Digital technologies in environmental protection and rational use of natural resources

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Abstract. The main directions and trends in the use of digital technologies in environmental practice are considered. The strategy adopted in the Russian Federation in the field of digital transformation of the ecology and environmental management industry is analyzed. Examples of the use of information methods and tools in environmental technologies are given. The used digital software products are grouped depending on the functionality embedded in them: information and legal systems; software products that implement calculation methods for assessing the impact on the natural environment; software designed for data processing and reporting of chemical analytical laboratories for environmental control and electronic cartographic data in the field of environmental protection. Particular attention is paid to the problems, risks and prospects for the development of information technologies in the field of environmental protection and rational use of natural resources.

1 Introduction

The modern "digital" revolution is an objective factor that has affected all aspects of the current stage of development of society, including the sphere of environmental safety. At the same time, it should be noted that digitalization of the environmental sphere is currently almost at the very beginning of its development [1-3].

Thus, according to available information, most of the technologies used are based mainly on the analysis of data obtained as a result of environmental monitoring, automation of decision-making in real time, forecasting of natural disasters, detection and identification of natural objects (living and non-living), as well as the collection and transmission of data from stationary and mobile observation points (as part of the development of the state observation network of the Federal Service for Hydrometeorology and Environmental Monitoring) [4, 5]. At the same time, the available data is often multifaceted and represents information from the websites of developers and government organizations.

2 Materials and methods

To write the work, information on digital tools used in the field of ecology and environmental management was used from various sources. The main emphasis was placed on data from

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software developer sites. The article also includes information provided on the websites of government organizations in the field of environmental protection at the federal and regional levels. Much attention is paid to the study of scientific works on this topic by other authors. During the work, information on the main stages of digitalization of the environmental sector, as well as modern programs used by structural units for environmental protection at enterprises, was analyzed and summarized.

3 Results and discussion

Automation of the environmental protection structure and related business processes began to actively develop in Russia since the early 90s of the last century. At the initial stages, the most popular programs were those aimed at automating individual processes, such as calculating fees for negative impacts on the environment, inventory of impact sources, and primary accounting in the field of air protection, water resources and waste management [6, 7, 8].

Pioneers in the 1990s–2000s were companies on the market in this area: Aviainstrument LLC (Environmental Safety), Logus Research and Production Enterprise (Kedr PC), KomEko LLC (Ecosphere series PC). The software products were mostly private in nature (not covered in the media) and were designed for a specific customer.

Over the past 20 years, the number of programs in the environmental automation market has increased several times and continues to grow, while the qualitative approach to automation has changed - from single-process to complex. This was mostly facilitated by government support and, in particular, the decree of the President of the Russian Federation "On the national development goals of the Russian Federation for the period until 2030", adopted in 2020, which especially highlights the importance of introducing modern digital approaches and information technologies in the field of ecology and environmental management.

Currently, in the software market in the field of environmental protection, three classes of solutions can be divided into three classes: highly specialized, self-written and ERP solutions [5, 6, 9].

Highly specialized solutions are designed to automate the execution of a specific task or business process. In such solutions, a chain of business processes can be completely built, taking into account their relationships within one subject area - environmental protection, while there is no integration with other subject areas. Often such software is used by companies that specialize in performing specific tasks, or by regulatory authorities. Examples of highly specialized software: environmental-legal system "EKOYURS", PC "Kedr", PC "EkoMaster", EcoReport, "ECO-Expert", EMEX, Rivo solutions.

Self-written solutions in terms of goals and implementation completely coincide with highly specialized solutions. The key difference is the genesis of these solutions: their appearance was initially initiated by the specific customer for whom the software was developed. A self-written solution is installed at the customer's enterprise; it is not tested at other enterprises. As a rule, information about such decisions is not publicly available.

ERP solutions are large systems that can be used to automate all enterprise management processes on a single platform. When automating a subject area based on an ERP solution, not only relationships within the area are built and implemented, but also integration scenarios with basic business functions (accounting and tax accounting, personnel management, dispatch control, financial management, equipment maintenance and repair management, etc.).

For environmental protection in the Russian Federation, integration scenarios with financial management and accounting are relevant for generating applications for financing

and “seamless” accounting entries (without data loss) based on data for calculating fees for negative environmental impacts.

Dispatcher control data is used by environmentalists to calculate pollutant emissions.

The financial component of activities, inspections and audits in the field of environmental protection is information that is maintained by related structural divisions of the enterprise in the financial management system.

Thus, ERP solutions allow one to create a single database, increase their transparency and legitimacy, and make it possible to access the same data from the perspective of different business processes.

Based on functionality, software for ecologists can be divided into several groups:

- information and legal systems that provide ecologists with the opportunity to familiarize themselves with federal and regional legislation in the field of environmental protection;
- software products that implement calculation methods for assessing the impact on the natural environment from sources of negative impact;
- software designed for data processing and reporting of chemical-analytical environmental control laboratories;
- software products that allow one to automate the process of preparing environmental reports for industrial enterprises and private entrepreneurs, namely reports on environmental payments and statistical reports;
- electronic cartographic data in ecology;
- software systems that allow territorial environmental services to register information on the user of natural resources, enter their quarterly and annual reports, maintain a database of permits for each enterprise, monitor the timeliness and completeness of payments by enterprises for environmental pollution, and so on;
- ecological passports of the regions.

It should be noted that the above classification is somewhat conventional, since in a few cases the programs of the 2nd, 3rd and 4th groups form a single complex and make it possible to solve the problems of automation of environmental services as a whole. However, dividing the software into functional groups will allow one to most fully assess the current state of affairs.

It is also impossible not to mention the ever-increasing information and consulting focus of environmental Internet resources. Many of them have become an active discussion platform, including on issues of industrial ecology.

3.1 Information and legal systems

The market of information and legal systems in Russia has been quite successfully mastered by two leaders: Consultant-PLUS and Garant, which have long and consistently provided their users with up-to-date information on federal and regional legislation. The vast majority of industrial enterprises are clients of one of the listed competing companies.

The main problem remains tracking those legislative acts that in one way or another relate to the environment, because information and legal systems contain a complete list of legislative acts. At the same time, it is often difficult to separate a document related to ecology from “general” documents. For example, the main financial document of the country - the annual budget - contains an article that regulates the value of the inflation coefficient used in calculating fees for environmental pollution for a given year. One can get acquainted with the most likely value of the coefficients for the next year (since 2006, two of them have been established, depending on the year the payment standard was established) after the publication of the draft budget, and its final value will be determined after the adoption of the Russian Federation budget for the next year.

3.2 Software products that implement calculation methods for assessing environmental impact

This type of program is widespread. Most often, they are used both when conducting an inventory of sources of pollutant emissions, and when calculating current emissions for a period. The implemented methods are usually quite simple and their calculation part contains one or two simple mathematical formulas, however, a large amount of reference information on tabular coefficients, the convenience of storing parameters of previously performed calculations, and the ability to create well-designed reports on completed calculations make this type of program very popular.

These programs are widely used by both design organizations and environmental specialists. However, they are still of greatest interest to developers. As practice shows, environmentalists of enterprises often do not use purchased programs. When working, it is enough for them to enter the conversion formulas themselves in MS Excel tables to obtain quarterly or annual emissions. The exception is usually programs for calculating emissions from boiler houses and vehicles.

The leader in the market for such programs is the company “Integral”, St. Petersburg. It presents a wide range of programs, has a network of dealers throughout Russia, and regularly conducts seminars for users, during which environmentalists can get acquainted with the programs and ask questions about their use.

The most famous program of the Integral company is the Ecologist program, which automates the calculation of the dispersion of emissions from stationary sources using the OND-86 methodology. This is a formally approved methodology that should be used when developing draft emission standards. This software is also primarily developed for designers and is extremely rarely used in enterprises.

The development of LiDa Eng. LLC also seems professional and interesting. Moscow city. “Ecological software complex “Rosa”. This complex is also aimed at the developer.

3.3 Software designed for data processing and reporting of chemical-analytical environmental control laboratories

The process of automating the work of environmental control laboratories is of significant interest. This software is designed to solve the following problems:

- input and storage of initial information;
- maintaining electronic laboratory journals and metrological processing of measurement results;
- intralaboratory control;
- automated document flow of the analytical laboratory.

The development of the High Voltage Research Institute at the Tomsk Polytechnic University of the “Analyst Chemist” workstation is quite widely known. This software product is multifunctional, but is aimed only at solving the problems of a chemical laboratory. Its disadvantage is the lack of connection with software for environmentalists, which generates quarterly and annual reporting.

The ComEco enterprise offers its own development - the Ecolaboratory program, which, in addition to implementing automated document flow in the analytical laboratory, also allows one to automatically transfer observation results to the program for the environmental service of the Ecosphere-Enterprise enterprise.

3.4 Software products designed to automate the document flow of an enterprise's environmental service

Software products designed for generating environmental reporting are represented quite widely on the Russian software market. A number of industrial enterprises have software products created by programmers working in IT departments at the enterprises. Most enterprises use developments from third-party companies. The developments of ZAO NPP Logus, which has been working in this market for many years, are widely known. There are a number of software products from Integral.

After the release of new payment reporting forms in the summer of 2006, many new developments appeared that successfully solved the problem of creating these reporting forms. Now the “Rus” program, developed by the Aviainstrument enterprise in Kirov, is also actively promoted on the market, as well as the Ecosphere-ENTERPRISE software product, developed by KomEko LLC, Perm.

Attention should be paid to the fact that the market for this software is free, therefore the right to choose a software product remains with the enterprise. If there are requirements for reporting electronically, users should contact the developer to promptly update previously purchased software products to generate the appropriate reporting files.

3.5 Electronic cartographic data in the field of environmental protection

Geoinformatics is currently a very popular topic. The clarity of providing information on a map makes it very popular in all areas of human activity related to spatial analysis.

Traditionally, one of the domestic developers of this kind of software is the Integral Company. The mapping block is supplied as an option when purchasing Ecologist 3. LiDa Eng. LLC has similar developments. If there is a database of sources of emissions of pollutants into the atmosphere in the program formats of these developers, the user can view or print a map diagram of the industrial site of the enterprise. If the enterprise already has an enterprise map in electronic format (Arc View, MapInfo), information layers can be automatically converted into program data formats. The listed software is most often accompanied by a map editor, but this process is very labor-intensive and the most attractive way is to use maps previously developed by specialists.

KomEko LLC also offers enterprises software that works with cartography. The “Ecosphere-Enterprise” program gives the user the opportunity to view the location of sources on a schematic map of the enterprise. Maps of the Arc View format, one of the most popular in the Russian Federation, are used as a cartographic “substrate”. Using a map, the user can obtain a variety of information about a territorial object.

For example, for an emission source, one can display information about its parameters and emission characteristics for the period. In addition, the map gives a possibility to familiarize with the location of production monitoring points and its results, and obtain the characteristics of any other territorial objects, information about which is stored in the program database.

4 Conclusion

This article briefly examines the most important issues related to the use of software in the field of environmental protection and environmental management. It should be noted that in order to increase the efficiency of the ecology and environmental management industry, it is necessary to develop information systems and digital platforms using modern means for accumulating, storing, analyzing and processing data, Internet of Things technologies and artificial intelligence, creating databases of a new generation of natural objects (ecosystems),

including subsoil, water bodies, forests, habitats of fauna (including using digital twin models).

Among the digital platforms planned for creation are environmental monitoring services with an integrated platform in the field of hydrometeorology, forestry management, subsoil use, waste management, water resources management, support and development of eco-tourism. Undoubtedly, Russian enterprises are at the beginning of the path of automation of environmental services. There is enormous potential for development in this area; the necessity and feasibility of this process as such is beyond doubt.

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