

# Metatechnology of designing a hierarchical modifiable-intersecting database for remote control of bioecological parameters

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**ABSTRACT.** A conceptual model of the BaikallIntelli platform for universal storage, input and processing of arbitrary spatio-temporal databases of bioecological parameters is proposed. Information technologies that allow implementing the basic functionality of the universal metamechanism of data systematization are considered. The platform mechanism has been tested on the example of entering quantitative data of different types of oligochaetes – one of the mass groups of invertebrates of Lake Baikal. Web-based user interface for the database “Spatial and temporal variability of oligochaete populations in the area of industrial wastewater discharge of the Baikal pulp and paper mill” are implemented, programming language JavaScript.

**Keywords:** BaikallIntelli, systematization of data, information storage systems, databases.

Correct use of mathematical models is coming down not only to the selection of parameters, but also requires checking their adequacy. The authors of the paper are faced with the disparity of available data and the lack of interconnection, poor structuring and insufficient adaptation for processing by modern mathematical methods, as well as outdated geoinformation technologies for linking data to certain geographical areas. In this regard, it became necessary to develop a comprehensive integration information platform. Its main purpose is to organize data collection and processing in accordance with current requirements for modern information systems and big data storage. Such a platform will allow researchers from various fields of natural Sciences to interact integration in order to study the mechanisms of anthropogenic impact on the lake. Lake Baikal, as well as to form the possibility of using modern mathematical, statistical and information methods. In addition, it can provide an impetus for attracting young professionals to solve environmental problems of lake conservation. Baikall as part of the educational process of Irkutsk state University and other universities.

The BaikallIntelli platform is a polymorphic universal metamechanism of data systematization that allows organizing storage, input and processing of arbitrary spatial and temporal databases with different table structure and composition of requisites for

creating mathematical models of the dynamics of lake Baikal hydrobiont populations using optimal control methods.

The concept mechanism of the BaikallIntelli platform includes the implementation of the following requirements: 1. Organization of data entry in the context of global directions and nested sections. 2. Tree-like architecture of sections within a direction by organizing a hierarchical data storage structure. 3. Custom table template schemes within the scientific section, described using JSON format. 4. Entering an arbitrary number of tables within the scientific section using a universal data storage mechanism in JSON. 5. Binds to a geographical location within a section and data collection table. 6. ability to describe a section/table using Markdown format. 7. System for accessing registered users to scientific data within the section. 8. Universal mechanism for storing data in JSON format. 9. Distributed model of REST-exchange between parts of the application.

The basic functionality of the universal metamechanism of data systematization is formed using the asynchronous Django 3.0 web framework (Django...), in Python, which uses the Model-View-Controller (MVC) design template (Kedrin and Kuzmin, 2011). The specified design pattern provides a separate description of the data model using the ORM (Object-Relational Mapping) technology, which connects

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physical database objects with object-relational selection, allowing you to operate with more complex abstractions in the server logic of the application.

A data model of the BaikallIntelli platform has been developed that provides server logic for storing user databases. It consists of the following models implemented at the ORM level of the application architecture: “ScienceTheme” is a data model designed to generate a list and describe global research directions (projects). “LocalScienceTheme” is a hierarchical data model designed to describe local scientific sections within the project associated with the research location and allows to organize a logical tree structure of user databases. “SchemaTableSection” is a data model that is intended for universal description of the schema for storing table data using JSON format. “DataScienceCollection” is a data model designed to describe tables of user databases of research data within a given schema for storing table data using the “SchemaTableSection” model. “JSONCollection” is a data model designed for storing individual records of user database tables within a specified schema for storing tab-personal data using JSON format.

Within the “LocalScienceTheme” model, a mechanism for creating a tree-like list of records based on the mptt (modified-preorder-tree-traversal) hierarchical data organization technology was implemented (Van Tulder, 2003) at the data model level. This mechanism allows you to: create a recursive hierarchical list at the level of parent-child relationships; recursively bypass the built data tree; add nodes to the data tree; update nodes in the data tree; and provide cascading deletion of tree branches and dependent data. At the level of the “SchemaTableSection” and “JSONCollection” models, a universal data storage mechanism is developed using the JSON format, which allows hierarchical description of data in the form of two data structures: A collection of key/value pairs that can be interpreted as a structure or dictionary at the level of programming languages. An ordered list of values that can be interpreted as an array, list, or sequence at the programming language level.

To test the technology of the BaikallIntelli platform, a database “Spatial and temporal variability of oligochaete populations in the area of industrial wastewater discharge from the Baikal pulp and paper mill” was entered (Arguchintsev et al., 2020). It is intended for storing and analyzing up-to-date information about the state of oligochaetes (small-scale worms) – a mass group of invertebrates of lake Baikal, as well as for calculating the mathematical model of dynamics of their populations using optimal control methods and statistical analysis tools. The section of the user database includes the materials of T. V. Akinshina, I. V. Lezinskaya (research Institute of biology at ISU, headed by prof. O. M. Kozhova), transferred to L. S. Kravtsova, who took part in the collection and processing of samples from her student years, and then led (until 1998) the conduct of expedition work on lake Baikal.

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