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**GEOINFORMATION SYSTEMS IN THE DEVELOPMENT OF INTERACTIVE
SCIENTIFIC HISTORICAL MAP “THE PEOPLE OF KAZAKHSTAN”**

The article is devoted to the development of the scientific historical interactive map “The People of Kazakhstan”, using geoinformation and WEB technologies. The main objective of the interactive map is, through the creation of historical and graphic maps and the accompanying scientific and reference material, to reveal and highlight the consolidating role of the Kazakh nation, aimed to establishing social harmony, establishing interethnic peace, developing national unity and strengthening tolerance on ancient Kazakh land. The important place on the Map is occupied by the Kazakhstan model of social harmony and national unity, reflecting the processes of modernization of the public consciousness of Kazakhstan people, the spiritual renewal of the Nation. The article describes the performed research work on the development and implementation of the scientific historical interactive map “People of Kazakhstan” in the form of an extensive information resource that provides for the systematization and collection of information on the historical periods of Kazakhstan’s development into a single geodatabase. Description of the technical aspects of the Map implementation, development and vision of the concept, structure of the project are provided, and information on the main components of the interactive map system is provided. The interactive historical map “The People of Kazakhstan” is intended to demonstrate the general context of the formation events of the people of Kazakhstan, the tendencies of its formation in time and space, the process of uniting the ethnic groups of Kazakhstan into one People.

Key words: historical period, interactive map, vector data, cartographic base, geoinformation systems.

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**«Қазақстан халқы» интерактивті ғылыми тарихи картасын
жасаудағы геоақпараттық жүйелер**

Мақала «Қазақстан халқы» интерактивті ғылыми тарихи картасын, геоақпараттық және WEB технологияларды пайдалана отырып құрастыруға арналған. Интерактивті картаның негізгі міндеті тарихи-графиктік карталарды құрастыру және сонымен қоса жүретін ғылыми-анықтамалық материал арқылы ежелгі қазақ жерінде қоғамдық ынтымақтастық пен этносаралық бейбітшілікті орнату, халықтардың бірлігін дамыту мен толеранттылығын нығайтуға бағытталған, қазақ ұлтының нығайтушы рөлін ашып көрсету. Картадағы маңызды орынды, қазақстандықтардың қоғамдық санасын, Ұлттың рухани жаңғыруын модернизациялау процестерін көрсететін қоғамдық ынтымақтастық пен жалпыұлттық бірліктің қазақстандық моделі алады. Мақалада Қазақстан дамуының тарихи кезеңдер бойынша бірыңғай географиялық мәліметтер базасында жинақтау және жүйелеуді қамтамасыз ететін кеңейтілген ақпараттық ресурс түріндегі «Қазақстан халқы» интерактивті ғылыми тарихи картасын құрастыру және жүзеге асыру барысында жүргізілген ғылыми-зерттеу жұмыстарына сипаттама беріледі. Картаны даярлаудың техникалық аспектері, жасау және дамыту концепциясы, жобаның құрылымы мен интерактивті карталар жүйесінің негізгі деректерінің сипаттамасы беріледі. «Қазақстан халқы» интерактивті ғылыми тарихи картасы Қазақстан халқының қалыптасу оқиғаларының жалпы мазмұнын, оның уақыт пен кеңістіктегі қалыптасу тенденцияларын, Қазақстанның этникалық топтарын бір халыққа біріктіру процесін көрсетуге бағытталған.

Түйін сөздер: тарихи кезеңдері, интерактивті карта, векторлық мәліметтер, картографиялық негіз, геоақпараттық жүйелер.

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Геоинформационные системы в разработке интерактивной научной исторической карты «Народ Казахстана»

Статья посвящена разработке научной исторической интерактивной карты «Народ Казахстана» с применением геоинформационных и WEB-технологий. Основной задачей интерактивной карты является посредством созданных историко-графических карт и сопровождающего их научно-справочного материала раскрыть и осветить консолидирующую роль казахской нации, направленную на установление общественного согласия, установление межэтнического мира, развитие народного единства и укрепление толерантности на древней казахской земле. Важное место на Карте занимает Казахстанская модель общественного согласия и общенационального единства, отражающая процессы модернизации общественного сознания казахстанцев, духовного обновления Нации. В статье дается описание выполненных научно-исследовательских работ по разработке и реализации научной исторической интерактивной карты «Народ Казахстана» в виде обширного информационного ресурса, обеспечивающего систематизацию и сбор в единую базу геоданных информации по историческим периодам развития Казахстана. Приводится описание технических аспектов реализации Карты, разработка и видение концепции, структуры проекта и приводятся сведения об основных компонентах системы интерактивной карты. Интерактивная историческая карта «Народ Казахстана» призвана демонстрировать общий контекст событий формирования народа Казахстана, тенденции его формирования во времени и в пространстве, процесс единения этносов Казахстана в один Народ.

Ключевые слова: исторический период, интерактивная карта, векторные данные, картографическая основа, геоинформационные системы.

Introduction

The project was implemented on the Order of the Ministry of Education and Science of the Republic of Kazakhstan by the following scientific-research institutes: “Ch. Valikhanov Institute of History and Ethnology” RSBSE, “Institute of Geography” LLP and “Institute of Information and Computational Technologies” RSE on the REU.

Kazakhstan is a country, where representatives of more than 100 ethnicities live peacefully. According to the latest National Population Census, 129 ethnic groups live in Kazakhstan. The reasons for such a diversity of nationalities are associated with the history of the movement of peoples and the military gains in Central Asia. In earlier times, the Great Silk Road passed through the territory of the country. As a result, before the founding of the Soviet Union, Kazakhstan became home to a huge number of peoples: Kazakhs, Uzbeks, Turkmens, Kirghizes, Persians, Chinese, Uighurs, Tunguses, Russians, Ukrainians, Tatars and many others. Also after the end of the Second World War, some peoples were deported to Kazakhstan and representatives of other nationalities - Koreans, Germans, Chechens, Ingushes, Poles, Crimean Tatars, Turks, Greeks, many of whom were victims of deportations, began to live here.

The importance of the formation of historical consciousness, the preservation of historical memory in modern conditions is very great. First of all, it ensures people’s awareness of the fact that they constitute a single nation, united by a commonness of historical destiny, traditions, culture, language and psychological traits. At various stages of their development, the tribes, peoples, nations strove to preserve the memory of their past in various forms: from oral traditions and heroic epics, when there was no written language, to all kinds of written storytelling, imaginative writings, scientific papers, monuments of fine art. This contributed to the self-affirmation of this community of people as a nation. Therefore, the study of history and the formation of historical consciousness gain practical importance in modern conditions.

The interactive historical map “The People of Kazakhstan” is aimed at demonstrating the general context of the events of the formation of the Kazakhstan’s people, the trends of its formation in time and space, the process of unification of the ethnic groups of Kazakhstan into single People. The creation of the Map contributes to solving the tasks of the formation of the national historical consciousness of young people, the need to help them preserve national traditions, the sense of belonging to their people, the sense of citizenship, personal

responsibility for its security and the integrity of the homeland, pride in its history.

In order to ensure the convenience of use, the interactive historical map “The People of Kazakhstan” is compiled in 3 languages (Kazakh, Russian, English) and is presented in the form of a stylized dynamic Web-resource and is available on the official site of the People’s Assembly of Kazakhstan <http://assembly.kz/ru> for anyone who wants to study the history of the people of Kazakhstan anywhere in the world and at any convenient time. (<http://assembly.kz/ru>).

Materials and Methods of research

It is most conveniently to trace historical changes in the distribution and movement of the population due to political, economic, socio-demographic and other factors through cartographic visualization of the situation. Creation of the “The People of Kazakhstan” series of maps by means of a cartogram using administrative formations of this or that period as units of mapping, carrying out the geo-information analysis (visual), obtaining results in the form of thematic maps of interrelationships were carried out using the fully-functioning ArcGIS 10.3 geoinformation system.

Geoinformation technologies (GIS) have great possibilities of reflection, analysis and modeling of spatial objects and phenomena in comparison with traditional methods. GIS makes it possible to develop and implement cartographic and thematic databases of different hierarchical level and territorial coverage. Application of them allowed propelling the solution of spatial problems to new heights. The essence of geographic information systems is that they make it possible to collect data, create databases, enter them into computer systems, store, process and convert, and then issue them for users on their requests, often in cartographic form or in the form of tables, graphs, texts. (Evangelidis K. et al. 2018)

All cartographic information of “The People of Kazakhstan” interactive historical map is developed and presented in the form of thematic vector layers with a database, reflecting the ethnic foundations of the Kazakh people from the VII century B.C. to the beginning of the XIII century A.D., the settlement of tribes within the Kazakh steppe, ethno-demographic indicators of the population, as well as the modern period of the human population of Kazakhstan.

Conceptual foundations for the creation of “The People of Kazakhstan” interactive map, as well as other cartographic works, are determined and provided by:

- the system of visual and expressive cartographic works integrated by a general objective, the unity of methodology and consistency of results;

- the concept focused on cartographic support of state, regional and industry-based programs for socio-economic development and protection of the natural environment;

- common methodological approaches to creating cartographic products;

- the principles and methods of qualimetry through the integration of time, territorial, inter-component indicators;

- the system of targeted indicators of atlas mapping, displayed in maps: the inventory-assessment, forecast, advisory, control ones, with current databases (A.R. Medeu 2014: 45).

In general, the creation of “The People of Kazakhstan” interactive map is based on modern trends in science - interdisciplinary complexity, systemacity, the application of geoinformation technologies, traditional, remote and innovative methods. The works were performed using the results of previous studies, proven author’s methods of assessment, forecasting, mapping and planning. Methods of mathematical modeling are widely applied. (A.M. Berlyant 2014, V.P. Raklov 2014, I.K. Lurie 2016)

Results and discussion

According to the developed concept, “The People of Kazakhstan” interactive map is presented in the form of horizontal and vertical sections, displaying historical and geographical data. The horizontal section shows a chronology of events - historical periods of formation, demographic growth, migration and resettlement of ethnic groups in the territory of Kazakhstan. The vertical section describes historical events and the development of ethnic groups in certain historical periods. As a result, the following is displayed: the state-forming mission of the Kazakh nation in the process of consolidation of all ethnic groups on the Kazakh land; resettlement of ethnicities of Kazakhstan over the regions and districts of Kazakhstan (taking into account the changes in administrative-territorial division within the country (if necessary) and state borders, starting from ancient times and till the present. A detailed section demonstrates ethno-demographic, cultural-ethical characteristics of each ethnic group, in particular, the dynamics of numbers, specific density, resettlement, ethnic history, economics, ethnographic characteristics, during the entire period of historical development in the territory of Kazakhstan.

The process of creating the interactive historical Map has passed through a series of important stages. The comprehensive inventory-assessment stage for the collection and systematization of data on the history of the population of Kazakhstan can be considered as the first stage. Coordination of the works on the issues of thematic cartography was implemented by the historians of the “Ch. Valikhanov Institute of History and Ethnology” Republican State Budget-Supported Enterprise.

Modern domestic historiography conditionally singles out five, sometimes six, major periods in the history of Kazakhstan. These are the most ancient, ancient, medieval periods, early modern and contemporary times. In contemporary times, the history of Kazakhstan in the Soviet period and the history in the period of independence are distinguished. It made it possible to identify 5 thematic units in “The People of Kazakhstan” interactive historical map (1 – History of the Great Steppe; 2 – On the path to independence: from the history of the formation of the people of Kazakhstan; 3 – Memory for the sake of the future; 4 – the Kazakhstan’s model of social harmony and national unity “Kazakhstan is the Nation of the One Future” by N. Nazarbayev; 5 – Thanksgiving Day). These units are considered as separate information pages in the framework of the Interactive Map, while an interactive historical map provides interaction of users with historical and geographical material based on the name and task setting of the map.

In the most ancient period, Kazakhstan has passed a stage from the emergence of the first man and to the formation of human societies, and this period corresponds chronologically to the Stone and Bronze Ages.

The second chronological stage of the most ancient period of the history of Kazakhstan is the Bronze Age (II century B.C. - VIII century B.C.). Its beginning can be attributed to the end of the II millennium B.C., when the ancient tribes mastered the production of bronze products.

In the VIII-IV centuries B.C., various Scythian-Saka tribal associations lived on the territory of Kazakhstan and adjacent regions, then at the turn of the Common Era, the first state formations of Yuezhi, Huns, Usuns and Kangyu appeared here (O.V. Korenets 2013:5). The disintegration of tribal associations served as an objective factor for the appearance in the first centuries of the Turkic tribes, who were mobile, proficient in horse-drawn archery as real nomads. The unification of the tribes led to the formation of a huge empire - the Turkic Kaganate, which lost its power and split into two states by the

mid-600s. Later, the Arabs and the Chinese perform expansion into this territory. The Talas battle (in 751) between the Karluks, the Byurgeshes, the Arabs and the Chinese stopped the intentions to spread Chinese influence to Central Asia for many centuries. The Mongolian period of governing is characterized by a tectonic change in the world order on a vast territory. The collapse of this empire contributed to the formation of the Kazakh Khanate in the middle of the XV century under the leadership of Zhanibek and Kerey. Despite the invasions of Kalmyk Oirats, the Kazakh Khanate managed to be preserved as an independent state formation until the entry of the Kazakh zhuzes (Junior (the Kishi) - 1731, Middle (the Orta) - 1735 and Senior (the Uly) - 1848) into the Russian Empire. The loss of independence and the change of state borders in the colonial period in the conditions of the USSR were accompanied by loss of land, economic and political independence. Kazakhstan was part of the Soviet Union as a quasi-sovereign state (M.K. Abuseitova 2010:120).

The XX century, which was rich in various events, made a dramatic difference in the life of the Kazakh steppe. The first two decades of the century were marked by major revolutionary events that radically changed the political structure of Kazakhstan and the entire Russian Empire, which was replaced by Soviet Russia. The first two decades (1917-1937) of the Soviet regime were accompanied by major social experiments of Communists - military communism, a new economic policy, the forceful collectivization of agriculture, industrialization, mass political repressions. In the 1920s, Kazakhstan experienced a period of administrative and territorial transformations, when it gained modern borders as a result of the national-state boundary settlement. Pervasive forced collectivization of agriculture caused a great famine in the Kazakh steppe, which resulted in the loss of half of the Kazakh population. During the Second World War of 1941-1945, Kazakhstan has become an important armory of the front. In 1954, there was mass development of virgin and fallow lands in the country, which had its positive and negative consequences. The aggravation of crisis phenomena in the economy of Kazakhstan and the whole country from the 1960s to the early 1980s eventually led to the collapse of the Soviet Union and the formation of new independent states.

First of all, with the gaining of independence (December 1991), Kazakhstan finally adjusted and legally formalized its borders along the entire perimeter with neighboring countries. It has all the attributes and symbols of statehood and is recognized by the international community. The independence

of the state formation of the Republic of Kazakhstan, for the first time established on a new international legal basis, makes it possible today to celebrate the 550th anniversary of the Kazakh statehood.

On December 16, 1991, Kazakhstan adopted the Constitutional Law “On State Independence of the Republic of Kazakhstan”, which finally completed the constitutional formation of our country as an independent, new state on the world map. Over the years of independence of the Republic of Kazakhstan under the leadership of the First President of the country N.A. Nazarbayev, all the attributes of real sovereignty were enshrined, and the socially-oriented democratic state, based on the principles of sustainable development, is being actively built (Z.E. Kabul'dinov, M.N., Kalimoldaev, A.R Medeu 2017:35).

Each section of the interactive map is accompanied by a thematic quote from the President of the Republic of Kazakhstan, showing the complex history of the formation of a polyethnic nation of Kazakhstan for the period from the Kazakh Khanate to modern Kazakhstan - the period of Independence.

Another important stage of the works was the transformation of information into a cartographic vector format in the form of layers of “The People of Kazakhstan” interactive map. The work was performed by GIS specialists of the Institute of Geography LLP. Vector layers with the display of the thematic historical information by the periods and the cartographic bases were created in the GDB (Geographic Database) in the *.gdb format, in the form of classes of spatial objects, in geographic information systems on the basis of the application of licensed ESRI software products: ArcGIS 10.2.

Traditional methods for creating and using digital vector bases include the definition of a mathematical framework as a necessary element. The mathematical framework includes the theory of cartographic projections, their application, scale, division of sheets, coordinate grids built in a given geodetic system, as well as nomenclature of maps. (Tomlinson R. 2003)

WGS 84 (World Geodetic System of 1984) is used in international practice as a standard for the calculation of locations, distances and other parameters. In addition, it is also necessary to represent the displayed on the map territories with known coordinates in any projection. This is important, since knowledge about the position of the compiled maps in space is a prerequisite for dealing with cartographic information in the GIS. Mathematical formulas are used to bring spherical geographical coordinates to two plane coordinates,

and the transformation process is defined as a cartographic projection (L.M. Bugayevskiy 1998:111).

In order to choose the most suitable projection, in our case, such aspect as preservation of equidistance in the mapping of the vast area of the earth's surface that the Republic of Kazakhstan occupies was taken into account. Therefore, we chose an equidistant conic projection with the definition of the central meridian and standard parallels as the projection for creating a digital topographic basis and all topographic layers.

A single spatial reference of all layers of maps is an important condition for the rules of topology, which is especially relevant when creating an electronic version of maps. For this purpose, all classes of spatial objects were grouped into object datasets. The sets were traditionally organized according to subjects: hydrography, administrative-territorial units, etc.

Digitization of the cartographic base represented by administrative-territorial division, settlements and hydrographic network was carried out on the basis of paper topographic maps at the scale of 1:1 000 000, which were compiled in 1984, as well as the latest digital satellite imagery. All objects of the digital cartographic base were represented in the form of classes of spatial objects (point, linear and area) - a digital representation of the reality object (digital terrain model) containing its location, a set of properties, characteristics and attributes.

The “Administrative-Territorial Division” class of spatial objects (vector layers) contains information on the general border of Kazakhstan, the boundaries of administrative areas in the form of polygonal and linear layers. The attribute table of these layers contains data with the name of regions and the Classifier of Administrative-Territorial Objects (CATO). The territorial-administrative borders visualize both the current situation with the latest changes and the inclusion of new administrative districts, as well as each historical period of the country's development, when the internal structure and configuration of administrative units were changing (Figure 1). In addition, changes in the state borders of Kazakhstan with neighboring countries were taken into account.

The “Settlements” class of spatial objects of the object dataset on modern population centers of Kazakhstan was created with the use of CATO of the settlements of Kazakhstan, the reference copy of which is maintained by the Agency for Statistics of the Republic of Kazakhstan. The entire set of objects of the administrative-territorial division

of the Republic of Kazakhstan is divided into groups that are located at levels according to their administrative subordination. Each level includes objects directly subordinate to the objects of the

previous level. The modern state of administrative-territorial objects, including population centers, is distributed among five levels, which are presented in Table 1.

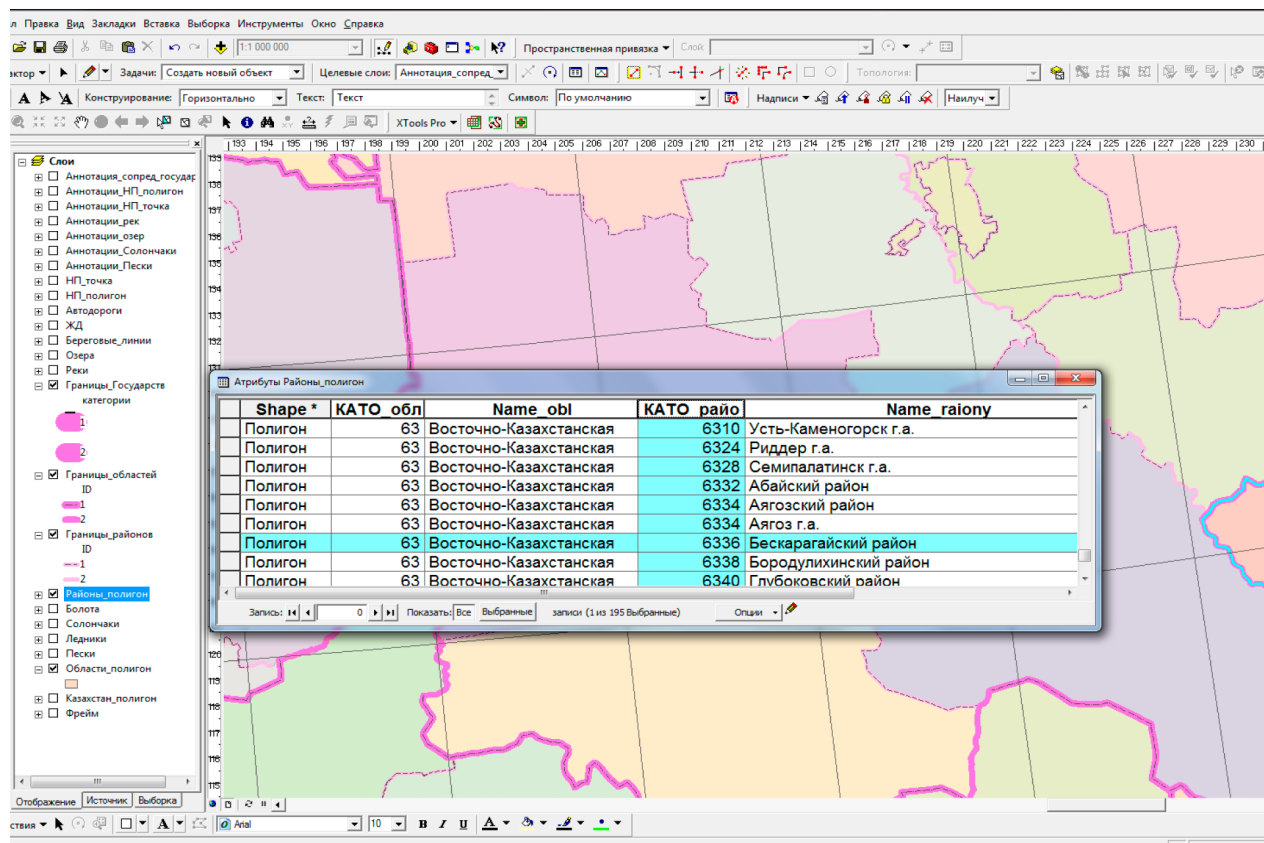


Figure 1 – Fragment of mapping layers of the state and administrative borders in ArcGIS

Table 1 – Levels of administrative-territorial objects and population centers

Level	CATO	PC
I	Regions Cities of national significance	-
II	Districts in the city of national significance Districts Cities of regional subordination	Cities of national significance
III	Districts in the city of regional subordination Cities of district subordination Townships Counties (aul/rural)	Districts in the city of national significance*) Cities of regional subordination
IV	-	Districts in the city of regional subordination*) Cities of district subordination Townships Auls/villages with a population size of 50 or more people
V	-	Peasant and other settlements with a population of less than 50 people

*) It is considered as PC conditionally, as it is an integral part of the city

With the application of the classification developed by the Agency for Statistics of the Republic of Kazakhstan, vector layers having a spatially and administratively precise reference were created for all population centers of Kazakhstan.

In order to create the digital cartographic base of Kazakhstan, rivers (in linear classes of spatial objects), lakes (in polygonal classes of spatial

objects) were vectorized. The obtained vector layers of watercourses and reservoirs contain attribute tables with names of hydrographic objects. The contours of the coastal lines of all water bodies in the territory of Kazakhstan were specified, updated and classified according to the LANDSAT satellite imagery. The data from a topographic base at a scale of 1:1 000 000, LANDSAT space images were also used for the vectorization of the

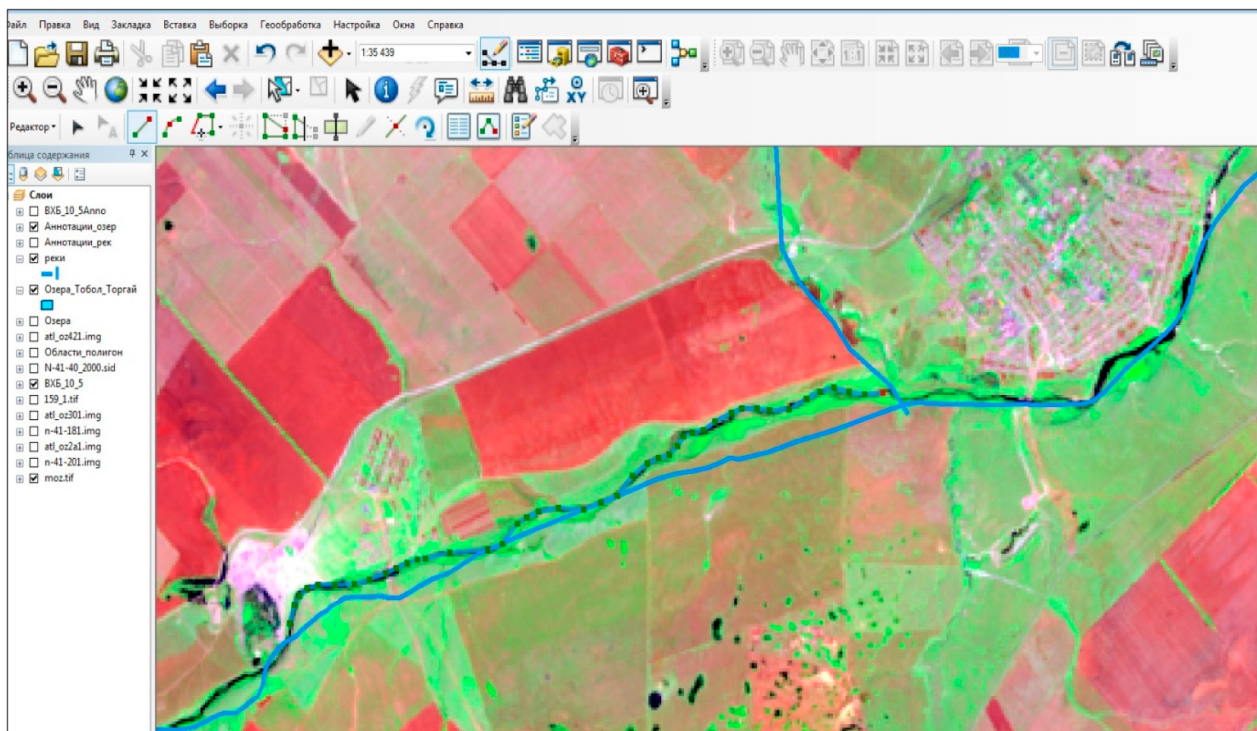


Figure 2 – Example of the use of the LANDSAT space images for the creation of the vector layer of rivers

layer of watercourses. Digitization was carried out at a detailing of 1:50 000 and covered the entire territory of Kazakhstan. Based on the use of topographic maps and the latest digital satellite imagery, a linear layer of watercourses was created (Figure 2).

The inscriptions of objects are made on the map based on the attributes of the layer of data on proper names of objects in the table. The margins with supplemental characteristics of the object contain (quantitative or qualitative) information for this object. The inscriptions for the objects of the digital base are simplified in comparison with the traditional ones, since complex, multi-layered conditional marks essentially inhibit the output of the map to the screen.

Vectorization of thematic historical layers of maps was carried out on the basis of the performed systematization and classification of historical materials in accordance with the requirements of digital cartography.

For the first time in ethno-cartographic practice, the ethnic history of the peoples of Kazakhstan was grouped in the legend of the electronic historical map according to the chronological principle. The interactive map is represented by the following main elements: stylistically compiled map of Kazakhstan with the indication of the modern borders of our country. Each historical period is supplemented by an information unit displaying text and graphic data corresponding to the selected historical period. Elements of the detailed section are displayed

in the pop-up data window when clicking on the corresponding object of the map.

Along with this, the development of a computer model for storing and presenting historical and GIS data was carried out by the specialists of the “Institute of Information and Computational Technologies” RSE on the REU. The model of representing historical data is a document-oriented object in the JSON format stored in the MongoDB non-relational database (<https://www.mongodb.com>). MongoDB is a document-oriented open-source database management system that does not require a description of the scheme of tables, and which is classified as NoSQL DBMS. This system applies JSON-like documents and a database schema. Each record of historical data in this system is bound to the corresponding layer

of the geoinformation system. Geoinformation data are managed in raster and vector format by the Quantum GIS (QGIS) server of GIS data. QGIS is a popular open-source GIS that has a wide range of capabilities (<https://www.qgis.org/>). The application of QGIS was aimed at making the use of geoinformation systems easy and understandable for the user. The interface of Quantum GIS is much more understandable for an inexperienced user than the interface of, for instance, GRASS (on which QGIS is largely based), and in some aspects even exceeds the widespread GIS. The interface of Quantum GIS was created using the Qt toolkit. This system made it possible to process electronic maps compiled with the use of the ArcGIS platform. The example of the QGIS system interface is shown in Figure 3.

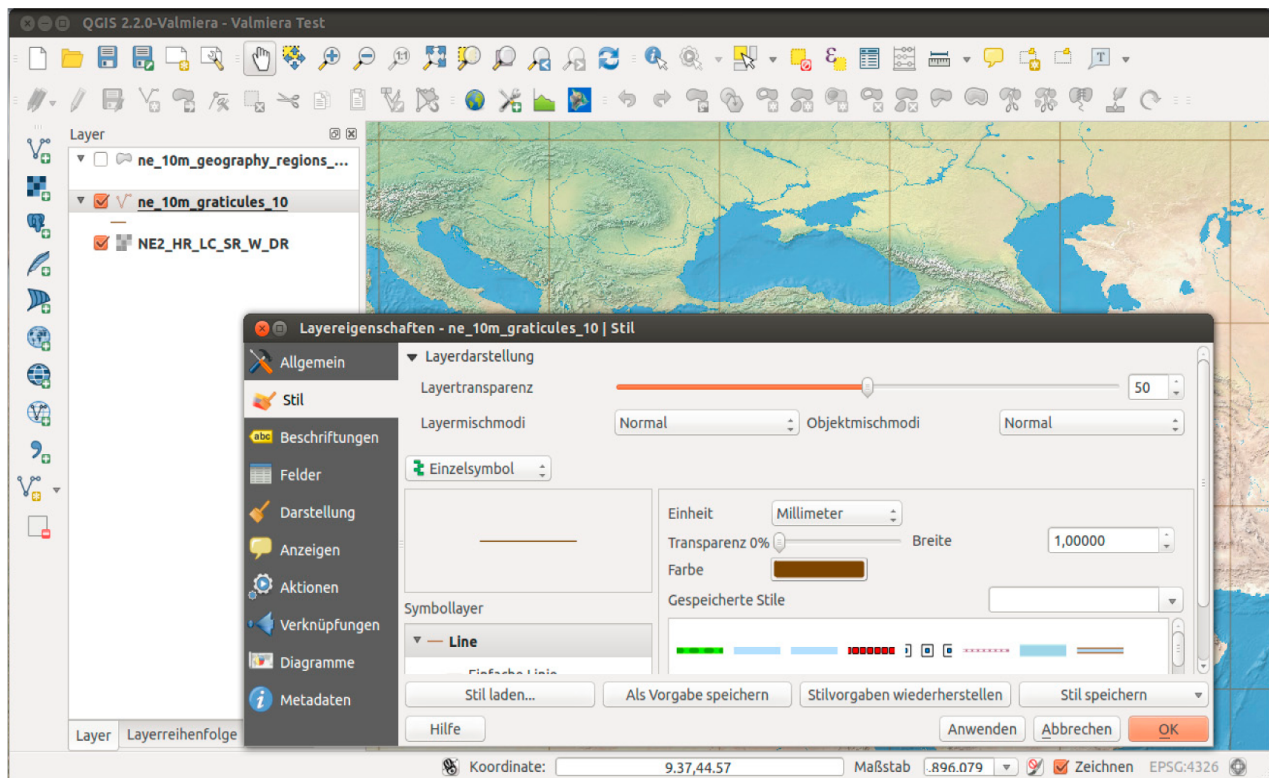


Figure 3 – Main window of the QGIS platform

The interface of the interactive map is represented by the following main elements:

- A stylistically compiled map of Kazakhstan and neighboring countries.
- Maps navigation tools;
- Information unit, which is the main element of the display of text and graphic information,

displaying data corresponding to the selected time period;

- Animated context data displayed over the map, visually displaying the changes in the selected time period; Individual map montages are presented in Figures 4-8.



Figure 4 – Ethnic foundations of the Kazakh people (the III century B.C. – the V century A.D.)

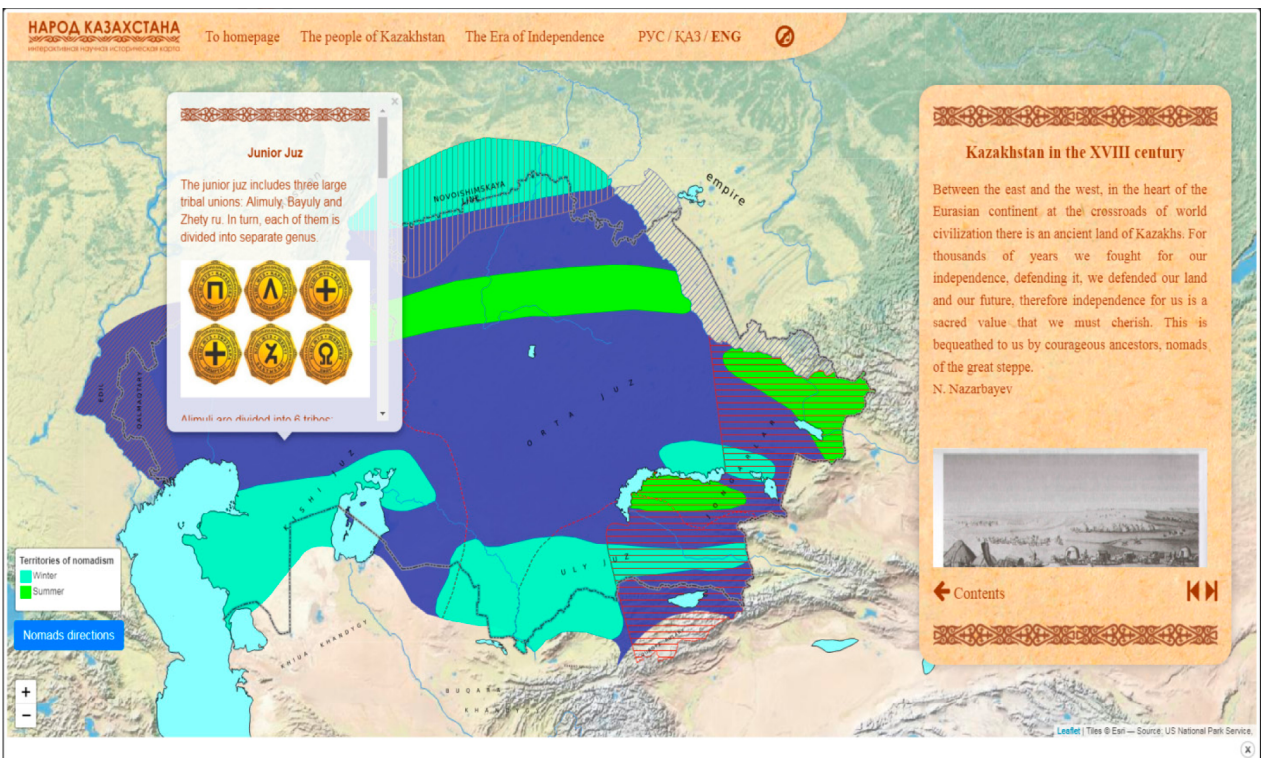


Figure 5 – Kazakhstan in the XVIII century

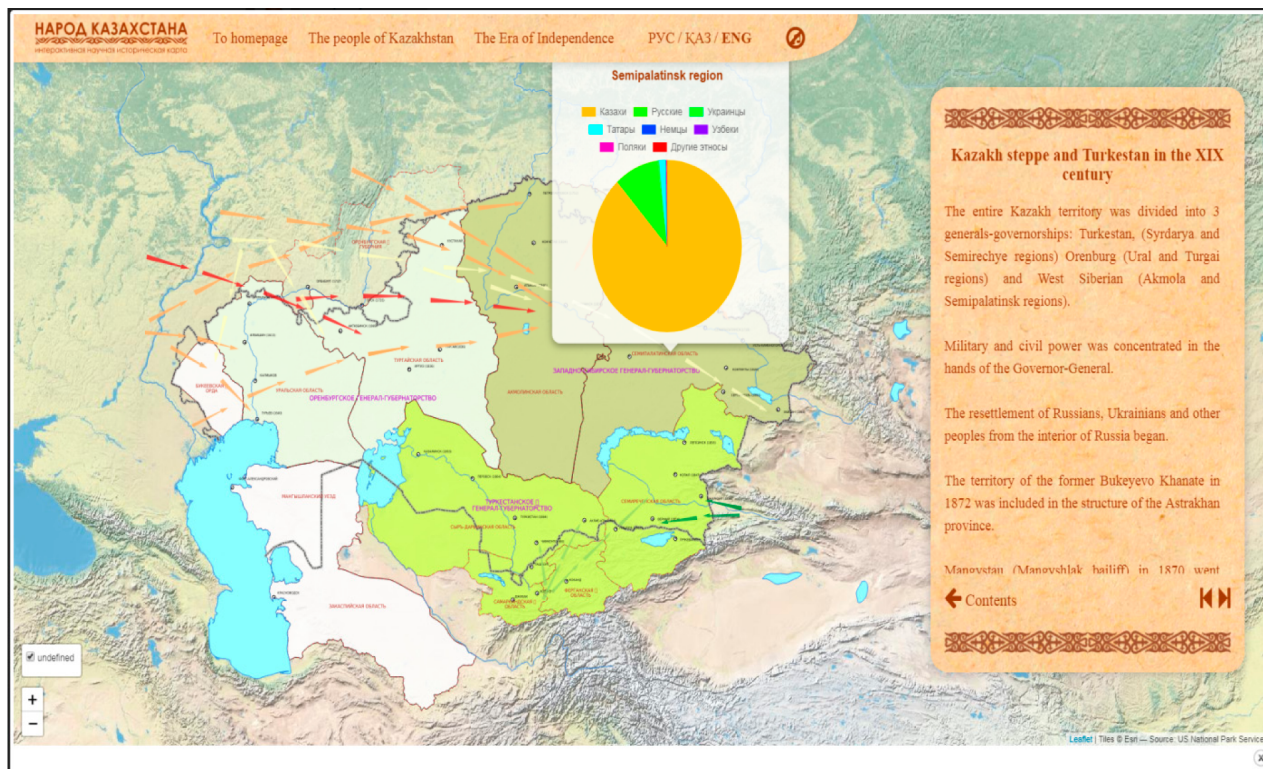


Figure 6 – Kazakh steppe and Turkestan in the XIX century

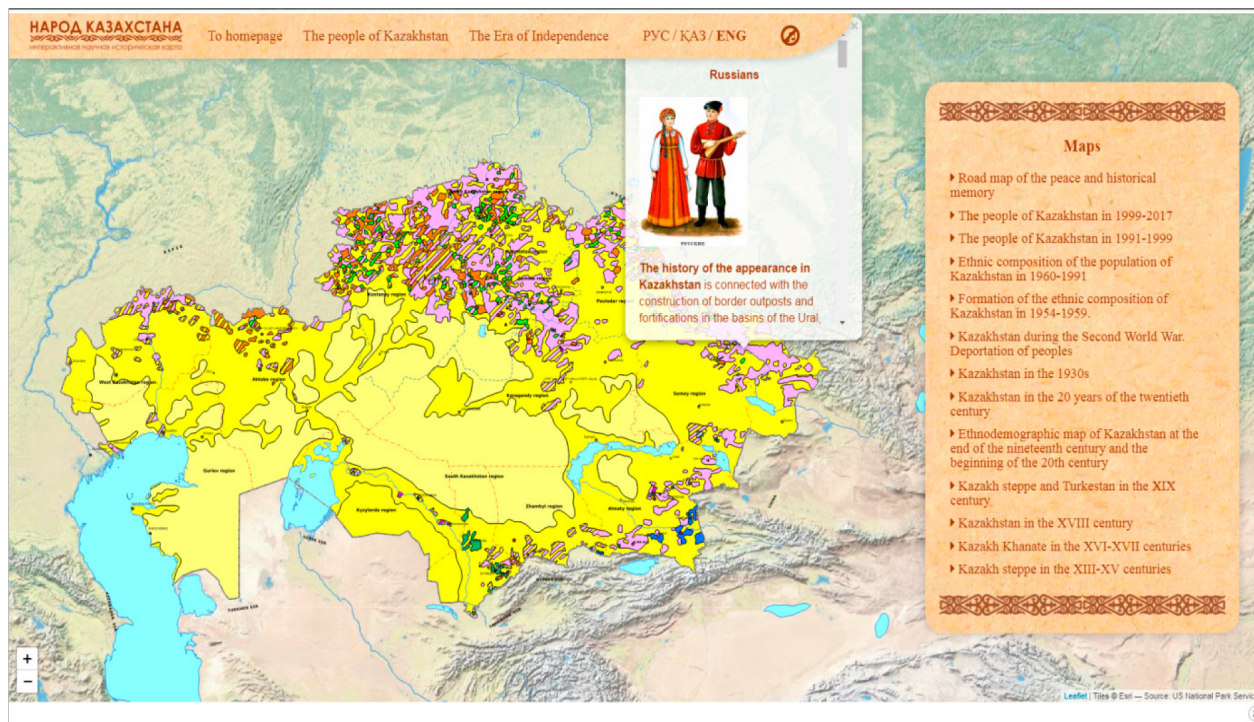


Figure 7 – Formation of the ethnic composition of Kazakhstan in 1954-1959.

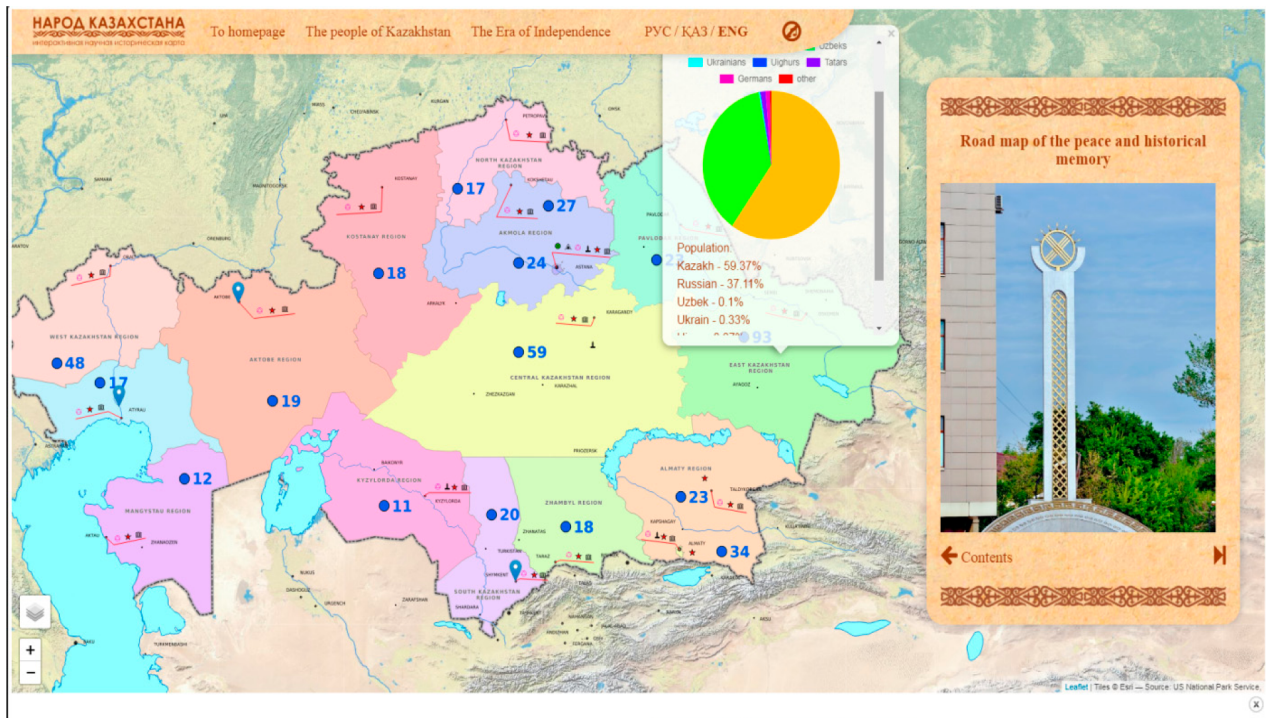


Figure 8 – Road map of the world and historical memory

The technical conditions (for example, the standard dimensions of graphic symbols), aesthetic moments (for example, visual balance of the entire composition) and especially the fundamental requirements aiming at correctly displaying the intent of the map, ensuring its ideological value and convenience in using it, were taken into account in the development of the maps.

Conclusion

“The People of Kazakhstan” scientific interactive historical map will become a kind of breakthrough in the field of dissemination of historical information also in the modern educational process, since the application of innovative computer and GIS technologies will make it possible to improve the

perception of the user of scientific products. The map is available in the form of a Web-based application, which will allow ensuring rapid and large-scale delivery of information to a wide range of Internet users. The cartographic interface will provide standard capabilities for working with maps: obtaining information on the object, visualizing thematic maps. According to its informative value, the electronic map can replace a huge paper information material of a school and university textbook.

Potential users of “The People of Kazakhstan” interactive scientific historical map are state bodies, scientific-research, educational and cultural-educational organizations, national-cultural associations, business sphere, domestic and foreign scientists, ordinary citizens and the People of Kazakhstan as a whole.

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