Identification of Location, Activity Time and Intensity of the Unknown Pollutant Source in River

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Abstract
In recent years, with increasing population and growing industry, most of the world's water sources, including rivers, lakes and ground water, have been infected. This has caused health problems for humans and other living organisms. If this situation continues, Humans face water shortage and irreparable risks. Pollutant source control continuously prevents water contamination by implementing pre-occurrence measures aimed at reducing environmental hazards, it can drastically reduce the costs imposed and manage the crisis. The most important way to maintain the quality of water resources and control it, is to editing rules, and appropriate and rigorous standards, and plan for its proper implementation. The water quality of rivers should be monitored continuously, because some industries often enter the river suddenly due to its limitations. Determine the time and place of the pollutant that has been abandoned in the past, can be of great help in protecting rivers. The main objective of this research is to identify the location of the pollutant in the river without any prior information from the source in the entire mathematical framework. The strength point of the proposed inverse model is that only by taking the concentration-time curve from two upstream and downstream points of pollution can the source location be obtained with highest accuracy. After obtaining the source location, the intensity of the source of the pollutant is restored. In this study, the error was entered into the flow parameters to observe the error in the location identification, and recovery of the source pollution intensity. The result showed that this model is not sensitive to parameter error. Verification between the exact state and the results of the inverse model with acceptable accuracy was acceptable.

Introduction
In several areas of applied sciences, inverse problems are playing a crucial role in estimating unknown causes using some observed consequences. Estimations of inaccessible parameters are usually the missing bits of information that may lead to a better understanding of the occurring phenomena, and even prevent

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worse consequences. In this paper, we are interested in studying an inverse source problem. A motivation of our study is an environmental application that consists of the identification of pollution sources in surface water. In fact, when toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they get dissolved or lie suspended in the water or get deposited on the bed.

In the field of reverse solving, the research projects that have been done so far are mostly associated with underground water environment and less attention has been given to surface water. In this research, using the techniques in the science of the inverse problem, it is attempted to identify the source of contamination quickly. The proposed model can identify the location, and the intensity of the source of the pollutant quickly and accurately.

Materials and methods

In this paper, the river is considered to have only one source of pollutants in it, the location and intensity of the pollutant source in this river is unknown, and no prior information from the source of contamination in the river is available. Two observation points should be selected so that one is located upstream (a) of the pollutant source, and another is downstream (b) of the pollutant source. Given that in the inverse solution of the advection-dispersion equation, a forward solution is needed, forward solving is done at the end. The river of the length of l is shown below.

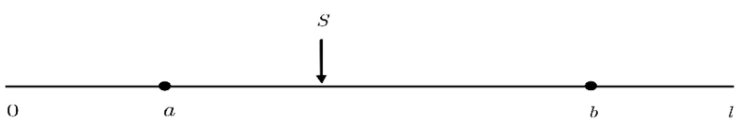

Fig. 1. Hypothetical river, and locating the polluting source, and measuring stations of concentration-time curves

The advection-dispersion equation in the above river is shown below:

$$\frac{\partial c}{\partial t} + V\frac{\partial c}{\partial x} - D\frac{\partial^2 c}{\partial x^2} + Rc = w(t)\delta(x - S) \quad (1)$$

$$c(x,0) = 0 \quad (2)$$

$$c(0,t) = 0 \quad (3)$$

$$\left.\frac{\partial c}{\partial x}\right|_{x=l} = 0 \quad (4)$$

In the above equations, c is the pollutant concentration, D is the dispersion coefficient, V is the stream velocity, $w(\mathrm{t})$ is the pollution source intensity function, $\delta()$ is the Dirac delta function and S is the source location.

Inverse model in the river

The application of the inverse model is to identify the location, and intensity of the pollutant source by measuring the spatial distribution, and the time of concentration in the solution range. In this research, concentrations are measured by concentration measurement at two points upstream and downstream of the river. Then, the proposed model provides the location and intensity of the source of the pollutant. In the next step, the location and intensity of the source of the pollutant are obtained.

a. Identification of the location of the pollutant source in the river

At this stage, after providing numerous mathematical formulas, the source location formula has been extracted.

b. Identification of the intensity of the pollutant source in the river

Once the location is identified, the source intensity can be extracted.

Forward model in the river

Concentration-time curves must be specified on the river in order to identify the source of the unknown pollutants in the river. This is done by solving a direct dispersion equation. For this purpose, the advection-dispersion equation, forward can be solved.

Results and discussion

This section verifies the reversal of the location and intensity of the pollutant source, and examines the results of the model. The method of verification is initially considered to be a hypothetical function in a specific river location. By implementing the direct model, the concentration-time curves are extracted in the upstream and downstream of the pollutant source, the extraction curves of the direct model apply errors, this data is then returned to the inverse model with different error values, and the results of the inverse model are evaluated with a precise state. This model is done for two hypothetical examples. Then the proposed model is implemented for the actual conditions of the Karun River. In this section, the coefficients of flow, which include the coefficient of speed and dispersion, add different values of the error and reduce the effect of these errors in the results.

Conclusion

In the present study, using the concentration-time curve measurement at two points of the river, location, activity time and intensity function of the unknown

source of contamination in the river are obtained. This is done in the river without any prior information from the source. This model was evaluated by two hypothetical examples and a real example in the Karun River. In this study, an error has been found in the flow coefficients to observe the resulting error in the results. The result showed that this model is not sensitive to coefficient error. According to the results, it can be concluded that this model is capable of well identifying the source of the unknown pollutant in the river. It also works well in real river conditions.

Keywords: Recovery of intensity of a point pollutant source, Solve the inverse, Identification of location of a point pollutant source, Pollution source control.