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APPLICATION OF GEOINFORMATION TECHNOLOGY IN THE ARMED FORCES IN THE REPUBLIC OF KAZAKHSTAN

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Abstract:

Introduction / purpose: This article is written in order to acquaint readers with geoinformation technology in the process of organizing topographic and geodetic support, as well as to make recommendations and suggestions that will enable the formation of an effective and comprehensive system of geoinformation support for the Armed Forces, other troops and military units of the Republic of Kazakhstan.

Methods: The analytical approach was used in the analysis of the causes of local warfare, armed conflicts and use of high-precision weapons in combat operations where sophisticated reconnaissance, geoinformation systems and communications are involved. The conclusions were also drawn on the basis of the analysis of the historical development of geoinformation technologies.

Results: The article provides a brief overview of geospatial support systems using geoinformation technologies in foreign countries and the topographic service of the Armed Forces of the Republic of Kazakhstan.

Conclusions: Creating a unified state geoinformation space is of high importance since technologies are developing in the direction of the

distribution of geoportals, cloud services and the development of service-oriented architecture systems that will allow the creation of distributed GIS of various kinds. Integration of geographic information systems with rapidly developing systems of remote sensing of the Earth will dramatically increase the capabilities of modern GIS, allowing real-time updating of spatial information, especially in the field of important decision-making.

Keywords: geoinformation technology, geoinformation support, geoinformation, geoinformation system, geospatial support systems, topographic service, remote sensing systems, Armed Forces of the Republic of Kazakhstan.

Introduction

Analyses of local wars and special operations show that, in the era of high-precision weapons and maneuverable combat operations, the highest importance is given to sophisticated reconnaissance equipment, topographic and geodetic and navigational support and communications. They provide timely detection and recognition of targets, command and control, accuracy and timeliness of strikes. Moreover, they allow all this to be done in real time.

The process of organizing topographic support for military operations 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 positions of missile forces and artillery and passing them to appropriate command and control bodies;
- providing staff 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 combat and during engagement in it;
- provision of appropriate systems for command and control, reconnaissance and guidance by digital electronic maps, digital terrain models;
- organization and timely communication to the troops of the results of topographic reconnaissance of the terrain and the enemy (Evglevsky & Morozov, 2005, p.40).

Topographic-geodetic and cartographic support is one of the main types of ensuring the effective development of economy, strengthening the country's defense and security and is a combination of managerial, production, scientific and educational measures for the creation, storage and communication of cartographic-geodetic data to consumers, including the territory and zones of the economic interests of the Republic of Kazakhstan and territories of foreign states.

The creation and use of cartographic and geodetic data is one of the most important factors contributing to the solution of key tasks of the state policy of the Republic of Kazakhstan, the creation of "Digital Kazakhstan", an increase in the share of digital products for command and control, a means in automated control systems.

All this dictates the need to take a fresh look at the problem of ensuring the country's security and fully sets the task of maintaining a high level of combat readiness of the Armed Forces, other troops and military units of the Republic of Kazakhstan, their comprehensive support, implementation of measures to develop operational (combat) support in modern conditions.

One of the types of operational (combat) support is topographic and geodetic support, which consists of the supply of geospatial information to the headquarters of the Armed Forces, other troops and military units of the Republic of Kazakhstan, for the effective management and use of weapons.

Nowadays, 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.

As was the case in the Gulf War, technology aspects are at odds with each other. Sometimes with technology, expectations become directly opposite without any kind of warfare. And sometimes a war ends in a very short time due to technology.

One of the most important parts of all types of wars is intelligence and operational information about the enemy and his units, reliable and obtained in a very short time.

The accuracy of the data in this article was proven in the conduct of hostilities by coalition forces in Iraq. In the article "Electronics today; November 1996" Major General Gurbaksh Singh says: "Lessons learned from military history show that victory over the enemy lies in being one step ahead of him in terms of the timeliness of providing information, managing subordinate units, and also the use of information systems.

Information systems and weapon control systems can warn the attack time, and assume the enemy's position with high probability and fairly accurately, in which case it is easier to take the necessary disposition before the enemy and destroy him" (Satyanarayana & Yogendran, 2009).

The preparation and conduct of warfare is impossible without reliable information about the terrain, which is reflected in the combat manuals of the armed forces of many countries of the world, including the United States.

Currently, the United States production facilities provide the creation of more than 300 types of geographic information documents not only for its Armed Forces, but also for the military contingents of the countries participating in joint operations with the American army. So, after the collapse of Yugoslavia, in military cooperation with the American army, military units of 33 countries used the American state standards in the field of cartography and information documents on the terrain created by topographers and surveyors of the United States (Azov, 2003).

According to the United States Ministry of Defense, in armed conflicts and local wars of the new century, the one who will win will be the one who is able to quickly collect multifaceted, constantly changing data on the course of the battle, analyze them, draw the right conclusions, make the right decision and quickly pass it to subordinates. For a guaranteed victory, it is necessary to achieve the so-called information superiority over the enemy, which makes it possible to forestall him in assessing the rapidly changing situation on the battlefield, making the right decision and planning the course of the operation (military operations). The description of the current situation should be large-scale, covering all aspects of the battle, sufficiently generalized and intuitive to decision-makers (Kulabukhov, 2007, pp.13-15).

The development of the 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, optical-electronic 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 in 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 in comparison to the armies of developed countries.

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 a society (Kulabukhov, 2007, pp.13-15).

Geoinformation support involves 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, a 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.

A 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. Many other functions are based on these two functions implemented with GIS (Goodchild & Kemp, 1990).

The term "geographic information system" (GIS), which appeared in the early 60s of the last century, underwent quite a lot of changes in its meaning, and for a long time did not have a clear and unambiguous interpretation. The number of existing definitions is almost equal to the number of authors who wrote on this topic. And since specialists from the most diverse branches of knowledge and practice (literally from geology to sociology) turned to GIS, considering them from their positions, the definitions of the essence of systems differ quite significantly.

With the development of science, knowledge about the earth, natural resources, geology and geography, geoinformatics in many countries of the world previously understood "a specialized section of computer science that deals with geography" (Ivanov & Markus, 1999, pp.36-37).

By area of the territory subject to cartographic and geodetic support, the countries closest to the Republic of Kazakhstan are: Russia, the USA, Canada and China. RK takes the 9th place in the world.

Historical aspects of the formation and development of a geoinformation system

The emergence and rapid development of GIS was predetermined by the rich experience of topographic and, especially, thematic mapping, successful attempts to automate the cartographic process, as well as revolutionary achievements in the field of computer technology, computer science and computer graphics.

Of particular note are the ideas and experience of integrated thematic mapping, which convincingly demonstrated the effect of systematic use of diverse data to extract new knowledge about geographical objects. Complexity and integrability are still the most important GIS properties that attract users.

Technological support for geo-mapping projects was implemented in the style of Automatic Design Systems. It is this approach that underlies modern geographic information systems. In the history of the development of GIS, the following main periods can be distinguished:

1. Pioneer period (late 1950s - early 1970s).

This is the time of researching the fundamental possibilities of creating GIS, accumulating knowledge, developing empirical experience, and creating the first large projects.

2. The period of state initiatives (early 1970 - early 1980).

This period was characterized by the development of large geoinformation projects supported by the state, the formation of state institutions in the field of GIS, and the reduction of the role and influence of individual researchers and small groups.

3. The period of commercial development of GIS (beginning of 1980 - end of 1990).

This was the period of creating a wide market for GIS software, creating desktop GIS, expanding their scope by integrating them with non-spatial data bases, the emergence of non-professional GIS users, and the emergence of distributed geodatabases.

4. User period (1990 - present)

This period has been characterized by increased competition among commercial manufacturers of GIS shells, the discovery of software systems that allowed users to adapt and upgrade the shell to their tasks, and the beginning of the formation of a global geographic information infrastructure (Baranov et al, 1999, p.14).

There are a few words to be said about organizations, projects and researchers who played a key role in the development of GIS.

The beginnings of GIS in Canada

The first geoinformation technologies were developed in the late 1950s - 1960s in Canada, the USA and Western Europe. Among the main achievements of this period in the GIS theory is the determination of the fundamental capabilities of geographic information systems; in the practical sphere, the development of the first large GIS. The largest and most successful of these was the Canada Geographic Information System (CGIS), developed under the guidance of renowned English geographer Roger Tomlinson.

The objectives of this GIS were to map the lands of Canada with their subsequent classification. It was decided to transfer tens of thousands of cartographic information storage units to computer media, to organize databases intelligently and to create software managing all this. Taken together, all this was to form a GIS.

What is fundamentally new to the creators of the Canada GIS in the formation and development of GIS technology?

1. The use of scanning to automate the process of entering geodata.
2. The division of cartographic information into thematic layers and the development of a conceptual solution about "attribute data tables", which made it possible to separate the planned (geometric) geoinformation files about the location of objects and files containing thematic (meaningful) information about these objects.
3. Functions and algorithms for overlay operations with polygons, calculation of areas and other cartometric indicators, and much more .

The advent of GIS in the USA

The US National Census Bureau, one of the organizations that played a key role in the development of geographic information systems, developed GBF-DIME (Geographic Base File, Dual Independent MapEncoding) format in the late 60s.

The history of GBF-DIME began in February 1967 when the US Census Bureau began experimenting with computer mapping. Bureau programmers struggled with inefficiency and redundancy when converting printed paper cards to digital cards. The problem was that in those days, every intersection of streets (in the US cities, there is often a trellis system when the streets form a grid of streets and avenues) was entered exactly eight times. According to Donald Cooke, who was a Bureau programmer at that time and became famous, in particular, for statements like “paper cards lead to fires but perform decorative functions well,” the problem was overcome thanks to the principles of cartographic topology proposed by Bureau's mathematician James Corbett.

Thus, the encoding scheme, later known as DIME, was discovered. The main idea was to renumber nodes (in this case, intersections of streets) and squares (blocks). In the summer of 1967, innovations showed their effectiveness in practice - they dramatically increased the efficiency of digitization and error detection and became the basis for mapping census results.

From the beginning of the 1970s to the beginning of the 1980s, the design of geographic information systems proved to be very costly, and the role of individual researchers in this area decreased markedly. At the same time, the role of state-funded large institutions increased. A number of large-scale geoinformation projects were implemented (Mishin, 2014).

The most famous of them is the census of the US National Census Bureau in 1970 using a special topological approach containing a mathematical method for describing the spatial relationships between objects, to organize the management of geographical information based on the presentation format of DIME map data.

This was a revolutionary innovation. The GBF-DIME format was later transformed into TIGER.

During the 70s, GBF-DIME cards were created for all US cities. This technology is still used by many modern geographic information systems.

The creation, state support and updating of DIME-files also stimulated the development of experimental work in the field of GIS based on the use of databases on street networks:

- automated navigation systems;
- systems for the removal of municipal waste and garbage;
- movement of vehicles in emergency situations, etc.

At the same time, based on this information, a series of atlases of large cities was created containing the results of the 1970 Census, as

well as a large number of simplified computer maps for marketing, retail planning, etc.

That is, in this period of the beginning of the 70s, a phenomenon such as raster computer mapping appeared. Points, lines and areal objects on the map were represented by many symbols. These data could be displayed on the plotter in various scales and projections. All attention and efforts at that time were focused on the map itself and then the foundations of modern GIS technology were laid.

The obvious advantage of computer mapping was the ability to select a site on the map and quickly draw it, while it took weeks to introduce changes to the map before introducing computer mapping. In the 80s, the foundations of modern computer cartography were laid. At this time, the attention and efforts of researchers were mainly focused on creating a high-quality digital map using graphic objects (points, lines and polygons) represented by a variety of coordinates. The obvious advantage of electronic cartography was the ability to select a plot on the map, change the scale, and display it on the plotter in various scales and projections. However, the cost of hardware and software was not available to all specialists. In this regard, opinions were even expressed about not promising and inexpedient development of GIS technology due to a very high price of the final product.

The oldest companies, founded in 1969, which are, to this day, the largest GIS developers, are ESRI (Redlands, California) and Intergraph (Huntsville, Alabama). These two companies are the producers of the most popular geographic information systems in the USA and in the world - for example, together they produce exactly half of the GIS used in the USA.

The largest contribution to the development of GIS and GIS technologies during this period was made by ESRI. The first ESRI commercial product, ArcInfo, was released in 1981. In the same year, the first ESRI user conference was held, bringing together 18 people. As new operating systems and new hardware emerged, ArcInfo quickly moved to new platforms. Deliveries of the latest version of the system - ArcInfo 8 - began a few months ago.

ESRI later focused on developing fundamental GIS ideas and applying them to real-world projects, such as developing a Baltimore reconstruction plan or helping MobilOil select a site in Reston.

Digital terrain models in the form of an irregular triangulation network were built at Simon Fraser University, which carried out the order of the US Defense Department. The main objective of the project was to solve the problem of matching the real hypsometric profile of a certain territory

(in other words, the elevation profile) with the model embedded in the computer. In other words, it was the military task of accurately guiding missiles at a target.

Widespread GIS and their active development led to a significant increase in competition in the market of geoinformation products, the intensification of research on their further improvement. At the same time, the processes of globalization of the geographic information infrastructure began.

The so-called "Age of Maturity" of GIS coincided in time with the intensive development of computer networks, which played a positive role in supplying geographic information systems with a wide variety of information. At this time, the demand for thematic information made us pay attention to the problem of data collection. The idea of an integrated information environment was formed when the data of space and aerial photographs coexisted peacefully in one system with a digital topographic base, various database tables, graphs, etc.

And finally, in the 90s, intelligent information systems appeared, using both visual and sound images, a variety of multimedia features. One of the latest achievements in the field of GIS is the construction of virtual worlds, while GIS provides three-dimensional visualization (Ivanov & Markus, 1999).

The GIS is currently a multimillion-dollar industry that involves millions of people around the world. Many experts call this period the user period, since the market for geographic information products has turned into the so-called customer market, when increased competition leads to the fact that the buyer, his preferences and needs begin to play a major role in the market.

During this period, an example of a new attitude towards users was shown by the developers and owners of the geographic information software GRASS (Geographic Resources Analysis Support System) for workstations created by the American military specialists (Army Corps of Engineers) for the tasks of environmental management and land management.

They opened GRASS for free use (public-domain), including the removal of copyrights to the source code of programs. As a result, users and programmers can create their own applications, integrating GRASS with other software products.

Currently, GRASS Version 4.1, created in 1993, including the source code of the programs, system and reference documentation, a training manual for users, a number of data sets as examples, is openly distributed on the Internet.

An example of Army Corpsof Engineers was followed by ESRI, which opened its ArcView 1 forWindows software product in 1994 for unlimited free use (also available on the Internet).

Currently, the leaders in global GIS are the products of two firms - this is the ArcFM system of the American company ESRI, and it provides users with a variety of tools. ESRI has strengthened its position as a leading provider of GIS software products; in 2017, it accounted for more than a third (more precisely, \$ 736.7 million, or 36%) of total sales of GIS software.

Intergraph Corporation (Huntsville, Alabama) took the second place in terms of sales of GIS software products. According to Daratech estimates, in 2017 this corporation delivered software for \$ 246.8 million, which is 9% of the total sales in the industry (in 2008 its share was 16%), (Gorno-Altayskiy Gosudarstvennyy Universitet, 2020).

The saturation of the market with GIS software tools, especially those designed for personal computers (Desktop GIS), has dramatically increased the scope of GIS technologies. This required substantial sets of digital geodata, as well as the need to form a system of training and education for GIS specialists. The GIS is studied in schools, colleges and universities.

Unfortunately, Kazakhstan and the former USSR did not participate in the global development of geographic information technologies until the mid-1980s. Nevertheless, our country has its own experience in the development of geographic information systems and technologies (Gorno-Altayskiy Gosudarstvennyy Universitet, 2020).

GIS history in Europe

In general, the achievements of the United States overshadow the achievements of Europe, and indeed the rest of the world. Nevertheless, Europe has also made a significant contribution to the process. The situation with computer mapping in Europe had certain differences, which led to the fact that Europe went its own way in the process of developing GIS.

It is interesting that one of the first successful experiments using the principle of complexing (combining and superimposing) spatial data using an agreed set of maps dates back to the 18th century! The French cartographer Louis-Alexandre Berthier used the transparent layers superimposed on the base map to show the movement of troops in the battle of Yorktown (Kulabukhov, 2007, pp.13-15).

The fact is that almost every European country has its own national cartographic agency.

Thus, about 30 organizations produce maps in Europe on a scale of 1:25 000 and higher, while in the United States there are only two such organizations - the civilian US Geological Survey and the military Defense Mapping Agency. In addition, the national cartographic agencies of European countries had more responsibilities and were engaged in both cadastres and land information systems - that is, they did the part of the work that universities or private campaigns did in the USA.

Some of the European agencies started experimenting with computerized inventory databases (for example, in Sweden and Austria) very early. Ordnance Survey in England, IGN in France and the national mapping agency of Germany quite successfully mastered the new technology. There were other pioneers. Alas, their heyday never came.

Unfortunately, the European companies that worked with GIS were not as successful as their American counterparts. So, approximately at the same time as ESRI and Intergraph, the English Ferranti and the Swiss Contraves were founded (a little later the Norwegian Koninglike Wappenfabriek and the German Messerschmidt-Boelkow-Bluehm joined them).

Ferranti offered a geographic information system for cadastral mapping in the late 70s, but soon disappeared from the market. Why did it stop developing? There is still no answer to this question.

Much can be gleaned from collections of reports at early GIS conferences. Survey companies such as Wild and Kern (which later merged with Leica) took up GIS under the influence of a successful project in Basel. The companies went in different ways - one of them adapted American products for the European market, the other developed its own product. Siemens, Laser-Scan (recently celebrated its thirtieth birthday) and Smallworld are European companies founded in the years of the GIS and still operating. True, you will not immediately remember which GIS each of them proposed.

It is believed that many of the differences between European and American GIS histories are caused, firstly, by the difference in the education system, and secondly, by the fact that people from various professions were involved in the creation of GIS on different sides of the Atlantic. In Europe (especially in Germany) they were mainly surveyors, in the USA - geographers. Programmers played a big role on both continents. In addition, the good old European conservatism influenced the development of GIS. Nevertheless, the exchange of ideas between Europe and America was very effective.

History of development of topogeodesic support in the Republic of Kazakhstan

The history of mapping of Kazakhstan is inextricably linked with the mapping of the territory of the USSR. Until 1945, all topographic and geodetic and cartographic work was carried out by the topographic and geodetic teams of the Central Asian Airborne Geodetic Enterprise and by the topographic teams of the West Siberian Airborne Geodetic Enterprise Figure 1.



Figure 1 – Mapping the territory of Kazakhstan
Рис. 1 – Картографирование территории Казахстана
Слика 1 – Мапирање територије Казахстана

In order to prepare personnel for the tasks of mapping the territory of Kazakhstan, by order of the USSR Minister of Education and the head of the Main Directorate of Geodesy and Cartography under the Council of Ministers of the USSR No. 64/195 of July 3, 1946, the Semipalatinsk Topographic College was opened. In the period from 1960 to 1985, the military department of the Semipalatinsk Topographic College carried out training with the qualifications of technician-geodesist, technician-aerial photo-geodesist, cartographer, and a military rank of sublieutenant.

Officers graduating from the topographic college served in the vast expanses of the Soviet Union - in Central, Central Asia, Volga, North-West, Siberian, Ural and Far Eastern districts, and also performed international duties in Afghanistan, Africa and other countries.

After the independence had been gained, graduates of the topographic college continued their service in the ranks of the topographic service of the Armed Forces of the Republic of Kazakhstan, namely: Lieutenant Colonels Myrzabaev K.S., Yaudenov B., Boyandinov A.B., Kozlov AV., majors Shipilin Yu.V., Akishbaev S.S., foreman Konakpaev S.K., sergeant Acheulov A.A., and many others.

Some graduates of the topographic college (not having the military rank of sublieutenant) decided to connect their fate with the army and graduated from the Leningrad Higher Military Topographic Command School named after Army General Antonov (later the St. Petersburg Higher Military Topographical Command School, 2003; Military Topographical Institute of the F.M. Mozhaysky Military Space Academy): reserve colonel Mausymbekov E.Z., master, colonel Zakiev E.S. and colonel Dzhanpeisov M.E.

From 1984 to 2005, only 5 officers graduated from the Leningrad Higher Military Topographic Command School named after the Army General Antonov (reserve colonel Karabalaev N., Zh., reserve lieutenant colonel Kenzebekov B.K., Lahanov K.T. colonel Baizanov A.L. (PhD) and colonel Maykhiev D.K.).

From 1990 to 2003, 7 officers (reserve colonel K.S. Bayashev, master colonel E. Zakiev, colonels S. Zholdybaev, S. Ashirov, P. P. Goncharenko, and reserve captains Kemerbaev N.T. and Mikhailovsky P.V.) graduated from the St. Petersburg Higher Military Topographical Command School (Zakiev & Gerasimov, 2017, pp.94-100).

They held various positions in the topographic service of the Armed Forces of the Republic of Kazakhstan. During 28 years of the existence of the topographic service of the Armed Forces of the Republic of Kazakhstan, it has undergone a number of transformations and changes in the organizational structure.

1992-1998

The Military Topographic Directorate of the General Staff of the Armed Forces of the Republic of Kazakhstan - creation and establishment of a topographic service.

1998-2001

The topographic service of the main operational management of the General Staff of the Armed Forces of the Republic of Kazakhstan during this period created the Republic State Enterprise *Kazakhstan GIS Center* with modern equipment to create topographic maps for the aircraft.

2001-2007

The Main Directorate of New Technologies of the Armed Forces of the Republic of Kazakhstan developed the "Concept for the creation of a geoinformation system of the Armed Forces of the Republic of Kazakhstan", which defines the main directions for the development and implementation of a geoinformation system in the command and control system.

In order to implement the Law of the Republic of Kazakhstan "On Geodesy and Cartography" and the Concept for the creation of a geographic information system of the Armed Forces of the Republic of Kazakhstan, an order was issued by the Chairman of the Committee of Heads of Staff - First Deputy Minister of Defense of the Republic of Kazakhstan No. 288 dated July 6, 2005 "On the implementation of a geographic information system and software MapInfo Professional in the Armed Forces Republic of Kazakhstan".

In addition, the Kazakhstan GIS Center joint stock company in the MapInfo Professional program for the Armed Forces of the Republic of Kazakhstan created digital (vector) topographic maps of the territory of the Republic of Kazakhstan on a scale of 1: 1,000,000, 1: 500000, 1: 200000, 1: 100000, and the creation of digital topographic maps with scale updates of 1: 50,000 (Zakiev, 2012).

2007-2010

With the withdrawal of the Military Topographic Directorate from the DPO (Department for Operational Planning of the Republic of Kazakhstan) and its transformation into an independent structural unit, certain measures were taken to improve the structure of the existing topographic support system.

In implementation of the provisions of the Military Doctrine on the self-sufficiency of groupings of troops, the provision of topographic and geodetic information to formations, military units and institutions is carried out on the basis of territorial affiliation from regional map stores.

The positions of chiefs of topographic services and topographical officers were introduced in the types of armed forces, military branches, regional commands, and constant readiness formations. Thus, a command and control structure was created from the tactical to the strategic level. In January 2010, the Military Topographical Directorate withdrew from the DPO. In 2008, the achievements in the field of digital cartography were demonstrated to the Supreme Commander-in-Chief of

the Armed Forces of the Republic of Kazakhstan - the President of the Republic of Kazakhstan.

The topographic service participated at the joint exercises of the CRRF CSTO (Collective Rapid Reaction Force of Collective Security Treaty Organization) Interaction-2009.

The training of reserve officers of topographic and geodetic specialties began in the Military Department of the S. Seifullin Kazakh Agro Technical University.

2010-2014

During this period, the Military Topographic Directorate of the General Staff of the Armed Forces of the Republic of Kazakhstan acquired modern topographic and geodetic instruments for performing topographic and geodetic work, Figure 2.



Figure 2 – Production of the terrain models by topographers of the Armed Forces of the Republic of Kazakhstan in 2010

*Рис. 2 – Изготовление макета местности топографами ВС РК 2010 г.
Слика 2 – Модел терена који су израдили топографи Оружаних снага Републике
Казахстан 2010. године*

At the joint exercises of the Shanghai Cooperation Organization Peace Mission-2010, the topographic service produced layouts of the area and completely restored the points of the state network and the points of the artillery network at the Matybulak training ground and at other military training grounds in the Republic.

In 2012, at the National University of Defense, a new course - Geoinformation Systems - was introduced at the Faculty of General Staff and subsequently for all specialties at the master's program, Figure 3.

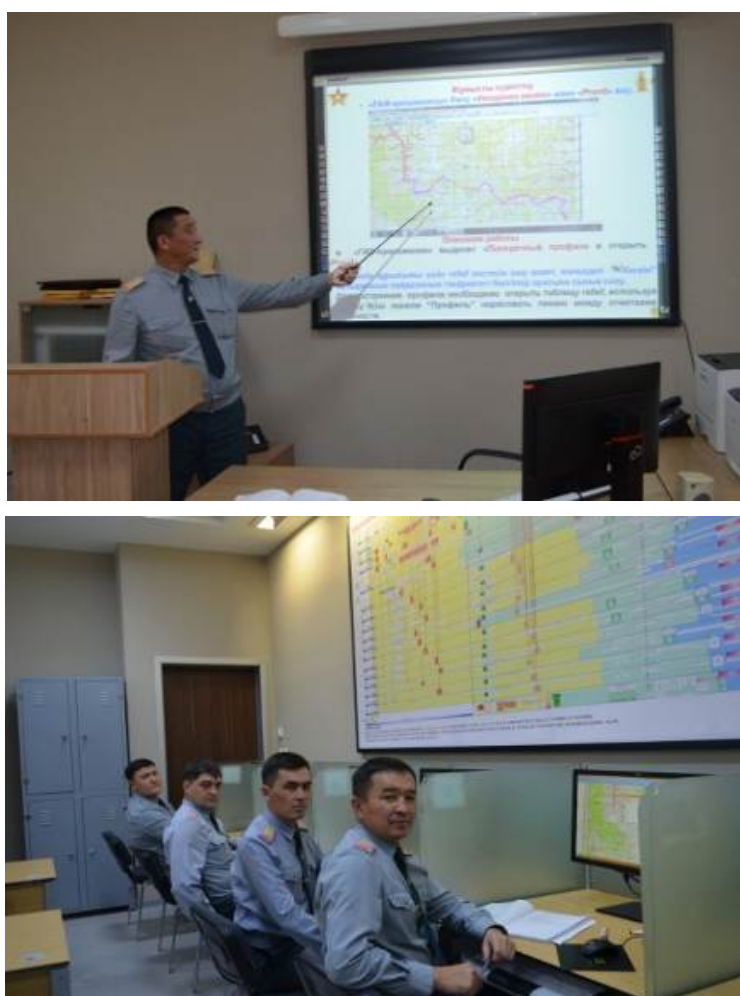


Figure 3 – Lesson with undergraduates in the GIS course
Рис. 3 – Занятие с магистрантами по дисциплине «ГИС»
Слика 3 – Предавање из предмета ГИС постдипломцима

2014-2017

During this period, the Department of Geoinformation Support of the Main Directorate of Armed Forces of the Republic of Kazakhstan purchased a mobile navigation and geodetic complex for the topographic part intended for the operational solution of tasks related to topographic and geodetic training of areas for combat use of troops, topographic and geodetic reference (control of the accuracy of topographic and geodetic reference) of the elements of military combat units, and topographic reconnaissance, Figure 4.



Figure 4 – Mobile navigation and geodetic complex
Рис. 4 – Подвижный навигационно-геодезический комплекс
Слика 4 – Мобилна навигација и геодезски комплет

At the National University of Defense named after the first president, Elbasy, a new subject named Topogeodesic Support of Troops was

introduced in September 2016 and a unified program for the Military Topography subject is being developed together with the Defense Ministry of Kazakhstan for all military institutes of the Armed Forces of the Republic of Kazakhstan.

As a result of studying the discipline, undergraduates of the National University of Defense named after the First President of the Republic of Kazakhstan - Elbasy should be informed:

- about the principles, tasks and systems of topographic and geodetic support;
- about the organizational structure of the topographic service of the Armed Forces of the Republic of Kazakhstan;
- about the system of providing troops with topographic maps, initial astronomical and geodetic data, special maps and photo documents of the area;
- on the purpose, armament and capabilities of the units of topographic and geodetic support;
- about the features of the tasks of topographic and geodetic support in various conditions;
- about modern concepts of the development of geographic information technology.

They should know:

- the content of measures of topographic and geodetic support of military operations of troops;
- organization of topographic and geodetic support;
- about geographic information technologies and their use in the command and control system;
- about the capabilities of geographic information systems and their development trends in the leading countries of the world.

They should be able to:

- plan and organize events for topographic and geodetic support of troops;
- perform stock calculations of topographic maps and special works;
- develop a plan for topographic and geodetic support and orders;
- work in a geographic information system with software (input, manipulation, management, query and analysis, visualization);
- identify and relate GIS problems to other sciences;
- apply GIS on command post exercises and in everyday performance.

The should familiarize themselves:

- with the purpose of geographic information technology in the processing of digital information about the area and its use;
- with the main directions of the development of geographic information technology in the state and the Armed Forces.

From 2013 to the present, undergraduates have been lectured in the discipline of Geoinformation Systems by years: 2013 - 60 people; 2014 - 83 people; 2015 - 113 people; 2016 - 137 people; 2017 - 149 people; 2018 - 121 people, 2019 - 113 people, which is total of 776 people.

2017-2019

The Directorate of Geographic Information Support of the Center for Military Space Programs of the Ministry of Defense of the Republic of Kazakhstan.

The problem of using unified geoinformation data 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 Operations Management Center and
- in the CoES 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.

From 2002 to 2016, a large volume of cartographic materials in the Mapinfo format has been created in the Ministry of Defense of the Republic of Kazakhstan. 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 is carried out with a loss of quality of materials (Zakiev et al, 2020, pp.356-382).

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.

To address all of the above aspects, officers of the National Defense University named after the First President of the Republic of Kazakhstan, the Leader of the Nation, took part in a competition for grant funding for the project *Development of the geographic information system in the Armed Forces, other troops and military units of the Republic of Kazakhstan*.

The purpose of the project is improving the quality of geoinformation information and increasing the effectiveness of planning and decision-making in combat operations and operations in the Armed Forces, other troops and military units of the Republic of Kazakhstan.

The tasks are:

- to develop the principles and requirements for the system of preparation and accumulation of unified geographic information and support in peacetime and wartime, and
- to develop recommendations for improving the system of transmission and control of geographic information of the Armed Forces, other troops and military units of the Republic of Kazakhstan.

2019 - until now

The Department of Geoinformation Support of the General Staff of the Armed Forces of the Republic of Kazakhstan plans to adopt in 2021 a Special Geoinformation Platform (hereinafter - the SGIP) created as part of the implementation of the scientific and scientific-technical program as part of targeted funding for the scientific and scientific-technical program (hereinafter - the program) "Development of a special GIS platform for the defense and security of the Republic of Kazakhstan."

The SGIP allows organizing the accumulation, storage, accounting, search and provision of interested consumers with geospatial information in real time on the principle of geographically distributed data banks.

Such information will be available in the electronic form to various categories of users through geoportals, both through secure and open channels of the Ministry of Defense data transmission system to other troops and military units in the Republic of Kazakhstan.

To date, navigation support in the Armed Forces of other troops and military units, related services and technical equipment has developed separately by branches and arms without close mutual coordination of organizational structures and coordination of technical policies for the creation of navigation equipment and systems. This entailed a number of organizational and technical problems.

The creation of a single special geographic information platform will allow the formation of a functional, organizational and technical unity of all weapon systems. Its concept is based on the principle of centralized management in combination with a rational distribution of powers and responsibilities between military command and control bodies.

Conclusion

Spatial data is crucial for a military commander in a battle, as he is responsible for making decisions in operation planning and developing. The Ministry of Defense in any country collects data on routing, filtering, analysis and presentation of information for decision-making. Regional conflicts, rapid deployments, and flexible responses place a heavy burden on military commanders, their staff, and auxiliary systems to maintain the situation on the ground with regard to enemy operations. Visualizing raw tabular data in a spatial structure has many advantages. Therefore, digital mapping and GIS are central to such diverse activities as battlefield simulation, mission briefing and communications planning, logistics management and team management.

The analysis of geospatial support systems made it possible to identify their main features and directions for future development. In particular, technologies are developing in the direction of the distribution of geoportals, cloud services and the development of service-oriented architecture systems that will allow the creation of distributed GIS of various kinds. Integration of geographic information systems with rapidly developing remote sensing systems of the Earth will dramatically increase the capabilities of modern GIS, allowing real-time updating of spatial information, especially in the field of important decision-making. It can be suggested that the three main categories of data collection used to create GIS databases include: field data collection and GPS, aerial reconnaissance, and satellite reconnaissance.

Thus, the Unified Special Geographic Information Platform will provide full and current cartographic and other specialized information about the navigation situation to all control units, which completely eliminates duplication and significantly reduces the time it is brought to the troops.

References

Azov, V.Yu. 2003. Kontsepsiya sozdaniya yedinoj informatsionno-upravlyayushchey struktury VS SSHA. *Zarubezhnoye voyennoye obozreniye*, 1 (in Russian) [online]. Available at: <http://pentagonus.ru/publ/3-1-0-72> [Accessed: 10 May 2020]. (In the original: Азов, В.Ю. 2003. Концепция создания единой информационно-управляющей структуры ВС США. *Зарубежное военное обозрение*, №1)

Baranov, Yu.B., Berljant, A.M., Kapralov, E.G., Koshkarev, A.V., Serapinas, B.B., & Filippov, Yu.A. 1999. *Geo-Informatics. Explanatory dictionary of basic terms*. Moscow: GIS Assotiation (in Russian). ISBN: 5-89227-019-X [online]. Available at: <http://www.geokniga.org/bookfiles/geokniga-berlyant-amkoshkarev-avgeoinformatikatolkovyy-slovarmgis-associaciya1999.pdf> [Accessed: 10 May 2020]. (In the original: Баранов, Ю.Б., Берлянт, А.М., Капралов, Е.Г., Кошкарев, А.В., Серапинас, Б.Б., Филиппов, Ю.А. 1999. *Геоинформатика. Толковый словарь основных терминов*. Москва: ГИС Ассоциация. ISBN: 5-89227-019-X).

Evglevsky, 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: Евглевский, И.В., Морозов, Н.Н. 2005. 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: 10 May 2020].

-Gorno-Altayskiy Gosudarstvennyy Universitet. 2020. *Istoriya razvitiya geoinformatsionnykh sistem* (in Russian) [online]. Available at: <http://e-lib.gasu.ru/eposobia/gis/2.html> [Accessed: 10 May 2020]. (In the original: Горно-Алтайский государственный университет. 2020. *История развития геоинформационных систем* [онлайн]. Доступно по адресу: <http://e-lib.gasu.ru/eposobia/gis/2.html>).

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).

Kulabukhov, A.N. 2007. Primeneniye sovremennykh informatsionnykh tekhnologiy v khode planirovaniya boya. *Voyennaya mysl*, 9, pp.13-15 (in Russian) [online]. Available at: <http://militaryarticle.ru/voennaya-mysl/2007-vm/10046-primenenie-sovremennykh-informacionnyh-tehnologij-v> [Accessed: 10 May 2020]. (In the original: Кулабухов, А.Н. 2007. Применение современных информационных технологий в ходе планирования боя. *Военная мысль*, № 9, с.13-15).

Mishin, E.I. 2014. *Geograficheskiye informatsionnyye sistemy: Uchebnoye posobiye*. Smolensk: Smolensk State Agricultural Academy (in Russian) [online]. Available at: http://www.sgsha.ru/sgsha/biblioteka/Geograf_vet.pdf [Accessed: 10 May 2020]. (In the original: Мишин, Е.И. 2014. *Географические информационные системы: Учебное пособие*. Смоленск: ФГОУ ВПО «Смоленская ГСХА»).

Satyanarayana, P., & Yogendran, S. 2009. Military applications of GIS. *Geospatial World*, 9 January [online]. Available at: <https://www.geospatialworld.net/article/military-applications-of-gis/> [Accessed: 10 May 2020].

Zakiev, E.S. 2012. *Geoinformatsionnaya sistema v VS RK: Uchebno-metodicheskoye posobiye*. Shchuchinsk: Izdatelskiy tsentr NUO (in Russian). (In the original: Закиев, Е.С. 2012. *Геоинформационная система в ВС РК: Учебно-методическое пособие*. Щучинск: Издательский центр «НУО»).

Zakiev, E.S., & Gerasimov, S.V. 2017. 25-let topograficheskoy sluzhbe Vooruzhennykh Sil Respubliki Kazakhstan. In: *Proceedings of International scientific-practical conference Professionalization of the army - a reliable guarantor of ensuring the military security of the state*, Astana, pp.94-100 (in Russian). (In the original: Закиев, Е.С., Герасимов, С.В. 2017. 25-лет топографической службе Вооруженных Сил Республики Казахстан. В: *Сборник материалов международной научно-практической конференции «Профессионализация армии – надежный гарант обеспечения военной безопасности государства»*, Астана, с.94-100).

Zakiev, E.S., Pankov, S.V., & Kalabay, K.B. 2020. Application of geoinformation systems in the armed forces and other military formations in the Republic of Kazakhstan. *Vojnotehnički glasnik/Military Technical Courier*, 68(2), pp.356-382. Available at: <https://doi.org/10.5937/vojtehg68-25830>.

ПРИМЕНЕНИЕ ГЕОИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ В ВООРУЖЕННЫХ СИЛАХ РЕСПУБЛИКИ 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

Резюме:

Введение/цель: Данная статья написана с целью ознакомления читателей с геоинформационной технологией в процессе организации топогеодезического обеспечения, а также с выработкой рекомендаций и предложений, которые позволят сформировать эффективную и полноценную систему геоинформационного обеспечения Вооруженных Сил, других войск и воинских формирований Республики Казахстан.

Методы: Применяя аналитический подход при исследовании причин локальных войн и вооруженных конфликтов с использованием высокоточного оружия и маневренных боевых действий с помощью видовых средств разведки, геоинформационных систем и связи. Выводы были сделаны и на основании анализа исторических аспектов становления и развития геоинформационной технологии.

Результаты: В статье приведен краткий обзор систем геопространственного обеспечения с использованием геоинформационных технологий в зарубежных государствах и топографической службе Вооруженных Сил Республики Казахстан.

Выводы: Создание единого государственного географического информационного пространства является весьма важным фактором, так как технологии развиваются в направлении распространения геопорталов, облачных сервисов и развитие систем сервисноориентированной архитектуры, которые обеспечивают создание ГИС различной направленности. Интеграция геоинформационных систем с быстро развивающимися системами дистанционного зондирования Земли резко увеличит возможности современных ГИС, позволяя в режиме реального времени актуализировать пространственную информацию, особенно в области принятия важных решений.

Ключевые слова: геоинформационные технологии, геоинформационное обеспечение, геоинформация, геоинформационная система, системы геопространственного обеспечения, топографическая служба, системы дистанционного зондирования, вооруженные силы Республики Казахстан.

ПРИМЕНА ГЕОИНФОРМАЦИОНЕ ТЕХНОЛОГИЈЕ У ОРУЖАНИМ СНАГАМА РЕПУБЛИКЕ КАЗАХСТАН

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ОБЛАСТ: информатичке технологије, геоинформатичке технологије
ВРСТА ЧЛАНКА: стручни рад

Сажетак:

Увод/циљ: Циљ чланка је да упозна читаоце са геоинформационом технологијом у процесу организовања топографске и геодетске подршке, као и да да препоруке и предлоге који ће омогућити формирање ефикасног и свеобухватног система геоинформационе подршке за оружане снаге, остале трупе и војне јединице Републике Казахстан.

Метод: При методу анализе узрока локалних ратова, оружаног сукоба и употребе високо-прецизног оружја у вођењу борбених операција у којима се примењују софистицирана средства за извиђање, као и савремени географски информатички системи и комуникације, коришћен је аналитички приступ. Закључци су изведени и на основу анализе историјског развоја географских информатичких технологија.

Резултати: Укратко су приказани системи геопросторне подршке који користе геоинформатичке технологије, како у страним земљама, тако и у топографској служби Оружаних снага Републике Казахстан.

Закључак: Стварање јединственог државног геоинформационог простора је од велике важности, будући да се технологије развијају у правцу дистрибуције геопортала, као услугама путем cloud-а и системима рачунарске архитектуре усмереним на услуге, који ће омогућити стварање разноврсних геоинформатичких система. Интегрисање географских информатичких система са системима даљинске детекције Земље који се брзо развијају драстично ће повећати могућности модерног ГИС-а, омогућавајући ажурирање просторних информација у реалном времену, посебно у области доношења важних одлука.

Кључне речи: геоинформационе технологије, геоинформациона подршка, геоинформације, геоинформациони систем, системи геопросторне подршке, топографска служба, системи даљинске детекције, оружане снаге Републике Казахстан.

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