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PROBLEM OF EVALUATION OF POLLUTION OF THE ENVIRONMENT

Abstract. In this article, a major review of the methods of forecasting the state of the environment is done. Features of monitoring of different environments are considered. Also are reviewed existing ones monitoring systems and review of technologies for forecasting the state of the environment. Also, based on the review of methods and technologies, research objectives were developed that include improved methods for assessing environmental pollution, in particular the use of trend forecasting models.

Keywords: forecasting; monitoring; monitoring system; forecasting system; environment; environment; pollution of the environment

Introduction

Ensuring a balanced solution to the challenges of maintaining a favorable environment, applying new approaches to protecting the environment and respecting economic interests of both enterprises and the general population requires a focused scientific approach. Recently, there is a close relationship between the development of the economy and changes in the environment, the mutual influence of both the state of ecology on economic development and the results of economic activity on the state of the environment grows.

In the conditions of constant deterioration of the ecological situation, the scientific basis of anthropogenic influence management, multifactorial analysis of the formation of pollution level in combination with operational forecast of pollution level is the only effective way to solve the problem.

The study of environmental pollution includes the study of air pollution, pollution of underground and surface waters, soil contamination and impact on the biosphere. Each type of pollution requires its own models and methods of research and forecasting.

Metanalysis of sources shows a significant increase in the interest of the international community in the study of environmental pollution. Most research publications on environmental pollution were carried out after 2012 [1; 2]. The main purpose of these studies is the development of new methods for predicting pollution, the study of monitoring systems of the environment and the creation of models of dependencies between pollution factors. At the same time 60% of publications are devoted to forecasting, which confirms the prospects of this research direction.

The purpose of the article

The research objective is:

1. To conduct an overview of the technologies of monitoring the state of the environment.
2. To review the methods of forecasting the state of the environment.
3. To formulate, based on the review of methods and technologies, research objectives that include improvement of methods for assessing environmental pollution, in particular the use of trend forecasting models.

Presenting main material**An overview of the methods of forecasting the state of the environment**

There are three main classes of environmental forecasting: expert methods, modeling and extrapolation methods [3].

In the case when the data are not subject to formalization and structuring, it is urgent to use the methods of expert forecasting. These methods are based on a survey of experts and specialized processing of their predictive assessments of different situations.

For short-term forecasts, extrapolation methods are most often used. The basis of these methods is the study of data, their quantitative and qualitative analysis for previous periods of time. In cases where the ecological situation is not subject to abrupt changes, then the definition of trends in the dynamics of the situation for the next projected period.

Recently, the most widespread methods of modeling using computer technology have been acquired.

There are three basic approaches to forecasting the state of environmental pollution:

1. In papers [4 – 6] an approach based on image recognition using neural networks is used.

2. The possibility of applying methods based on regression analysis is shown in papers [7 – 10].

3. Authors [11; 12] use methods of analysis of time series, in particular, trend forecasting methods.

The analysis of publications shows that each of the proposed approaches has its advantages and disadvantages. In particular, methods using neural networks require significant computing power and time to conduct training. However, this method gives the most accurate predictions. Regression methods are simple from a computational point of view, but can only be used for short-term forecasts.

It is also necessary to take into account the explosive growth in the number of available data in the XXI century and their insufficient number in previous periods. It should also be noted that the prediction of contamination of various components of the environment requires its approaches.

Features of monitoring various environments

As a result of research studies [13], it has been shown that the process of surface water contamination is stationary. Also revealed a pronounced seasonal nature of the fluctuation of all environmental indicators. The existence of a correlation between pollution indicators and meteorological indicators, in particular temperature and precipitation, is undoubtedly a fact. Also, as a result of the study, there is a steady linear trend of growth both in Ukraine and in China [13; 14].

The peculiarity of atmospheric air pollution is its ability to spread pollutants spreading over huge distances and a significant dependence on weather conditions. Also, the atmosphere should be considered not only as a polluted environment, but also a mediator of anthropogenic pollution of other components of nature [15]. The problem of anthropogenic and technogenic pollution is particularly relevant in large cities with a large number of industrial enterprises, motor vehicles and the population [16].

The soil cover is a system that is less dynamic and more buffering than atmospheric air or reservoirs. One of the features of the soil is that it collects information about the processes and changes that occur, and therefore not only indicates the state of the environment at the given time, but also reflects past processes. Soils play a tread role in relation to natural waters, the atmosphere and vegetation. At the same time, performing protective functions, soils can become the main source of many chemicals that pollute natural waters and are dangerous to plants.

Redistribution of contaminations in the soil, and, consequently, adjacent to it environments (plants, water, air) is caused by the displacement of heavy metals on the

soil profile. Unlike organic chemical contaminants that decay with time, heavy metals can only be redistributed between components of the natural environment, and the periods of their decay may be many thousands of years [17].

The integrity of the system of soil-plant indicates the need for research and plants on the chemical impact on them of pollution. With regard to various pollutants, the protective capabilities of plants are uneven: lead, for example, is delayed already at the root, cadmium easily penetrates into ground organs. The nature of the absorption and accumulation of heavy metals by plants in conditions of pollution is determined by the level of contamination, the selectivity of plants, the influence of the associated emissions, which acidify or suspend the soil solution.

There is an undeniable link between the chemical composition of plants and the elemental composition of the medium, but the direct dependence of the content of heavy metals in the plants on soil content is often disturbed through the selective property of the plants to the accumulation of elements.

Monitoring systems for forecasting the state of the environment

For information on the dynamics of the content of harmful substances in the environment and drawing up maps of its pollution based on experimental data, it is necessary to carry out regular measurements of concentrations of pollutants in the air.

Automated information monitoring system (AISM) is a system with distributed organization of collection, processing of documentation and analysis of parameters of the environment. In any system of environmental monitoring AISM is a basic element and is intended for collection, processing, operational and long-term preservation of information, forecasting the state of the environment on its basis, as well as providing information to local information centers, management of enterprises and their units on environmental protection, other users of information. AISM provides the following functions:

- automatic measurement of controlled parameters;
- information gathering and its initial processing;
- control the deviation of the current values of these parameters from their control levels;
- displaying information and creating an operational environment;
- documenting information;
- forecasting changes in the environment;
- transfer of information to interested persons, adjacent systems.

At present, Ukraine has introduced an automated control system (ASC) "Ecoinspektor" [18]. This ASC is a comprehensive solution that includes hardware and software, which can be divided into three parts:

- software for mobile devices as well as sensors for monitoring the parameters of excitation, which performs the functions of registration of information and sampling and measurements carried out directly at the place of control;

- server support that performs data storage and processing functions;

- providing for a regular personal computer for other operations.

The basis of the system is a set of subsystems for processing data from one analyst department of the economic, regional, national level. The software of the national level has an additional set of subsystems for importing data from all analytical units into a single data bank, as well as for processing them and generating different kinds of reports.

The complex of subsystems for processing data of the analytical department of the ecological inspection consists of four subsystems:

- subsystem "Emissions" is intended for

accumulation, processing and analysis of data on emissions of stationary sources of air pollution;

- Subsystem "Soils and Waste", designed to accumulate, process and analyze data on waste pollution sources and soil contamination;

- subsystem "Water and discharges", intended for the accumulation, processing and analysis of data on sewage discharges and the state of natural waters, mainly superficial;

- subsystem of registration of information on sampling and measurements carried out directly at the place of control.

The results of the system can be seen in real time using the interactive environment monitoring map [19], which is available on the website of the Ministry of Ecology and Natural Resources of Ukraine (Fig. 1). Similar environmental monitoring systems operate around the world, in particular the air pollution monitoring system in China (Fig. 2), which became the basis of the international project The World Air Quality Index [20].

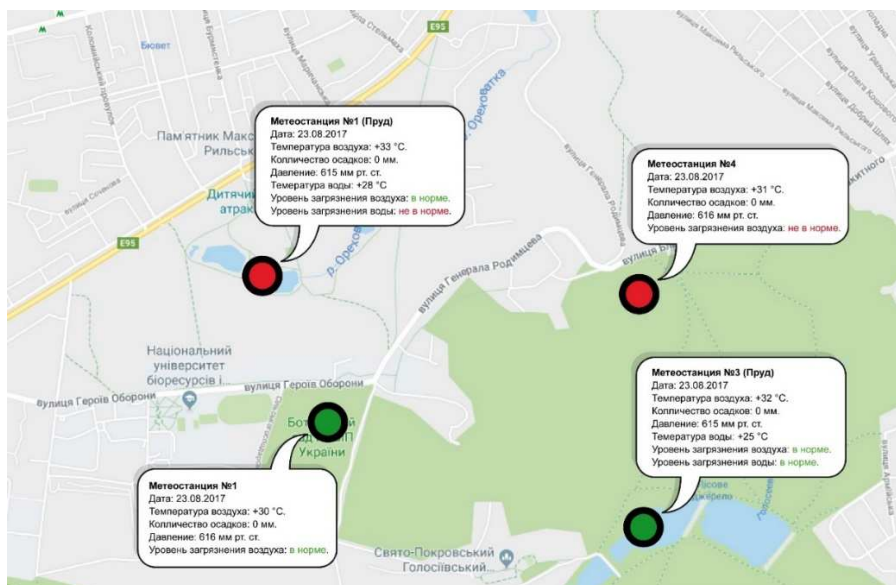


Figure 1 – An interactive map of environmental monitoring on the example of the Inspector Meteo system

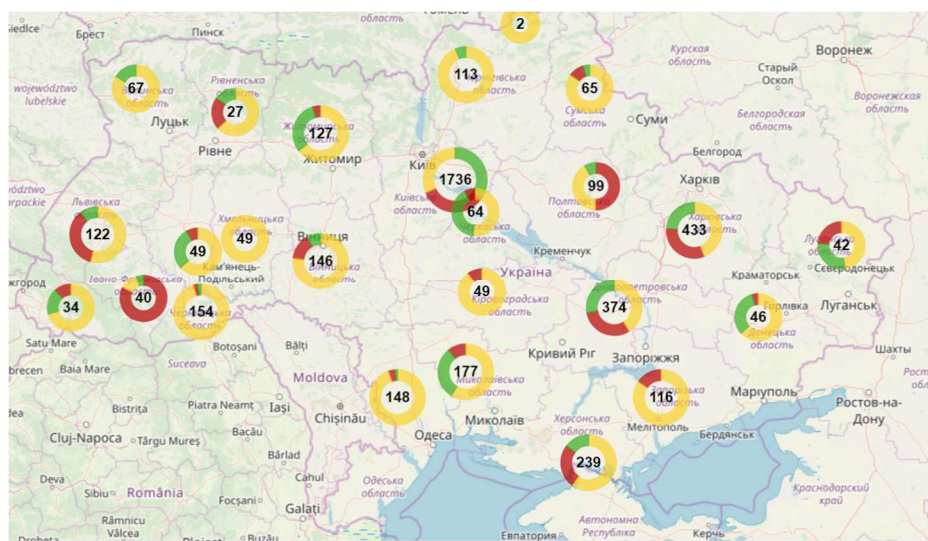


Figure 2 – Interactive map of monitoring environment of the environment

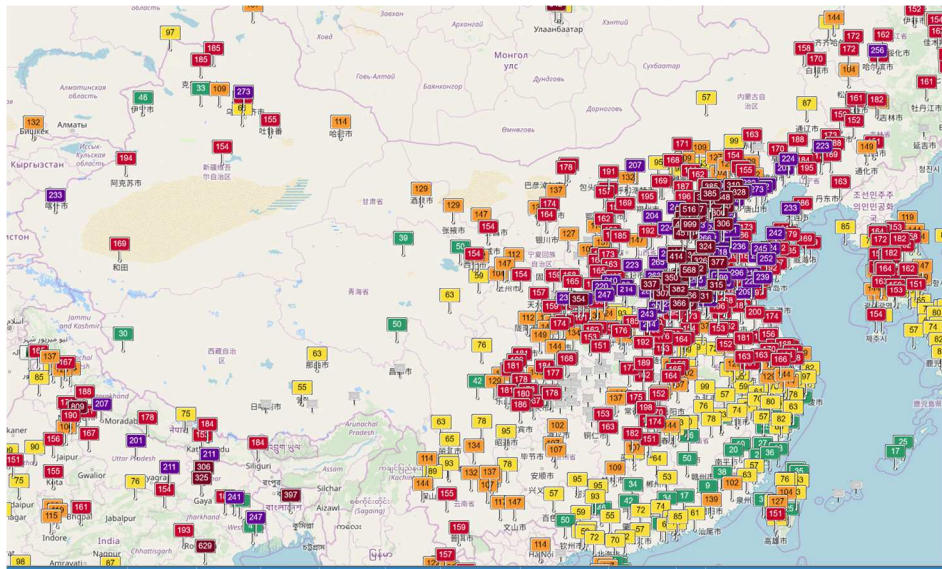


Figure 3 – Air Pollution in China: Real-Time Air Quality Index for Visual Map

The traditional approach to environmental monitoring includes the use of surveillance and centralized data processing points. Such an approach is not always economically feasible. Distributed networks are a concept in which individuals, groups and communities are actively involved in data collection to build a knowledge base. This is mainly done in two ways: using a large touch network and using available devices (such as mobile phones) to create custom networks. The positive experience of using such an approach is known in India and in Pakistan [21].

Conclusions and perspectives of further research

The review of environmental monitoring technologies and an overview of the methods of

forecasting the environment are reviewed. Based on the review of methods and technologies, research objectives are provided that improve the methods for assessing environmental pollution, in particular the use of trend forecasting models.

The urgent task is to develop methods. Thus, the perspective tasks of the study are:

1. Sustainable research of known methods.
2. Develop new and modify existing methods. The developed methods should take into account the needs of government agencies and individuals, groups and communities that are actively involved in data collection.
3. Integrate the developed methods into the system.
4. In the future it is planned to carry out the verification of the developed system and methods.

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ПРОБЛЕМА ОЦІНКИ ЗАБРУДНЕННЯ СЕРЕДОВИЩА

Анотація. Розглянуто задачу оцінювання забрудненості навколишнього середовища та прогнозування його стану. Розглянуто особливості моніторингу різних підсистем середовищ: атмосферного повітря, ґрунтів, поверхневих і ґрунтових вод та біосфери. Наведена класифікація методів прогнозування дає змогу здійснити раціональний підхід до їх вибору відповідно до задачі дослідження. Огляд технологій прогнозування стану навколишнього середовища, що базуються на розпізнаванні образів за допомогою нейромереж, на основі регресійного аналізу та трендових методів аналізу часових рядів показав наявність недоліків цих технологій. Виявлені особливості забруднення підсистем дають змогу здійснити вибір більш ефективних й точних методів прогнозування його стану. Існування сезонності, мала пластичність параметрів забруднення обґрунтовує доцільність застосування трендових методів прогнозування. Розглянуто автоматизовані інформаційні системи моніторингу, що функціонують в Україні, Китаї та міжнародні проекти моніторингу. Виділено інваріантну та варіативну складові їх структури. На основі здійсненого огляду методів прогнозування стану та технологій моніторингу сформовано задачу подальшого дослідження, яка полягає в покращенні методів оцінювання забрудненості навколишнього середовища, зокрема, шляхом застосування трендових моделей прогнозування.

Ключові слова: прогнозування; моніторинг; система моніторингу; система прогнозування; навколишнє середовище; стан навколишнього середовища; забрудненість навколишнього середовища

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