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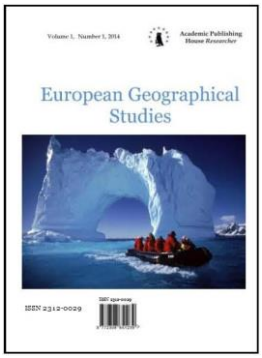

The History and Current State of Thematic Mapping in Russia

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Abstract

The paper describes a 300-year history of thematic cartography in Russia, which began in the first half of the XVII century. Special attention is given to atlas mapping that was first implemented at end of the XIX century. The most prominent examples are the Great Soviet World Atlas and Physical Atlas of the World. The National Atlas of Russia (in four volumes) is described in detail. The role of integrated regional atlases of the country is demonstrated. The modern thematic cartography in the country is focused on mapping seas, oceans, and environment, and creation of maps for higher educational institutions.

Keywords: Russia, thematic mapping, history, atlases.

1. Introduction

Thematic mapping is multifaceted and covers all areas of the environment, demography, and economics, as well as all territorial levels – the world, as a whole, continents, countries, and individual regions; it is a comprehensive representation of geographical phenomena and processes. Comprehensive mapping involves creation of systems of interrelated (interconnected) thematic maps that reflect natural and/or socio-economic territorial complexes. The concepts of territorial complexes laid a foundation for methodological principles that allow creation of systems of interconnected maps (Evteev et al., 1997a). These principles require modeling of relationships between elements, presentation of characteristics and relationships of the mapped territorial systems with the help of charts, creation of functional mapping types (base, derivatives, independent) that determine sequence of mapping stages, and reconciliation of the methods (i.e., semantic and graphic [contour, network, etc.]) (Integrated regional atlases). Comprehensive mapping is the cornerstone of system mapping, which places stricter requirements on temporal relationships of mapped data, scales, generalization approaches, etc., when establishing characteristics of various types of systems. Computer mapping should be specifically emphasized. Thus, a computer version of a comprehensive atlas, in terms of the systemic approach, is a system of interrelated thematic layers, which allows one to readily superimpose, change, update, and enhance them, which, in turn, allows developing new maps and new knowledge on structure, interrelationships, and dynamics of phenomena. The informational content of a comprehensive atlas may be broken into several functional types:

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multifaceted – these layers are the basic layers for general geographical maps and thematic layers for other maps (hydrographic and transportation networks, populated locations and administrative boundaries);

inventory – these layers, including the basic layers, are thematic layers that are included in other maps completely or partially (e.g., landscape, soils, land use, unsettled territories);

assessment and assessment-forecast – these layers are based on expert comprehensive or specific assessments (e.g., environmental conditions of natural environment – terrain, surface water, soil, vegetation, etc.);

monitoring – these are the actual thematic layers that require continuous updates (e.g., emissions, effluents, radiation, forest fires, etc.) (Evteev et al., 1997b).

These principles are embodied in comprehensive thematic maps and atlases, and more recently, in atlas information systems.

The purpose of this paper is not the analysis of the entire array of cartographic products of various periods in the Russian history but the presentation of the most significant cartographic works, especially those that are not readily available to specialists who do not possess knowledge of the Russian language, though we have considered some works on the history of the Russian cartography published in English (e.g., Postnikov, 1996; Postnikov, 1999, Postnikov, 2005). This paper also does not discuss the contribution of foreign prominent scientists (such as Alexander von Humboldt) to the Russian thematic mapping, which can be a subject of separate analysis.

2. Discussion

The first thematic maps of Russia. A consistent mapping of the country began in the middle of the XVIII century; however, certain mapping efforts had been made much earlier (the XVII century).Academy of Sciences played the major role in mapping of the country from the 1740s to the end of the XVIII century; in 1739, the Department of Geography was established specifically for this purpose. Since 1797, systematic scientific mapping work was carried out mainly by the Mapping Depot of the General Staff, transformed in 1822 into the Corps of Military Surveyors. Production of marine (nautical) maps concentrated in the Cartographic Drawing Office of the Admiralty Board, established in 1777.

From the middle of the XIX century, many agencies, institutions, organizations, and private companies were involved in mapping activities, among which was the largest private mapping company in Russia founded in1859 “A. Ilyin’s Mapping Surveying”; another prominent company was “Marx Publishing House.” The Russian Geographical Society was also actively involved in mapping work; it published a large number of maps and took part in creation of many cartographic products.

Though most areas of thematic mapping were developed in the XX century – the time of the most intensive advancement of thematic mapping – mapping of rivers’ networks, forests, and mining industry started in the XVII century (Yanvareva, 2012). The history of these cartographic areas is presented in this paper only briefly.

Hydrographic charts. Rivers have been the main transportation routes in Russia since ancient times. In the XVII century, map sketches identified navigable routes, which were not only the transportation ways but played an important military role. Rivers connect Russia with all the seas: the Baltic, White, Black, and Caspian. On sketches, rivers were reflected in most possible detail and showed navigation features. The sketches from all over Russia were stored in the Senate, the Siberian and the Ambassadorial Prikazs (i.e., offices or boards). In the XVIII century, the first collections were compiled; the collections included atlases and general maps at small scales (the classification of scales in Russian cartography is generally as follows: 1:200 000 and larger – large-scale; 1:200 000 – 1: 000 000 – medium-scale; and 1: 000 000 and smaller – small-scale). The first general map was created in 1782.

During the rule of Peter the Great, construction of water systems connecting water basins of the main European Russian rivers (Mayinskyaya, Vyshnevolotskaya, and other systems) began. In 1832, the General Directorate of Railways issued the “Hydrographic Atlas of the Russian Empire” and a series of general maps at scales of 1: 1680000 and 1:3260 000. At the end of the XIX century, “Lists of Inland Waterways of European and Siberian Parts of Russia” that catalogued all the rivers with their length and other characteristics, were compiled.

Forest mapping. The first forest map of the Russian forests was the "Drawing of Forest Surveys" (1701; approximate scale 1: 400000). The forests were broken by species.

From this time on, under the orders of Peter the Great, and until the XIX century, drawings and, later, land-maps of timber mast suitable for construction of ships, galleys, boats, and sloops were compiled.

The forest maps covered only strips along rivers. Wood was rafted to the shipyards where the ships were built. The maps indicated the size of forest area. The Forest Department of the Admiralty Board kept thousands of such maps. The first "Forest Atlas" was compiled from these maps in 1733-1782. In the 1841-1842, the "General Map of Forests and Forest Industry" was created. It showed four levels of forested land, species, and forest-industry facilities. After the introduction in Russia of the German land administration system (the land was subdivided into sections by strips), statistical atlases, e.g., "Forest Statistical Atlas of European Russia" (1878), were compiled only at small scales.

Mining industry. By the XVII century, Russia had substantial knowledge on proven mineral resources. The construction of mining plants began (iron foundries, iron works). The first two mining-plant regions formed in Russia. The first one was around Tula and Moscow and the second one, the northern, worked with Swedish ore and was near Belogorsk, Vologda, and Velykyi Ustyug. At the end of the XVII century, the construction of facilities began in Urals. In 1700, at the initiative of Peter the Great, the Ore Prikaz (it managed construction of plants) was established (and the Berg-Collegia, in 1719).

Examples of thematic maps of the end of the XIX century – beginning of the XX century (Fig. 1 and 2).

Fig. 1. Ethnographic Map of Slavic Peoples, St. Petersburg, 1877. Scale 1:4200000

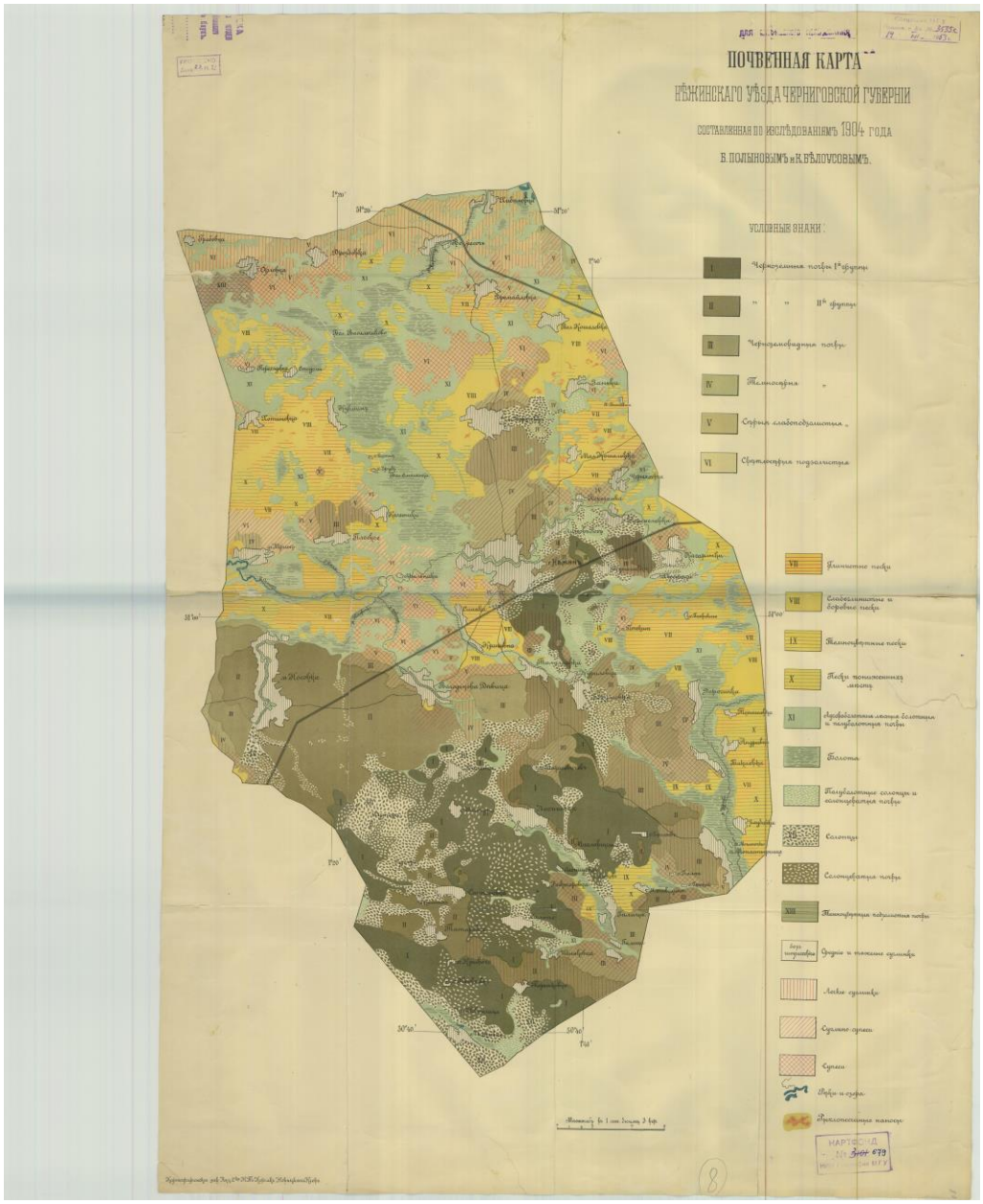

Fig. 2. Soil Map of the Nezhinsk County of the Chernigov Province compiled based on research of B. Polynov and K. Belousov conducted in 1904. Scale 1 inch = 3 verst

Examples of thematic maps of the first half of the XX century (Figs. 3 and 4)

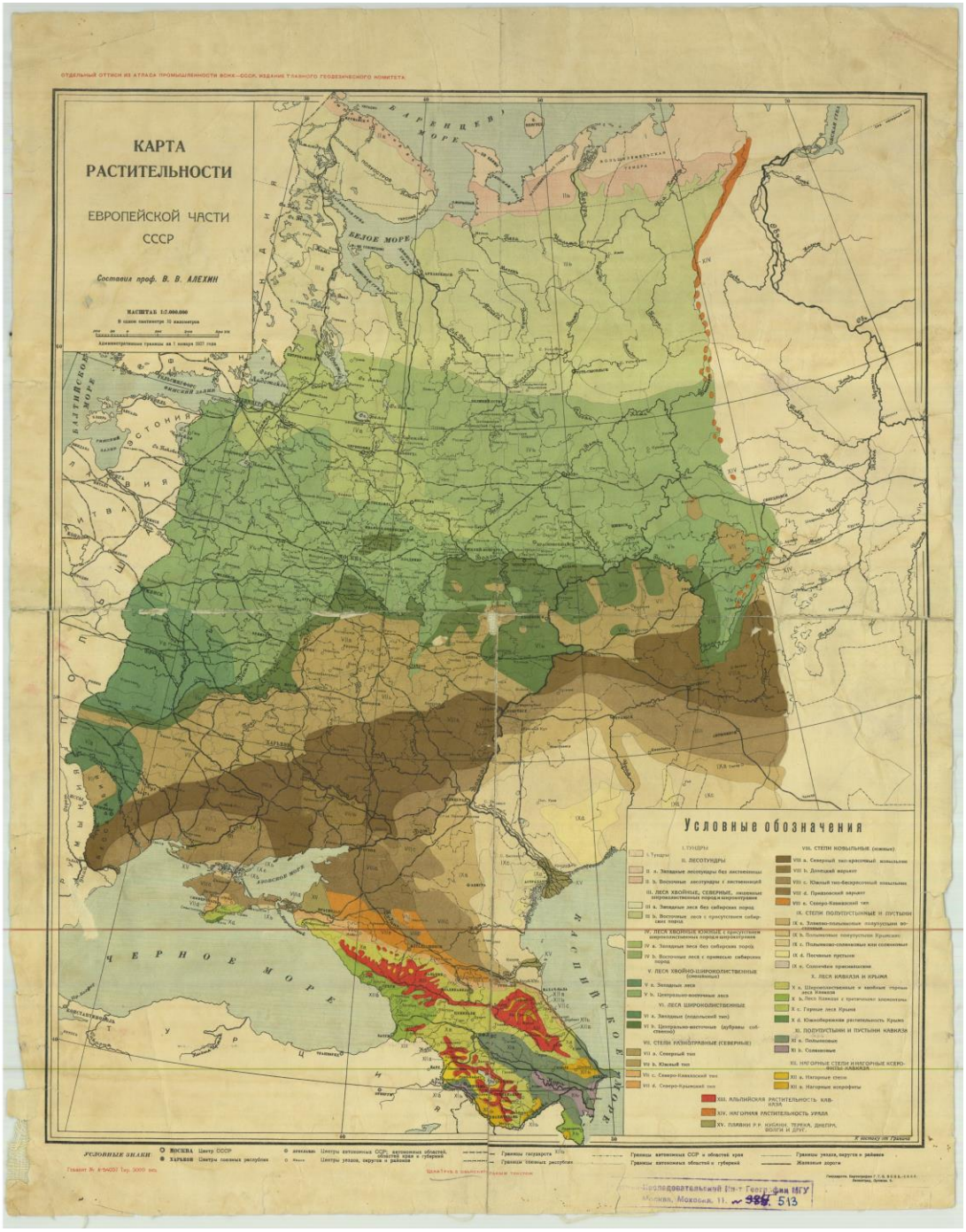

Fig. 3. Vegetation Map of the European Part of the USSR, 1927. Scale 1: 7000000

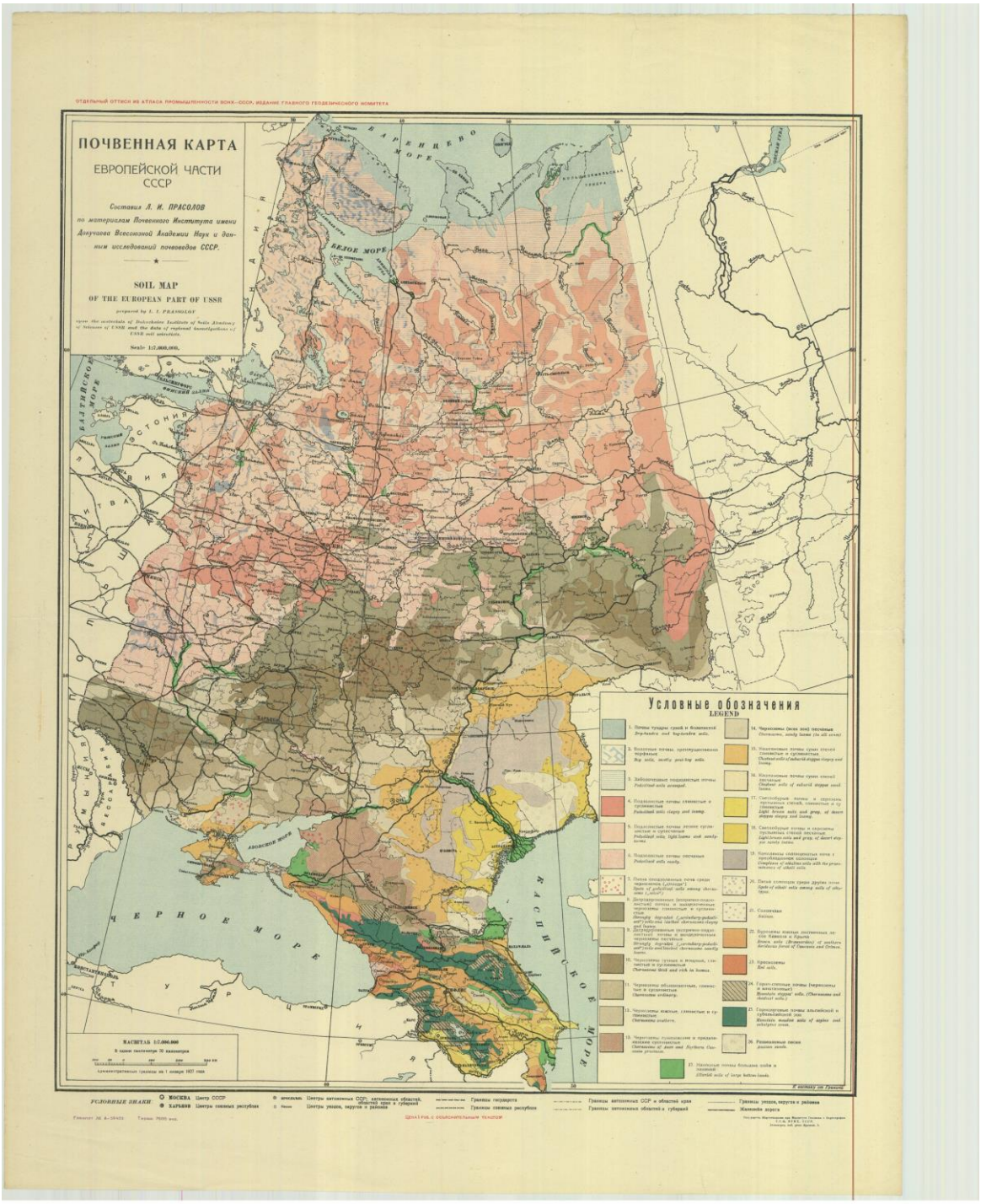

Fig. 4. Soil Map of the European Part of the USSR, 1927. Scale 1: 7000000

Atlases. At the end of the XIX century, a series of atlases was created in Russia: "Forest Statistical" (1873), "Economic Statistical", (by the Department of Agriculture; 1851), and "Statistical of the Most Important Sectors of the Manufacturing Industry of the European Part" with by-name lists of factories and plants of the Department of Trade and Manufactures (1869). They provided information in statistical format. Representation of true geographical locations of the objects was not required.

Russia was transitioning from the feudal and industrial-serfdom relationships to the industrial-capitalist system. Feudal relationships impeded economic development and division of labor. Serfdom workhouses were transforming into plants. It was necessary as quickly as possible to be able to obtain information about the current state of affairs. At approximately same time

(1861) serfdom was abolished in Russia. According to the law of 1906, peasants received the right to leave the communities to establish farmsteads. The prior existing form of peasant land tenure had led to fragmentation of farms in the central provinces of the European part of Russia and the lack of available land. P.A. Stolypin's reform was aimed at solving the problem of land shortage through resettlement of peasants in Siberia.

In 1914, a fundamental comprehensive "Atlas of Siberia" was published by the Resettlement Division of the Main Department of Land Development and Agriculture. The atlas contained maps of natural land conditions in Siberia, the existing forms of land use, and a series of sectoral maps of locations of various types of agricultural activities, resettlement conditions, and land-use types. Prior to the release of the atlas, the Resettlement Division in 1911, 1912, and 1913, created maps for the settled areas of the part of the Urals at a scale of 1:1680000. In addition to the maps on resettlement and economic sectors (farming, life stock breeding, fishing, hunting), the atlas contained three volumes of text on geography and economics. This was the first scientific reference atlas in Russia in the beginning of the XX century.

The "Great Soviet World Atlas" (GSWA) represented a special stage in the development of thematic mapping. It was created by the decision of the Central Executive Committee and the Council of People's Commissars from December 17, 1933.

For this purpose, a special institute was established, whose function was to develop a program of the atlas, identify agencies and organizations that had to provide information, and involve in work on the atlas the best scientists of the country.

The original design of the atlas included three volumes. The first volume contained maps of the world. The second volume contained maps of Russia. The third volume contained maps of foreign countries.

The first volume had the following maps:

geographical representations of the Earth (the V century BC map of Hecate, the II century BC Ptolemy map; hemispheres from the 1492 M. Behaim's Atlas; maps of expeditions and discoveries [from 1200 to 1918]); a series of physical maps of the hemispheres; bathymetric maps of the oceans (Atlantic, Pacific, and Indian) with data on the temperature at the water surface (February and August), atmospheric pressure, wind, and salinity at the surface of the water;

the Arctic (with the routes of scientific expedition from different countries);maps of the Kara and Barents Seas. A map of Atlantic;

maps of the world (the magnetic declination, gravimetric, volcanic activity, epicenters of catastrophic and devastating earthquakes);

a series of maps on deposits, climate (atmospheric pressure, wind, precipitation, temperature), and the Köppen climate classification.

a series of global maps on soils (135 types), vegetation, zoography (with the distribution of animal species);

a series of maps on population density, nationalities, tribes, and religion;

economic mapson electrification (the world and Western Europe), maps on coal and oil industries, ferrous and nonferrous metals, machinery, chemical industry in the capitalist countries, as well as maps of rubber and chemical raw materials;

maps of forest and paper industry; textile raw materials, and food products;

Makarov's point-map on farming (point weight is 50 thousand ha);

mapson fisheries;

a series of transportation maps: water and rail.

The GSWA contained maps on financial leverage of capitalist countries (export of capital and capital investment spheres, markets and raw materials markets) and political maps (1785) ‚world' division of 1784-1876 and 1877-1914, maps on competing powers before the first world war of 1914-1918, the first world war – the military operations and the theater of war; the political map of the world (in 1933), the map of the pacific ocean, and the map on economic cooperation of the pacific nations.

Such a detailed description of the subjects of the first volume of the GSWA, which was created in just three years, demonstrates how multifaceted and original the themes of the maps were. It also explains the reaction of the scientific community to the Atlas when it was shown at the World Exhibition in Paris in 1937 and where it was awarded the "Grand Prix" diploma.

The second GSWA volume contained economic and natural-environment maps of the USSR and its regions; it was published in 1940 and was presented at the International Fair in New York where it also sparked great interest in the scientific community.

The third GSWA volume has not been published because of the outbreak of the Second World War.

Almost simultaneously with the GSWA, several cartographic products were released: "Atlas of Industrial Sectors of the USSR" in five volumes (1929-1935) and "Atlas of Energy Resources of the USSR" (1933-1935).

The next scientific-information atlas created in Russia was the atlas on physico-geographical conditions of the world.

The Physico-Geographical Atlas of the World (PGAW). Twenty five years had passed since the publication of the GSWA. A large volume of information on natural environment had been accumulated over this period. Comparison of the GSWA and the PGAW legends show the increase in the volume of the accumulated information; specifically, the volume of information had increased in the areas of geology-geomorphological and soil and vegetation sciences three-, two-, and four-fold, respectively. The principles and methods of mapping of the natural environment had changed also.

The main purpose of the PGAW (Gerasimov, Leontiev, 1967) was to reflect as best as possible a complete and precise situation in the natural environment of the world using modern theories of geography and cartography. In terms of its content, the atlas was unrivaled at the time.

An example of thematic map of the second half of the XX century (Fig. 5).

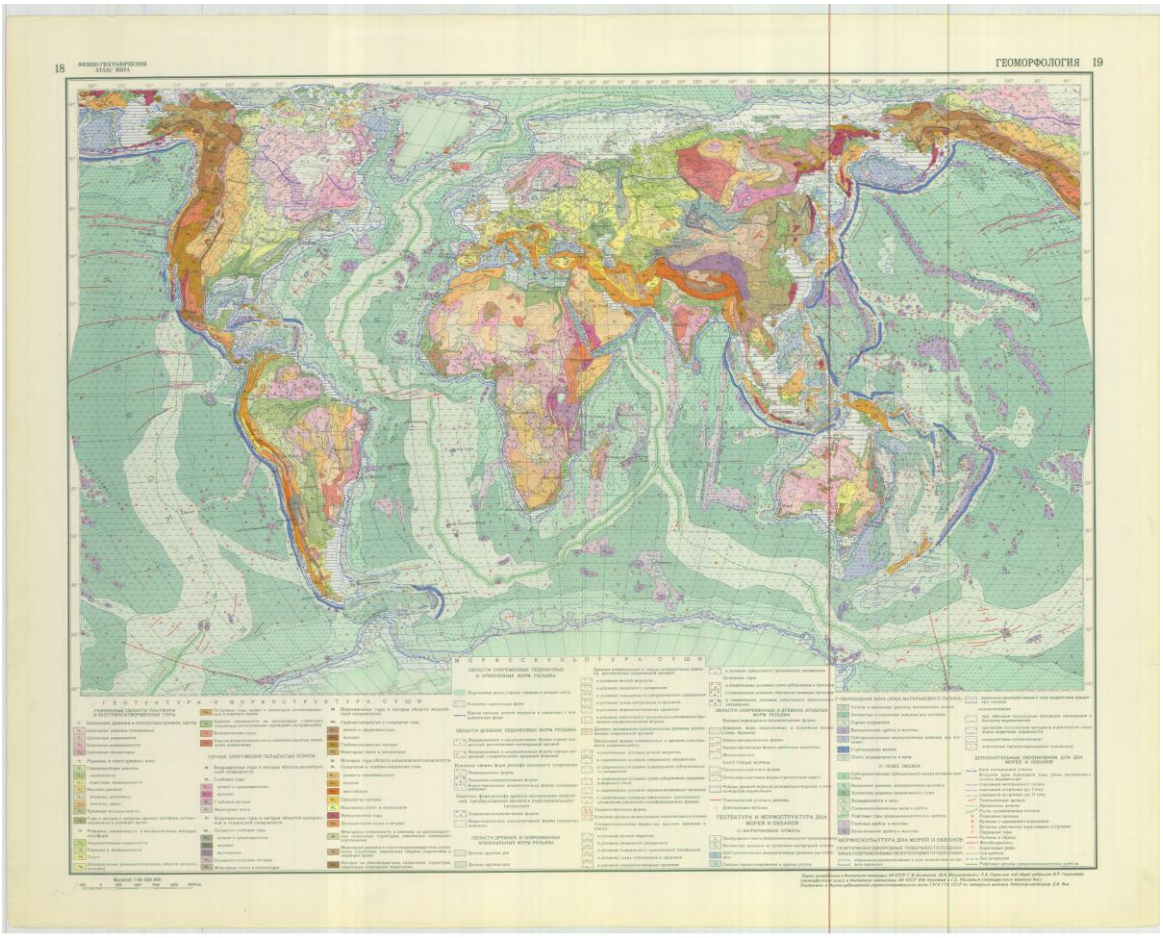

Fig. 5. Geomorphologic Map (in: Physico-Geographical Atlas of the World), Moscow, 1964. Scale 1:60000000

The atlas was created at the initiative of the Institute of Geography of the USSR, together with the Geological Committee of the USSR, the Hydrometeorological Service of the USSR, and the Ministry of Higher and Specialized Secondary Education of the USSR. Hundreds of experts in the field of geology and geography and the leading scientists of the country were involved in the creation of the atlas. The atlas included three main regional levels: world, continents, and the USSR.

The atlas had eight sections and included maps of the world; the Arctic and Antarctic; Europe, including the territory of the USSR to the Urals and part of West Siberia; Asia, Africa, North America, South America, Australia; and several maps of the USSR.

The maps of these eight sections described the relief, tectonics, geology of mineral resources, geomorphology, climate, vegetation, and fauna. Each section ended with physico-geographical zoning maps. The section on the USSR had the largest number of maps. Climate and surface- and groundwater were presented in great detail. At the end of the atlas, there was a textual part on the natural conditions of the continents and oceans.

The main scales of the PGAW were: world – 1:80 000 000 and 1:60 000 000; Europe – 1:7 500 000; Asia – 1:25 000 000 and 1:40 000 000; Africa, North and South America – 1:20 000000 and 1:30 000 000; Australia – 1:25 000 000 and 1:30 000 000; USSR– 1:15 000 000, 1:20 000 000 and 1:35 000 000 (climate).

It should be noted that the PGAW, for the first time in the history of atlas mapping, has emphasized map adjustment and reference. This greatly increased the value of information and, above all, scientific credibility of the atlas (demonstration of genetic links of the mapped objects). The atlas improved assessments (in comparison with the World Atlas of 1962) of the land areas of Asia (+1.25 %), Africa (+0.31 %), Australia (-3.39 %), North America (+0.96 %), South America (-0.76 %), and Europe (-7.68 %).

Among the major atlas products, several other atlases should be mentioned: “Climate Atlas of the USSR” (1960-1962), “Atlas of Earthquakes in the USSR” (1962), “Atlas of the World” (1964), “Physical Atlas of the World” (1964), “Atlas of the Antarctic” (1966, 1969), “Atlas of the Economy and Culture of the USSR” (1967), “Agroclimatic Atlas of the World” (1972), “Atlas of the Oceans” in five volumes (1974, 1977, 1980, 1993, 1996, and 2005), “Geologic- Geophysical Atlas of the Indian Ocean” (1975), “Atlas of the Arctic” (1985), “Geologic- Geophysical Atlas of the Atlantic Ocean” (1990), and other products. This is far from the complete list but it demonstrates the breadth of scientific research and high level of utilization of thematic mapping in fundamental research.

The end of the XX century in Russia was marked by the publication of the major fundamental atlases: “Atlas of Snow and Ice Resources of the World” (1997), “Our Earth” (1997), “The Nature and Resources of the Earth” in two volumes (1998), and “Atlas of the World” (1999). These atlases continued the traditions of the Russian school of geographical cartography and are the products of a new generation in terms of thematic presentation, the character of information used, and application of remote sensing and methods of creation and publication. The digital comprehensive atlas of the continents “Our Earth” was developed as an active geographical information system with the use of ArcInfo and ArcView and became the first interactive atlas of the Earth. The “Atlas of Snow and Ice Resources of the World” won the highest Prize of the Government in the Field of Science and Technology.

Several thematic atlases cover the entire country’s territory: “Agricultural Atlas of the USSR” (1960), “Atlas of Economy and Culture of the USSR” (1967), “Forest Atlas” (1973), “Atlas of Ranges and Resources of Medicinal Plants” (1976), and many other products.

Thus, a scientific school of comprehensive atlas mapping has formed in Russia; M.V. Lomonosov Moscow State University (MSU) and the Institutes of Geography of the Russian Academy of Sciences (IG RAS) and the Siberian Branch of the Russian Academy of Sciences (IG SB RAS) played the leading roles. Scientific experience of these and other organizations and scientific and technological potential of the enterprises of “Roskartographiya” and other institutions supports the statement that Russia at that time had accumulated sufficient scientific and technological potential to produce its own national atlas discussed at the end of this paper.

Influence of traditions on the modern state of thematic mapping. *Mapping of the seas and oceans.* Marine cartography represents a special epoch in thematic mapping. First of all, we should mention the “Naval Atlas” (1950-1953). This atlas became an outstanding cartographic

product. It was created by the Naval General Staff and commissioned by the Council of Ministers of the USSR. Many organizations participated in its creation: research institutes of the USSR Academy of Sciences, universities, the General Directorate for Hydrometeorology, All-Union Geographical Society, etc. The atlas was based on a large volume of factual data. The first volume was published in 1950 and contained general navigation-geographical characteristics of the oceans and seas and showed the main world's ports. The atlas maps presented similar detailed topographic description of the seas and land (isobaths and contours), i.e., the maps rendered the global surface.

The second volume (1953) included maps of the natural conditions of the World Ocean. The maps also presented characteristics of water and land. For example, sea currents were shown on a supplemental map together with wind directions on land, which influence the currents. The relationships and interactions were reflected on a set of hydrological and climatic maps: reconciled maps on thermal balance and atmospheric circulations, climate and hydrography, etc.

The third volume of the atlas described the history of naval theory and battles from the ancient time to the present day.

The next fundamental work was a five-volume "Atlas of the Oceans": Pacific Ocean (1974); Atlantic Ocean (1977); and Arctic Ocean (1980).

The first three volumes of the atlas had the same structure and contained seven sections: history of oceanic research, oceanic floor, climate, hydrology, hydrochemistry, biogeography, and reference navigation-geographical maps.

The maps "History of Oceanic Research" described expeditions from 1872 to 1970.

The section "Oceanic Floor" had maps on oceanic floor relief, epicenters of earthquakes, volcanoes, tectonics, geomorphology and types of shores, types of precipitation, and a series of bathymetric maps of the oceanic floor. It also had information on morphometry of the oceans and seas (volume, area, maximum depth) with updated calculations based on large-scale nautical naval maps. There were also detailed data on tsunamis and the amount of thermal energy emitted by the oceanic floor – the most important energy characteristic of the Earth.

The basic map scales of the atlas were 1:10 000 000, 1:16 000 000, and 1:12 000 000. In the 1960s-1980s, two more comprehensive fundamental atlases were published ("Atlas of the Antarctic" [1969] and "Atlas of the Arctic" [1985]). The atlases had nearly 300 maps on the natural conditions associated with ice regime and history of exploration of the circumpolar regions.

Environmental mapping. Environmental mapping developed rapidly in the 1990s when data on human impact on the environment became readily available. Approximately at that time, the maximum permitted concentrations (MPC) of pollutants in the atmosphere from industrial and transport emissions – dangerous to human health level – have been established.

Also at that time, the methods for studying pollution and the most efficient sequence of research have been identified: 1) the impact on the natural environment; 2) changes in the natural environment by human activities; and 3) methods of protection of the environment as human habitat. Spatial changes of the state of the environment were presented on environmental maps. Methods of their creation have been developed in Moscow, St. Petersburg, Saratov, and other research centers.

Differentiation of environmental maps took place rather rapidly. The objects of mapping were the ecological state of the atmosphere in the cities; pollution of rivers and other water bodies; contamination of soils and mining sites; the environmental state of forests; etc.

In 1997, the first comprehensive environmental and geographical map of the USSR (scale 1: 4 000 000) was created. Its legend represented a system of tables that assessed the stateof forests, soils, and rivers.

Maps for Higher Education. The Decree of the Ministry of Higher and Secondary Special Education of November 10, 1974, marked the beginning of a new period in development of thematic mapping – maps for higher education. The Decree stated the need for establishment of the Scientific-Editorial Board (SEB).

The MSU Faculty of Geography was charged with the implementation of the work. Prof. K.A. Salishchev, Head of the Department of Cartography and Scientific Advisor of the Fundamental Research Integrated Mapping Laboratory (FRIML), was appointed the SRB Head.

The purpose of the maps for higher education was to provide scientific-informational support of instruction on general fundamental courses in all areas of geography and geology, which was offered at approximately 100 institutions of higher education in the nation, and to create a pool of highly educated experts who possess knowledge on a wide range of subjects.

Prior to the beginning of work, FRIML had defined a preliminary list of thematic and general geographical maps through polling and systematization of the responses form institutions of higher education. This list was discussed and approved by the SEB. It was decided to compile thematic maps of the world (1:15 000 000), of the USSR (1: 4 000 000), and the regions of the USSR (1:10 000 and 1:6 000 000). General geographical maps of the continents were compiled at these scales also. A special basis and projections have been developed for the general geographical maps. A group of homolographic projections with small distortion of angles was selected: the CSRI-GAC arbitrary polyconic projection (M. Urmaeyev) for the world with insert maps of the Antarctic Basin and the Antarctic, which were used for the world map on modern tectonics sand climate. The equidistant conic projection was used for the maps of the USSR. The azimuthal projection was used for the general geographical maps of the continents (scale 1:10 000 000).

A number of internationally renowned scientists were involved in this work: M.A. Glazovskaya, I.P. Zarutskaya, V.I., Fridland, G.V. Dobrovolskyi, O.A. Mazarovich, N.V. Bashenina, O.A. Leontiev, V.E. Khain, R.S. Chalov, A.G. Isachenko, A.N. Rakitnikov, and many others.

Most of the thematic and geographical maps had been created for the first time ever. Among them: “Geographical Zones and Zonal Types of Landscapes of the World”; “Landscape Map of the USSR”; “Soil and its Main Structures of the World”; “ Water Balance of the USSR”; “Channel Processes (Morphology and Dynamics of Riverbeds) of the USSR”; “Climatic Zones and Zones of the World”; “Neotectonics of the World”; “The USSR Cryolithozone”; “Nature Protection of the USSR”; “Land Use of the World and the USSR”; “Natural Forage Lands”; “Functional Types of Settlements”; and a number of other maps.

The FRIML and its scientists were the maps’ authors and editors. The work on the maps in 1983-1987 and 2000-2001 resulted in creation of over 50 maps, primarily of the world and the USSR, and many general geographical maps of the continents and the USSR and its regions (I.P. Zarutskaya, [Ed.]). A number of maps have been reprinted several times since their creation (Maps for higher education; New maps for higher education).

The work on the maps for higher educational institution represents a separate epoch in thematic mapping and became part of the “golden fund” of the history of thematic cartography of Russia, suggesting its high scientific and methodological level. These maps have made an unprecedented contribution to the development of thematic mapping in Russia. All the wealth of information contained in the maps of the time, existed only as hard copies or as non-vectorized electronic versions. In order to preserve the maps for higher educational institutions, it was necessary to create a system of interconnected databases that use geo information technology and modern media.

At present, the work on a series of maps for higher educational institutions has been resumed. In 2014, several maps were published: “Landscape Geochemistry”; “Peoples and Religions” and “Population of Russia”. Several maps have been prepared for publication: “Biomes”; “Mudflows in the World and Russia”; “Metallurgy, Oil, and Gas Industries”; “Transport Network of the World” and “Agriculture of the World” (Tikunov et al., 2014).

Integrated regional atlases. These types of atlas products are similar to the national atlases. The first atlases of this kind in the USSR were the “Atlas of the Moscow Oblast” (1933), “Atlas of the Leningrad Oblast” and “Atlas of the Karelian Autonomous Soviet Socialist Republic” (1934). In the late 1950s, development and publication of comprehensive atlases of the republics, territories, and oblasts of the Soviet Union resumed (“Integrated Atlases of the Republics, Territories, and Oblasts of the USSR,” 1961). The 1960s-1980s experience of development of regional atlases gained by the MSU Faculty of Geography has been especially valuable. In terms of their depth and detailed design, these atlases match modern national atlases. A fundamental work “Comprehensive Regional Atlases” (1976) summarized this experience. Atlases of the former Soviet republics (Belarus, Ukraine, Moldova, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Georgia, Armenia, Azerbaijan, Lithuania) published in these years can now be considered the national atlases of these states.

In the middle of the XX century along with comprehensive atlases, several sectorial and problem-oriented atlases were published. They include "Atlas of Ranges and Resources of Medicinal Plants" created by the All-Union Institute of Medicinal Plants (1983), "Climatic Atlas of the USSR" (1960-1963), "Atlas of Agriculture of the USSR" (1960), and a number of other industry atlases; these map products represented fundamental works and contributed greatly to the development of thematic mapping in the USSR.

"Forest Atlas of the USSR" (1973) consisted of three sections: 1. Overview of Forests and Forest Industry (maps of the state of knowledge of forests, forest cover, ranges, main tree species, yield class, timber resources, forest groups); 2. Timber Enterprises and Forest Reserves (reserves of wood in m^3per 1 ha for coniferous and deciduous species); Forest Exploitation and Wood Processing Enterprises; 3. Forests: Location and Species Composition of the Forest Reserves.

In the XX century, comprehensive regional mapping was developing intensely. During this time, a number of regional atlases of the republics, territories, and oblasts were created. The importance of comprehensive multipurpose regional atlases for studies of the national territory and its resources has been recognized by the national geographers; the USSR Geographical Society at its III Congress on 30 January – 7 February, in Kiev, decided to call a special meeting to review the state of affairs in this area of thematic mapping. Such a meeting was held in 1961 at the MSU Faculty of Geography by the Ministry of Higher and Secondary Special Education of the RSFSR co-jointly with the USSR Geographical Society, the Head Office of Geodesy and Cartography (GUGiK), and the Ministry of Geology and Mineral Protection of the USSR. The participants shared their experience of creating atlases of Armenia, Azerbaijan, Georgia, Kyrgyzstan, Uzbekistan, Estonia, Tatarstan, Komi Autonomous Republic and Vologda, and the Voronezh, Irkutsk, Kiev, Kustanai, Moscow, Ryazan, and Yaroslavl oblasts.

The meeting started with reports by K.A. Salishchev "Integrated Atlases of Republics, Territories, and Regions" (objectives and content), I.P. Zarutskaya "Methods of Creation of Comprehensive Regional Atlases" and G.V. Artamonov "Prospects for Work on Comprehensive Atlases of the USSR" (GUGiK).

There were several presentations by faculty members of various departments from the MSU Faculty of Geography and of other organizations on climatic, geologic, hydrologic, relief, geobotany, forest, population, industry, transport construction, agriculture, economic land use, and culture. Comprehensive regional atlases of the1970s-1980s turned to be fundamental multivolume cartographic products. They laid a foundation for new directions of thematic mapping, e.g., assessment cartography ("Atlas of the Tyumen Oblast and the Altai Krai").

Among the more modern regional atlases, we should note the "Atlas of Khanty-Mansi Autonomous Okrug–Yugra" (Gubanov et al., 2009; Kotova et al., 2002). It was commissioned by the Governor of the Autonomous Okrug A.V. Filipenko and was published in two volumes that characterize the history, demography, economy, nature, and environment of the territory. The atlas was created by the MSU Faculty of Geography and the Scientific and Production Center "Monitoring" (Khanty-Mansiysk) in collaboration with a number of leading research and production facilities of the country and the territory and with the active support and participation of the local administration.

The atlas, for the first time ever, presented the territory in a comprehensive way. This territory had been studied relatively well, however, inconsistently, i.e., only for some of its parts and certain themes. The new atlas systemically described the territory with the help of maps, texts, and illustrations using the latest scientific-methodological and technological achievements. The atlas analyzed and generalized long-term research of the territory conducted in the course of oil and gas exploration. These data were not used in the previous atlases of the Tyumen oblast (1971, 1976) and of the Khanty-Mansi Autonomous Okrug (1980).

Two volumes of the atlas contained more than 500 maps, grouped into 26 thematic sections. The conventional map-sections' sequence was inversed. The atlas started with the presentation of the history, population, and economy of the territory, and only then the characteristics of its natural resource potential and current environmental conditions were given; this approach is described in (Tikunov, 2002). Time will tell if this approach is accepted in regional atlas mapping; however, it is clear that it is flexible and applicable in the situations when the object of research in an troposphere is the role of humans in deformation of the integrity of the surrounding environment.

The atlas utilized the sophisticated methodological procedures: 1) multi-level presentation of phenomena and objects on the global, federal, regional, and local levels (and, therefore, at different scales); in some cases, they were presented as anamorphoses; 2) comparative-geographical, for the purpose of presenting features within the county in comparison with other subjects of the Russian Federation. Certain maps were unique and made the users appreciate rather unique natural conditions, and more precisely, adverse living conditions in the region (the highest in the Russian Federation ratio of paludal land to the population density, presence of permafrost, transportation inaccessibility, etc.)

The concept and all its subsequent implementation were built on the idea of sustainable development of the territory. The address of the Governor to the population of the territory and, thus, to all users of the atlas, at the beginning of the atlas, was permeated with the idea of the need to inform and educate the public as an essential condition of its conscious participation in solving the problems of the region and the country in the transition to a balanced development. The atlas can facilitate management decision making process, which would require its transformation into an information system (Tikunov, Yanvareva, 2002).

As was mentioned previously, a special area – assessment cartography – has formed within comprehensive regional atlas mapping. Assessment maps rendered prospects of construction of roads, pipelines, and civil engineering facilities, irrigation of arable land, and favorable living conditions in terms of the natural environment. The natural environment could favor the construction, raise the price of it, or generally be unsuitable for construction. The themes of assessment maps include types of construction or other impacts on the environment. Obstacles to the implementation may include relief, mechanical properties of soils, depth of groundwater, soils strength characteristics, climatic parameters, etc.

Small scale of the maps in the atlases (smaller than 1: 1 000 000) restricted their use to the front end of engineering design. First assessment maps were compiled for the Tyumen and the Altai territories. The Atlas of the Altai Territory (Volume I; 1980) contained a full set of assessment maps: construction of roads, irrigation of arable land, mechanized tillage; living conditions of the population with climatic parameters of temperature and precipitation regime. The "Khanty-Mansi Autonomous Okrug–Yugra" atlas had also a number of assessment maps.

The first "Environmental Atlas of Russia" was published in 2002. It contained environmental assessment of water bodies, forests, soils, and atmospheric air in cities; this atlas won the Prize of the Government of the Russian Federation in the Field of Science and Technology. The atlas consisted of six sections: 1) Conditions of the Formation of the Environment; 2) Anthropogenic Impact on the Environment; 3) Changes in the Natural Environment; 4) the State of the Natural Environment; 5) Medical and Environmental Conditions; 6) Environment and Nature Protection. The atlas was published in electronic and paper versions. Its 128 pages had 93 maps with explanatory texts. The prevailing scale was 1:20 000 000. The environmental-geographical map (scale 1: 4 000 000) and environmental atlas were created at the MSU Faculty of Geography with participation of 11 other organizations. Currently, a new environmental atlas of Russia is in the process of preparation for publication.

The National Atlas of Russia (NAR). Russia and then the Soviet Union in the first half of the last century were close to creating a national atlas, but it did not happen for a number of reasons. In 1914, the comprehensive "Atlas of Asian Russia" was published; its content was close to the idea of a national atlas. However, this atlas did not cover the entire territory of the Russian Empire.

The idea of the creation of the national atlas of the USSR was intensely developing beginning in the late 1950s – early 1960s. However, real steps have been taken only in the late 1980s, when the MSU Faculty of Geography was commissioned by the Production Cartographic Enterprise "Kartographiya" to prepare a scientific report on the issue of the national atlas creation.

The implementation of the NAR project began in 1993, when the Federal Service on Geodesy and Cartography of Russia instructed the Central Scientific Research Institute of Geodesy, Aerial Surveying, and Cartography (CSRI-GAC) to assess the prospect of setting the theme of research work "Development of the Concept, Structure, and Program of the Creation of the National Atlas of Russia." In early 1994, CSRI-GAC prepared the specification of requirements. Due to lack of the necessary financial resources, the effort failed. In 1994, the Government of the Russian Federation adopted the Resolution "On the Federal Target Program for 1994-1995 and until 2000 'Progressive Technologies of Cartographic-Geodesic Support of the Russian Federation', in which the creation

of the NARwas identified as one of the most important tasks. In reality, the project implementation began only in 1995, when the Federal Center “Priroda”, with participation of researchers and cartographers of 11 scientific and educational institutions, various ministries, and entities, developed a draft concept of the NAR (The basic concepts...; The concept of the National Atlas...) and proposals on the development of the federal target program “The National Atlas of Russia.”

The concept defined the main goals, objectives, and scope of the NAR, its structure, content, and organizational issues. According to this concept, the NAR represented a fundamental comprehensive cartographic work designed to provide a holistic view of nature, population, economy, environment, history, and culture of Russia, a body of scientifically processed and coordinated spatial and temporal information on the national scale that is applicable in all sectors of economy, management, science, education, and national defense.

It was decided that the NARwould consist of 10 volumes: “General Geography”, “Nature and Resources”, “Population and Social Life”, “Economy”, “Environment”, “History,” "Culture and National Heritage”, “Russia and Space”, “Regions of Russia,” and the cumulated volume.

All that, being part of the NAR, intended to be an independent cartographic work, which has its own information and cognitive value. The NAR, as a whole, and its individual volumes had to include maps, aerial and satellite images, textual content, references, references to geographical names, etc.

The reference nature of the NAR demanded the use of large-scale maps (for the territory of Russia as a whole, a scale of 1:10 000000 was used), detailed information, reliance on modern scientific concepts and knowledge, and exploratory research. The scientific-reference nature of the NAR and the basic scale of its maps have defined the format (45 × 57 cm). There were supposed to be two versions of the NAR, i.e., a traditional printed and a digital. The use of the same initial information would allow linking processes of creating these two versions.

Beginning in 1997, the work on the NAR was resumed, but as a four-volume edition of the official governmental publication. Its new concept was developed. The NAR came to be regarded a fundamental comprehensive cartographic work designed to give a holistic view of nature, environment, population, economy, history, and culture of the country; each of the volumes represented a separate finished work.

Thus, after five years of work, the NAR was published in four volumes: Volume 1 “General Characteristics of the Territory”, Volume 2 “Nature. Environment”, Volume 3 “Population. Economy” and Volume 4 “History. Culture.”

The first volume “General Characteristics of the Territory” (A.N. Krayuhin [Ed.]) was published in 2004. It was intended to serve as a scientific and cartographic reference source for a wide range of consumers. It contained, in addition to general geographical and reference maps, a significant block of physico-geographical and social-economic characteristics of the country; satellite images were also used. The traditional publication of the first volume of the atlas was supplemented with its electronic version on CD/DVD.

The second volume “Nature. Environment” (V.M. Kotlyakov [Ed.]), was published in 2007. It mapped natural conditions, resources, and the state of the natural environment of Russia. The volume, besides thematic maps, contained a large volume of text, supplemental graphs, photographs, and space images.

The third volume “Population. Economy” (V.S. Tikunov [Ed.]) was published in 2008. Its structure was more complex hierarchically. Thus, its first section “General Characteristics of the Russian Federation” described contemporary Russia's place in the world in regard to various socio-economic parameters, changes of its geo-economic position, spatial aspects of the country’s organization, as well as geographical factors of settlement and economy. The second section of the volume was devoted to the characterization of the population, social environment of its habitat, and social development. Accordingly, there were three subsections: the population and resettlement, social sphere, and socio-political development. The third section of the volume “The Economy and Economic Development” include done introductory and four main sections. The structure of the section was based on a logical transition from the general characteristics of the economy (introductory subsection) to a consistent characterization of the main sectors of the economy: Production – Infrastructure - Investments. The themes of the “Production Sphere” were basically related to the “primary” (agriculture, forestry, fishing, and hunting) and “secondary”

(industry and construction) sectors of the economy (which is close to the internationally accepted classification of the economy). Finally, the fourth section "Regions and Regional Development" was dedicated to the regional component. Its first part contained a series of comprehensive socio-economic maps for large geographical areas (in some cases, maps of individual entities were included), which reflected their socio-economic structure and the main features of the regional economy.

The final, fourth, volume "History. Culture" (Yu.A. Vedenin[Ed.]) was also published in 2008; it had two sections, on history and on culture. The first section described the main periods of the history of formation and development of the country, starting from characteristics of the ancient peoples and tribes inhabiting the present territory of Russia and ending with the situation at the beginning of this century. The second section provided information not only on the culturebut also on the conditions of formation of the cultural and natural heritage of Russia.

3. Conclusion

Mapping in the XXI century differs radically from the classical cartography of the XX century and earlier periods. It incorporates modeling, GIS technology, electronic mapping, and systemic approach. In all of this, we believe that at the present time, Konstantin Salishchev and Irina Zarutskaya were and still remain the ideologists of modern cartography.

The works of K. A. Salishchev (Integrated atlases...; Salishchev, 1968; Salishchev, 1990 and other) analyzed emerging new ideas and views on the cartography. Having deep understanding of geography, he always argued the need for close connection between cartography and geography. As President of the International Cartographic Association and Chairman of the Commission on National Atlases of the International Geographical Union (during 15 years, from 1956 to 1972), created on his initiative, he promoted his ideas in the country and abroad. K.A. Salishchev participated directly in the creation of fundamental cartographic works (GSWA, PGAW, Naval Atlas, and Atlas of the Oceans) that have always aroused great interest in the scientific community.

I.P. Zarutskaya (Zarutskaya, 1966) created the map adjustment and reconciliation theory and developed methods of its implementation; the theory was also based on the idea of a close connection between cartography and geography. The theory clearly revealed a genetic link between elements of the environment: geology and tectonics; hydrology and climate; soils and vegetation; topography, geology, and tectonics; sea currents, the relief of the ocean floor, and motion of atmosphere; etc.

The current state and prospects of development of Russian thematic cartography are associated not only with revolutionary changes in electronic technologies, but in many respects with the wealth of knowledge, traditions, methodologies, and techniques of mapping and map compilation, which have developed over more than a 300-year history of cartography in Russia.

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