Program and economic assessment of environmental protection on the example of the Irkutsk region

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Abstract. The state policy in the field of environmental management is part of environmental policy. One of the national priorities designated by the Russian government is the rational and competent use of natural resources, i.e. improving the system for monitoring the quality of air, soil and water, as well as the formation of a high environmental culture in society. One of the most important socio-economic tasks, as we see, is to study the state of the natural environment, predict changes in its conditions, both in natural conditions and under the influence of anthropogenic factors, in order to predict possible risks. The study of the problem of assessing the state of the environment in combination with the use of information technologies is very promising, including when analyzing the impact of toxicants on the environment.

1. Introduction

Currently, there is an ecological paradox: on the one hand, it is necessary to preserve nature, on the other - humanity cannot abandon technologies that are dangerous to nature. At the same time, the material needs of people and the entire human society are unlimited and insatiable, and natural resources, as a means of meeting needs, are limited and rare, and the ability of nature to self-regulate and self-purify is not unlimited. Is there a way out of this? Economic and political aspects can influence the course of history. What will make humanity look at nature and its components from the other side, from the side of nature protection. The economy of nature management takes into account these contradictions and determines a rational relationship between the level of consumption, production development and environmental factors. It is this science that solves the issue of balanced economic development and environmental improvement [1].

In modern society, problems of environmental safety are subject to economic assessment – the damage caused to the territory, the population is evaluated to determine the level of environmental danger.

The quite a number of different libraries and application packages have been developed to support forecasting tasks in recent years. Currently, the most applicable software products on the market in the field of environmental protection are software products developed by Integral, United in the Ecologist series. The Ecologist series of programs solves a wide range of environmental problems, such as those...
related to the protection of the air basin, the safe disposal of industrial and consumer waste, etc. Much attention is paid to software development for solving regional problems [2].

The most widespread in the Russian Federation is the environmental monitoring system of the city (region) «Ecologist-city». The software «Analytical complex with unified software for environmental monitoring» implements modern technologies for monitoring the chemical composition of environmental objects, the results of which can be used to predict the state of the environment. However, among the developed software for predicting environmental changes, no complexes were found that allow for a comprehensive assessment of the natural environment under anthropogenic load.

The scientific and technological progress has led not only to the emergence of new effective technologies, but also to an increase in man-made pressure on nature, as well as to the consumption of non-renewable natural resources to a dangerous point. One of the most important socio-economic tasks is to study the natural environment and monitor its condition in order to predict possible risks of environmental and economic damage both in natural conditions and under the influence of anthropogenic factors.

2. Methods

For a considerable time, the risk of contamination and soil cover by various groups of toxicants, its consequences, and the relationship between man-made loads and soil stability are not given enough attention [3].

The soil resources are one of the most necessary prerequisites for ensuring life on Earth, and the soil itself, as an element of the biosphere, is designed to provide a biochemical environment for humans, animals and plants. It is intended as a scientific study to perform automated processing of the data obtained to identify potential risk zones. After all, only soil can provide full-fledged conditions for the production of food and animal feed.

The integral functions of the soil as a natural body are the accumulation of precipitation and regulation of water balance, the concentration of plant nutrition elements, and the formation and purity of underground water. Thus, this topic is very promising and useful.

The works of E. A. Musikhina present fairly complete data on the state of the natural environment of the Irkutsk region. The problems of assessment, accounting, elimination and prevention of environmental damage at the current level are considered. A deep philosophical justification of the problem is presented. A systematic analysis of the natural environment of the Irkutsk region is carried out, taking into account modern ideas about time and its properties. A detailed description of the anthropogenic impact on the soil of the Irkutsk region is given. The proposed technological scheme is based on spatial and temporal modeling of the assessment of anthropogenic impact on the natural environment and is applicable not only to the Siberian region, which is in urgent need of competent environmental assistance, but also to any other region [4].

3. Results

It is not possible to carry out a reliable assessment of the impact on the natural environment without the use of new and improved methods and software tools. Based on this approach [5], software packages (modules) were developed under the guidance of E. A. Musikhina:

- the «calculation of the interference density of anthropogenic impact on the soil cover of the Irkutsk region»;
- the «calculation of the interference density of anthropogenic impact on the soil cover of the Irkutsk region»;
- the «visualization of complex anthropogenic impact on the air environment of the Irkutsk region».

To perform automatic calculation and visualization of negative natural and man-made impacts on the state of the soil cover, the software solves the following tasks:
the systematization of data for calculating the risk of environmental and economic damage;
the organization of visual representation of the boundaries of anthropogenic impact on the soil cover using the spatio-temporal method;
the identification of areas of overlapping exposure from different types of toxicants;
the calculating the area of overlay zones;
the organization of the process of saving calculation results and exporting data to Microsoft Office (in particular, to MS Excel);
the creating a reference system that contains comprehensive information about the program and how to work with it, as well as methods for calculating the risk of environmental and economic damage;
the organization ability to work with material that contains theoretical bases of technology of complex assessment of the ecological capacity of the territory;
the software tool contains the ability to adapt to any other area of impact.

Based on the results of calculating the area of anthropogenic impact on the soil cover (density interference) of industrial centers in the Irkutsk region, an analysis of the interaction of changes in the soil cover of cities and natural zones can be performed using a technical tool figure 1.

![Figure 1](image)

Figure 1. The part of the city’s territory exposed to man-made loads (in the Irkutsk region).

The software product «Calculation of anthropogenic impact on water resources by mercury and chlorine» which implements the original method of automatic calculation of anthropogenic impact of industrial centers of the Irkutsk region on the water environment in places of direct discharge of wastewater, taking into account the spread of toxicants to the periphery of the surrounding space, allows you to calculate the risk of exposure to water resources by mercury and chlorine. The module «calculation of anthropogenic impact on water resources by chlorine and mercury» is characterized by the following functional specification:

• the storage of data on pollution of some rivers and reservoirs of the Irkutsk region with chlorine and mercury with the function of protection of permanent source data and with the function of authorized change of permanent source data;
• the calculation of damage according to the author’s method;
• the graphical representation of the impact on the water environment by year or by reservoir figure 2;
• the graphical representation of the damage to water environment and wastewater discharges on water bodies figure 3;
• the forecasting possible impacts on the aquatic environment.

Figure 2. The example of a function graph-damage by water bodies.

Figure 3. The visualization of areas of risk of anthropogenic impact on water resources in cities and industrial zones.

The mathematical basis of the developed software product is a structurally hierarchical spatial-temporal model of the impact of mining operations, taking into account the spread of influence from anthropogenic impact to the periphery of the surrounding space [3].

The program «Visualization of complex anthropogenic impact on the environment of the Irkutsk region» to render the complex anthropogenic impact on the environment of the territory of Irkutsk region. The program systematizes and structures data from various reports containing information about the state of the air environment for the period from 2006 to 2011 figure 4. The proposed data structure allows simultaneous access to source data and calculated indicators of air pollution. The main function of the program is to automatically plot graphs for visual analysis, including comparison of pollution levels in 13 cities of the Irkutsk region based on user-selected time intervals of the indicators of interest figure 5.

In addition, changes in parameters are visualized based on the analysis of dynamic series in order to
predict the state of the air environment of the city selected by the user for the next two-year time interval. The program is protected from the possibility of changing the results of the received assessment.

**Figure 4.** The histograms of total emissions of major pollutants into the atmosphere in Irkutsk from 2006 to 2011.

**Figure 5.** The histogram of the characteristics of a qualitative indicator of the state of the air environment in the cities of the Irkutsk region for 2011.
The total impact on the air environment (excluding spatial distribution) in Irkutsk increases from year to year. Having slowed down its growth in the period 2008-2009 which can be attributed to the global economic crisis, the indicator increases again in 2010. The linear forecast characterizes only the overall picture figure 6.

![Forecast for the total, Irkutsk](image)

**Figure 6.** The forecast schedule for the total air impact indicator Irkutsk.

Use to predict a function is impractical because this figure depends on many factors that are not included in the study (economic, social, technological, etc.) figure 7.

For systematization and processing of data according to calculations and estimates of ecological-economic risks was used the programming language Visual Basic for Applications for MS Excel, which will automate the visualization, and perform forecasting [6].

**4. Conclusion**

Speaking about the rational principles of territorial nature management, first of all, we mean the organization of an independent regional environmental service, the main activities of which are:

- the monitoring compliance by nature users (enterprises, organizations, individuals) with environmental requirements in accordance with current regulations;
• the mandatory environmental assessment of new construction projects and, in case of insufficient environmental reliability, a ban on their construction;
• the promoting entrepreneurship, contributing to the improvement of the environment, including through the social partnership [7].

To ensure that environmental management does not harm society, it is necessary to take into account certain conditions and factors that determine the rational use of natural resources. Thus, a necessary condition for the rational use of natural resources is the creation and implementation in all industries of new technological methods that prevent or reduce the scale of environmental pollution by industrial waste. The transition of enterprises to a closed cycle of water use, the use of solid waste from the main production for the needs of the accompanying one, and the installation of modern highly productive filters will significantly reduce the anthropogenic load on the natural environment of the territories. In mining areas, it is desirable, in addition to more complete extraction of minerals, to carry out reclamation of land disturbed during the development of the Deposit. In agriculture, the use of agrotechnical and land reclamation measures aimed at preserving the soil cover and increasing land fertility is required to maintain soil bonicity. Such a set of measures for the rational use of natural resources and protection of natural resources will simultaneously ensure the maintenance of an optimal environment for human life and health [8-9].

It is impossible to solve environmental problems on a global scale without changing the currently prevailing anthropocentric public environmental consciousness, which puts the person and his personal interests at the forefront to the detriment of the interests of the natural environment surrounding him. Therefore, the main role in the development of the process of ecological revival of Russia, in our opinion, belongs to environmental education, which should be considered in several aspects:

• the education of the population who knows the laws of ecology and the place of man in the environment and cares about the natural environment;
• the training of professional ecologists in various fields: ecology, environmental protection, environmental safety;
• the courses for managers on environmental safety at enterprises.

The updating and implementing the program will significantly simplify and speed up the processes of data processing and analysis, increase the reliability of mathematical calculations, and avoid the possible influence of someone’s interests in the decision-making process. Economic assessment of environmental damage allows you to develop measures to reduce it through funding from the Federal budget in part or in full.

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