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To the question of the estimation of the impact of transport streams on the ecosystems of roads

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Abstract. The article is devoted to solving the actual problem of assessing the environmental situation and the choice of options for further development of economic and economic activity of man without destroying the stability of the natural environment. This article discusses a system designed to support the analytical activities of forest enterprises. An assessment of the environmental situation in the area of operations of enterprises is presented. The choice of options for further development of human economic and economic activities is aimed at sustainable development without destroying the stability of the natural environment.

1. Introduction
Assessment of the environmental situation and the choice of options for the further development of the economic and economic activities of a person without destroying the stability of the natural environment (sustainable development) is currently an urgent task for enterprises of the country’s road complex. In the design and subsequent construction of roads, a comprehensive analysis of all environmental factors, including positive and negative ones, is necessary. In order to optimally lay the route of the future road, it is necessary to determine the need and cost of the protective structures of the future road. The road radically changes the existing system of surface runoff, the supply of adjacent water bodies, swamps, despite the properly organized drainage system. Uncontrolled concentration of runoff leads to soil erosion, clogging of its road-building components of the embankment. The violation of ecological balance leads to the most difficult to take into account the consequences of the construction of the latter \cite{1,2}.

2. Materials and methods
The main problems encountered in the development and justification of methods for solving these categories of tasks are the following:

– multi-extremes;
– the mutual influence of various factors that is non-linear;
– multicriteriality;
– dynamics;
– uncertainty of the initial information;
– non-formalizability of a complete description of the decision support process;
the need for dynamic design (or rolling planning).

At present, the overwhelming majority of information formation for decision-making support consists of multilevel integrated mathematical models, which represent a hierarchical control structure in a dynamic formulation.

It should be noted that most of the models, due to their sufficient complexity and, as a rule, high dimensionality, can be effectively solved only with the help of modern computing facilities - a computer. Therefore, if in the course of the subsequent presentation some procedures for performing manual calculations are considered, then this is done, firstly, for the simplest tasks that are far from the actual conditions, and, secondly, only for the purpose of deeper understanding and mastering the essence of the modeling process.

In each case, when implementing a model, it is convenient to deal with one criterion, and not with their set. Although at present the mathematical apparatus has been developed for solving some classes of multietremal problems, these solutions are quite complex and do not provide satisfactory results in all cases. This is due to the fact that for multicriteria problems, each of the criteria can reach an extremum for different values of controlled parameters. At the same time, it is unclear which of the values should be taken as a decision, and in many cases one has to agree on not always justified compromises, which are far from each individual optimum.

What should be done in such cases? Either, if it is possible to construct one combined method from several indicators using artificial methods, or from among all indicators taken for consideration, choose one that most fully reflects the essence of the problem being solved. The decision in this case is determined on the basis of this indicator, which becomes the criterion. The remaining indicators are not at all discarded: they are translated into the category of so-called constraints and are necessarily taken into account when solving the problem with the subsequent choice of the most appropriate option based on logical reasoning and comparative assessments [3].

3. Results and discussion
During the research it has been found that the system designed to support the analytical activities of enterprises should be divided into the following main elements:

1) bonding data (heaping) using tools that provide storage of heterogeneous information, maintaining identification directories;
2) data warehousing (data warehousing, DWH) and their labeling, convenient for describing and extracting various semantic groupings; the result DWH is represented as a multidimensional cube; each point inside corresponds to a set of semantically homogeneous elementary objects;
3) combining; combining data (combining) - creating a multidimensional space, where each coordinate corresponds to a set element or DWH cube point mapped to linearly ordered graded axes (only in this space relationships can be established and an analysis is based on metric proximity);
4) computed tomography or multidimensional analysis - allows you to construct images of complex relationships between data series, observe the dynamics of education and the development of anomalies;
5) reconnaissance data analysis (data mining) – “sifting” of information in order to find in it features and anomalies specified by the description of patterns or threshold values;
6) recovery of dependencies (forecasting) by empirical samples - mathematical processing of multidimensional observations (statistical and case analysis, assessment of the trend of time series, etc.);
7) decision making, planning and management (deciding - computer aided engineering) are displayed by a special network “resources - flows - events”.

Currently, the formation of information to support decision-making overwhelmingly constitutes a multi-level system. In this case, it is possible to distinguish three levels (Figure 1), differing in the methods of working with environmental information.

The upper level consists of software modules for decision-making support, the middle level is software that allows for a systematic analysis of environmental information, and the lower level is the modules for processing primary environmental information.
Figure 1. Formation of information to support decision-making concerning the state of the environment.

At the lower level of this system, various database management systems (DBMS) are used to store data on the state of the environment. They provide storage and quick retrieval of the necessary information (the steps of “gluing, storing and combining data”). For processing the results of observations, very different software products are used - spreadsheets, software packages such as “Statistica”, “Statgraphics”, “SPSS”, “SAS”, “Minitab”, “Systat”, “Stadia”, “SANY” “Mezosaurus” and many others. Such variety of software is due to the enormous number of diverse tasks of processing the results of observations of the state of the environment, obtained using local and remote methods of environmental monitoring. It was repeatedly noted that the formal application of statistical methods without a scrupulous analysis of their suitability for processing a particular type of data leads to completely unbelievable results. This is due to the extraordinary complexity of data processing tasks in the study of the natural environment. One of the solutions to this problem is the use of expert systems, in which, after analyzing the properties of the entered data, the most efficient algorithm for their processing is automatically selected.

At the middle level of the ecological information system, geographical information systems (GIS - ArcInfo, MapInfo, Ingeo, Manifold System, ObjectLand, GeoGraph, Map-2000, etc.) are used to analyze information on the state of the environment. Such systems, providing input, storage, updating, processing, analysis and visualization of all types of geographically related information, allow systematizing the issuance of such information to reduce the impact on the environment, realizing the experience gained by experts in this field [4].

It is important to note that today the existing multifunctional monitoring systems in the field of environmental safety do not fully meet the requirements for ensuring decision-making procedures in the field of protection and environmentally safe use of resources.

The rationale for the selection of multi-agent technology constitutes a system of environmental safety of geobiocoenosis in the area of operation of forest enterprises.

The multi-agent system (MAS) is a relatively new information technology focused on the joint use of scientific and technical achievements and advantages provided by ideas and methods, distributed databases, software tools supporting the theory of distribution and openness. MAS is sometimes defined as a more advanced class of dynamic expert systems that have the following basic capabilities [5]:
- distributed problem solving decomposed into parallel solvable subtasks with independent knowledge sources;
- the use of different strategies for the derivation of conclusions depending on the type of problem being solved;
- processing large amounts of information from databases.
The development of the MAC is due to many factors. First of all, it is the complexity of modern systems and organizations, which reaches such level that a centralized management in them becomes ineffective due to the presence of huge flows of information when too much time is spent on its transmission to the center and making decisions. The systems themselves are also becoming more and more complex and include a number of subsystems of different nature with different functional characteristics and interacting with various specialists, remote from each other. In addition, as complexity increases, the reliability of systems decreases, and it is increasingly difficult to formulate their adequate objective function.

Second, the tasks themselves or the systems being developed are sometimes heterogeneous and distributed: a) in space; b) in functional terms, since no single person can create a modern complex system alone.

Third, the MAC refers to open systems. That is, it has developed capabilities and means of adapting to environmental changes, including by modifying its structure and parameters. Thus, MAC will help to carry out distributed processing of a large amount of data and knowledge, to ensure a significant increase in the level of information and intellectual support, organization of processing knowledge about the subject area in order to increase the efficiency of the decision-making process at various levels of the hierarchy \[6\].

The relevance of the consideration of this class of systems is due to their ability to solve weakly structured tasks, which include problems of reducing environmental safety, characterized by the absence or complexity of formal decision algorithms by reproducing individual human activities \[7\]. They are accumulation and synthesis of knowledge, hypothesis development and forecast, decision making, their explanation, etc. Dynamism and distribution, polygamy are in the structural composition and multiply connected components of the structural units ecosystems:

1. The main complexity of the solution is associated with the use of weakly formalized knowledge of practitioners.
2. The input data (information on the amount of emissions into the environment, on the conditions of migration of pollutants, etc.) and knowledge about the subject area (emission standards, models of geo-ecosystems, etc.) are voluminous and fragmented.
3. The complexity of the geo-ecosystem at the “structural level”, which is determined by the number of elements of the system and the links between them.
4. There is no unique algorithmic solution to the problem.
5. The greater complexity of solving problems of environmental safety requires a complete analysis of a set of conditions and facts.

The capabilities of the MAC in solving the above problems are due to the principle of autonomy of individual parts of the program (agents), jointly functioning in a distributed system, where many interrelated processes take place simultaneously.

In fact, using the concept of “agent”, each development team defines its agent with a specific set of properties depending on the goals of development, the tasks to be solved, the technique of implementation, the criteria. As a result, within the framework of this direction, many types of agents appeared, for example: simple agent-mechanisms, whose task is to collect and transmit information; coordinating agents that interact with other agents; search agents that search packets of information and return some selected particles; training agents who form generalizing concepts based on the information received; decision-making agents who distribute tasks and draw conclusions based on limited information \[8, 9\].

It is advisable to use the following concept of an agent - an autonomous software object that is able to analyze the situation, make decisions, communicate with other agents, negotiate with each other to resolve conflicts that arise and then inform the system and the user about the results of their actions.

When creating an MAC, it is assumed that an individual agent can have only a partial view of the task and is able to solve only some of its subtasks. Therefore, to solve any complex problem, as a rule, interaction of agents is required, which is inseparable from the formation of the MAC. In MAC, tasks are distributed between agents, each of which is considered as a member of a group or organization \[10\].
For a successful solution of the tasks set before an intelligent agent (IA), it must have the following properties:

1) autonomy - relative independence from the environment. Therefore, each agent has a range of tasks, and he has little or no knowledge about what other agents are doing or how they do it. Each agent performs its independent part of the solution to the problem and either issues the actual result, or reports the result to other agents.

2) reactivity - the ability to perceive the state of the environment and changes in this state, as well as to take this information into account in its activities;

3) activity - the ability to generate goals and act in a rational way to achieve them;

4) basic knowledge - knowledge of the agent about the environment, including other agents. The level of intellectuality of a certain agent can be assessed as its ability to use old knowledge in new, perhaps unknown, previously unknown situations and problem areas, where the evaluated agent is acceptable as an active task solver;

5) beliefs - a variable part of basic knowledge that may vary over time;

6) communication - the property of agents to interact with each other. The overall, joint result of the MAC should be considered as something more than the sum of the individual contributions of each agent. As a result, it provides not only a differentiated assessment of individual elements of environmental impact on the quality of the Armed Forces, but also a general assessment.

Thus, the use of intelligent agents for solving problems of reducing the impact of forest transport processes on the environment is determined by their work opportunities mainly on dynamic problem areas:

- setting goals and plans to reduce the impact of forest transport processes on the environment. The goal is the desired state of the environment or its individual components;
- finding means for perceiving the state of the environment;
- working in a dynamic and open environment. In general, the complexity of the environment is not limited. At any time, the medium can change its state, which can affect the current plans of the agent;
- adjusting their plans in accordance with the possibility of their achievement in a dynamically changing environment. If at some point the current plan is unattainable, then a new plan is built;
- desire to make the most optimal decisions that are possible in a given situation;
- predicting the future state of the environment to build a workable plan and estimate the time available to achieve it.

4. Conclusions

Intellectual agents, possessing the above listed properties, developed internal representation of the external environment, are able to analyze the current environmental situation, draw conclusions from this, evaluate and predict changes in the environmental situation at the facilities identified by them (enterprise, locality, region and region). With this approach, each structural unit in the ecological-economic system (the administrative body of the environmental service, enterprises that have an impact on the environment) will be assigned a software agent. Thus, a set of interacting software agents will provide an adequate description of the real interaction of all the participants of the ecological system.

Without a multi-agent system capable of ensuring the interaction of environmental bodies and enterprises, the implementation of the proposed system of environmental safety management would be simply impossible. The use of MAC technology allows solving the problem of accumulation and storage of information, significantly reducing the time spent on information processing and ensuring decision-making at all hierarchical levels.

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