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Development of a conceptual GIS model to support management decision making

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Abstract. Making (identifying) the right decision, just making a decision is a choice from a variety of acceptable alternatives, depending on various factors, one in which the effective value is optimized. If a decision maker (DM) or a decision support system (DSS) can isolate a control parameter with unconditional preference that is relevant and most fully characterizing the properties of the system (process, object), it can be considered an objective function, subject to certain restrictive (by an acceptable set, resources) conditions. A similar problem is single-criterion, solved by classical methods of the decision theory. Decision-making tasks can be solved by a sequence of steps, a procedure: generation of acceptable options, selection of relevant criteria, search for an acceptable choice, its evaluation. In solving the problems of the decision support system (DSS), the decision-maker is usually involved - an expert, an analyst with competencies in the subject area and evaluating options, a consultant who helps to formulate acceptable options. The article discusses the development of a conceptual model of a geographic information system to support managerial decision-making. The basis of such GIS is an automated mapping system.

1. Introduction

At present, GIS technologies are being actively introduced in forestry, primarily in forest management, with the systematic updating of the forest fund information base and forest resources, maintaining a forest register, organizing monitoring, and monitoring forest exploitation. The rational use, reproduction, protection and increase of forest productivity is a difficult task when making managerial decisions, requiring a high level of information [1, 2].

When considering the process of making managerial decisions on the basis of the forecast system, it is first necessary to determine the initial data, as well as the goals and objectives that the decision-makers face, and the time horizon for the process under consideration. For the time horizon for which it is required to determine the values of the time series, the designation "lead time" is adopted. The tasks of making management decisions depending on the lead time can be divided into the following: operational management; medium-term management; strategic management.

To automate the process of making such decisions, the developed forecasting models are implemented in automated decision support systems. A separate class of such systems is the geographic information systems of decision support, which combine several functions at once.



GIS technologies are a powerful tool for ensuring sustainable development and integrated forest management; this is an additional reserve of time for professional analysis of likely scenarios, and concentration of efforts on solving the most complex problems requiring urgent solutions.

GIS includes a powerful set of software tools for creating and editing geographic databases for the purposes of spatial analysis, search, presentation and data management. These funds can be used to support a variety of forest management functions, wood supply strategies, forecasting the dynamics of stocks, choosing a logging system, conducting visual landscape analysis with overlay plots, resolving disputes regarding property boundaries, establishing boundaries of natural habitats, modeling forest fire propagation scenarios implementation of tactical planning to extinguish fires.

2. Methods and Materials

Modern approaches, design trends, development of integrated automated systems are based on various aspects of data integration, technology, technical, technological means:

- data integration based on a systematic approach and data model design methods, development of a universal information-logical model supporting data exchange protocols;
- integration of IP technologies, generation of optimal technological solutions for information processing using relevant methods - well-known and new, innovative ones being developed;
- integration of technical means, creation of distributed processing systems based on the concept of "open systems", CASE design.

The development of automated IT on the basis of the existing non-automated technology is unprofitable, inefficient. Novelty is determined by the efficiency and effective use of new automated technologies.

For a hardware platform, GIS is classified as professional and desktop. Classic GIS of a professional level, designed to function as part of workstations, networks. They support a ton of necessary applications, including cartographic material vectorization modules. Desktop GIS is a software product that has advanced tools for working with spatial information. Such GIS is PC-oriented, use by the mass user. They have a smaller set of functions than professional GIS, while they have a low price and are suitable for organizing jobs in more powerful GIS projects (multi-level type).

Universal GISs are characterized by openness, the ability to work with various data formats, the presence of a sufficiently powerful graphic editor, development tools, and the implementation of the necessary applications. This GIS class is the most used, such systems allow you to adapt to various tasks, increasing the capabilities of embedded specialized subsystems, modules. Special GISs are designed to solve a narrow, special range of tasks, parametrically customizable. Their main task is to control the course of processes, prevent unwanted situations, and automate workflow. GIS viewer is intended for visualization, printing of spatial information. As a rule, the viewer is not equipped with spatial analysis and modeling tools.

Basic concepts, hierarchy levels of an integrated information system - in figure 1. The highest level of concepts is an integrated system (an independent complex that processes the processing, presentation, exchange of information). The scheme includes various system levels, subsystems, tasks, processes. A system can be incomplete (partially processing, entering data, or using other systems during processing) and complete (implementing a full technological cycle). The full cycle includes processes:

- input (the ability to enter) of all types, types of data necessary to solve the tasks, information in this subject area;
- information processing, involving a set of tools, information, and interface tools available in the system (for solving the class of problems under consideration);
- output, presentation of data in output forms, according to the specifications of the problem being solved, without using other systems.

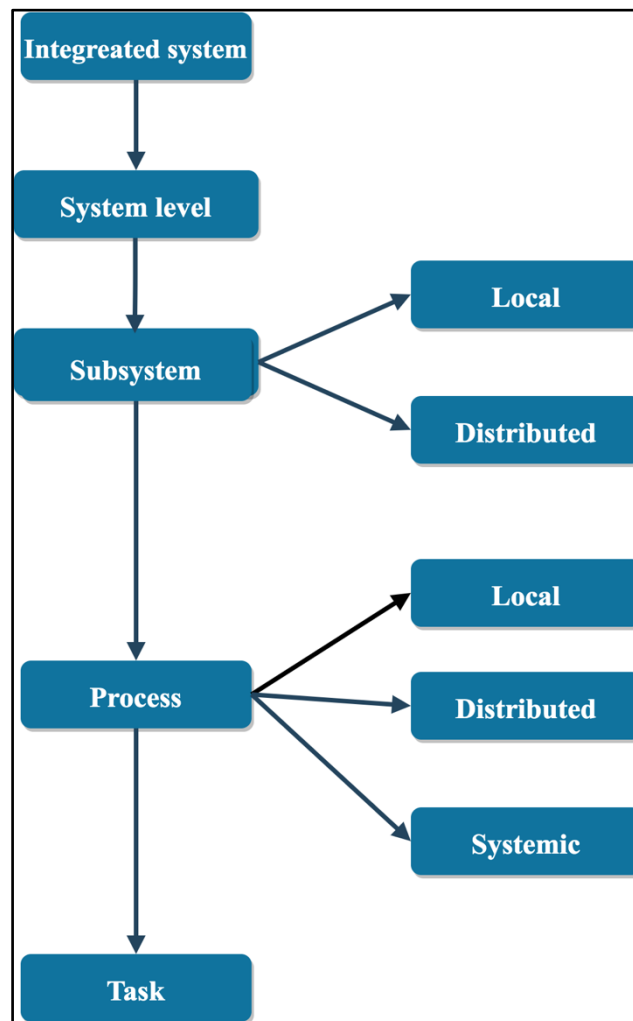


Figure 1. Integrated system structure.

The structure of a GIS is usually represented by a set of information layers. Layers are clusters of the same type of spatial objects, grouped by topic or objects within a certain territory and in the system of spatio-temporal and geo-coordinates common to layers.

3. Results and Discussion

Making (identifying) the right decision, just making a decision is a choice from a variety of acceptable alternatives, depending on various factors, one in which the effective value is optimized. If a decision maker (DM) or a decision support system (DSS) can isolate a control parameter with unconditional preference that is relevant and most fully characterizing the properties of the system (process, object), it can be considered an objective function, subject to certain restrictive (by an acceptable set, resources) conditions. A similar problem is single-criterion, solved by classical methods of the decision theory.

Decision problems can be solved by a sequence of steps, a procedure: generation of acceptable options, selection of relevant criteria, search for an acceptable choice, its evaluation. In solving the problems of DSS, the decision-maker is usually involved - an expert, an analyst with competencies in the subject area and evaluating options, a consultant who helps to formulate acceptable options.

When developing a geographic information system (GIS), DSS can be:

- representing relevant, fairly complete cartography, a description of the control object, necessary when making management decisions;

- creating a geographic information site in the Internet space, together with GIS, providing the possibility of operational processing and display of information.

It is possible to use cartographic dynamic information, if you use GIS / Database-technology. The demand for mass, accessibility to users was determined by the choice of Web-technologies.

GIS decision support allows you to solve the following functional tasks:

- collection, placement in the database of information on the parameters of the control object;
- import from the primary data database, display of the control object on the determining map;
- the formation of analytical maps with indicators of the state, evolution of the control object, their export to the Web site;
- formation, export to the website of analytical maps on personnel policy;
- formation, export to the website of analytical maps for financial and technical support of the facility;
- 3D-cartographic analysis, control, decision-making on spatial planning, management;
- Generation, printing of reports, layouts of maps.

At the stage of system design, a conceptual model of the analytical geographic information system was developed, which is implemented as a set of diagrams in UML notation, which allow describing the structure of the system, options for using the main actors, the business logic of the application, the nature and relationship between them, as well as the general architecture of the system.

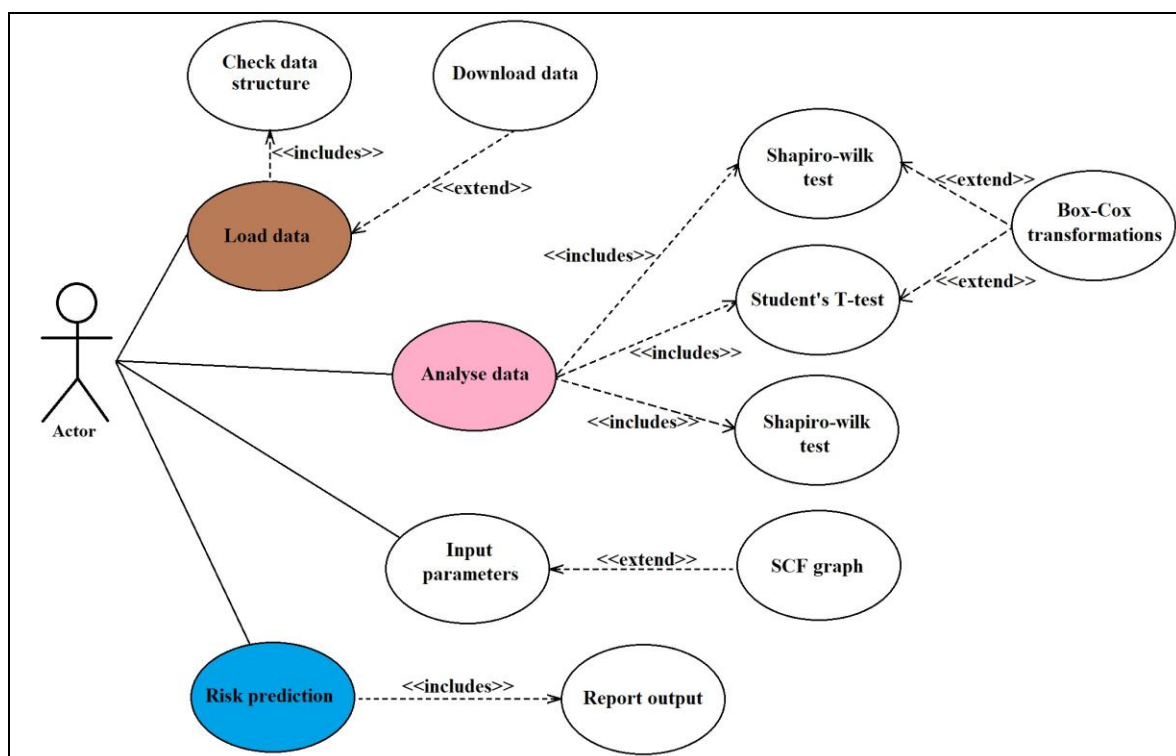


Figure 2. Use case diagram.

From the diagram it can be concluded that the user has 3 main use cases, which in turn can branch out and include additional options depending on the prevailing conditions.

To describe the real database entities, relationships and relationships between them in figure 3 presents the diagram "entity-relationship".

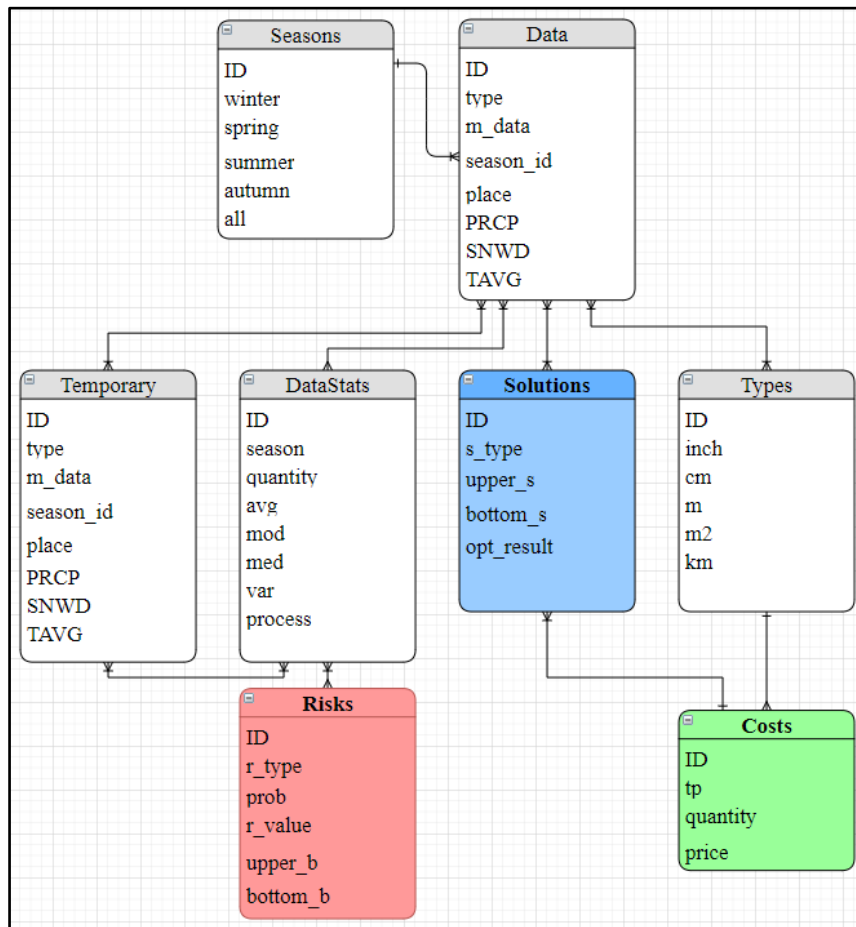


Figure 3. ER diagram.

As can be seen from the diagram for the designed system, a data model was developed with certain entities and properties due to the subject area and parameters of the mathematical model.

The model of the geographic information system is based on a client-server architecture, which is characterized by two interacting processes. The proposed architecture allows you to meet the following requirements:

- 1) reliability,
- 2) integrity,
- 3) scalability,
- 4) security,
- 5) flexibility.

In figure 4 presents a conceptual model of an analytical GIS for geo-risk assessment and 3 modules proposed by the author are identified that follow from the geo-risk assessment methodology based on controlled parameters.

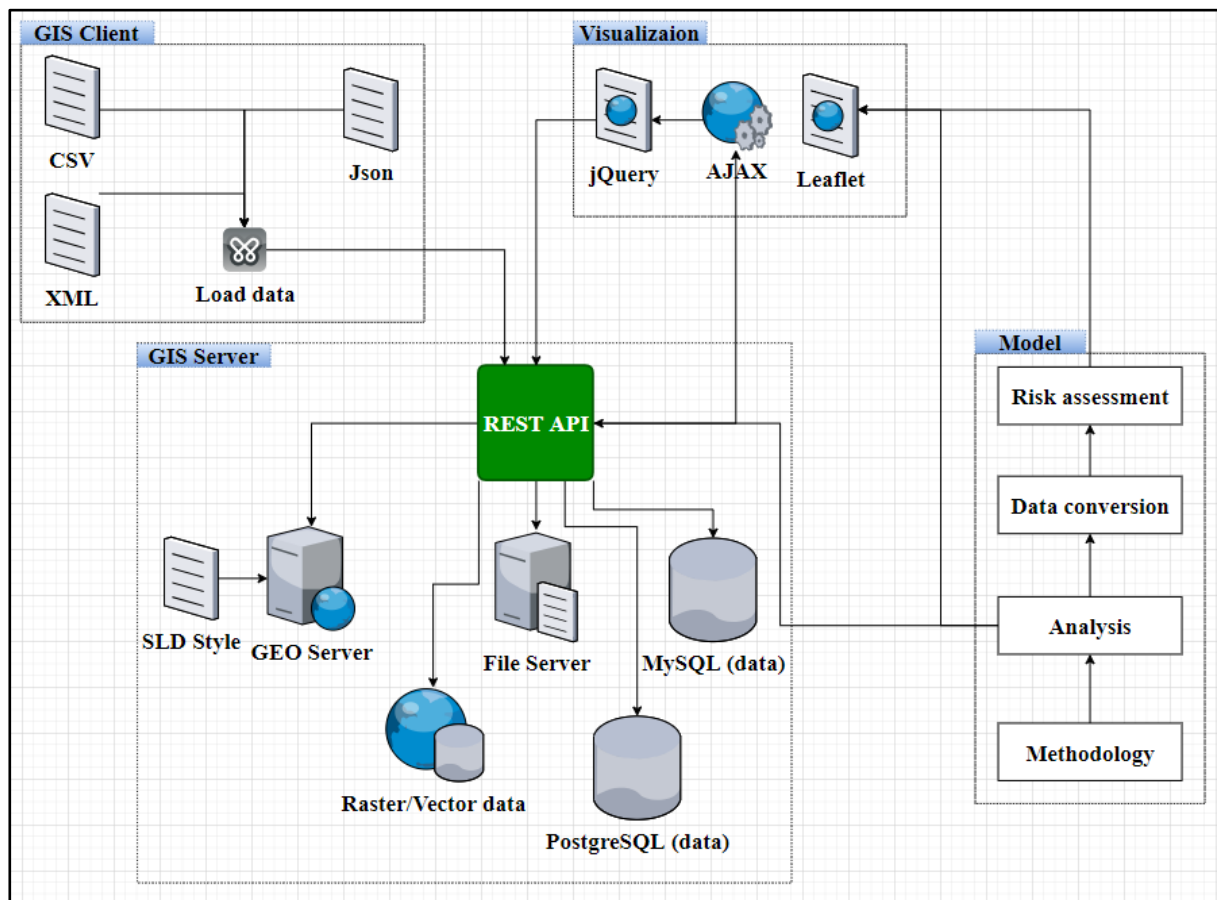


Figure 4. Conceptual model of analytical GIS geo-risk assessment.

4. Conclusion

The conceptual modeling of the system was carried out using the unified modeling language UML. As a result, a conceptual, logical and physical model of the information system was implemented, presented in the form of a set of diagrams in accordance with the chosen notation. In addition, an ER-model of the system and the topology of the database tables were built.

The developed conceptual model allows:

- Use data from most known formats.
- Store and use data on both risks and relative damage, while maintaining the relationships and relationships between them, thanks to the developed topology.
- Automate the process of assessing geo-risks based on a priori geodata [3, 4].

Implementation of the GIS conceptual model will increase the guarantee that the needs of all persons associated with forestry will be met. This is what makes it expedient to develop a GIS for strategic forest management planning, which consists in making forecasts for various forest management methods.

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