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Evaluating performance of stormwater sampling approaches using a dynamic watershed model

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ABSTRACT

Accurate quantification of stormwater pollutant levels is essential for estimating overall contaminant discharge to receiving waters. Numerous sampling approaches exist that attempt to balance accuracy against the costs associated with the sampling method. This study employs a novel and practical approach of evaluating the accuracy of different stormwater monitoring methodologies using stormflows and constituent concentrations produced by a fully validated continuous simulation watershed model. A major advantage of using a watershed model to simulate pollutant concentrations is that a large number of storms representing a broad range of conditions can be applied in testing the various sampling approaches. Seventy-eight distinct methodologies were evaluated by "virtual samplings" of 166 simulated storms of varying size, intensity and duration, representing 14 years of storms in Ballona Creek near Los Angeles, California. The 78 methods can be grouped into four general strategies: volume-paced compositing, time-paced compositing, pollutograph sampling, and microsampling. The performances of each sampling strategy was evaluated by comparing the (1) median relative error between the virtually sampled and the true modeled event mean concentration (EMC) of each storm (accuracy), (2) median absolute deviation about the median or "MAD" of the relative error or (precision), and (3) the percentage of storms where sampling methods were within 10% of the true EMC (combined measures of accuracy and precision). Finally, costs associated with site setup, sampling, and laboratory analysis were estimated for each method. Pollutograph sampling consistently outperformed the other three methods both in terms of accuracy and precision, but was the most costly method evaluated. Timepaced sampling consistently underestimated while volume-paced sampling over estimated the storm EMCs. Microsampling performance approached that of pollutograph sampling at a substantial cost savings. The most efficient method for routine stormwater monitoring in terms of a balance between performance and cost was volume-paced microsampling, with variable sample pacing to ensure that the entirety of the storm was captured. Pollutograph sampling is recommended if the data are to be used for detailed analysis of runoff dynamics.