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Field-derived phosphorus accumulation rates and fractionation in bioretention cells

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Bioretention cells are urban stormwater control systems with potential for reducing peak flows and runoff volumes and promising performance in improving water quality. However, variable efficiencies are often observed for phosphorus (P): outlet concentrations of some P fractions sometimes exceed inlet ones. Therefore, there is a need to better understand the internal biogeochemical mechanisms governing the fate of P in bioretention cells. This study contributes to filing in this research gap. First, we estimated the accumulation rates of P using field samples collected in a bioretention cell at two depths over a period of 9 years. Second, we conducted sequential soil extractions to investigate the fractions of P in vertically- and longitudinally-distributed samples. The acquired data, when combined with previously available data for the site, showed an average total P (TP) accumulation rate of 87.6 ± 29.1 mg P kg^{-1} y^{-1} in the top 10 cm of media and 32.7 ± 17.7 mg P kg^{-1} y^{-1} in the 25–45 cm deep region, with linear trends implying that the bioretention cells were not yet approached saturation with P. The sequential extractions allowed to associate P with 6 main fractions of organic or inorganic origins. This analysis showed that redox-sensitive P and organic matter-associated P (organic P, humic-bound P, and exchangeable P) fractions best represented total P variation in the system. The results of this study inform the design of bioretention cell for enhanced P retention performance.