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Source Identification of Continuous Discharge Pollution in River Accidents Based On A DREAM Inverse Method

Yinying Zhu[1] and Zhi Chen[1, *]
[1] Department of Building, Civil and Environmental Engineering, Concordia University
1455 Boulevard de Maisonneuve O, Montreal, Canada
z_yinyin@encs.concordia.ca; *zhichen@bcee.concordia.ca, correspondence

Extended Abstract

Prompt identification of pollution source information in river emission incidents is of great importance for emergency response. In the early stage of water pollution accidents in rivers, pollution source information is unknown due to insufficient monitoring data. Contrary to forward models, pollution source identification is an ill-posed problem because source parameters cannot be directly obtained by solving advection-diffusion equations. Therefore, inverse models have been proposed for pollution source identification based on the time series of observed pollutant concentrations at monitoring sites [1]. The optimization method and probabilistic method are two main categories of inverse models. Generally, the optimization method (i.e., Genetic Algorithm (GA)) cannot quantify the source uncertainties like those from the observation errors. And the identified source results obtained from the basic probabilistic method (i.e., Metropolis-Hastings (MH)) are influenced by the prior range of source parameters. The novel DiffeRential Evolution Adaptive Metropolis (DREAM) algorithm has shown better performance than the basic MH algorithm in solving highly nonlinear problems for parameter calibration [2]. Many studies have been undertaken to develop inverse models for instantaneous source identification in surface waters [3], [4]. However, previously only a few studies focus on continuous source identification in rivers [5].

In this study, a new inverse model is proposed to identify the pollution point source with the continuous discharge in river accidents, aiming to estimate source strength, location, release time, and spill time. The developed inverse model combines the up-to-date DREAM algorithm and the forward transport advection-dispersion equation to infer the posterior distributions of source parameters. In addition, the performance of the DREAM method is compared with other two commonly used methods, the MH method and the GA method. A hypothetical case with real river conditions and a field tracer case are studied to examine the effectiveness of the developed DREAM-based method. First, the DREAM method performs very well in a hypothetical case, and the results show that the absolute percent biases are 1.67 %, 0.80 %, 7.50 %, and 1.25 % for the estimated mean values of source strength, location, release time, and spill time from the DREAM method, respectively. Second, a field-scale tracer case study also confirms the applicability of the DREAM method in practice. The results from this field tracer case study give that the absolute percent biases are 1.92 %, 4.93 %, 10.29 %, and 4.67 % for estimated mean values of source strength, location, release time, and spill time from the DREAM method, respectively. In conclusion, this study indicates that the DREAM method has a significant advantage in improving accuracy and saving computational time compared to the MH method and the GA method. The findings of this study would improve decision-making during emergency responses for accidental river pollution events.

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