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Optimizing Stormwater Sampling Design for Estimation of Pollutant Loads

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Abstract : Stormwater runoff is the leading contributor to pollution of receiving waters. In response, an efficient stormwater monitoring program is required to quantify and eventually reduce stormwater pollution. The overall goals of stormwater monitoring programs primarily include the identification of high-risk dischargers and the development of total maximum daily loads (TMDLs). The challenge in developing better monitoring program is to reduce the variability in flux estimates due to sampling errors; however, the success of monitoring program mainly depends on the accuracy of the estimates. Apart from sampling errors, manpower and budgetary constraints also influence the quality of the estimates. This study attempted to develop optimum stormwater monitoring design considering both cost and the quality of the estimated pollutants flux. Three years stormwater monitoring data (2012 – 2014) from a mix land use located within Geumhak watershed South Korea was evaluated. The regional climate is humid and precipitation is usually well distributed through the year. The investigation of a large number of water quality parameters is time-consuming and resource intensive. In order to identify a suite of easy-to-measure parameters to act as a surrogate, Principal Component Analysis (PCA) was applied. Means, standard deviations, coefficient of variation (CV) and other simple statistics were performed using multivariate statistical analysis software SPSS 22.0. The implication of sampling time on monitoring results, number of samples required during the storm event and impact of seasonal first flush were also identified. Based on the observations derived from the PCA biplot and the correlation matrix, total suspended solids (TSS) was identified as a potential surrogate for turbidity, total phosphorus and for heavy metals like lead, chromium, and copper whereas, Chemical Oxygen Demand (COD) was identified as surrogate for organic matter. The CV among different monitored water quality parameters were found higher (ranged from 3.8 to 15.5). It suggests that use of grab sampling design to estimate the mass emission rates in the study area can lead to errors due to large variability. TSS discharge load calculation error was found only 2 % with two different sample size approaches; i.e. 17 samples per storm event and equally distributed 6 samples per storm event. Both seasonal first flush and event first flush phenomena for most water quality parameters were observed in the study area. Samples taken at the initial stage of storm event generally overestimate the mass emissions; however, it was found that collecting a grab sample after initial hour of storm event more closely approximates the mean concentration of the event. It was concluded that site and regional climate specific interventions can be made to optimize the stormwater monitoring program in order to make it more effective and economical.

Keywords : first flush, pollutant load, stormwater monitoring, surrogate parameters
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