscoring the role of vegetation in enhancing treatment efficiency. These findings demonstrate the suitability of *T. angustifolia* as a phytostabilising species in PSCWs for improving effluent quality and mitigating heavy metal pollution, contributing to the long-term stabilisation of toxic metals in constructed wetland environments.

Keywords: *Heavy metals, Municipal wastewater, Partially saturated constructed wetlands, Phytoremediation*