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A multistage multicriteria spatial sampling strategy for estimating contaminant mass discharge and its uncertainty

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Abstract:

Mass discharge across a control plane has great potential to serve as a metric for the assessment of the impact of partial source zone depletion and for the development of risk-based source plume remediation strategies. However, field-estimated mass discharge is always subject to uncertainty, arising from nonexclusive sampling. The accuracy of the estimated discharge and the magnitude of its quantifiable uncertainty depend upon the amount of information provided by the sample data. A multistage spatial sampling strategy is proposed to select optimal sampling locations and determine minimal sampling density for accurate quantification of mass discharge uncertainty. Two sampling criteria are incorporated to ensure coverage of the control plane and delineation of highly concentrated areas (hot spots). Multiple criteria decision making theory is adapted to objectively weight the two sampling criteria, on the basis of the information importance of each criterion, with additional observations located according to the weighted average of the two criteria. Application of this methodology to numerically simulated plume transects shows that in comparison to one stage sampling design (regular pattern), this sampling strategy yields a 50% reduction in required sampling density for accurate uncertainty modeling. The developed sampling algorithm can be used in real time to guide staged field sampling.

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