СТРУЧНИ РАДОВИ
ПРОФЕССИОНАЛЬНЫЕ СТАТЬИ
PROFESSIONAL PAPERS

APPLICATION OF GEOINFORMATION SYSTEMS IN THE ARMED FORCES AND OTHER MILITARY FORMATIONS IN THE REPUBLIC OF KAZAKHSTAN

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DOI: 10.5937/vojtehg68-25830; https://doi.org/10.5937/vojtehg68-25830

FIELD: IT, Geoinformation Technology
ARTICLE TYPE: Professional Paper
ARTICLE LANGUAGE: English

Abstract:

Introduction/purpose: The purpose of the paper is to present the importance of geoinformation systems (GIS) in the process of geotopographic support to all levels of command as well as the necessity of developing the GIS platform concept based on geoinformation data as a support to decision making.

Methods: Besides an analytical approach to some of foreign experiences in developing GIS and a sample analysis, the authors give the content and the architecture of the adopted program named „Development of a special GIS platform for the defense and security of the Republic of Kazakhstan".

Results: The paper presents the structures and the level achieved in the development of the single geographic information platform (SGIP) which aims at helping the state to create modern army and efficiently use geoinformation technologies in the support to the armed forces of Kazakhstan.

Conclusion: The importance of creating, at the state level, a unique geographic information space based on the integration of geospatial data at all levels of command has been pointed out as well as the importance of eliminating overspending while creating geoinformation data. In addition, efficient usage of geoinformation technologies will contribute to better combat control of troops and armament thus creating a modern and ready military.

Keywords: geotopographic and cartographic support, geoinformation, geoinformation system, visualizations, geographic overview, aviation maps, city plan, electronic photographic plan, matrix of terrain properties, automated system, remote sensing.

Introduction

Recently, geographic information systems (GIS) are considered as an effective tool for analyzing various types of data in the study of regional development and the development of integrated solutions. Currently, GIS occupy one of the leading places among various information technologies in the field of management and planning.

A geographic information system (GIS) is a hardware-software human-machine complex that provides for the collection, processing, display and distribution of spatial coordinate data, the integration of information and knowledge about the territory for their effective use in solving scientific and applied problems associated with inventory, analysis, modeling, forecasting, environmental management and territorial organization of society.

GIS is a management tool. It is generally accepted that geographic data represent about 70% of the total volume of circulating GIS information. (Goodchild & Kemp, 1990)

The structure and implementation of GIS

Geographic information systems include five key components: hardware, software, data, performers and methods.

Hardware

This is the computer on which the GIS is running. The GIS currently runs on various types of computer platforms, from centralized servers to single or networked desktop computers.

Software

GIS software contains the functions and tools necessary for storing, analyzing and visualizing geographic (spatial) information. The key components of software products are:

- tools for entering and operating the geographic information database management system (DBMS or DBMS); - tools for supporting spatial queries, analysis and visualization (display);

- Graphical user interface (GUI or GUI) for easy access to tools and functions.

Data

Data is probably the most important component. Spatial location data (geographic data) and associated tabular data can be collected and prepared by the user or purchased from suppliers. In the process of managing spatial data, a geographic information system combines (or rather, combines) geographic information with data of other types. For example, already accumulated data on the population, soil character, proximity of hazardous objects, etc. (depending on the task that will have to be solved with the help of the GIS) may be associated with a specific piece of the electronic map.

Moreover, in complex, distributed systems for collecting and processing information, there is often no data associated with an object on the map, but only its source, which allows real-time monitoring of the state of such an object. This approach is used, for example, to deal with emergencies such as forest fires or epidemics.

Performers

Performers are people who work with software products and develop plans for their use in solving real problems. It may seem strange that people working with software are considered to be part of the GIS, but this makes sense. The fact is that for the geographic information system to work effectively, it is necessary to comply with the methods provided by the developers; therefore, without trained performers, even the most successful development can lose all meaning.

GIS users can be both technical specialists who develop and maintain the system, and ordinary employees (end users), whom the GIS helps to solve current everyday affairs and problems.

Methods

The success and effectiveness (including economic) of the use of the GIS in many respects depends on a correctly drawn up plan and

work rules, which are compiled in accordance with the specifics of the tasks and work of each organization.

GIS subsystems

The GIS structure, as a rule, includes four mandatory subsystems:

1) Data input, providing input and / or processing of spatial data obtained from maps, remote sensing materials, etc .;

2) Storage and retrieval, allowing quick receipt of data for appropriate analysis, data update and data adjustment;

3) Processing and analysis, which makes it possible to evaluate parameters, solve computational and analytical problems;

4) Presentation (issue) of data in various forms (maps, tables, images, block diagrams, digital terrain models, etc.)

Application and charcteristics of the GIS

Thus, the creation of maps in the circle of “responsibilities” of the GIS is far from the first place, because to get a hard copy of the map most of the GIS functions are not needed at all, or they are used indirectly. Nevertheless, both in world and in domestic practice, the GIS is widely used, precisely for preparing maps for publication and, to a lesser extent, for analytical processing of spatial data or managing the flow of goods and services (Tikunov, 2004).

The GIS allows making decisions based on geographic information. Unlike other types of information processing tools, the GIS understands the concept of location, as it is based on information tied to the coordinates on the map, and allows the information presentation in a graphical form for interpretation and management decisions.

Geoinformation technologies are inextricably linked with the GIS. Geoinformation technologies can be defined as a combination of software and technology tools for obtaining new types of information about the world. Geoinformation technologies are designed to increase efficiency: management processes, storage and presentation of information, processing and decision support (Tikunov, 2004).

The main feature of the GIS, which determines its advantages in comparison with other AIS, is the presence of a geographic information base, i.e. digital maps (DM), giving the necessary information about the earth's surface. In this case, the DM must ensure:

- exact binding, systematization, selection and integration of all incoming and stored information (single address space);
- comprehensiveness and visibility of information for decision making;

- the possibility of dynamic modeling of processes and phenomena;
- the ability to automatically solve problems associated with the analysis of the features of the territory;
- the ability to quickly analyze the situation in emergency cases.

GIS experience

Geoinformation technologies, offering new effective approaches to the analysis and solution of territorial problems, continue to gain more and more popularity and official recognition in our country, and digital spatial information begins to play an increasingly important role in the tasks of socio-economic, political and environmental development and environmental management, production and labor potential in the national interest.

Foreign experience in operating various GIS indicates that the need to analyze the geographical location of phenomena and objects, their quantitative and qualitative characteristics using a map arises among representatives of armed forces and various sectors of economy (Kapralov et al, 2005).

An analysis of the forms and methods of combat use of troops (groupings of troops) in special operations in Chechnya allows us to conclude that the goal of topographic and geodetic support (hereinafter TGO) should be the preparation and timely delivery of accurate and reliable topographic and geodetic information in the required volume to headquarters and troops, contributing to the creation of necessary conditions for solving the following tasks:

- maintaining troops (forces) in constant combat readiness;
- timely covert deployment (creation) of force groupings;
- accomplishment of assigned tasks by troops;
- ensuring the effective use of weapons and military equipment.

The process of organizing topographic support for the combat operations of troops in modern conditions, taking into account the experience of counter-terrorism operations in Chechnya, Afghanistan and Iraq, necessarily includes the following aspects:

- timely and complete provision of command and control bodies with topographic and special maps, early production of topographic plans of cities;
- preparation of initial astronomical and geodetic data on the positional areas of the missile forces and artillery and bringing them to the appropriate command and control agencies;

- providing staffs and troops with additional information about the terrain in the form of special photo documents of the terrain, with other reference materials made in direct preparation for hostilities and during their conduct;

- providing appropriate systems for command and control, reconnaissance and guidance with digital electronic maps, digital terrain models;

- organization and timely communication to the troops of the results of topographic reconnaissance of the terrain of objects and the enemy (Evgievsky & Morozov, 2005, pp.39-43).

An analysis of the provision of geospatial information of the Armed Forces of the Republic of Kazakhstan in everyday life, during preparation and during exercises, indicates a serious lag in these matters from the armies of developed countries. The command and control bodies of the troops receive information about the area in the form of the same topographic map and according to the same procedure as fifty years ago. After the application has been sent to the relevant authority, the data of archived topographic maps are processed, then separate sheets are issued, combined and filled in with official symbols and descriptions.

At the same time, it should be noted that the topographic map in an analog form is the main working document of the commander and staff used in planning operations and combat operations, when setting up tasks for subordinate troops and exercising control over the progress of the troops in fulfilling assigned tasks.

The experience of armed conflicts of foreign countries shows that topographic maps on a paper basis, under the conditions of active influence on the weapons and equipment of electronic means of suppressing the enemy, are the main information document. Consequently, activities to create, store and bring to the troops a paper map will retain its significance along with the creation of a digital cartographic database.

Geoinformation support

The development of a modern army, as well as the development of modern society as a whole, is based on the introduction and development of information technology. The most important component of most technologies is the processing of digital terrain information in conjunction with diverse data about the enemy and their troops.

Now that the world is entering the new millennium with an understanding of the benefits of digital imaging, sound and

communications, topographic and geodetic support simply cannot be left out of technological progress.

It becomes obvious that geoinformation support is the topographic and geodetic support of the 21st century. It includes aerospace, optoelectronic reconnaissance, satellite communications, digital computer technology and classical methods of geodesy, cartography and photogrammetry. An analysis of the tasks solved by the topographic services of the associations of the Armed Forces of the Republic of Kazakhstan during the preparation and during operations and combat operations, as well as the means and methods of solving them, indicates that there is a serious lag in these issues from the armies of developed countries.

Geoinformation support assumes the circulation of terrain data through channels connected to databases of geographical information systems (GIS). Actually, they are the basis of geoinformation support. At its core, the GIS is a combination of a geographic or topographic map and an extensive array of digitally expressed heterogeneous information, systematized and linked to the corresponding point in the cartographic image. Digital information about the terrain can be presented in the form of an electronic topographic, geographic, aviation map, city plan, diagram, electronic photographic plan, elevation matrix, matrix of terrain properties, etc.

The GIS performs two important functions: creating a digital map of the area, integrated with an expanded database, and turning a digital map into electronic - visualization - with the possibility of interactive work with the user. Based on these two functions implemented with the GIS, many others are based (Ivanov & Markus, 1999, pp.42-45).

Geospatial information, formed on the basis of the collection and analysis of cartographic, geographical, climatic, hydrological, aerological, administrative data and information on the infrastructure features of the territories, plays an increasingly important role in ensuring the military and public security of the state.

Modern technologies make it possible to generalize and link geospatial data, provide the possibility of their visualization and interactive access to them, and provide support for management decisions.

An analysis of the development of modern systems of geospatial support for armies of foreign countries and the prospects for their development allows us to conclude that the practical effect of increasing the combat capabilities of troops is achieved not only by increasing fire, maneuverability and other characteristics of weapons platforms, but also

primarily by the reduction of the combat command cycle and decision-making on the basis of geographic information components of the combat space.

For example, in the armed forces of the NATO countries, the implementation of a new concept for providing geospatial information, denoted by the term Situational Awareness, is made possible through the use of the neogeography method, which assumes, in particular, the location of the user “inside the data” in real spatial time continuum, instead of the obligatory mediation of cartographic conventions.

The problem of determining a single special geographic information platform arose due to the heterogeneity of geospatial information used in the Armed Forces, other troops and military units. Issues within departmental information interaction and analytical decision support based on geoinformation data were implemented using various software tools.

Currently, the ArcGIS software platform has partially created geospatial data:

- in the Ministry of Internal Affairs of the Republic of Kazakhstan as part of the deployment of the “module of the geographic information system” of the Operational Management Center,
- in the emergency committee of the Ministry of Internal Affairs of the Republic of Kazakhstan as part of the deployment of the GIS subsystem of the "corporate information and communication system" (presentation attached),
- a large volume of cartographic materials in the Mapinfo format has been created in the Ministry of Defense of the Republic of Kazakhstan.

So, from 2002 to 2016, by the order of the Ministry of Defense of the Republic of Kazakhstan, plans and topographic maps were produced in analog and electronic formats on a scale of 1:10 000 - 1: 1000 000 on the territory of the Republic of Kazakhstan, border states, military training grounds, as well as on the territory of regional centers and large cities, covering 8034 nomenclature sheets.

In addition, single materials of large-scale topographic maps were produced on the territory of military training grounds in the ArcGIS format on 164 nomenclature sheets. At the same time, the conversion of geospatial data from one format to another was carried out with a loss of quality of materials.

In addition, the implementation of the SGIP project acquires special relevance in connection with the sanction ban on the provision of ArcGIS and MapInfo software licenses, as well as the provision of technical

support services (including the delivery of software updates as part of the existing technical support) to a number of defense and oil and gas enterprises.

At the same time, ESRI GIS refers to the relevant order of the Department of Foreign Assets Control of the US Department of the Treasury and the Bureau of Industry and Security of the US Department of Commerce.

Program: Development of a special GIS platform for the defense and security of the Republic of Kazakhstan

To solve all of the above tasks and programs, officers of the National Defense University named after the First President of the Republic of Kazakhstan, the Leader of the Nation, took part in the implementation of the both scientific and scientific and technical program as part of targeted funding for the topic of a both scientific and scientific and technical program (hereinafter - the program): “Development of a special GIS platform for the defense and security of the Republic of Kazakhstan” which will be based on the integration of large arrays of cartographic materials, other geospatial data, infrastructural information on operational equipment of the territory and mobilization resources by sectors of the economy, detailing materials for the certification of terrorist vulnerable objects, and will be the basic platform of information systems for decision-making support of the Armed Forces, other troops and military units, government bodies and organizations, the joint activities of which rule in the solution of tasks of ensuring military security of the Republic of Kazakhstan.

Research Objectives

- development of a prototype of a unified software platform for collecting, accumulating and visualizing GDB, with the functions of performing GIS applications that solve the range of tasks of terrain analysis, with the possibility of creating geospatial products for various purposes and publishing topographic and special maps;
- creation of an electronic geospatial information bank;
- development of geospatial engineering products;
- development of converters for re-issuing DTMs into a single format of the SGIP platform.

At this stage of the study, the goal was to analyze the views of domestic and foreign experts on the development of geographic

information platforms and to develop the structure of a special geographic information platform for the Armed Forces of the Republic of Kazakhstan.

Based on the goal, the following tasks were identified:

- study of world experience in the development of geographic information platforms;
- the formation of the structure of a special geographic information platform;
- development of technical specifications for the development of a special program of the SGIP.

Fulfillment of the tasks set and achievement of the goal at this stage provides the basis for further research and helps substantiate the novelty and significance of the study.

Scientific novelty and relevance of research

The SGIP will be a domestic software product based on the integration of a large number and scale cartographic materials, geospatial data of the military state and operational infrastructure information.

The formation of the SGIP structure, the development of technical specifications, the acquisition of the necessary software equipment and the development of special programs will allow to:

- promptly display and use in work any requested area of the terrain from a large volume of source geospatial information databases (satellite images, cartographic materials);
- along with electronic maps, create geographic information products that are visualized in the form of layers of maps and tabular information;
- ensure the uniformity of requirements for protocols for the exchange of geospatial information between users of the GIS;
- ensure the formation of electronic documents (orders, directives, orders) and the issuance of commands when changing environmental conditions;
- and, on the whole, create a single information space based on the integration of generally applicable data and their descriptions by types of functional activity at all levels (links) of the Armed Forces command.

The development of the SGIP will contribute to the achievement of the goals of creating a modern combat-ready army, the effective use of geographic information technologies in the implementation of combat control of troops and weapons.

Analysis of foreign specialists of the development of geoinformation platforms

Due to the variety of GIS platforms, only the most common ones were selected for the analysis.

ArcGIS platform

The ArcGIS platform is the optimal solution for building a corporate GIS, the foundation of an information system for the effective management of large state and commercial organizations (Raklov, 2011).

The ArcGIS - produced by the American corporation ESRI, one of the few GIS platforms supports full-fledged work with a topological model of data representation, as well as storage, processing and visualization of three-dimensional representation of spatial data. It has an open architecture (more than 800 standard additional target applications), but source codes are not transmitted to users.

The use of this GIS platform will require the conversion of the entire range of maps to the ArcGIS format, while the work will require a lot of manual labor and financial costs.

Price policy: for one ArcView license - 600 000 tenge, ArcEditor-1 - 2 000 000 tenge, ArcInfo-2 - 1 500 000 tenge, time libraries completion - 300 000 tenge, development tools - 2 100 000 tenge for one year. The GIS price is not fixed.

MapInfo

MapInfo was produced by the American company Pitney Bowes Software and is intended for the collection, storage, display, editing and analysis of spatial data. MapInfo is used in 130 countries. Due to its ease of development, rich functionality and moderate cost, MapInfo has become the most popular GIS.

Based on this program, the entire range of electronic cards for the Armed Forces of the Republic of Kazakhstan has been created. Price policy: GIS MapInfo Professional for Windows - 900 000 tenge, GIS MapInfo Professional for Windows (Russian version) including technical support for 1 year - 600 000 tenge.

The ArcGIS and MapInfo have an open architecture; however, since the source codes of these GIS platforms are not transmitted to users, it is not possible to check for the presence of undeclared functions.

Functionality, usability and adequate technical support are at the highest level; however, it is difficult to use it due to the fact that not all modules and instructions are translated into Russian.

Free legitimate distribution is practically impossible. There is a high level of technological dependence on foreign manufacturers.

Analysis of Russia and Belarus specialists of the development of geoinformation platforms

Due to the lack of ready-made GIS solutions on the domestic market, the GIS developments of Russia and Belarus, which have in-CIS GIS platforms of their own design, were examined.

In order to make the analysis objective, the opinions of both the GIS manufacturers themselves and competent users were taken into account.

In the post-Soviet space, the most common are the developments of Russian manufacturers.

GIS Integration

GIS Integration. Developed by the closed joint stock company KB Panorama for FGUP NII TP.

Positive sides:

- adopted by the Armed Forces of the Russian Federation and is a military product.

Negative sides:

- does not meet security criteria due to the impossibility of transferring source codes to check for the presence of non-declared functions;
- there is low-level technical support, the system is underdeveloped, and since the last update was carried out in 2005, there is a discrepancy between the system and the requirements of the troops;
- all system improvements can only be made by the developer; and
- there is a threat of technological dependence on foreign manufacturers.

Despite the decisions taken by the Council of Ministers of Defense of the Commonwealth of Independent States on the Concept of creating a unified GIS for years, appeals to the General Staff of Russia on the transfer or sale of GIS Integration were ignored.

GIS Operator

The geographic information system Operator was accepted for supply to the RF Armed Forces by order of the Minister of Defense of the Russian Federation No. 598 dated August 15, 2013. The set of programs developed by the closed joint stock company KB Panorama allows organizing topographic and geodetic support based on the principles of network-centric technologies in advanced automated systems and controls in power departments. (KB Panorama, 2020)

Positive sides:

- according to the results of comparative tests of geographic information systems, the GIS Operator in 2012 was recognized as the most fully meeting the requirements of the armed forces for military GIS and in 2013 it was adopted by the Armed Forces of the Russian Federation;
- the ability to transfer source codes to check for the presence of non-declared functions;
- the system is constantly evolving, the developer promptly responds to user requirements;
- cards created through the VTU General Staff of the Armed Forces of the Russian Federation are produced on the software complexes of closed joint stock company KB Panorama.

Negative sides:

- impossibility of free distribution, i.e. expansion of the user structure entails additional costs for licenses, and all system improvements can only be made by the developer;
- the product is quite complicated to learn and maintain, focused on the professional use of the system;
- there is a threat of technological dependence on foreign manufacturers.

Price policy: GIS Map 2011 - 95 000 tenge, professional GIS Map 2011 with development tools - 270 000 tenge.

GIS Horizon

Developed by FGUP NIIIAA and named after Semenikhin.

Positive sides:

- the ability to transfer source codes to check for the presence of non-declared functions;

- the possibility of "free distribution of GIS", i.e. the user's right to freely run, copy, distribute, study, modify and improve it;
- the possibility of creating a domestic GIS on a ready platform, i.e. technological independence from foreign and private producers of GIS;
- there is an official partner in the Kazakhstan market.

Negative sides:
- the system has not been adopted by the Armed Forces of the Russian Federation;
- there is no information that the system is being updated and developed.

"GIS for military use"

Despite the fact that Russia is a strategic partner not only politically, but also militarily, in addition to the operation of Russian GIS platforms, Belarus is actively developing its own GIS - "GIS for military use", created on the basis of the closed joint stock company KB Panorama software core.

It is developed by the Joint Institute for the Study of Informatics Problems of the Belarusian Academy of Sciences.

Positive sides:
- adopted by the Armed Forces of the Republic of Belarus;
- the ability to transfer source codes to check for the presence of non-declared functions;
- the possibility of "free distribution of GIS", i.e. the user's right to freely run, copy, distribute, study, modify and improve it;
- the possibility of creating a domestic GIS on a ready platform.

Negative sides:
- it is not a complete GIS, it is used as a tool to support decision making.

Pricing policy: no information.

Types of GIS in use in other armies

Out of all the listed programs, the following ones are actually adopted and used as GIS platforms of automated control systems of the armed forces:

In the NATO countries, including: the United States of America, France, Germany, as well as in Ukraine (from the CIS countries) - ArcGIS.

Turkey, as a member of NATO, simultaneously with ArcGIS uses a proprietary GIS platform - Netcad.

Sweden uses ArcView GIS and MapObjects, derived from ArcGIS.

In Russia and Armenia, the GIS Integration is used, and in return the GIS Operator is being prepared.

In addition to the GIS Integration, Belarus uses a GIS platform of its own design - military GIS.

Israel - ArcGIS, Adlib;

Uzbekistan uses ArcGIS in the field of communications and information technology;

China - no data;

In the Republic of Serbia, as a neutral country, the Serbian Armed Forces are developing a GIS project called "Universal User Software Platform (UKSP) of the Serbian Armed Forces GIS". This GIS is a modular software platform intended for spatial support in the decision-making process at all levels of command in all missions of the Serbian Armed Forces, which is in the final stages of adopting into the arms and equipment of the VS.

In the Republic of Kazakhstan, among government agencies, the situation is as follows:

ArcGIS is operated in the National Security Committee, Ministry of Emergencies, MEP, KTZ, and KMG;

Mappinfo is operated in the Ministry of Defense, and the Interior Ministry.

Transition to a single GIS platform

One of the ways to solve the problem of heterogeneous software products is to create uniform standards for the language for describing the modeling space (Konovalova & Kapralov, 1997).

However, the lack of work to standardize objects of the operational-tactical situation, control languages, and other elements of information support does not allow solving this problem. The choice of a single basic GIS platform should be the first step in creating a single information space of the state.

A distinctive feature of military conflicts of a new type, at the end of the twentieth and the beginning of the twenty-first century, is that the role of informational aspects in ensuring the actions of armed forces has

grown. This was facilitated by the rapid development of information technology, which began to invade all areas of human activity, including the military sphere. Ensuring information superiority over the enemy has become one of the decisive factors for achieving success in the war.

Modern information and network technologies in military affairs are the basis for the integration of geographically dispersed command and control bodies, reconnaissance, surveillance and target designation systems, military groups and weapons in a highly adaptive gliding system.

At present, new tools that reflect the current level of geoinformatics are increasingly used. These include the means of complex multivariate spatial analysis and the preparation of high-quality synthesized images based on maps, images, and the operational environment (Lurie, 2000).

Geoinformation technologies make it possible to move to a unified planning system, form a single picture of situational awareness, develop modern methods of control and management of weapons of war, including unmanned and robotic systems, increase transparency and operational efficiency of the rear and reduce the level of advanced presence through the formation of virtually remote headquarters and other bodies management.

To determine the feasibility of using a specific GIS, it is necessary to consider how much it meets the requirements stipulated by the specifics of the tasks to be solved when processing geospatial information shown in the modules of the geographic information system (Fig. 1).

The spatial analysis and modeling module is one of the key GIS. The functional completeness of the analysis and modeling tools mainly determine the versatility and effectiveness of a particular GIS (Berlyant, 1997).

Basic operations include groups of operations such as measuring operations, polygonal operations (overlaying polygons, determining whether a point belongs to a contour, and others), transformation of coordinate systems and projections, analytical and modeling operations (selection of objects according to specified criteria, network tasks, processing of geodetic survey data, construction of buffer zones and others), surface analysis, digital processing of Earth remote sensing data, and other operations.

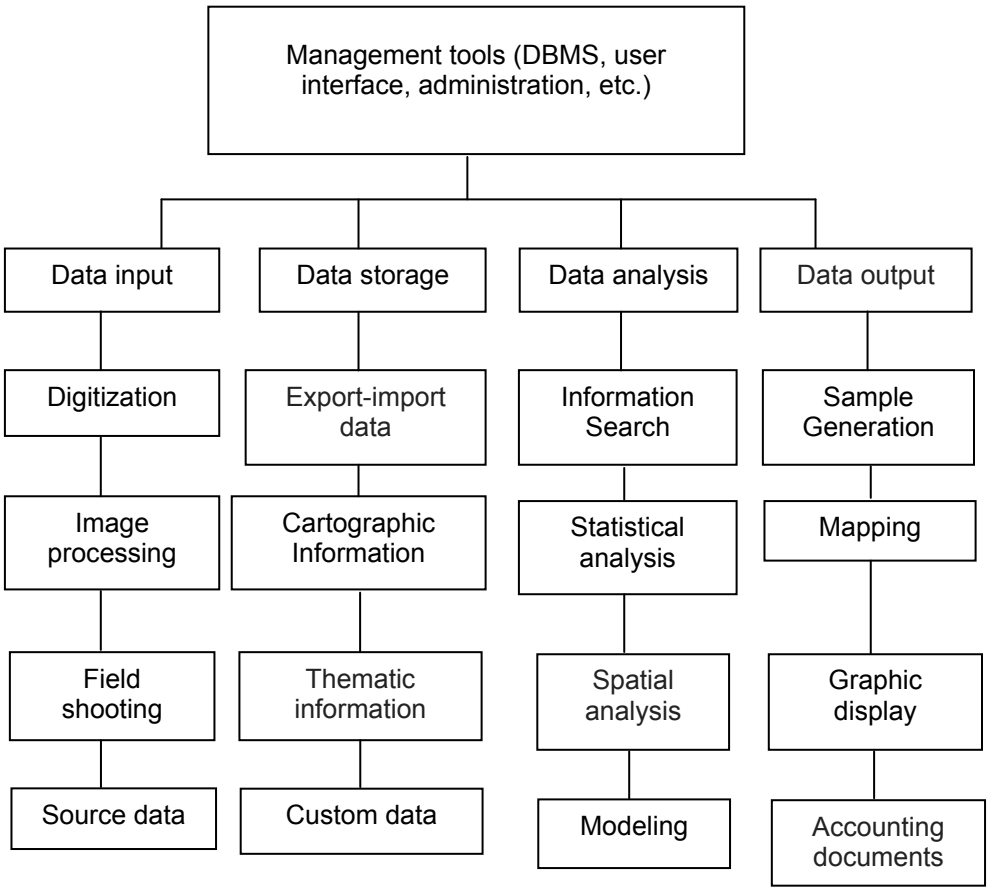

Figure 1 – Module of a geographic information system
Рис. 1 – Модуль геоинформационной системы
Слика 1 – Модел географског информационог система

The GIS management tools include access operations to internal and external databases, a user interface, a system for organizing access to the system's functional procedures, development and integration tools for user applications in the GIS, and others (Tsvetkov, 1997).

The GIS possesses the term basic characteristic properties: the presence of spatial databases, coordinate reference of object modeling and analysis, and spatial analysis tools. Apparently, one should proceed from this, taking into account the target orientation of the information system and the depth of use of digital models in spatial analysis.

Examples of the transition to a single GIS platform

Based on the research conducted above, the experience of the transition of the armies of foreign countries to a single GIS platform is interesting.

For example, the US Geospatial Intelligence Agency purchased the Commercial Joint Mapping Toolkit, which provides access to scalable GIS using standard interfaces. Northrop Grumman, the developer of the GIS, acts as a system integrator, ESRI became ArcGIS core, Leica Geosystems supplied image processing modules, and Analytical Graphics offered tools for analyzing satellite data. Vector maps in the system are maintained on the Oracle 10g DBMS, and raster maps are supported by the ESRI File Based Geodatabase engine. ArcGIS Explorer, which supports web architecture, is used as a typical client software.

At the first stage of the introduction of unified GIS technology within the framework of the C31 program (operational command, control and communication information systems), the Swedish army acquired several thousand licenses of MapObjects and ArcView. Products are used at all levels of command, as well as by lower-level personnel for everyday tasks. As the circle deepened and expanded, which can be solved using GIS tasks, the Swedish Armed Forces realized the need to create a GIS battlefield with specialized functions for creating tactical situational maps, planning convoys, analyzing targets, monitoring war games, and solving other operational and tactical tasks. The new software product, called GeoPres, is based on the ArcView GIS and MapObjects standards adopted by the Swedish Armed Forces, expanded in accordance with the requirements of the army.

Standardization was based on ArcView GIS and MapObjects from ESRI. As a result, the Swedish Armed Forces have developed many extensions to both software products to adapt them in the military field. A GIS built into the C3I system provides a solution to a number of typical problems associated with the use of this technology in everyday activities in peacetime, during exercises and in a combat situation on the battlefield. It is quickly mastered by end users and allows a quick response to a constantly changing situation on the ground.

According to the results of a closed competition in January 2013 for the best GIS development, in order to create a single GIS platform for all power structures in Russia, the GIS Operator was unanimously determined by order of the Minister of Defense of the Russian Federation

No. 588 of 08/15/13. The Operator geographic information system is accepted for supply to the Armed Forces of the Russian Federation.

In order to select a single GIS platform for the Armed Forces of the Republic of Kazakhstan, it is proposed: to develop our own software products with similar functions that exist in the best examples of foreign GIS, which will form the basis of a single information platform for the power structures of the Republic of Kazakhstan; to intensify interaction with the Ministry of Transport and Communication, as the responsible body for the implementation of "electronic government" and JSC "National Information Technologies", as the project integrator of the infrastructure of "electronic government". When choosing a GIS platform for the Armed Forces of the Republic of Kazakhstan, use the results of the development of technical documentation for the creation of a national GIS; organize trial operation of the GIS CJSC KB Panorama software and hardware on the basis of Kazakhstan GIS Center JSC and, based on its results, determine the feasibility of determining it as a GIS platform.

Formation of the special geoinformation platform structure

The structure and content of a special geographic information platform

The research team has formed the structure of a unified geographic information platform. The goals and objectives, the place of the GIP in the Digital Army are defined, the architecture is developed taking into account the vertical of subordination and the movement of the created geospatial engineering products, and a typical GIS solution is found. The sources of geospatial information were identified and a list of software necessary for the development of software products was compiled.

The work of the research group was organized on the basis of Kazakhstan GIS Center JSC, according to the contract for the lease of premises and equipment of equipment from 03/06/2018. No. 9/18/1.

Technical specification for the acquisition of software and development tools

In 2018, agreement No. 9/18/2 of March 6 2018 was signed for the purchase of software and development tools for the creation of special programs that form the basis of the GIP platform.

The following software and processing tools are acquired under the contract, including: a complex for maintaining a geoportal; software for

creating and updating digital terrain models; specialized software for displaying and editing the military situation; GIS application development tools; development tools for geographic information WEB applications; environment program for fast program development with the ability to create client-server solutions, multilevel databases, and web applications.

Technical specification for the development of a special SGIP program

Based on the established structure of the GIP, the study of domestic and international experience in creating various GIS systems, the research group developed the Technical specification for the creation of its own special software products that form the basis of the GIS platform (Koshkarev & Tikunov, 1993).

The technical specification formulates and describes the structure and functioning of the SGIP, and describes the functionality of each software module.

Development of special geoinformation platform programs

Development of a program for generating atlases of electronic terrain maps

As part of the research work, a program for the formation of atlases of electronic maps of the area was developed (DeMers, 2008).

The program maps the raster maps of BMP, JPEG, TIFF, GeoTIFF, TGA (Targa), BIL (SPOT), and SID formats with the geographical information contained in them with the possibility of transforming the raster.

It allows building mosaic raster atlases of the formats BMP, JPEG, TIFF, GeoTIFF, TGA (Targa), and BIL (SPOT) based on the use of adjacent and overlapping raster data of large volumes of the formats BMP, JPEG, TIFF, GeoTIFF, TGA (Targa), BIL (SPOT), and SID by transforming them over a set of control points.

It is possible to combine the attached raster with a previously created electronic map and to interactively create atlases of electronic topographic maps, geographic and special maps, which are nomenclature sheets of electronic materials sewn into a single block, belonging to one or different blocks, belts, zones, which allows selecting the zone number and recalculation of coordinates in the coordinate

system of this zone, as well as automatic stitching of double and quadruple nomenclature sheets.

There are also opportunities for interactive selection with the mouse of nomenclature sheets for creating atlases on the layouts (prefabricated tables - blank maps) of the corresponding subsystems and blocks displayed on the screen and drawing lines of a dynamic coordinate grid on a map of the area at the operator's command.

The program localizes the list of errors when stitching atlases with the name of the error.

It is also possible to create an atlas from materials in different projections, coordinate systems, with different units of measurement and automatically determine the working area of the atlas by the spatial position of the data and their coordinate system.

Development of a converter for converting digital terrain models into a single platform format

Geospatial data materials are in various vector formats and, when they are converted by standard means, there arises a problem of ambiguous conversion of digital map data into the selected single format - a combination of the ways of graphical representation of objects, a set and attribute values (KB Panorama, 2020). In particular, it requires establishing a correspondence between the attributes of objects on the source map and objects on the map in a single format, processing incorrect input of attribute values, etc.

A system is proposed for converting cartographic information presented in the MID / MIF (MapInfo) exchange format into a single SIP format.

The developed converter for re-designing the DTM allows a change of the existing geospatial data from the original format to the unified format of the SIP.

The converter allows users to accurately and reliably reformat existing cards into a single format. The developed converter allows forming the source digital data in the SGIP system, including both metrics and semantics. The converter also provides an unambiguous conversion of these materials to the SIPIP card format.

With the converter, the map data in the MID / MIF format is converted to the SIPM map format. The converter parses a MID / MIF file, forming both a graphic and semantic representation of objects.

Thus, the development of the SGIP will help achieve the goals of creating a modern combat-ready army, the effective use of geo-

information technologies in the implementation of combat control of troops and weapons.

During the reporting period, the scientific group carried out the following work:

- the analysis of the views of domestic and foreign experts on the development of geographic information platforms;
- the structure of a special geographic information platform has been formed;
- developed technical specifications for the SGIP;
- prepared technical specification for the acquisition of software and development tools:
- a program for the formation of atlases of electronic terrain maps has been developed;
- a converter has been developed for redesigning digital terrain models (DTMs) into a single platform format.

The formation of the SGIP structure, the development of technical specifications, the acquisition of the necessary software equipment and the development of special programs will allow to:

- promptly display and use in work any popular area from a large volume of source bases geospatial information (satellite images, cartographic materials);
- along with electronic maps, create geographic information products that are visualized in the form of layers of maps and tabular information;
- ensure the uniformity of requirements for protocols for the exchange of geospatial information between users of the GIS;
- ensure the formation of electronic documents (orders, directives, orders) and the issuance of commands when changing environmental conditions;
- and, on the whole, create a single information space based on the integration of generally applicable data and their descriptions by types of functional activity at all levels (links) of the Armed Forces command.

Conclusion

The development of the State Information System will provide managers of all levels of government agencies and organizations whose joint activities are aimed at solving the problems of ensuring the military security of the Republic of Kazakhstan with objective and operational geospatial information, as well as increase the efficiency of decisions by reducing the time to collect information about the area, to evaluate current geospatial data and to communicate it to the troops. This will help

achieve the goals of creating a modern combat-ready army, the effective use of geo-information technologies in the implementation of combat control of troops and weapons.

The development of special programs allows you to:

- promptly display and use in work any requested area of the terrain from a large volume of source geospatial information databases (satellite images, cartographic materials);
- along with electronic maps, create geographic information products that are visualized in the form of map layers and tabular information.

In general, it will contribute to the creation of a single information space based on the integration of generally applicable data and their descriptions of the types of functional activities at all levels (links) of command of both the Armed Forces and other troops and military units of the Republic of Kazakhstan.

References

Berlyant, A.M. 1997. *Geoinformatsionnoye kartografirovaniye*. Moscow: Lomonosov Moscow State University (in Russian). (In the original: Берлянт А.М. 1997. *Геоинформационное картографирование.* Москва: Московский государственный университет имени М.В.Ломоносова).

DeMers, M.N. 2008. *Fundamentals of Geographic Information Systems, 4th Edition.* Hoboken, New Jersey: Wiley. ISBN: 978-0-470-12906-7.

Evgievsky, I.V., & Morozov, N.N. 2005. Opyt TGO boyevykh deystviy voysk v 21 veke. *Nauka i voyennaya bezopasnost,* 2, pp.39-43 (in Russian). (In the original: Евгиевский, И.В., Морозов, Н.Н. Опыт ТГО боевых действий войск в XX веке. *Наука и военная безопасность,* № 2, с.39-43).

Goodchild, M.F. & Kemp, K.K. 1990. *NCGIA Core curriculum in GIS* [e-book]. Santa Barbara, CA: National Center for Geographic Information and Analysis, University of California. Available at: https://ibis.geog.ubc.ca/courses/klink/gis.notes/ncgia/ [Accessed: 20 April 2020].

Ivanov, V., & Markus, A. 1999. Topograficheskaya karta 21 veka. *Armejskij sbornik*, 9, pp.42-45 (in Russian). (In the original: Иванов, В., Маркус, А. 1999. Топографическая карта XXI века. *Армейский сборник*, № 9, с.42-45).

Kapralov, E.G., Koshkarev, A.V., & Tikunov, V.S. 2005. *Geoinformatika*. Moscow: Academia. ISBN 5-7695-1924-X (in Russian). (In the original: Капралов, Е.Г., Кошкарев, А.В. и Тикунов, В.С. 2005. *Геоинформатика*. Москва: Академия. ISBN 5-7695-1924-X).

-KB Panorama. 2020. *GIS "Panorama"* [online]. Available at: https://gisinfo.ru/products/products_panorama.htm [Accessed: 20 April 2020].

Konovalova, N.V., & Kapralov, E.G. 1997. *Vvedeniye v GIS: Uchebnoe posobie*. Moscow: GIS-Associacija. ISBN 5-88952-012-1 (in Russian). (In the original: Коновалова, Н.В., Капралов, Е.Г. *Введение в ГИС: Учебное пособие.* Москва: ГИС-Ассоциация. ISBN 5-88952-012-1).

Koshkarev, A.V., & Tikunov, V.S. 1993. *Geoinformatika*. Moscow: Kartgeocentr-Geodezizdat (in Russian). (In the original: Кошкарев, А.В., Тикунов, В.С. 1993. *Геоинформатика.* Москва: Картгеоцентр-Геодезиздат).

Lurie, I.K. 2000. *Osnovy geoinformatsionnogo kartografirovaniya (uchebnoe posobie)*. Moscow: Lomonosov Moscow State University (in Russian). (In the original: Лурье, И.К. 2000. *Основы геоинформационного картографирования (учебное пособие).* Москва: Московский государственный университет имени М.В.Ломоносова).

Raklov, V.P. 2011. *Kartografiya i GIS*. Kirov: Konstanta & Moscow: Akademicheskij proekt (in Russian). (In the original: Раклов, В.П. 2011. *Картография и ГИС.* Киров: Константа и Москва: Академический проект).

Tikunov, V.S. 2004. *Osnovy geoinformatiki.* Moscow: Academia (in Russian). (In the original: Тикунов, В.С. 2004. *Основы геоинформатики.* Москва: Академия).

Tsvetkov, V.Ya. 1997. *Geoinformatsionnyye sistemy i tekhnologii*. Moscow: Finansy i statistika (in Russian). (In the original: Цветков, В.Я. 1997. *Геоинформационные системы и технологии.* Москва: Финансы и статистика).

ПРИМЕНЕНИЕ ГЕОИНФОРМАЦИОННЫХ СИСТЕМ В ВООРУЖЕННЫХ СИЛАХ, ДРУГИХ ВОЙСКАХ И ВОИНСКИХ ФОРМИРОВАНИЯХ В РЕСПУБЛИКЕ КАЗАХСТАН

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РУБРИКА ГРНТИ: 36.00.00 ГЕОДЕЗИЯ. КАРТОГРАФИЯ;
36.29.00 Топография. Фототопография
36.29.33 Топографические и специализированные карты и планы. Цифровые модели местности.
ВИД СТАТЬИ: профессиональная статья
ЯЗЫК СТАТЬИ: английский

Резюме:

Введение/цель: Данная статья написана с целью ознакомления читателей со значимостью геоинформационной системы (ГИС) в процессе топогеодезического обеспечения всех сегментов командного управления и необходимостью развития концепции платформы ГИС, основанной на геоинформационных данных и функциях поддержки при принятии решений.

Методы: Применяя аналитический подход в изучении имеющихся причин, а также на основании опыта развития системы ГИС за рубежом, в данной статье приведены содержание и архитектура, установленной программы «Разработка специальной геоинформационной платформы в интересах обороны и безопасности Республики Казахстан»

Результаты: В статье приведен краткий обзор достигнутого уровня развития и структуры единой специальной геоинформационной платформы (СГИП), которая будет способствовать осуществлению государственных задач в создании современной армии и эффективном использовании геоинформационных технологий в поддержке вооруженным силам Республики Казахстан.

Выводы: В статье рассматривается важность создания единого государственного географического информационного пространства, основанного на интеграции геопространственных данных на всех уровнях управления, а также важность устранения дублирования бюджетных расходов при сборе и отображении геопространственной информации. Соответствующее применение геоинформационных технологий будет также способствовать повышению эффективности в управлении и контроле воинскими формированиями и вооружением, а также в создании современной армии, подготовленной к военным конфликтам.

Ключевые слова: геотопографическое и картографическое обеспечение, геоинформационные данные, геоинформационная система, визуализация, географический обзор, аэронавигационные карты, план города, электронный фотоплан, матрица свойств местности, автоматизированная система, дистанционное зондирование.

ПРИМЕНА ГЕОИНФОРМАЦИОНИХ СИСТЕМА У ОРУЖАНИМ СНАГАМА, ДРУГИМ ВОЈСКАМА И ВОЈНИМ ФОРМАЦИЈАМА У РЕПУБЛИЦИ КАЗАХСТАН

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ОБЛАСТ: геоинформационе технологије
ВРСТА ЧЛАНКА: стручни рад
ЈЕЗИК ЧЛАНКА: енглески

Сажетак:

Увод/циљ: Циљ рада је предочавање значаја геоинформационог система (ГИС) у процесу геотопографског обезбеђења свих сегмената командовања и неопходност развоја концепта ГИС платформе засноване на геоинформационим подацима у функцији подршке доношењу одлуке.

Методе: Користећи аналитички приступ на бази узрока и страних искустава развоја ГИС система приказује се садржај и архитектура усвојеног програма „Развој посебне ГИС платформе за одбрану и безбедност Републике Казахстан".

Резултати: Приказан је достигнут степен развоја и структура јединствене географске информационе платформе (СГИП) која треба да послужи остварењу државних циљева – стварању модерне војске и ефикасном коришћењу геоинформационих технологија у подршци оружаним снагама Казахстана.

Закључак: Сагледан је значај стварања јединственог државног географског информационог простора, заснованог на интеграцији геопросторних података на свим нивоима органа управљања, као и важност елиминисања дуплирања буџетских издатака при изради геопросторних информација. Такође, ефикасно коришћење геоинформационих технологија допринеће спровођењу борбене контроле трупа и наоружања и стварању модерне војске спремне за борбу.

Zakiev, E. et al, Application of geoinformation systems in the armed forces and other military formations in the Republic of Kazakhstan, pp.356-382

Кључне речи: геотопографска и картографска подршка, геоинформациони подаци, геоинформациони систем, визуализација, географски преглед, аеронаутичке карте, урбанистички план, електронски фотографски план, матрице карактеристика терена, аутоматизовани систем, даљинска детекција.

Paper received on / Дата получения работы / Датум пријема чланка: 23.03.2020.
Manuscript corrections submitted on / Дата получения исправленной версии работы / Датум достављања исправки рукописа: 13.05.2020.
Paper accepted for publishing on / Дата окончательного согласования работы / Датум коначног прихватања чланка за објављивање: 14.05.2020.

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