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HARDWARE OF THE INFORMATION SYSTEM FOR ENVIRONMENTAL POLLUTION MONITORING

Anthropogenic factors are significant sources of environmental pollution. Particularly acute pollution is a problem for countries with rapid industrial development. The effects of environmental pollution are not a local but a global problem, as they threaten the entire Earth. Developing information systems for monitoring environmental pollution is a very important task. The study deals with the consideration of the hardware component of the data acquisition subsystem of this system.

The environmental monitoring system receives data from many sensors that are connected to the network. The following three classes of sensor networks can be distinguished: static, public, and transport. Public networks are characterized by a higher density of sensors in the place of residence, and transport - along the transport routes. Inexpensive sensor technologies can significantly increase the density of air pollution data. This will improve impact assessments and increase community awareness of air pollution. Poor data quality remains a major challenge to the widespread adoption of low-cost sensor technologies. Unreliable data can mislead users and potentially have alarming consequences, such as reporting acceptable levels of air pollutants when they exceed the limits recognized as safe for human health. Bioelectronic noses used for monitoring water pollution are much more expensive and technologically sophisticated devices. It is advisable to use impact-based tools, such as biomarkers. The main problem with soil contamination research is to collect the need to collect soil samples and transport them to the laboratory.

Keywords: environmental pollution, monitoring, sensors, information system.

1. Introduction. Over the past few hundred years, human activity has changed the accounting of the Earth tremendously. Humanity has a significant impact on the state of the environment. Mostly this influence is negative from the point of view of other living beings as well as humans. Pollution is a change in the quality of the environment, with negative consequences. That is, anthropogenic factors are significant sources of pollution. Particularly acute pollution is a problem for countries with rapid industrial development. Often, capitalist corporations in the pursuit of profit forget about the interests of the people. But pollution cannot be considered a local threat. The effects of environmental pollution are threatening to all inhabitants of the Earth. The development of environmental pollution monitoring information systems is a very important task

2. The based material presentation. 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.

Figure 1 shows a graph of changes in the number of scientific publications devoted to the study of environmental pollution found in the online version of the Extended Scientific Citation Index (SCI-Expanded) for the period from 1991 to 2017. To search, the following keywords were used: "pollution", "pollutions", "polluted", "polluting", "pollutant", "pollutants", "pollute", "pollutes", "contamination", "contaminations", "contaminate", "contaminant", "contaminants", "contaminated", "contaminating", "estuary", "estuaries", "estuarius", "estuaria", "estuaries", "estuarial", "estuarian", and "estuarine".

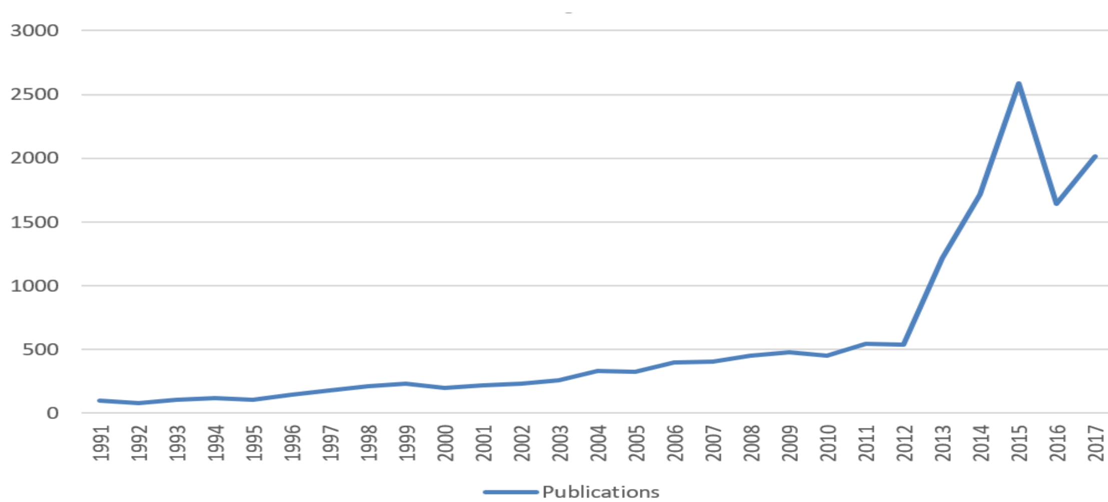

Fig. 1. Chart of changes in the number of scientific publications devoted to the study of environmental pollution.

The importance of the need for environmental research is also confirmed by the fact that governments in all leading countries spend an average of 0.8% of the budget of their countries (more than $ 600 billion) on environmental protection measures [3]. Among these, R & D spending is in 3rd place.

Pollution can be classified by pollutant and pollution environment. The study of each type of pollution requires the use of specific models and methods [4].

As described in [5], the environmental monitoring information system should include the following 4 subsystems:

1) Subsystems collecting information about the state of the environment. This subsystem includes hardware for measuring environmental performance, import APIs from other environmental monitoring systems, and methods for converting data to a single format used in the storage subsystem.
2) The storage and storage subsystem must be optimized to take account of the specifics of the data stored. This is where the DBMS is used to save and process the time series.

3) The environmental prediction subsystem includes forecasting models and methods for selecting which models to use in the particular case to achieve greater prediction accuracy.

4) The user interaction subsystem is one of the most important parts of the information system. It should provide information in a convenient form. These include the submission of reports, interactive maps of the state of the environment, recommendations for dangerous changes in environmental factors, such as exceeding the maximum permissible concentrations of certain pollutants. Therefore, the integration of this subsystem with GIS and mobile devices is relevant.

Consider the first subsystem in more detail. It is possible to distinguish hardware and software components. Let's take a closer look at the hardware component.

3. The hardware component of the subsystem of data collection of the environmental monitoring system. An important issue is the technical component of obtaining data on the state of the environment. At [6], three types of monitoring networks are classified based on sensor characteristics: Static Sensor Network (SSN), Community Sensor Network (CSN) and Vehicle Sensor Network (VSN). Also, comprehensive reviews and comparisons of these three types of sensor networks were conducted, which revealed their significant limitations. A real-time system with high spatio-temporal resolution can solve the problems of limited data availability and poor scalability of conventional pollution monitoring systems. The authors propose the concept of the Next Generation Air Pollution Monitoring System (TNGAPMS) based on the technology of deep perception, MicroElectroMechanical Systems (MEMS) and Wireless Sensor Network (WSN). However, and it has limitations in terms of the lack of data collection capability and the flexibility of the sensor network. Inexpensive sensor technologies can potentially revolutionize the scope of monitoring air pollution by providing data on the high density of air pollution. Such data can be used to complement traditional pollution monitoring, improve impact assessments and increase community awareness of air pollution. However, the quality of data remains a major problem that impedes the widespread adoption of low-cost sensor technology. Data misconduct can mislead users and potentially lead to disturbing effects, such as reporting acceptable levels of air pollutants when they exceed the limits recognized as safe for human health. The paper [Rai] addresses the issues of efficient deployment of inexpensive sensors while providing sufficient data quality. For large sensor networks, where routine calibration checks are inappropriate, statistical methods should be used to ensure data quality. There is a need for mathematical and statistical methods to calibrate gauges, detect malfunctions, and provide data quality.

Monitoring the status of water is a much more expensive and technologically complex process. So, in [8], bioelectronic nose is described for real-time water quality assessment. Built on the principle of human olfactory receptor on the basis of a single-walled carbon nanotube field-effect transistor (swCNT-FET). The bioelectronic nose is capable of selectively detecting Geosmin (GSM) and 2-methylisoborneol (MIB) at low concentrations. The main problem of this sensor is the need to use Carbon nanotube field-effect transistor.

The paper [9] describes nanomaterials used to monitor water quality, in particular nanomaterials used to detect traces of contaminants and pathogens. These nanomaterials include carbon nanotubes, magnetic nanoparticles, nanomaterials of noble metals and quantum dots.

The authors [10] state that the exact recognition of the sources and routes of transportation of various substances in the catchment area is of particular importance for any management activity. On a small to medium scale, this task can be solved by using online measurements with high temporal resolution. In this paper we propose an approach that uses mobile measurement stations to provide real-time monitoring of various parameters. There is a problem of combining commercially available sensors and those wet chemical analyzers into a new set.

A Water Framework Directive (WFD), 2000/60 / EC, has developed a technical report on Wernersson water monitoring tools. Potential impact-based tools (e.g. biomarkers and bioprocesses) that can be used in the context of various monitoring programs (surveillance, operational and investigative) that link the assessment of the chemical and environmental status are identified [11].

Levels of contamination with trace elements in surface soils can be estimated using soil analysis and leaching tests. However, a significant problem is the collection of soil samples and their transport to the laboratory. China has three national monitoring programs, MEP, MLR and the Ministry of Agriculture [12].

The study [13] proposes an alternative method for monitoring and evaluating the contamination of micronutrients on ground soils using lichens. Lichens grown on abandoned sections of mines and contaminated areas of southwest Japan and their substrates were analyzed using inductively coupled plasma-mass spectrometry and X-ray fluorescence spectrometry to find out the relationships between Cu, Zn, As and Pb in lichens and soils, including their absorption properties. The concentrations of these elements in lichens positively correlated with those that exist in the soil, regardless of the type of lichens, location, habitat or soil conditions. The analyzed lichens did not have either competitive or antagonistic properties in elemental absorption, which made them good biomonitors of contamination with trace elements in the surface soil. In the distribution maps of average concentrations of Cu, Zn, As and Pb in each selection area, almost all soil contamination of Cu, Zn and as was detected. Therefore, lichens can be used in practical applications for monitoring Cu, Zn, and as contamination in surface soils.

4. Conclusions and prospects for further research. The study addresses the important topic of building an information system for environmental monitoring. Particular attention is paid to the air, water and soil pollution monitoring hardware. Air pollution monitoring and forecasting have been found to be the most promising. First, air condition sensors are much cheaper. Secondly, rates are changing at a faster rate. Therefore, further research will be devoted to the development of an information system and models for predicting the state of the air. For large sensor networks where routine calibration checks are impractical, there is a need to develop mathematical and statistical methods for sensor calibration, fault detection, and data quality assurance.

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Хе Ю., Білощицький А. О. Апаратні засоби інформаційної системи моніторингу забруднення навколишнього середовища.

Антропогенні фактори є суттєвими джерелами забруднення навколишнього середовища. Особливо гострою проблемою забруднення є для країн, в яких відбувається швидкий розвиток індустрії. Наслідки забруднення навколишнього середовища є не локальною, а глобальною проблемою, адже вони загрожують всій Землі. Розробка інформаційних систем моніторингу забруднення навколишнього середовища є дуже актуальною задачею. Дослідження присвячене розгляду апаратної складової підсистеми збору даних цієї системи.

Система моніторингу стану навколишнього середовища отримує данні із багатьох датчиків, які поєднані в мережу. Можна виділити такі три класи мереж датчиків: статичні, громадські та транспортні. Громадські мережі характеризуються більшою щільністю розміщення датчиків в місці проживання людей, а транспортні – вздовж транспортних шляхів. Недорогі сенсорні технології можуть значно збільшити щільність даних про забруднення повітря. Це призведе до покращення оцінок впливу та підвищення обізнаності громади щодо забруднення повітря. Низька якість даних залишається основною проблемою, що перешкоджає широкому впровадженню недорогих сенсорних технологій. Ненадійність даних може ввести в оману користувачів і потенційно призвести до тривожних наслідків, таких як звітування про прийнятні рівні забруднювачів повітря, коли вони перевищують ліміти, визнані безпечними для здоров'я людини. Біоелектронні носи, які використовуються для моніторингу забруднення води є значно дорожчими і технологічно складнішими пристроями. Доцільним є використання інструментів на основі впливу, наприклад, біомаркерів, Основною проблемою дослідження забруднення ґрунтів є збір необхідність збору зразків ґрунту та його транспортування до лабораторії.

Ключові слова: забруднення навколишнього середовища, моніторинг, датчики, іфнормаційна система

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