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Advancing assessment and design of stormwater monitoring programs using a self-organizing map: Characterization of trace metal concentration profiles in stormwater runoff

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ABSTRACT

Stormwater runoff poses a great challenge to the scientific assessment of the effects of diffuse pollution sources on receiving waters. In this study, a self-organizing map (SOM), a research tool for analyzing specific patterns in a large array of data, was applied to the monitoring data obtained from a stormwater monitoring survey to acquire new insights into stream water quality profiles under different rainfall conditions. The components of the input data vectors used by the SOM included concentrations of 10 metal elements, river discharge, and rainfall amount which were collected at the inlet and endpoint of an urban segment of the Yeongsan River, Korea. From the study, it was found that the SOM displayed significant variability in trace metal concentrations for different monitoring sites and rainfall events, with a greater impact of stormwater runoff on stream water quality at the upstream site than at the downstream site, except under low rainfall conditions ($\leq$4 mm). In addition, the SOM clearly determined the water quality characteristics for "non-storm" and "storm" data, where the parameters nickel and arsenic and the parameters chromium, cadmium, and lead played an important role in reflecting the spatial and temporal water quality, respectively. When the SOM was used to examine the efficacy of stormwater quality monitoring programs, between 34 and 64% of the sample size in the current data set was shown to be sufficient for estimating the stormwater pollutant loads. The observed errors were small, generally being below 10, 6, and 20% for load estimation, map resolution, and clustering accuracy, respectively. Thus, the method recommended may be used to minimize monitoring costs if both the efficiency and accuracy are further determined by examining a large existing data set.

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