Equation to Predict Riverine Transport of Suddenly Discharged Pollutants

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Abstract: Pollution discharge to rivers is the leading cause of freshwater pollution. This paper presents a method for predicting the concentrations of a pollutant that is suddenly released into a river. The prediction method is based on a first-order Gaussian function. The coefficients of the Gaussian function are calculated using three power equations. These equations have six parameters whose values are optimized with the genetic algorithm (GA). The results of this paper's case study are compared with those obtained with the artificial neural network method (ANN), genetic programming (GP), and from the analytical solution of the differential equation for riverine transport of suddenly released pollutants. The proposed equation is applied in a case study that confirms its suitability for estimating the concentration of pollutants downstream from a sudden release location in a river. The correlation coefficient (R^2) and the root mean square error (*RMSE*) of the training and testing data obtained from the application of the proposed equation increase and decrease approximately 14 and 50%, respectively, in comparison with the values associated with the application of the analytical advection-dispersion to calculate the transport of sudden pollution in rivers. **DOI: 10.1061/(ASCE)IR.1943-4774.0001083.**

Author keywords: Sudden pollution; Pollution propagation; Advection-dispersion equation; Genetic algorithm; Data mining tools.

Introduction

Riverine water quality has been degraded by inadvertent, intentional, and accidental discharge of pollutants in streams. The assessment of riverine water pollution is key to developing remedial and response actions (Hou et al. 2013). Water sampling is the most accurate method for establishing the degree of riverine water pollution. Yet, comprehensive spatial and temporal monitoring of riverine water quality is expensive in time and funding demands. For this reason, other indirect methods that rely on numerical prediction models of riverine water quality and pollutant transport have been developed to supplement measurement campaigns.

Matsuda (1979) developed a pollution prediction system to control the national waters and ports of Japan using the finite element method. Wen et al. (1998) used a multiobjective optimization model based on artificial neural network (ANN) to manage water quality in the Tou-Chen River in Taiwan. Demirdag et al. (2000) applied the ANN method to estimate values of the water quality parameters in the Gediz River in western Turkey. Drago et al. (2001) presented a three-dimensional numerical model for water eutrophication and pollution transmission. They used this model to analyze solid particles and pollutants discharged to water bodies. Suen and Eheart (2003) estimated the nitrate concentration in the Sangamon River of Illinois using the ANN. They compared the results of back propagation neural network (BPNN) and radial basis function neural network (RBFNN) methods with the results of the multiple regression analysis (MRA) method and the soil and water assessment tool (SWAT) considering the estimation accuracy of the nitrate concentration. Caplow et al. (2004) studied the pollution tracing and pollution advection and dispersion in the Hudson River, including several reservoirs under operation. The latter authors used a sulfur hexafluoride concentration as the pollutant and traced it for seven days by solving the advection-dispersion equation of pollution to evaluate the pollution distribution in the river. Their results indicated that the coefficients of advection and dispersion for sulfur hexafluoride were approximately 9.0 km/day and 17.3 m^2/s, respectively. El-Badia et al. (2005) identified the location and value of point-source pollution using mathematical models of river flow and contaminant transport. Jha et al. (2005) reported that fertilizers and chemical substances used on Indian farms cause nonpoint pollution sources and discharge of these pollutants to surface water and ground waters. They estimated input nutrients from three farms relying on 576 sets of water quality data. Riahi-Madvar et al. (2009) developed a method for estimating the coefficient of longitudinal dispersion in rivers using adaptive network-based fuzzy inference system (ANFIS), field measurements, and several statistical indices. The obtained results indicated that the developed method is more accurate than 12 other experimental methods used to calculate the dispersion coefficient. Noori et al. (2011) determined that the dispersion coefficient is the most important factor for modeling pollutant transport in surface waters. They developed a model based on the ANN for predicting the dispersion coefficient in natural waters. Tong and Deng (2015) established that identifying unknown sources of pollution is essential

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