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THEORETICAL AND EXPERIMENTAL SUBSTANTIATION OF CONSTRUCTION REGIONAL SECURITY MONITORING SYSTEMS TECHNOSPHERIC

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ABSTRACT

In the article theoretical and practical basis for forming regional safety monitoring systems of technosphere are stated. The authors' application systems theory concept reveals to the solution of important scientific and technical problem. In particular, it is established on the basis of the references and results analysis of research, that in the region it is logical to apply monitoring structure with chain of the adjusting feedback coupling and the block of the complex forecasting constructed with use of the synergy principle of elements to implementation of the purposes of status monitoring and perspective for health and safety forecasting. Application theoretical research results are given to the practice for providing comfortable accommodation conditions of the population in the urbanized territory.

Keywords: territorial monitoring system, integrated system analysis, synthesis, elements, synergy, energy forecasting, dynamics.

1. INTRODUCTION

Providing technosphere safety at the present economic development stage of the Russian Federation represents outstanding scientific and technical problem in connection with two fundamental processes [1]:

- Considerable equipment and the cars used aging in production on transport and other national economy branches (physical wear of many technical objects makes 70-80%);
- Technical and technological modernization structure of the country industry, which generates scientific uncertainty in the activity population safety.

The specified global factors cause the need for continuous control and perspective forecasting of the condition of production objects and habitat as within the territory (the city, area), and Russia in general.

One of the principal circumstances constraining comprehensive expected information application on development and systems deployment of providing technosphere safety is insufficient development of techniques and technologies to expeditious obtaining authentic data on current state of the production environment and its negative influence on the population, the territory flora and fauna, and also development dynamics of situation in the long term. These procedures realization often has a significant amount of shortcomings: inaccuracy and discrepancy of the obtained data, not - timeliness and analysis results irrelevance, etc. The specified Plan seems indicative analysis of forecasting parameters flooding developed space in the coal mines liquidation in the Russian Donbass [2]. Rather weak existing methods efficiency indicators of characteristics assessment of flooding technogenic processes, important for the region, developed the space connected with elimination of coal mines (Table-1) convincingly indicate the need of technosphere safety forecasting methods improvement.

Table-1. The forecasting parameters results of technogenic process by various methods.

Methods	Reliability of the forecast, %	Accuracy of determination of parameters, %
1. Expert estimates	50÷60	55÷60
2. Geological and surveying calculations	60÷65	55÷60
3. Geophysical control methods	65÷70	60÷70

Thus, there is number of theoretical and practical questions that decision will allow to provide reliable information as the basis for adoption of administrative decisions in the field of technosphere safety. In this article

authors state results of the research allowing to meet the available lack.

2. MATERIALS AND RESEARCH METHODS

The modern situation in the assessment sphere and perspective forecasting of the condition of technosphere safety is characterized by a variety of application of methods, technologies, organizational and technical structures. Depending on the purpose of research, used an expert, formalized and combined methods. (Figure-1)

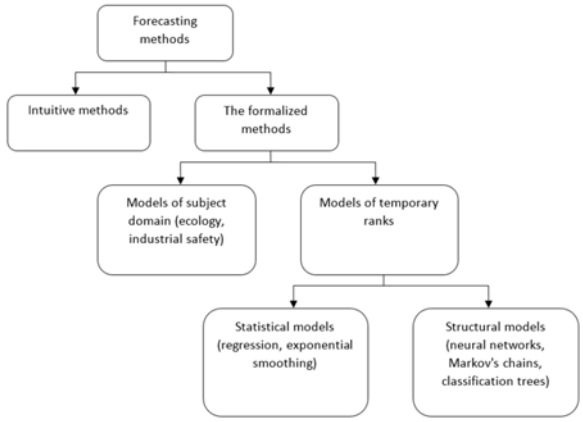

Figure-1. Forecasting methods classification.

In the last decade, scientific and technical progress in the area of information and computer technologies has served as powerful impulse for the mathematical forecasting methods introduction. Rosenberg G. S., Shitikova V. K. fundamental work is devoted to the matter and Brusilovsky P. M. "Ecological forecasting" [3]. In the monograph, theoretical and applied forecasting questions of temporary ecological systems dynamics are in detail considered by statistical analysis methods, and the main paradigms and are given the general methodology of ecological forecasting. With the use of concrete supervision examples over components of ecosystems working capacity and an efficiency of the classical mathematical analysis methods, the trend interpolation is estimated by polynomials, splines and models of regression. Predictors collectives provide the algorithms description for obtaining sophisticated forecasts.

Scientists and experts to forecasting with the use of nondestructive control methods of the state of the environment (MNK) give the close attention. The value of MNK consists that the technique of tool measurements is proved by the fundamental changing dependencies of physical fields characteristics of techno genic influences. In modern science, there is particular scientific direction and schools of sciences (for example, Shkuratnik V. L. are created, Yamshchikov V. S., etc.). In works of scientists' methods are stated means of receiving, processing and information interpretation [4-6]. In the context of the analysis, it is important to note the high reliability of forecasts and accuracy of determination of the parameters created based on research into nondestructive control methods.

The references analysis shows, that now the best technical capabilities for receiving reliable information about the technosphere safety systems monitoring the condition to what scientific articles and monographs testify [7-9, 12] possess. The specified thesis is confirmed by results of author's assessment on criteria (Table-2).

Table-2. The results of the analysis of possibilities of methods and forecasting systems.

The analyzed categories	Results (representation form)	Merits and demerits
1. Methods		
1.1. Expert (intuitive)	Judgment	Parameters of the forecast are defined by the experience of the expert.
1.2. Formalized (logical, mathematical)	Model	The projection parameters determined adequacy of the model and the real object
1.3. The combined methods	Judgment, model, generalization, representation	Advantage: high quality of the forecast. Shortcoming: high expenses
2. Organizational and technical measuring structures		
2.1. Field groups	Report	Low reliability and validity
2.2. Automatic sensors	Telemetric information	Narrow specialization of research, the complexity of changeover for a change of task.
2.3. Systems of monitoring	The developed report	High reliability of the forecast, efficiency of obtaining information

We offer the territorial system concept of technosphere safety monitoring (TSMTS). TSMTS is the integrated complex of logically interconnected scientific views in the sphere of health and safety, methodical recommendations, technical means providing full-scale control of security activity status,population region and perspective forecasting the dynamics of the situation.

The presented concept about TSMTS in the concentrated form expresses author's position on the problem improvement of the regional monitoring systems formation. Idea essence consists that only the described approach will ensure technosphere safety in the region at the level is international the recognized acceptable risk, because the complex of the scientific, methodical, technical and technological procedures coordinated in time and space is carried out.

At the heart of the monitoring systems creation, according to our version, the integrated system analysis and structure elements synthesis based on the multiple criteria choices of alternatives has to lie. In practice, this thesis is realized in the form of the expected system synthesis algorithm (Figure-2).

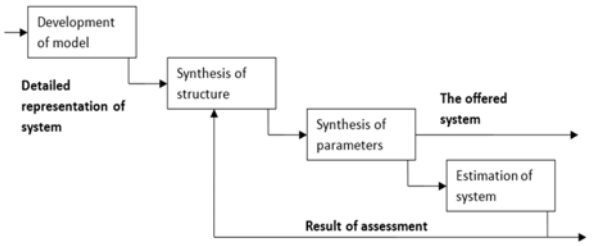

Figure-2. Synthesis algorithm of the expected system.

Use of the systems theory and the analysis is based on fundamental system properties - emergence and synergy [10]. The first property characterizes the ability of the system to possess analytical, methodically and technical parameters that have no the elements and subsystems making it.

The second situation is reflected in the transition from the separate forecasts train of the technosphere objects condition to the synthesis of the general dynamic forecast for the concrete urbanized territory (the settlement, the city, the region). It opens new opportunities. In this case, there is formally very difficult system, and we need to allocate from it the most important. System synthesis allows taking from the variables mass, which is necessary for the administrative decision adoption. Their coupling can carry out the optimum collective of forecasts separate system process development. The specified reception realization in practice of system forecasting causes three interconnected

tasks solutions: systems (processes) and assessment models parameters calculation of their quality for the corresponding criteria, aggregation techniques development, the synthesized forecast and assessment formation of its quality. Authors understand the development process of the general optimum forecast of development of the system of coupling (synthesis) of number of forecasts and being an initial forecasts function.

The similar collective forecast has to be constructed so that three principals were realized as a result: systematics, robustness, and eliminations. The first condition defines the systematic effect: there is completely more than its parts sum - the sophisticated forecast reliability has to be above reliability of any individual forecasts. This theoretical approach is confirmed by the authors' long-term forecasting practice within which it is established, that, as a rule, collective reliability forecasts is 10-15% higher, reliability of its initial components. The complex forecast scheme development is submitted in Figure-3.

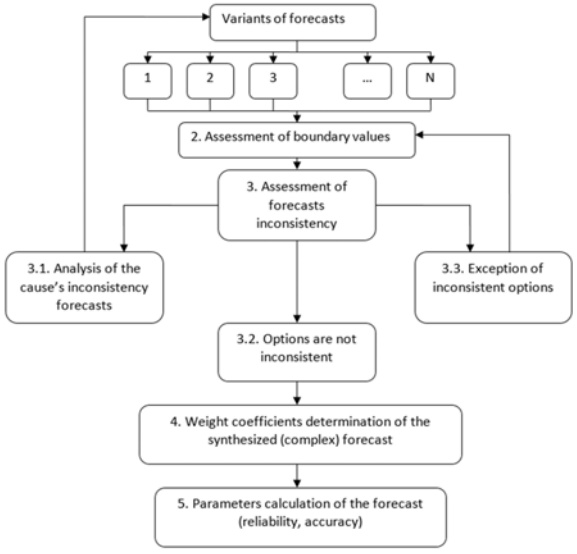

Figure-3. Complex (synthesized) forecast development.

In increase forecasting reliability, when using the complex forecast, the manifestation of synergetic effect consists. Secondly, sophisticated forecasts have to be robust, which small share errors of individual forecasts, should not have an impact on the total reliability of the collective expert opinion. The elimination condition defines the need for inclusion in the complex documents of the most various among themselves of individual forecasts. Thus, an important role is played by the right optimum version choice of the forecast both private set of alternatives and collective of forecasts. The process of optimization represents search of the best alternative to the use of the solution of the multicriteria problem of choice.

Thus, process analysis results of the theoretical and pilot studies logically brings to the thought to the need for the forecasting methodology development which cornerstone formation of a system of forecasting and synthesis of forecasts is.

System analysis application allowed to develop a methodology for a monitoring system, which is to form the basic theoretical principles, information requirements, design features, configuration and technical complex, methodical support package and control programs.

The primary paradigm of research methodology in the sphere of technosphere safety is expressed by the following logical formula:

SA + FO + GO,

where SA - the system analysis; FO - formalization of operations (judgments, conclusions); GO - global optimization.

The research conducted by each component of the given formula are directed to the solution of the general task: reliable assessment of condition of technosphere safety and reliable forecast of dynamics of development of situation in the long term. By means of formalization of operations, inclusion in the process of mathematical methods and information technologies is reached. Global Optimization by us is defined as the method allowing receiving at each stage of work of system results with the smallest material and technical inputs at simultaneous observance of the set conditions.

Within methodology number of the fundamental principles concerning both technologies of the current measurements, and perspective forecasting of the security status of the region is formulated. In particular, when performing practical works it is necessary to observe the principle of scientific validity and adequacy causing compliance of methods and means of forecasting to the studied object. The principle of continuity demands updating of forecasts for a measure of receipt of the new information on the forecasting object.

Here pertinently to point to one important aspect that is fundamentally distinguishing our project of system of monitoring from the other scientists development. It is about the function of the feedback used in radio engineering systems. The essence of our offer consists of continuous tracking of a condition of a technosphere safety. At the change of a real situation consequences of adverse impacts quickly pay off with the attraction of the constant working security model for the region and the correcting actions are developed. It is lawful to call such "active" monitoring system, meaning not only the existence of functions of supervision and an assessment, but also the forecast updating functions.

The described control system is in essence power efficient (energy saving), because due to realization in practice of the methodological principles, allows to carry

out first research in the optimum mode, saving time, means and finance for cycle of works; secondly, due to reliability of assessment and forecasting costs of elimination of negative consequences of production environment decrease factors influence.

The TSMTS main component is the expected and analytical Center (EAC) to which all primary information from peripheral measuring complexes comes. In essence, the structure represents the automated information system (AIS) which is created based on local computer network. The AIS problems are storage and information search about the condition of the environment, ecological situation and processes; continuous processing and the analysis of the obtained data; drawing up technosphere safety forecasts.

Follows from the tasks analysis, that organizationally automated information system has to consist of four main units, which is directed to the solution of one of the listed tasks (Figure-4).

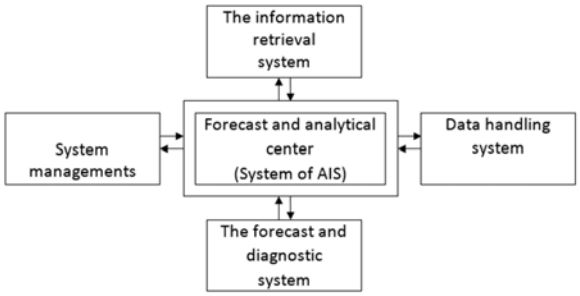

Figure-4. Automated information system flowchart.

The first AIS block is made by the automated information retrieval system (AIRS) which, in essence, represents the database. All primary ecologic-geophysical materials, which collect in a specialized databank come to AIPS on communication channels from production service, previously are processed, exposed to sorting and are used then in all subsequent operations and procedures for the analysis and forecasting. Furthermore, data stored in the bank reference materials. Besides, reference materials are stored in a databank. The second AIS block - the automated data processing system - carries out-processing and assessment of the arriving information. The AIS following block represents the automated expected and diagnostic system (AEDS). By means of this block, all issues on drawing up the current and perspective forecasts according to function chart of monitoring are resolved. The fourth AIS block is made by the automated control system that is carrying out the solution of tasks of management of processes and development of recommendations. All blocks are connected among themselves by information streams and form the uniform functioning system.

3. RESULTS AND DISCUSSIONS

Thus, in this article scientific and methodical approaches are stated to the regional system technosphere safety monitoring formation. The paradigm that is put forward by authors is proved by the use of fundamental provisions of the system analysis and confirmed by the practical methods development, means, and organizational monitoring structure.

As viability and system effectiveness confirmation in providing technosphere safety of the region serve results in introduction of the scientific ideas and technical sentences stated in work in practice of monitoring of processes of elimination of unpromising coal mines in the territory of the Russian Donbass. Administrative decisions development and adoption in the technology field and the liquidating works organization on 29 mine fields has allowed to avoid the environmental disasters connected with flooding of the developed space and the subsequent salinization of fertile soils and flooding of settlement territories. On the average forecasting reliability of the approach of negative ecological events and reliability of the predicted parameters of the situation is estimated at 85-90%.

The monitoring system constructed with the use of the scientific and methodical device in practice provides reliable forecasts that serve as scientific justification for the formation of a long-term sustainable development strategy.

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