ҚАШЫҚТЫҚТАН ЗОНДТАУ
ДИСТАНЦИОННОЕ ЗОНДИРОВАНИЕ
REMOTE SENSING

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ДАЛАЛЫҚ ОРМАНДАРДЫ ЕСЕПКЕ АЛУ ЖҰМЫСТАРЫН ОРЫНДАУ ҮШІН ЖАҢА БУЫННЫҢ МОБИЛЬДІ ГАЖ ПАЙДАЛАНУ

ИСПОЛЬЗОВАНИЕ МОБИЛЬНЫХ ГИС НОВОГО ПОКОЛЕНИЯ ДЛЯ ВЫПОЛНЕНИЯ ПОЛЕВЫХ ЛЕСОУЧЕТНЫХ РАБОТ

USING NEW GENERATION MOBILE GIS TO PERFORM FIELD FOREST RECOGNITION

Аңдатпа. *Ормандарды тұрақты басқаруды қалыптастыру орман шаруашылығының негізгі міндеттерінің бірі болып табылады. Ормандарды тұрақты басқару Адам мен орман экожүйелерінің мақсатты, ұзақ мерзімді, экономикалық тиімді қарым-қатынасын білдіреді.*

Тиісті ақпараттық қамтамасыз етусіз орманды тиімді орналастыру және орман шаруашылығын басқару мүмкін емес. Есептеу техникасы мен ақпараттық жүйелердің жылдам дамуы, ГАЖ-ның кеңістікте бөлінген әр түрлі уақыттағы ақпаратты пайдалануды қамтамасыз ететін ақпараттық жүйелер ретінде пайда болуы орман шаруашылығын басқару мен орман шаруашылығын басқарудың бүкіл ақпараттық жүйесін түбегейлі өзгерту және орман шаруашылығының міндеттерін шешу үшін мамандандырылған геоақпараттық жүйені құру қажеттілігіне әкелді.

Мақалада орман орналастыру мен орман шаруашылығында географиялық ақпараттық жүйелерді практикалық қолдану қарастырылған. Қазіргі заманғы бағдарламалық құралдардың қайшылықтары мен кемшіліктері атап өтілді. Орман саласында геоақпараттық жүйелерді одан әрі пайдалану перспективаларымен талдау мен жетілдіруге көп көңіл бөлінді. Орман шаруашылығының жекелеген бағыттары мен олардың кезеңдері – орман орналастыру, орман карталарын жасау, жер учаскелерінің шекараларын өлшеу, кеспеағаш жұмыстары, орман шаруашылығы іс-шараларын жоспарлау, құрылыс, орманды қалпына келтіру үшін маңызды ГАЖ функциялары егжей-тегжейлі қарастырылады

Түйін сөздер*: ГАЖ технологиялары; геоақпараттық жүйелер; мобильді ГАЖ; экожүйе; орман орналастыру; орман шаруашылығы; орман есепке алу; болжау.*

Аннотация. *Формирование устойчивого управления лесами является одной из основных задач лесного хозяйства. Под устойчивым управлением лесами понимается целенаправленное, долговременное, экономически выгодное взаимоотношение человека и лесных экосистем.*

Эффективное лесоустройство и управление лесным хозяйством невозможно без соответствующего информационного обеспечения. Быстрое развитие вычислительной техники и информационных систем, появление ГИС – как информационных систем, обеспечивающих использование пространственно-распределенной разновременной информации, – привело к необходимости кардинально изменить всю систему информационного обеспечения лесоустройства и управления лесным хозяйством и создать специализированную геоинформационную систему для решения задач лесного хозяйства.

В статье рассмотрены практическое использование географических информационных систем в лесоустройстве и лесном хозяйстве. Отмечены противоречие и недостатки современных программных средств. Большое внимание уделено анализу и совершенствованию с перспективами дальнейшего использования геоинформационных систем в лесной отрасли. Детально рассматриваются функции ГИС, важные для отдельных направлений лесного хозяйства и их этапов – лесоустройства, составления лесных карт, измерения границ земельных участков, лесосечных работ, планирования лесохозяйственных мероприятий, строительства,

лесовосстановления.
Ключевые слова: *ГИС-технологий; геоинформационные системы; мобильная ГИС; экосистема; лесоустройство; лесное хозяйство; источник; прогнозирование.*

Annotation. *Formation of sustainable forest management is one of the main tasks of forestry. Sustainable forest management refers to a purposeful, long-term, economically beneficial relationship between humans and forest ecosystems. Effective forest inventory and forestry management is impossible without appropriate information support. The rapid development of computer technology and information systems, the emergence of GIS – as information systems that ensure the use of spatially distributed multi-temporal information – has led to the need to radically change the entire system of information support for forest inventory and forestry management and create a specialized geographic information system for solving forestry problems.*

The article discusses the practical use of geographic information systems in forest management and forestry. The contradiction and shortcomings of modern software tools are noted. Much attention is given to the analysis and improvement with the prospects for further use of geographic information systems in the forestry industry. The functions of GIS that are important for certain areas of forestry and their stages are considered in detail - forest management, drawing up forest maps, measuring the boundaries of land plots, logging operations, planning forestry activities, construction, and reforestation.
Key words*: GIS technologies; geographic information systems; mobile GIS; ecosystem; forest management; forestry, forest accounting; forecasting.*

Introduction. Over the past decades, the composition, content and technologies of forest inventory work, forms and methods of processing information about forests have changed significantly. Modern forestry specialists are required to master the basics of computer technology, both general and specialized, to have the skills to work with specialized databases.

The relevance of the use of geographic information systems in forestry in modern conditions is due to the growing requirements of a market economy for the accuracy of multidisciplinary information about the state of the forest fund, economic activity and forest management in it. The scheme for organizing spatial data in a GIS is shown in Figure 1.

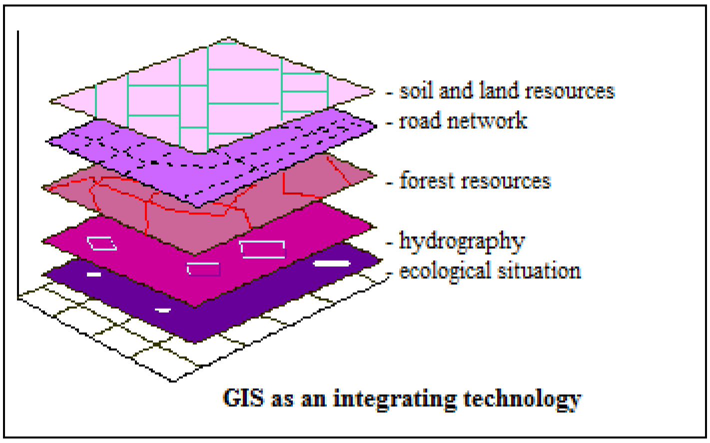

Figure 1. Scheme of organization of spatial data in GIS

The main idea of GIS is the connection of spatial and attributive data, that is, work with coordinate-referenced information.

The sources of data when creating a GIS are:

1) cartographic materials: topographic maps, land plans, tablets of the former forest inventory;
2) geodetic survey using GPS receivers (global positioning system);
3) taxation databases;
4) Earth remote sensing data: space photography, aerial photography, photography using light

aircraft. An example of a space imagery of the city of Ust-Kamenogorsk in Figure 2. [1]

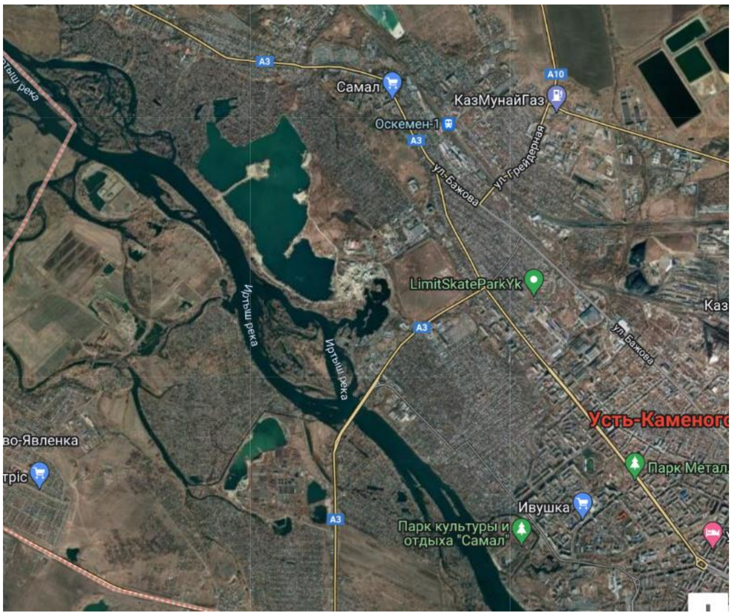

Figure 2. A fragment of a satellite image of the city of Ust-Kamenogorsk

Materials and research methods. Technologies for creating and using geoinformation data for forest management continue to develop continuously. In addition, new sources of information are constantly being added and directions for the practical application of information technologies are being formed. [2]

Therefore, in the late 90s, the main objectives of the application of GIS technologies in forestry were automation of certain types of cameral forest inventory work (mainly related to the creation and reproduction of forest maps), standardization of a number of operations for the design of maps, increasing the accuracy of cartographic measurements. Including expanding the possibilities for visual presentation of results; the possibility of constant updating of attributive and cartographic databases in the course of continuous forest management; transition to digital media as well.

Reforming forestry requires new approaches and methods for processing and presenting information about forests, improving the accuracy and efficiency of data processing, the possibility of combining spatial data on forests with data from other departments, and increasing the volume of processed information. The development of GIS and related technologies (remote sensing data processing tools, spatial analysis, satellite geopositioning, Internet technologies) over the past decade has contributed to solving forest management problems using modern technical means. It is expected that GIS and other information technologies in the forest complex, in addition to traditional tasks (forest management, processing of logging fund materials), will be used to implement new areas – state forest inventory, monitoring of forest use, cadastral assessment of forests.

Over the past decade, the use of information and, in particular, GIS technologies in the forest complex has become, like taxation methods, one of the universal means of information processing.

GIS technologies are used in almost all areas of modern forestry.

The main tasks of using GIS technologies in the branches of the forest complex.

In forestry (forestries):

– Search for information in databases (taxation descriptions, fragments of forest maps, statements, and reports), display, and print;

– Introduction of current changes to the databases (after fires, logging, changes in boundaries, clarification of taxation characteristics, inventory of forest crops, etc.);

– Processing of data from the logging fund (material and monetary assessment of logging sites, printing of forms and statements, outlines and technological maps of plots);

– Compilation of the annual accounting of the forest fund for forestry.

In forest management (organizations that carry out forest inventory of forests, forest management design):

– Creation of attributive and cartographic databases (Processing of raster images, creation of vector images, symbols, automated determination of polygon areas, creation and maintenance of attributive databases);

– Output of documents - printing of cards. Dachshunds descriptions (taking into account standard formats);

– forest management design (calculations of the main and intermediate use, calculations of the allowable amount of forest use by type, drawing up felling plans, drawing up statements, reports on forest management data, calculation of rent);

– Selections, queries to GIS databases, creation of thematic maps;

– Implementation of the annual accounting of the forest fund of the GULF;

– Processing of logging fund materials.

Theoretically, the possibilities of GIS technologies for solving the problems of the forest complex are quite extensive and complex. True, their industrial application is still far away for a number of reasons.

Promising directions for using GIS technologies in the forest complex:

– Planning of strategic forest management (forecasting the state of forests under different management scenarios).

– Tactical planning of logging (selection of logging sites in automatic mode, taking into account the road network, soil, forest inventory characteristics, estimated logging sites).

– Road network planning and economic feasibility of road construction (taking into account location, construction time, road building standards, feasibility study of construction, taking into account the stability of the surface and slopes, calculation of cuts and embankments, ... construction requirements)

– Assessment of the impact of forest management on the environment (the cost of wood, environmental damage).

– Assessment of natural resources based on the processing of remote sensing data. GIS – for georeferencing information, assessment of reserve forests and other natural resources.

– Integrated resource management – a comprehensive analysis of large areas, taking into account many factors.

The perspective of the listed and similar opportunities for forestry is obvious, but practical implementation requires the development of technologies, the use of more expensive software, and the participation of highly qualified personnel.

The expected development of GIS technologies in the forest complex is associated, on the one hand, with new technical achievements – the use of related technologies (satellite geopositioning, Internet technology, and photogrammetry), hardware (GPS, PDA, geodetic and forest inventory instruments) and software and spatial data (materials of open access, spatial databases, and high-resolution satellite images).

Areas of forestry where the use of new GIS technologies is forest inventory, forest inventory, state forest inventory, monitoring (environmental, forest management, fire danger, diseases ...), forest certification, landscape and ecological planning, study of protected areas, land cadastre.

The main tasks of forestry software for forest management at different levels are shown in the table 1 [5-9].

The detail of forest management information at different levels of management should be different and decrease with the transfer to higher management bodies. For example, at the level of forestry, individual databases are needed, at the level of natural resource management, quarterly databases are needed, at the level of the region, the forestry can be the minimum unit.

Table 1. Tasks of information technologies in forest management at different levels

Management levels		The purpose of using information technology
Administrative	Forest Management	
Local	Allotment (1-50 ha)	– processing of materials of the forest and logging fund; – control of forestry activities; – entering GPS data, etc. – making current changes – determination of transport accessibility.
	Quarter (50-400 ha)	
	District forestry (hundreds – thousands of hectares)	
	Central Forestry (thousands – hundreds of thousands of hectares)	– calculation of forest use by leased parts
Regional	Forest management of regions	– calculation of forest management by forestry enterprises; – transfer of land plots for rent, – assessment of the resource potential of territories;
Republican	Ministry of Natural Resources	– planning of forest management by region; – strategic forest management; – monitoring of the state of forests; – comprehensive analysis of forest management taking into account many factors, including time

Between neighboring levels of management, information should be exchanged with the possibility of storing and generalizing (generalizing) information with an increase in level.

Restrictions on the widespread use of information technology with a unified system for the exchange and updating of information is associated with a number of administrative, financial, technical, and personnel reasons.

Negative aspects:

– Different parts of the Republic of Kazakhstan use different systems for creating and using GIS. There are no uniform programs.

– Most of the analytical functions of GIS remain unclaimed

– The main users and customers of forest databases do not have sufficient computer skills.

– There is regularly a need to modify programs and create additional modules to comply with forest legislation.

– Trend of using inexpensive GIS software.

– Information Security.

– Reassessment of the real possibilities of GIS.

– Use of different systems of projections and coordinates (or use of the simplest "map-scheme" systems).

– Compliance with information security related to the commercial nature of certain information about forests (quantity, quality and cost of resources, lease relations), secrecy (presence of important state facilities on the territory of the forest fund, the use of the SK-63 coordinate system)

– Unreasonably high user expectations for the capabilities of GIS technologies

The experts in the field of GIS technologies, without detracting from the importance of the possibilities of processing and presenting spatial information in a GIS, emphasize that GIS is not the only and defining tool for solving management problems as well. The capabilities of GIS contribute to more accurate and faster processing of spatial information, narrowing the range of possible solutions. However, the final decision always remains with a person - a forestry specialist who has a wider arsenal of information with the help of GIS.

GIS-technologies in forest management production.

The main technological approaches to the creation of GIS forest inventory:

– Repetition of manual operations for creating paper maps using GIS: digitization of boundaries, hydrography, quarterly clearings according to sheets of topographic maps within forest management tablets; digitization of the boundaries of sections according to APS; collection of tablets in the plans and in the scheme of the forestry. Its advantage is a simple technology, and disadvantage is that, after digitization of individual tablets, discrepancies appear, when summarized in forest plantation plans.

– All cartographic objects are digitized into separate vector layers by reference points, then all layers are converted into a single coordinate system, a summary is performed, and materials are collected throughout the forestry. Only vector data are transformed.

Disadvantages: after digitizing individual layers, discrepancies appear during the summary, it is necessary to reduce by hand the boundaries between separately digitized images, maps.

– Digital cartographic bases are created for the entire forest management object (based on raster layers of topographic maps, combined aerial photographs or satellite images). Raster layers are used to create vector layers of borders, roads, and hydrography. Digitization of all objects in this case becomes a continuous procedure. All discrepancies are visible immediately on the raster layers.

The use of mobile GIS and measuring instruments of a new generation for performing field forest accounting.

The emergence of new computer systems and universal software, as well as the successful implementation of the WAP (Wireless Application Protocol) protocol in telecommunication networks, contributed to the emergence of a new concept, which was called the mobile office.

Such systems, called mobile GIS, enable access to GIS spatial and attribute data anytime, anywhere.

Traditionally, the attention of GIS developers has been concentrated on static spatial objects. Such geographic information systems are called static (GIS). In SGIS, data analysis is associated with the coordinates and attributes of objects without taking into account their change.

In particular, it is impossible to describe the change in the boundaries of land plots belonging to a certain owner in the SGIS. In 1988, Lengrem and Kraisman introduced the concept of a temporal GIS (TGIS) focused on changing (moving) objects. In VGIS, the number of categories of analysis has been replenished with time. However, both static and temporary GIS only support geographic features (roads, mountains, buildings), but ignore non-geographic features (cars, goods, etc.).[2-3]

Mobile GIS is a geographic information system focused on working with non-geographic objects that move in space. In particular, such systems include a geographic information system obtained by integrating GIS technology, global positioning system (GPS) and wireless Internet access and used to track the location of vehicles.

Mobile GIS is not just a conventional GIS adapted to work on the larger computers, but a system based on a completely different paradigm. It provides mobile device users with access to vast amounts of information and powerful GIS services. Mobile GIS opens up new opportunities for the use of geographic information technologies in business and many other applications.

A typical mobile GIS architecture integrates a mobile client, a server, a wireless network, and a client location system such as GPS. The mobile client may be a car with a GPS navigator displaying digital maps and interacting with the server via a digital wireless network (GSM, CDMA, CDPP or GPRS). Mobile GIS are divided into two categories according to the principle of access to the Internet. The first category uses text or multimedia messaging services (SMS/MMS), the second uses WAP.

Mobile GIS based on SMS/MMS are suitable for cell phones with a simple set of features, not very advanced user interface and limited presentation capabilities, because short messages are unable to transfer large amounts of data, are difficult to handle and are often delayed in delivery. [7]

WAP is a standard, method-independent protocol optimized for mobile devices with small screens and keyboards that use slow wireless links. The WAP protocol enables applications and services to operate over GSM, CDMA, PHS, TDMA and WCDMA wireless networks. The WAP specification includes a relatively simple and compact version of an XML markup language called WML (Wireless Markup Language) that allows maps to be received on mobile terminals as embedded bitmaps (eg, in WBMP format).

Thus, a WAP-based mobile GIS has more information sharing capabilities, a more convenient user interface, richer functionality, and a broader scope than an SMS/MMS-based mobile GIS. In addition, such systems can run on a wide variety of mobile devices, from PDAs to cell phones and vehicle on-board computers. The functionality of mobile GIS based on WAP is almost identical to the functionality of Internet GIS, but at the same time, mobile GIS provides access to services at any time, from any place and without the restrictions imposed by the operating system and wired communication channels. It is likely that, thanks to the benefits of WAP, mobile GIS based on this protocol will take a leading position in the market for mobile information services.

Mobile GIS based on WAP is a distributed system based on thin client technology. It is an open, extensible, cross-platform system, the properties of which are determined by the growing needs of users and the variety of mobile devices. [4]

Currently, all popular types of distributed system architectures are based on distributed object technology. There are three leading standards for this technology: Microsoft's Windows DNA/.NET (Distributed Network Architecture), Object Management's CORBA (Common Object Request Broker Architecture), and Sun's J2EE (Java 2 Enterprise Edition). Windows DNA/.NET-based systems are only compatible with Microsoft development, deployment, and runtime platforms and tools, which appears to be one of the major drawbacks of this architecture [4,5]. The CORBA architecture is too large and complex, and updating its standards and technologies is rather slow.

The developers of the J2EE specification and standard are Sun and its industry partners. The J2EE standard covers technologies such as Enterprise JavaBeans (EJBs), Java Servlets APIs, and Java Server Pagers (JSPs). J2EE-based solutions reduce the cost and complexity of building multi-tiered distributed systems that support rapid development and deployment, and improve the portability, security, load balancing, and extensibility of distributed systems. The advantages of creating distributed GIS based on J2EE are:

1. Support cross-platform interaction.

2. Layered architecture that makes it easy to solve complex problems.
3. The ability to reuse components.
4. Support for modular development.

The presentation layer includes a WAP client mobile application primarily responsible for presenting GIS data. As a rule, the role of the client is performed by a device without permanent local memory, which runs a WAP browser with a user interface similar to that of a standard web browser. The WAP browser does not execute the GIS application code and does not connect directly to the database server. In addition, it does not store any state information. According to these features, it is, in essence, a "thin" client. A J2ME (Java2 Micro Edition) application can also act as a client.

A WAP-based mobile GIS can include different types of client devices (eg PDAs and WAP-enabled cell phones) with different levels of presentation capabilities. Therefore, the web server must provide a mechanism to determine the type of client device in order to generate appropriate web content for it. For this purpose, the Servlet Engine is used, which implements support for two types of servlets.

The first is responsible for creating web content suitable for a specific client, the second selects the servlet responsible for determining the type of client device (by the identifier that the client sends when connecting to the mobile network), and then passes the results to the first servlet.[7-10]

The application layer, which is central to the J2EE architecture, is represented by the GIS application server, which communicates with the web server through the RMI (Remote Method Invocation) mechanism.

The data layer is represented by database servers, which are used to store spatial and attribute data of the entire system. Object-oriented DBMS (OODBMS) are best suited for serving GIS, but this type of DBMS is currently not yet “mature” and OODBMS has a very high cost. All this prevents the widespread use of OODBMS. To store GIS data, RDBMS such as DB2, Oracle, Sybase, and SQL Server are most widely used today. At the same time, to ensure the interaction between the data layer and the application layer, they create and use spatial DBMS (PSDBMS) based on open standards, such as ArcSDE, Spatial Ware and Oracle Spatial.

Currently, slow communication channels are still the main problem in the implementation of all mobile applications. This requires further research both in the field of data organization on "thick" servers that manage spatial information, and in the field of information presentation on "thin" clients. Fortunately, third-generation 3G telecommunication networks are being developed, in which mobile terminals can exchange data at speeds up to 144 Kbps. The speed of data exchange with a stationary or slowly moving terminal in an open area is 384 Kbps, and indoors - up to 2 Mbps. 3G networks fully comply with the requirements for the transmission of spatial information over radio channels. All this opens up broad prospects for mobile GIS. [12]

Conclusion. The widespread introduction of computer technology into the practice of forest accounting as well as the transition to geographic information systems (GIS-technologies) accelerates scientific and technological progress in forestry.[11] Thanks to the use of computers, automation of the processing of forest inventory materials, obtaining versatile information about the forest resources of objects, forest users, including tenants of forest areas, carry out detailed forest management and forest industry calculations that comprehensively characterize the state of forest resources [15].

To accelerate scientific and technological progress in the field of forest inventory work, closer coordination and interaction between scientists, design organizations and forest management bodies is necessary.

As a result of the performed research, the following main results were obtained:

– The analysis of the tasks of forest inventory and the tasks of forestry management was carried out, the prospects for the development of forest inventory based on new methods for obtaining and processing data, as well as methods for making managerial decisions using geographic information systems, were considered.

– The technology of the state forest inventory based on the stratifications using high and medium resolution satellite imagery and the LesGIS geoinformation system.

The use of mobile GIS and new generation measuring devices for monitoring, which solves the following issues, such as: detection of illegal logging; performance of forest accounting works, control over compliance by forest users with the basic rules and regulations for the organization of forest management; assessment of the state of felling areas after the completion of logging (survey of felling sites) [11-15].

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