КОМПЬЮТЕРНЫЕ ТЕХНОЛОГИИ В ФИЗИКЕ

NEW TECHNOLOGIES OF 2D AND 3D MODELING FOR ANALYSIS AND MANAGEMENT OF NATURAL RESOURCES

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For ensuring technological support of research and administrative activity in the sphere of environmental management, a specialized modular program complex was developed. The special attention in developing the program complex is focused on designing convenient and effective tools for creation and visualization of 2D and 3D models providing the solution of tasks of the analysis and management of natural resources.

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INTRODUCTION

The state scientific center of the Russian Federation VNIIgeosystem specializes in the development of scientific, methodical, and technological support of programs for the effective solution of problems of environmental management. More than 50 years we are engaged in the solution of applied tasks in the field of geological studying of a subsoil, mining, environmental protection; development of software products for implementation of similar projects; carrying out educational actions in these subject domains.

For ensuring technological support of research and administrative activity in the sphere of environmental management, we developed a specialized modular program complex. Its components provide realization of three main stages of any similar project:

— effective management of data and constructing of information and analytical systems of various complexity;

— complex analytical processing of spatial information and solution of expected and diagnostic tasks;

— operative visualization of data and results of researches among the Internet, creation of the situational centers of support of administrative decisions.

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DECISION MAKING PROCESS SUPPORT

The interesting technological decisions realized in this platform are the interface tools of the analysis of alternatives [1]. They allow one to formalize and present the analyzed problem in the form of a model — a hierarchical tree of possible alternatives of its decision — to range the existing alternatives on a complex of the subjective or objective preferences defined on the basis of initial indicators (standard or situational), and to choose the best solution of an objective. On the basis of the algorithmic providing the method of the hierarchical analysis of semistructured data is used, it includes various algorithms of numerical methods of the decision of the systems of equations, statistical methods and methods of situational modeling. This approach provides deep analysis of the situation which allows one to answer a number of questions, important at acceptance of a final decision, such as:

— what contribution on final result was made by each factor or criterion;

— how the resultant situation will change when entrance data, expert preferences, standard indicators change;

— what is necessary to change for improvement of a negative situation, and so on.

TOOLS FOR SPATIAL MODELING

The subsystem of spatial modeling, which is a part of the multipurpose geoinformation MGS server [2], provides the solution of other, not less important aspect of problems of support of decision-making in the sphere of territorial administration — creation and the analysis of the models provided with the spatial attached data. It includes the analysis of geographical factors of possible risks when planning new objects of social, economic, and production infrastructure, an assessment and the forecast of ecological and emergency situations on the basis of data of expeditious monitoring of a state of environment, choice of the most suitable arrangement of objects when elaborating strategy of development of the region.

The program and technological environment of spatial modeling provides creation of hierarchy of the factors defining the analyzed event or process, calculation of their spatial characteristics (intensity, usefulness, danger, etc.) with the use of semantic descriptions, the range scales and strict mathematical dependences, receiving the complex assessment of the analyzed properties reflecting a total picture of a state (the forecast, manifestation) events in the studied territory. The algorithmic device of the environment includes various dependences for calculation of one-, two-, and three-dimensional signs of natural processes and technogenic objects. Environment includes original means of processing of classification and dispersive models, and also the tools for management of system of expert preferences and gradation of the criteria assessment of factors of model and their derivative characteristics allowing one to count "on a time" the constructed model taking into account dynamics of development of a situation or the changed views of its assessment.

The main advantage of the above-mentioned means of support of decision-making is the use of integrated system approach to processing of diverse data, interesting algorithmic decisions, including, with the use of methods of the distributed calculations, and also possibility of full integration of these tools into geoinformation platform with providing not only local but also remote operating mode.

GIS FOR 2D AND 3D GEOLOGICAL MODELING

The applied geographic information system of GIS INTEGRO is developed for creation of the desktop GIS applications focused on research projects in the field of geological studying of a subsoil and the forecast of minerals. The system contains the tools of electronic cartography, provides a wide set of algorithms and the interface functions for carrying out mathematical, probabilistic, statistical, and heuristic data processing, a construction tool of two- and three-dimensional models of geodata on a complex of the data obtained from all levels of sounding of a terrestrial surface and deep structure [3].

The GIS INTEGRO tools provide all necessary stages of the geoinformation analysis:

— preparation of GIS projects of any complexity for information support of researches and performance of analytical data processing with the possibility to use libraries of reference symbols;

— work with the main raster and vector formats, and also specialized formats of submission of geologic-geophysical data;

— joint visualization of data of various spatial localizations (a well — a section — the card — volume); positioning and synchronization of cursors in several windows;

— vectorization on a raster in the semi-automatic mode and object editing with support of internal and interlayer topology;

— tools of cartographical binding of rasters and vector maps with big library of projections and data;

— programming on the built-in macrolanguage for formation of own algorithms and packages of processing.

The analytical part of GIS INTEGRO includes a full range of functions of the geoinformation analysis of vector and raster data and also has algorithmic providing for carrying out specialized processing: structural, textural, and morphological analysis of fields and images; the formal analysis of quality of data on completeness and consistency; recognition of images and division into districts on a set of spatial characteristics, etc.

On the basis of functionality of system, the specialized program and technological complexes configured for the solution of specific thematic objectives are developed: data processing of geophysical shootings, forecast of mineral deposits, geological mapping, etc. Interfaces of such complexes are focused on the subject expert and do not demand from the user profound knowledge of geoinformatics. The models of a structure of subsoil plots created during analytical researches can be published in shape web GIS of appendices with the use of functionality of MGS-framework which libraries provide effective 3D visualization of models of any complexity in the mode of remote access.

CONCLUSIONS

The presented program complex is widely used at scientific institutes, Russian and foreign geological companies, and business. As examples of the most interesting projects in the field of modeling of the natural processes and situations realized on its basis can be allocated:

— creation of monitoring system of dangerous petroleum wells, including model of support of decision-making on prime elimination of the most dangerous ones, from the point of view of impact on the environment;

— the analysis of natural and technological hazards for a number of regions of the Russian Federation with creation of computer Internet models for an assessment and the forecast of a situation;

— creation of three-dimensional models of a structure of crust on the basis of integration of geophysical, geological, and space data for the solution of tasks of the forecast of fields of solid minerals and hydrocarbons for territories of the Western and Eastern Siberia.

We have a lot of experience of its application in educational process in cooperation with the leading higher educational institutions of Russia and foreign countries. We are ready to offer partners producing of projects in the fields of environmental management and environmental protection and ready software solutions for implementation of the tasks.

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