Modelling phosphorus reduction performance of urban best management practices at the watershed scale

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A variety of best management practices (BMPs) are being implemented to attenuate the increasing eutrophication risk caused by excessive phosphorus (P) export via urban stormwater runoff. However, P reduction performance of the BMPs are highly variable under different climatic, watershed, and design settings. Many of BMPs are actually reported to enrich P concentrations, which questions their efficiency to reduce P load export from urban watersheds. In this study, we developed a data-driven machine learning model to predict P reduction or enrichment in urban stormwater BMPs. The model is trained and validated using hydrologic and P concentration data for several typical urban stormwater BMPs, including traditional systems (retention pond, wetland basin and detention basin) and low-impact development (LID) systems (bioretention cell, grass swale and grass strip), from the International Stormwater BMP Database. Unlike other models in previous studies, our model can simulate both P reduction and enrichment by urban BMPs under specific input and climatic, watershed, and BMP design conditions. Additionally, a PCSWMM (Stormwater Management Model) was developed for a small urban watershed in Southern Ontario (Lake Wilcox (LW) watershed) to provide representation of the rainfall–runoff processes in the watershed. Parameters obtained by PCSWMM were calibrated using the observed data, and these will be used along with data-driven BMP P model for LW to estimate projected changes in P export under different BMPs application and climatic scenarios at the watershed scale. This study will propose an innovative and more robust method to estimate attenuation of P export by BMPs at watershed scale. It will also improve our understanding about critical climatic, watershed and BMP design variables that control BMPs P reduction performances.