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Gertsiuk M.M.
State University of Telecommunications, Kyiv

THE METHOD OF POTENTIALLY DANGEROUS OBJECTS DETERMINATION, INVOLVED INTO POLLUTANTS EMISSION INTO RIVER BED

Abstract*. This article describes a method of determination potentially dangerous objects, that could be involved in pollution based on the specified riverbed monitoring point.*

A way to solve the problem is considered through the filtration and sorting potentially dangerous objects list algorithm, which applies facts database, that allows to determine a possible rived bed potentially dangerous objects list.

There are a number on software models and methods, which allows to determine an approximate or exact rived pollutant spill point in case of determining dangerous and/or rising pollutant concentration level from below downstream. Such methods work by forecasting the situation, or direct analysis of the natural environment. These methods make it possible to find the point of toxic substances spillage on the riverbed. However, it is not possible to find the enterprise/factory that made such an emission. Such problem mostly solved using analytical way.

A method, which allows to determine a possible list of riverbed pollution potentially dangerous objects has been developed.

Current development validation is a series of test checks and simulations that show the correctness of the neural network.

A practical realization is implementation of the river pollution forecasting system in emergency situations informational system, to make a functionality, that determines a possible polluting object list based on the selected point of release of hazardous substances. Method can also be used with methods that allow to determine an approximate or exact rived pollutant spill point to find the enterprise/factory that made such an emission.

Key words: *water quality assessment, potentially dangerous object, mathematical modeling, filtration algorithm.*

Герцюк М.М.
Державний університет телекомунікацій, Київ

МЕТОДИКА ВИЗНАЧЕННЯ ПОТЕНЦІЙНО НЕБЕЗПЕЧНИХ ОБ'ЄКТІВ, ПРИЧАСНИХ ДО ВИКИДІВ ЗАБРУДНЮЮЧИХ РЕЧОВИН В РУСЛО РІЧКИ

Анотація*. У даній статті описано методику визначення потенційно небезпечних об'єктів, які можуть бути причетними до забруднення на основі вказаного руслового пункту моніторингу.*

Розглядається шлях вирішення проблеми за допомогою алгоритму фільтрації та сортування списку потенційно небезпечних об'єктів, який використовує базу фактів, що дозволяє визначити можливий перелік потенційно небезпечних об'єктів розривного русла.

Існує ряд програмних моделей і методів, які дозволяють визначити приблизну або точну точку розливу забруднюючих речовин у разі визначення небезпечного та/або підвищення рівня концентрації забруднюючих речовин знизу за течією. Такі методи працюють шляхом прогнозування ситуації або безпосереднього аналізу природного середовища. Ці методи дозволяють виявити місця розливу отруйних речовин на руслі річки. Проте знайти підприємство/завод, який здійснив такий викид, неможливо. Така проблема здебільшого вирішується аналітичним шляхом.

Розроблено методику, яка дозволяє визначити можливий перелік потенційно небезпечних об'єктів забруднення русла річок.

Валідація поточної розробки — це серія тестових перевірок і симуляцій, які показують коректність нейронної мережі.

Практичною реалізацією є впровадження інформаційної системи прогнозування забруднення річок у надзвичайних ситуаціях для створення функціональності, що визначає перелік можливих забруднюючих об'єктів на основі обраної точки викиду небезпечних речовин. Метод також можна використовувати з методами, які дозволяють визначити приблизну або точну точку розливу забруднюючих речовин, щоб знайти підприємство/фабрику, яка здійснила такий викид.

Ключові слова: *оцінка якості води, потенційно небезпечний об'єкт, математичне моделювання, алгоритм фільтрації.*

1. Introduction

A pollution source determining problem may arise cause of the dangerous level of concentration determining in the riverbed, which can cause an emergency. There are a number on software models and methods, which allows to determine an approximate or exact rived pollutant spill point in case of determining dangerous and/or rising pollutant concentration level from below downstream. Such methods work by forecasting the situation, or direct analysis of the natural environment. These methods make it possible to find the point of toxic substances spillage on the riverbed. However, it is not possible to find the enterprise/factory that made such an emission.

Such problem mostly solved using analytical way. This article describes the analytical method, which designed to help solve the problem.

2. Review

Methods, which allow to determine approximate, or exact pollution riverbed spill point are:

- modeling using such application as MONERIS, with preliminary data acquisition of chemical analysis;
- some river quality monitoring system that performs chemical analysis of the composition of the river's substances;
- conducting a few chemicals analyzes at some points upstream.

Biological methods are used, for river state determination, based on assessment basin flora and fauna state[1][2].

When conducting chemical analysis, an important indicator for making forecasts is the hydrochemical regime of river waters. Such a regime includes such a complex of factors as flow dynamics, climatic and natural conditions, intensity of economic activity, etc.

When using physical and chemical methods of prediction, it is important to determine such characteristics, as temperature, water transparency, substances concentration, ionic composition, mineralization, biogenic components content, organic substances, dissolved oxygen in water, various toxic substances, pH, etc [3]. Such complex of factors requires a riverbed and an adjacent natural and man-made ecosystem detailed analysis.

Thus, a process of determining the pollution emission point is complex enough. An equally important part is a possible factory determination, that could perform an emission, because a communication with a subject can give more data, when planning on emergency consequences liquidation. A definition of the emission subject requires a complex analysis of legal and technogenic factors. Such parts of analysis are information about chemical compounds (or a few chemical compounds), which were emitted, an availability of potentially dangerous objects near emission point and possibility of such an object making an emission. A list of such objects is a potentially dangerous objects registry [4], means object, which deals with substances (or compounds), which may represent a real thread in case of emergency.

A decision may be analysis of some factory possibility to become a pollutant when emergency happens, basing on several factors.

Considering the possible size of potentially dangerous objects list, or an analytical operations complexity, a necessity of method development, which allow to determine a list of most probable factories is relevant.

This method is considered, as analytical method, that may be interesting to environmental inspections, meteorological services, and other interested parties, as simplifying analytical calculations mechanism. It is designed to solve a very narrowly focused problem, when used with a narrowly focused method of forecasting a water pollution effect in emergencies. Similar methods that could solve certain problem with given restrictions were not found.

3. Objective

Most possible pollutant may be a factory, that is registered in potentially dangerous objects list. This factory can be located close to a pollution point or can have some relation. Also, this factory should deal with substances, that were spilled into riverbed. Certain point pollution frequency factor can play a secondary role.

A real set of factors, that can influence on pollution source determination may be different between locations. To solve the problem a method, based on a facts database, that is processed by some filtration algorithms have to be developed.

4. Research method

As previously mentioned, this method should contains of 2 parts: a facts database, that consists of necessary entities, and a filtration method, that process this database.

Database

Considering objective purposes and restrictions, such entities can be distinguished:

- potentially dangerous object;
- monitoring point;
- substance;
- emergency;

A factor, that describes an association between potentially dangerous and monitoring point is relation between these entities. Also, a fact of potentially dangerous object to be worked with certain substance describes by according relation. Finally, a factor of object became certain point pollution reason is relation between emergency and potentially dangerous object. Thus, such relations are being formed:

- potentially dangerous object – monitoring point relation;
- potentially dangerous object – substance relation;
- emergency – substance relation.

Described relations scheme is shown at fig. 1.

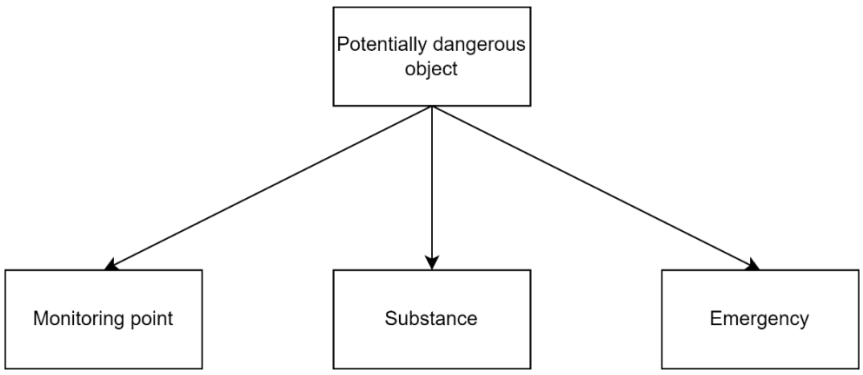

Fig. 1 Database relations scheme

Filtration and sorting algorithm

Current algorithm consists of the next steps:

1. potentially dangerous objects identification, linked by the fact with selected monitoring point;
2. a resulted list filtration, based on relation between objects list and dangerous substance;
3. a resulted list sorting by the sum of emergencies, that were caused by certain object;

A block-scheme of an algorithm is shown at fig. 2.

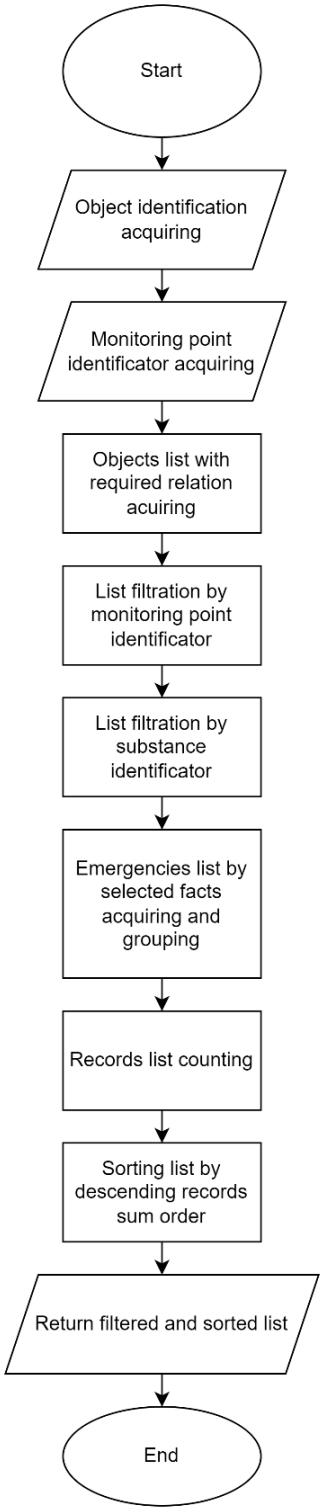

Fig. 2. A potentially dangerous objects list filtration algorithm block-scheme

Thus, a result is most probable potentially dangerous objects list, that are sorted by the count of rived bed pollutions in descending order.

Method validation

An algorithm validation is represented, as testing algorithm and performing some simulations with use of test database. The indicator of correctness is a comparison of expected results with derived ones. Algorithm test case series is shown at table 1.

Table 1.

Method validation test checks

№	Description	Expected result
1	Find possible potentially dangerous objects to a certain monitoring point and substance, that don't have a relation with potentially dangerous object and substance.	A list is empty.
2	Find possible potentially dangerous objects to a certain monitoring point and substance, that don't have a relation with potentially dangerous object.	A list is empty.
2	Find possible potentially dangerous objects to certain monitoring point, that don't have a relation with substance.	A list is empty.
3	Find possible potentially dangerous objects to a certain monitoring point, that don't have a relation with potentially dangerous object and substance.	A certain potentially dangerous objects list returned
4	Find possible potentially dangerous objects to a certain monitoring point, that have a few relations with potentially dangerous object and substance.	A potentially dangerous objects list returned
5	Find possible potentially dangerous objects to a certain monitoring point, that have a few relations with potentially dangerous object and substance. There are also several emergencies caused by potentially dangerous objects.	A potentially dangerous objects list is returned, keeping the order sorted by pollution frequency in descending order

Described list covers most cases, that could be performed with method.

Some test database, consists of nominal data should be created to perform a simulations. Such points have the next view:

- Monitoring points:
  - Point A
  - Point B
  - Point C
  - Point D
- Potentially dangerous objects:
  - Object 1
  - Object 2
  - Object 3
  - Object 4
  - Object 5
  - Object 6
  - Object 7
  - Object 8
- Substances:
  - Substance 1
  - Substance 2
  - Substance 3
  - Substance 4

- Substance 5
- Substance 6
- Substance 7
- Substance 8

Data relation is shown at table 2.

Table 2.

Test database relations

Monitoring point	**Potentially dangerous objects**	**Substance**
Point A	Object 1	Substance 1
		Substance 2
	Object 2	Substance 2
Point B	Object 3	Substance 3
		Substance 4
	Object 4	Substance 4
		Substance 5
	Object 5	Substance 5
Point C	Object 6	Substance 6
	Object 7	Substance 7
Point D	Object 8	Substance 8

Simulation cases are shown at table 3.

Table 3.

Simulations expected results

Input		**Result**
Point	**Substance**	**Possible expected objects**
Point A	-	-
Point B	Substance 2	-
Point B	Substance 3	Object 3
Point C	Substance 1	-
Point D	Substance 7	-
Point A	Substance 2	Object 1, Object 2

Acquired from algorithm testing results, which block diagram shown in Fig. 2 should be compared to the expected result. In case of coincidence an algorithm can be considered as validated. As can be seen, the calculated and expected results should be equal.

The sorting algorithm does not require validation, cause uses already existing valid sorting algorithms.

5. Conclusions

A method, which allows to determine a possible list of riverbed pollution potentially dangerous objects has been developed.

Current development validation is a test checks series and simulations, that shows the correctness of neural network.

A practical realization is implementation to the river pollution forecasting system in emergency situations informational system, to make a functionality, that determines a possible polluting object list based on the selected point of hazardous substances release. Method can also be used with methods, that allows to determine an approximate or exact rived pollutant spill point to find the enterprise/factory that made such an emission.

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