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Assessment of efficient sampling designs for urban stormwater monitoring

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ABSTRACT

Monitoring programs for urban runoff, which are highly variable and do not fit a point source model, have not been assessed for effectiveness or efficiency in estimating mass emissions. In order to determine appropriate designs for stormwater, total suspended solids (TSS) and flow information from the Santa Ana River was collected nearly every 15 min for every storm of the 1998 water year. All samples were used to calculate the "true load" and then three within storm sampling designs (flow-interval, time-interval, and simple random) and five among-storm sampling designs (stratified by size, stratified by season, simple random, simple random of medium and large storms, and the first *m* storms of the season) were simulated. Using these designs, we evaluated three estimators for storm mass emissions (mean, volume weighted, and ratio) and three estimators for annual mass emissions (median, ratio, and regular). Designs and estimators were evaluated with respect to accuracy and precision. The optimal strategy was used to determine the appropriate number of storms to sample annually based upon confidence interval width for estimates of annual mass emissions and concentration. The amount of detectable trend in mass emissions and concentration was determined for sample sizes 3 and 7. Single storms were most efficiently characterized by taking 12 samples following a flow-interval schedule and using a volume-weighted estimator of mass emissions. This design and estimator had the best combination of small bias and standard error. Randomly selecting the medium and large storms within a season achieved the smallest bias for concentration and reasonable bias for estimating mass emissions. This design also attained a small standard error. The ratio estimator most accurately estimated concentration and mass emissions from the simple random sample of medium and large storms, and had low bias over all of the designs. This estimator minimized standard error when coupled with the simple random sample of medium and large storms. Sampling seven storms is the most efficient method for attaining small confidence interval width for annual concentration. Sampling three storms per year allows a 20% trend to be detected in mass emissions or concentration over five years. These results are decreased by 10% by sampling seven storms per year.

Full Text

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