

# Application of Geographic Information Systems in the Republic of Yakutia

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**Abstract** – This article provides examples of the use of geographic information systems in the Republic of Sakha (Yakutia). The results of the creation of a GIS - project with ethnological expertise of the territories of traditional environmental management of indigenous peoples of the North are presented. Created by GIS - the project provides an opportunity to objectively assess the impact of industrial facilities on the environment. An extensive database of spatial data on the territories of traditional nature management has been formed. The result of this project was getting the first results of the assessment of the calculation of damage caused by industrial organizations to the territories of residence and economic activities of the small indigenous peoples of the North. Additionally, there is an example of the implementation of the Regional Geographic Information System of Territorial Planning (RGIS TP), which is intended to create a unified information environment and form a technological platform. The conclusion is made about the active development of geographic information systems in the Republic of Sakha (Yakutia).

**Keywords** – *geographic information system (GIS); ethnological expertise; Sakha Republic (Yakutia); RGIS TP.*

## I. INTRODUCTION

Information systems have recently made a big breakthrough in the field of data visualization in various areas of human activity, and statistics is no exception to this trend. Geographic information systems (GIS) add a living spatial dimension to a rectangular matrix of numbers of territorial statistics.

The Republic of Sakha (Yakutia) occupies a special place on the map of the Russian Federation, possessing rich reserves of natural resources - diamonds, gold, coal, natural gas, oil, wood

and is characterized by harsh natural and climatic conditions. It is necessary to analyze examples of the use of geographic information systems in the Republic of Sakha (Yakutia). Currently, in the republic, including in the territories of traditional environmental management (TTEM), large-scale development of mineral and fuel and energy resources is underway. Within the framework of industrial development, the rights and interests of the small indigenous peoples of the North are often affected, especially in connection with the construction of pipelines. In order to protect the rights to preserve the original environment and traditional way of life, the Federal Law "On Guarantees of the Rights of Indigenous Minorities of the Russian Federation" provides for compensation for losses caused to indigenous peoples as a result of damage to the original environment by their business activities of organizations of all forms. To compensate for damage to traditional nature use, it is necessary to conduct an ethnological examination with the determination of the extent of losses for users of land and other natural resources in places of traditional economic activities of the Indigenous Peoples, caused by industrial companies. For the ethnological examination to be complete, it is necessary to create a single information base of the territory of traditional nature management of the Republic of Sakha (Yakutia). [3]

The regional geographic information system of territorial planning of the Sakha Republic (Yakutia) as an integrated source of spatial data of the region is additionally analyzed in the studied subject of the Russian Federation. Thanks to this system, an archive of documents is formed at the municipal and regional levels, centralized access to spatial data and their visual analysis without the use of instrumental GIS is formulated for

decision-making, a basic component of the regional spatial data infrastructure is formed — the SDI catalog and geoportals, and the information resource of the authorities is formed executive power.

## II. METHODS AND MATERIALS

One of the tasks of the unified information database for ethnological expertise is the creation of a GIS project (a geographic information system). The main goal of the GIS-project with ethnological expertise is the creation of a tool - a spatial database for scientific research and generalization of the results of the impact of industrial objects on the original habitat of small peoples.

About 40 thousand people live on the territory of Yakutia. (4.2% of the population), which belong to the indigenous peoples of the North: Dolgans, Yukagirs, Chukchi, Evenks and Evens. Many of them are engaged in traditional economic activities (reindeer herding, fishing, hunting and gathering wild plants), which are the means of subsistence. [four]

Traditional nature management is the basis of the livelihoods and survival of indigenous peoples. There is a close relationship of small peoples with their environment, with the peculiarities of natural and climatic conditions and landscapes. The use of the natural resource potential of the natural landscape is the foundation of the livelihoods and livelihoods of the ethnic community. Also, an important role is played by environmental conditions that affect the ethnocultural methods of nature management.

The economic activity of indigenous peoples is based on the exploitation of pastures, commercial, soil resources by historically established methods, which allows for a long time to maintain its balanced development. The main areas of traditional nature management are confined to the places of residence of the indigenous peoples of the North.

Currently, according to the law of RS (Y) of July 13, 2006 N 370-3 N 755-III "On the territories of traditional nature use and traditional economic activities of the indigenous minorities of the North of the Sakha Republic (Yakutia)" 54 territories of the traditional nature use as local and republican are formed values with a total area of 169.25 million hectares. [6]

In Yakutia, the Law of the Republic of Sakha (Yakutia) "On Ethnological Expertise" was adopted, and the rules for conducting ethnological expertise were approved. Existing legal norms at the federal level prescribe the participation of the public and representatives of small indigenous peoples in decision-making about the use of lands of their traditional residence and economic activities and mandatory compensation for losses to traditional environmental management. The concept of ethnological expertise was first introduced by the Federal Law of April 30, 1999 No. 82-Φ3 "On guarantees of the rights of indigenous minorities of the Russian Federation". Ethnological expertise is a scientific study of the influence of changes in the original habitat of small peoples and the socio-cultural situation on the development of an ethnos (Article 1, paragraph 6).

Order No. 565 of the Ministry of Regional Development of the Russian Federation of December 9, 2009 approved the

methodology for calculating the size of losses in traditional sectors of the indigenous peoples' economy "On the approval of the methodology for calculating the amount of losses caused to associations of indigenous peoples of the North and Siberia in the Far East of the Russian Federation as a result of economic and other activities organizations of all forms of ownership and individuals in the places of traditional residence and traditional economic activities of the indigenous people The Russian Federation." This methodology for calculating the amount of damages caused to associations of small indigenous peoples of the North, Siberia and the Far East was developed in accordance with federal laws and regulatory legal acts in order to ensure the rights of small indigenous peoples of the North, Siberia and the Far East of the Russian Federation to protect their original habitat, traditional way of life, management and crafts, including "Guidelines for assessing the quality of land that is the original habitat of indigenous approved by the Head of the Roscadast of Russia on March 2, 2004. [2]

According to this methodology, various requirements for the implementation of land quality assessment in 5 areas are highlighted: landscape-ecological zoning; geobotanical survey; valuation of land suitable for reindeer pasture use; valuation of land used for hunting and fishing grounds; valuation of lands used for wild plants, which require specialists from different scientific fields. To carry out land assessment, an important role is the creation of a landscape-ecological map of 1: 100000 scale, which will be the basis for a complex of works on resource assessment of land quality. Such work requires a modern approach to assessing the quality of land and the basis of such research should be based on the use of geographic information systems (GIS). [3]

Geographic information system (GIS), designed for the collection, storage, processing, display and distribution of spatial-coordinated data, including spatial analysis, mapping and modeling, classification, assessment, zoning of the territory, etc.

GIS is widely used in various fields and areas of territorial activity: in cadastres (land, water, forest, real estate, etc.); in municipal government; in the design, construction, operation of facilities; in geological studies; in the development and operation of various fields; in agriculture, forestry and water management; in environmental management and environmental monitoring, etc.

At the present level of development, the role of GIS is not limited to the collection, storage and transmission of information. Modern GIS become a tool for modeling natural, economic, social processes and situations, tracking their relationships, interactions, forecasting development in space and time, obtaining new qualitative and quantitative information, and most importantly - a means of providing (supporting) managerial decision-making and presenting conclusions.

GIS makes it possible to build based on the created spatial databases thematic maps reflecting the current state, the study of the dynamics of changes in space and time, modeling the development of the situation, obtaining comprehensive assessments, building various graphs, tables and charts. The use of GIS makes it possible to reliably calculate the damage, since

the geographically related information of various thematic layers is the basis for the calculation.

ArcGIS 10.4 from ESRI was selected as the basic GIS software platform for a GIS project with ethnological expertise. ArcGIS is a complete system that allows you to collect, organize, manage, analyze, share, and distribute geographic information. [7]

To perform ethnological expertise will require not only an assessment of the quality of the land, but other data characterizing the territory of the study: climatic and socio-economic data. To perform an impact assessment on the ethnological environment, a common information database should be created on the natural, socio-economic and demographic characteristics of the territory in which the GIS is one of the branches for conducting a study.

The main stages of building a GIS - project with ethnological expertise:

- The choice of a logical structure and the creation of a spatial database based on materials, the creation of a cartographic basis;
- Formation of a database of boundaries of nomadic tribal communities, territories of traditional nature use;
- Compilation of a database of industrial facilities in the study areas for which calculations of the calculation of losses will be made;
- Formation of a database of socio-economic indicators of the territory;
- Performance of land quality assessment in 5 directions;
- Creation of thematic maps for nomadic tribal communities and territories of traditional nature use.

An important step was the formation of a spatial database, which created thematic maps of land valuation in different directions. Based on the created thematic maps, zones of influence of industrial facilities were identified using the analytical tools of the ArcGIS program.

Based on the use of GIS, the first results of the assessment of the damage caused by industrial organizations were obtained. A spatial database of updated boundaries of nomadic tribal communities, territories of traditional nature use has been created and geobotanical maps with descriptions have been compiled.

Further, it is worth noting the regional geographic information system of territorial planning of the Republic of Sakha (Yakutia) as a combined source of spatial data of the region. In 2014, a group of companies "NEOLANT" commissioned by the Ministry of Architecture and Construction Complex of the Republic of Sakha (Yakutia) was designed and implemented in the volume of the first phase of the Regional Geographic Information System of Territorial Planning (RGIS TP). [4]

The regional system of territorial planning is designed to solve a whole range of tasks, the most important of which are:

- Creation of a unified information environment that ensures the use of relevant and consistent information in the development and decision-making in the area of territorial development planning at regional and municipal authorities, automating business processes for preparing and updating regional planning documents, and providing a single point of access to urban planning documentation to organizations and citizens;
- Formation of a technological platform for the implementation of a unified source of spatial data - a regional element of the spatial data infrastructure, which allows to accumulate various sources of cartographic information, including distributed cartographic resources of ministries and departments at the level of the constituent entity of the Russian Federation, as well as local governments.

The regional geo-information system of territorial planning has been developed in accordance with the requirements of the current normative legal acts in the field of urban planning. The system contains a set of standard modules for deploying information systems of urban planning (IS OGD) in the bodies of architecture of municipal formations and their integration with the regional level information system.

As can be seen from the diagram presented in Fig. 1, the main components of the RGIS TP located at the regional level are:

- a central repository containing a section of operational data (spatial planning documents and information about them, System settings and directories, a catalog of spatial data, templates of report forms, etc.) and a section of spatial data (graphic parts of TP documents);
- instrumental GIS, consisting of the server part and the user application;
- open data web portal (data publishing subsystem, open planning data territorial portal);
- User's automated workplace that implements the user application subsystem.

At the municipal level, there are two modes of operation of the System: the mode of direct access to the central repository of the RGIS TP (if there are stable communication channels) and the disconnected mode with the possibility of two-sided replication of information between the central repository and the local database of the IS database.

For work in the detached mode, there are options with / without instrumental GIS, considering the relevance of solving problems at the municipal level for entering and editing spatial data (placement of spatial data in the database and viewing them are implemented in the user's automated workplace). [3]

One of the urgent tasks in the Republic of Sakha (Yakutia) today is the formation and development of a regional node of the spatial data infrastructure. Therefore, when designing the RTWS TP, special attention was paid to the creation of a technological platform, designed to become the basis for solving this problem.

In accordance with the design solution, both commercial and free software can be used as a GIS platform providing the formation and publication of spatial data.

For the implementation of RGIS TP in the Republic of Sakha (Yakutia) at the republican level, Esri software was selected as a GIS platform. The choice was made primarily due to a wide range of tasks that can be solved out of the box software vendor. In addition, a few departmental geographic information systems already existing and developing in the region were implemented on this platform, and spatial data sets were prepared, including graphic parts of the republic's spatial planning scheme and general plans of settlements. [2]

As part of the creation of the first stage of the RGIS TP, the NEOLANT group of companies delivered the basic software of the GIS platform and implemented the modules for maintaining the Spatial Data Catalog and the web portal of open data of regional spatial planning (Fig. 1, 2).



Fig. 1. Information system for urban development

The basic software of the GIS platform includes the following products and components: [7]

- ArcGISforServerStandardEnterprise - to solve the problems of creating and managing multiuser geodatabase based on DBMS and publishing map services (GIS services) for an unlimited number of users on the Internet or within the internal network;
- ArcGISforDesktop - desktop applications of the ArcGIS family, providing all the necessary tools for high-grade work with geographic information: from creating and editing data to designing and publishing maps, building queries and analyzing information;
- ArcGISRuntime SDK for WPF - for developing mapping applications for Windows.



Fig. 2. Spatial Data Catalog

Using software interfaces and the functionality of the platform described above, as well as products and materials of OpenSource projects, NEOLANT developed a universal component (GIS-viewer) that provides for connecting, viewing and importing spatial data sets from various sources and formats in RGIS TP.

### III. RESULTS

The use of GIS in ethnological expertise allowed us to use the possibilities of geographical representation of the state of the study area, to perform a spatial analysis and to map the areas of impact of industrial objects on the environment, for which damage is calculated.

The main results of the implementation of regional geographic information system of territorial planning in the Republic of Sakha (Yakutia) today:

- Formation of the archive of documents at the municipal and regional levels.
- Organization of centralized access to spatial data and their visual analysis without the use of instrumental GIS for decision-making.
- Formation of the basic components of the regional spatial data infrastructure - the catalog of the IPD and geoportals.
- The formation of information resources of the executive branch - the branch layers of spatial data with structured data.

### IV. CONCLUSION

Thus, it is necessary to conclude that by investigating the market for regional geo-information systems in the Russian Federation and examples of their use, it is obvious that our development at this time can be actively used in the Republic of Sakha (Yakutia) and compete with foreign leaders in this field. The advantages of regional developments are that within the framework of the state they can react to transformations that occur in specific areas more actively and more specifically than foreign countries. Therefore, it is important to apply this advantage to the maximum and to form object-oriented GIS for the implementation of specific goals and significant contribution to the progress of the digital economy of the Russian Federation. It is also worth remembering that the active use of geographic information systems in the Republic of Sakha (Yakutia) must consider the main problems in the development of GIS. Among the factors that hinder the progress of GIS is the lack of financial and regulatory support from the perspective of the state, due to the high cost of GIS projects. Safety issues are also another problem for the progress of the GIS market in the digital economy.

From a regulatory and legal point of view, it is necessary to determine that the state is most interested in the development of geographic information systems, as evidenced by the fact that on September 1, 2015, the head of the Russian Government, Dmitry Medvedev, defined the plan of activities for 2015-2030 for the implementation of in the interests of modernizing the

economy of the Russian Federation and the development of its regions for the period up to 2030 ”.

Compared to previous years, there are shifts in the formation of national spatial data infrastructure, which is a geographically distributed structure for collecting, processing, storing and providing customers with spatial data from various departments, ranging from federal and regional levels to district and municipal levels. The use of GIS makes it possible to provide absolutely all services at an essentially new level with information and to carry out technical, technological, economic and several other tasks on this basis.

GIS technologies perfectly solve the needs of many market sectors. They are often used for a long time, but initially in data collection systems on the state of network objects, where they studied not only the networks themselves, but their interaction with the environment.

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This is a section of Gratitude. Here you write links to grants, projects and contracts with which the research in the article is carried out. Also, this section may contain thanks to the organization that supported the research. If there is no need to write thanks, then this section should be deleted.

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