

# **Conceptual Bases of Developing the Branch of Geodesy and Cartography in the Russian Federation**

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## **SUMMARY**

The basic conceptual positions of development of branch of a geodesy and cartography in the Russian Federation are stated. The concept basis – three-level technological system of creation of the cartographic and geodetic information is offered. Innovative information-technological and organizational-functional offers of development of branch of geodesy and cartography in the Russian Federation are considered.

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Development of branch of a geodesy and cartography is one of necessary conditions of effective functioning of various branches of economy, strengthening of safety and country defence. According to article 71 of the Constitution of the Russian Federation branch activity is in state conducting.

Qualitative changes in economic and defensive activity in the XXI-st century have essentially increased dependence of its productivity on cartographic and geodetic maintenance of huge territory (17,1 million in km of 2 states), as causes necessity of definition of new conceptual approaches for branch development.

Now the Federal Agency of the state registration registration, cadastre and mapping (Rosreestr) is engaged in the decision of the primary goals of cartographic and geodetic maintenance of the country. The state control over manufacture and quality of cartographic and geodetic works and as behind correctness of storage, uses of materials and licensing is carried out by local bodies of Rosreestr in geodesy and cartography.

Defining role in economic activities is occupied with cartographic and geodetic manufacture. Now radical reorganization on the basis of introduction of satellite technologies of existing system of manufacture of the geodetic data is spent.

Within the limits of the federal target program «Global navigating system» (GLONASS) works on creation of high-precision state geodetic networks are developed:

Fundamental astronomy-geodetic network (FAGS),

Precision geodetic network (VGS),

Satellite geodetic network of 1 class (SGS-1).

The State fundamental gravimetric network and gravimetric network of 1 class and the Main high-altitude basis of the country (GVO) are supported and develops. The Main high-altitude basis of Russia on the present is generated by lines of levelling I and II classes.

Geocentric coordinates system PZ- 90.02, state reference system of geodetic coordinates SK-95 and local system of coordinates MSC are accepted and are used. In the course of performance of a complex of geodetic, cartographical, geographical works cartographical maintenance of the Russian Federation which is represented in the form of the state topographic maps and plans, cartographical atlases and catalogues of place names, thematic, etc. cartographical products is formed. Now the geodesy and cartography branch carries out creation and maintenance of consumers of cartographical production in two forms: digital and analogue (paper). On all territory of the country topographic maps of scales 1:25 000 – 1:1 000 000 in analogue and scales 1:100 000 – 1:1 000 000 in the digital form are created.

Results of geodetic and cartographical works are a basis of navigating maintenance. System of geodetic points functionally provides ephemeris definition of companions of global navigating

system and creation of a satellite geodetic differential network. In economically developed areas and along the basic transport arteries of the country the network of stationary satellite differential stations is created, and for other areas mobile satellite differential stations are offered. Use of differential stations at site definition, provides reception of co-ordinates with accuracy of the first centimeters.

On all territory of the Russian Federation on the basis of digital topographic maps digital navigation charts in scales 1:100 000 and 1:50 000 are created. On economically developed and developing regions of the country digital navigation charts of scale 1:25 000 are created, and on settlements with the population over 50 thousand manufacturing of digital navigating plans in scale 1:10 000 is carried out.

The created digital navigation charts are located with the established order in federal cartographic and geodetic fund. Realization of technologies of cartographic and geodetic manufacture is carried out in the established information (information-cartographical) maintenance. Rules of the digital description concern a supply with information, the qualifier, a format library of conventional signs. Since 2003 the uniform supply with information on creation and representation of digital cartographical production in format SXF is accepted. The accepted information maintenance is used at all enterprises of branch and periodically improved and updated.

Industrial-technological activity of branch is regulated by normative and technical maintenance. Instructions concern normative and technical documents, manuals, positions, norms, standards, etc. Now in branch operates more than 500 normative and technical instructions.

Estimating a current state of branch of a geodesy and cartography it is necessary to consider that except the enterprises of branch the specialized organizations of Ministry for Protection of the Environment and Natural Resources, the Minister of Defense, the Ministry of Agriculture and more than five thousand commercial non-governmental enterprises are engaged in creation of cartographic and geodetic information. Thus customers of cartographic and geodetic works are not only the ministries, federal and municipal bodies, but also many large companies.

It is necessary to ascertain that now exists separate and from different departments and uncoordinated system of orders for performance of cartographic and geodetic works. Thus each customer for their functional interests orders cartographic and geodetic materials (data), which are created from initial (aero- and space survey, construction of plan-high-rise basis) and to a final technological stage.

Estimating a current state of domestic branch it is necessary to recognise that during the last years it was possible to stop negative processes of obsolescence cartographic and geodetic information, owing to the successful organization of manufacture on creation digital topographical, navigation charts and to construction of a geodetic network with system of points of supervision of companions GLONASS/GPS. At the same time it is necessary to allocate and the available problems demanding conceptual consideration and their decision by innovative development of branch of a geodesy and cartography .

So absence of the organizational and technological mechanism of interaction of branch with other departments and the ministries leads to formation divided, systems from different departments of orders for performance of works and as consequence to their duplication.

Duplication of manufacture of the cartographic and geodetic data takes place at federal and municipal levels and as at performance of orders in interests of the large state and commercial companies that as a result leads to considerable unjustified financial expenses. Thus the cartographic and geodetic information is created with use of various technologies, software packages, coordinates systems and formats with formation is information the incompatible data. Created for the concrete customer in own interests of department such data does not receive wide use.

In geodesy and cartography branch transition from analogue to the digital technologies having ample opportunities of division of the created information on levels, the layers providing the organization of "economical" technological manufacture, functioning on new principles «under the order», «just in time» is almost finished. However new perspective approaches are not realized yet and operating manufacture is focused on full cycle of creation of capacious end production demanding the big financial expenses on resources about districts in the form of topographical analogue and digital cards and further on their duplicating, a premise in base (fund) of the data, warehousing and the storage organization [1].

Thereupon huge volumes of cartographical materials created on the basis of industrial principles «on a warehouse», instead of on principles of "economical" manufacture «under the order», will not be claimed by consumers and in due course become outdated and are utilized [2].

Basis of modern digital cards are topographic maps created and repeatedly exposed to updating ("repair") in a Soviet period. The digital maps created on the basis of analog topographical maps on the accuracy and a degree of conformity of district do not correspond modern to requirements concerning the digital information on landscape.

Demands specifications and a geodetic basis constructed in the last century under new perspective approaches of satellite geodetic measurements. Monitoring and maintenance in an actual condition of the cartographic and geodetic information also restrains absence modern domestic highly metric cartographical space complexes of remote sounding of the Earth (RSS). Elimination of available problems is supposed to be executed on vertical structural construction of the mechanism of activity of branch from a direction of development of technologies through perfection of normative and technical maintenance to transformation of organizational-functional structure.

The branch basis is made cartographic and geodetic manufacture thereupon a base initial direction of development will be information-technological.

The information-technological direction of development of branch should get new normative and technical support. Besides, at entering of innovative changes in branch activity there is a necessity for their is standard-legal registration and introduction of corresponding administrative regulations.

Creation of normative and technical bases becomes a following direction of development of branch. At the closing stage the assumed conceptual technological and normative and technical decisions will lead to necessity of modification of the organizational-functional structure providing creation of the modern cartographic and geodetic information.

Consideration of all these directions, since defining technological, makes a conceptual basis of development of branch of a geodesy and cartography.

With a view of improvement of quality, elimination of duplication and the organization of flexible "economical" manufacture all complex of cartographic and geodetic works is subject to division into three separate functionally independent and technologically interconnected levels. Division of technological manufacture into levels with formation of three-level system and information, normative and technical and its organizational maintenance functioning it is represented a defining direction of development of cartographic and geodetic branch.

Functioning of technological manufacture in conformity with three-level system assumes at 1st level creation base (basic), on 2nd – standard (universal) and on 3 – the thematic (branch) cartographic and geodetic information. [3]

The base (basic) the cartographic and geodetic information concern: preliminary processed materials of aero- and space survey; catalogues and lists of co-ordinates of geodetic points; the according to plan-high-rise bases received by geodetic methods or construction of networks of a phototriangulation; the digital matrixes of a relief made photogrammetrical or cartographical methods, created digital ortophotomaps and the available digitized layers of maps with the catalogue of place names.

The standard (universal) the cartographic and geodetic information concern: digital and analogue topographic maps, plans and the unified digital models of district.

The thematic (branch) the cartographic and geodetic information concern: digital and analogue thematic cards, plans, models (cadastral, wood, geological, navigating, soil, etc.).

The base the cartographic and geodetic information is created beforehand with regular, continuous maintenance of its urgency and is a basic basis for manufacturing at following technological levels of various kinds of the standard and thematic information.

Priority problems of 1st level on creation of the base the cartographic and geodetic information on intermediate term prospect concern:

Creation of the modernized system of geodetic maintenance of territory of the Russian Federation by construction of basic geodetic networks FAGS, VGS and SGS-1, qualitatively raising efficiency of application of classical and satellite methods cartographic and geodetic branch maintenance.

Construction of new national geodetic system of the co-ordinates, being a basis for functioning GLONASS and creation of digital cartographical production.

Development of the main high-altitude basis and high-precision basic gravimetric networks. Carrying out of full cataloguing of system of an according to plan-high-rise substantiation of territory of Russia. Development of domestic perspective cartographical systems with creation of a network of points of reception and preliminary processing of the digital space information.

Performance of a complex of cartographic and geodetic works on an according to plan-high-rise substantiation, creation, a digital matrix of a relief and digital ortophotomaps, on all territory of the Russian Federation, appropriate on quality and accuracy to a map of scale 1:25000. Results of the executed complex of works to accept in quality of a base (basic) basis for full-scale mapping of territory of the Russian Federation.

Formation of federal geoinformation bank of the base (basic) cartographic and geodetic information and adhered in coordinates place names.

The urgency of the created base cartographic and geodetic information should be supported by system of the continuous remote space and territorially distributed monitoring by divisions of Rosreestr.

On the basis of the base (basic) cartographic and geodetic information at 2nd level the standard (universal) information is created. Actually this kind of the cartographic and geodetic information is allocated by standard and universal characteristics and can be used for the decision of the general problems of orientation, studying of district, designing etc. practically by all legal bodies and citizens of the Russian Federation. The standard (universal) cartographic and geodetic information finds wide use as in interests of development of various areas of economy, so for strengthening of defence and safety of the country.

Priority problems of 2nd level on creation of the standard cartographic and geodetic information concern:

Creation of the unified digital models of district (UDMD). UDMD it is created on the basis of digital ortophotomaps, matrixes of the relief, the available separate digitized layers of cartographical materials, the catalogue of place names and results of field inspection. UDMD represents the formalized digital model, most precisely and full displaying all objects of the district, belonging to the class "topographical", and their characteristics in the unified conventional signs. The unified digital model of district is a universal cartographical basis for creation of topographic maps and plans in any scale of all scale number with representation in the digital and analogue form.

Definition of requirements for the standard cartographic and geodetic information and in operative terms «under the order» consumers in necessary volumes and scales, with use UDMD creation of digital and analogue topographic maps and plans.

Finishing of level of maintenance of requirements of public authorities, defences, safety and the population the standard (universal) cartographic and geodetic information corresponding to a current state of district, to 100% from the standard.

Increase in assortment and volumes of working out and release of high-quality fundamental cartographical products, with representation to their consumers in the analogue and digital form.

Formation of system of optimum distributed federal funds of the digital standard (universal) cartographic and geodetic information.

At 3 level under the concrete customer and the consumer thematic (branch) cartographic and geodetic and other geospatial should be created the information, by adaptation, addition with necessary layers and the data of already ready base and standard information. Realization of the accepted technological approach will provide an exception of duplication of works between geodesy and cartography branch and other branches creating the thematic information.

Priority problems of 3rd level on creation of the thematic (branch) cartographic and geodetic information concern:

Definition of thematic (branch) kinds of the geospatial information for which creation functional and technological responsibility is born by branch of a geodesy and cartography with working out of perspective technologies of their creation;

Working out of requirements and realization of technology of creation of a standard navigation chart with construction of its functional-technological system of addition by its various thematic layers with the subsequent transition from cards to navigating services.

Specification of local and other local branch coordinates system.

Working out, introductions and the coordination with other branch departments is information compatible cartographical and technological maintenance for creation of a various kind of the thematic geospatial information.

Transfer of manufacture into three-level technological system will demand not only technological development, but also working out of new information-cartographical maintenance (ICM) under each level of creation the cartographic and geodetic and other information. Creation ICM with working out of the unified qualifiers and libraries of the unified conventional signs of topographical objects of district will be a separate information-technological problem. Performance of works on reduction in a uniform convertible information format available digitized of cartographical materials is necessary also. There is a requirement and for creation ICM for manufacturing of fundamental cartographical products in the digital form.

The important information-technological direction demanding realization in intermediate term prospect is construction of the Russian infrastructure of the spatial data (RISD). Conceptually it is supposed that basis RISD will be made by the cartographic and geodetic information and registration data of Rosreestr. Association of these details with addition of the information cadastral and branch registers will provide creation of key element RISD in the form of the integrated intellectual knowledge base of Rosreestr.

Successful realization of offers of an information-technological direction of development of branch it is possible by means of effective scientific and technical maintenance of each offered interconnected decision.

Assumed conceptual the approach with realization of three-level system will provide the qualitative control of preparation of the cartographic and geodetic information at each level and will allow to refuse inefficient and labour-consuming operating manufacture on preliminary creation end production «on a warehouse» with introduction of the advanced industrial system functioning «under the order» and excluding duplication of works.

With a view of effective functioning of branch of a geodesy and cartography with realization of the three-level technological approach of its functioning entering of additions and working out of the volume complete set of normative and technical documents is necessary:

Processing about 300 normative and technical instructions of system of geodetic, cartographical instructions, norms and rules in national standards, position about system of certification in the field of a geodesy and cartography.

Development and standard legal base of branch of a geodesy and cartography is supposed. The concept does not provide modification of item 71 of the Constitution of the Russian Federation in which it is fixed that the geodesy, cartography and the name of geographical objects concerns conducting the Russian Federation. At the same time the concept assumes

processing of 3 Federal laws and about 30 decisions and Government orders, and also modification of 5 Federal laws and about 20 decisions and Government orders.

Transition to three-level technological manufacture causes in organizational-functional changes of system of creation of the cartographic and geodetic information. The basis of these changes is a differential vertical distribution of functions between the head department which is responsible for creation of the cartographic and geodetic information on the basic technological levels, and other branch departments allocated with powers on manufacturing of the thematic information.

The geodesy and cartography branch should be head department on creation of the cartographic and geodetic information which as in the past, and now according to the current legislation is responsible for this kind of activity in the country. At the same time at realization of three-level technological system the personal organizational-functional problem is assigned to geodesy and cartography branch on creation of the information of 1st and 2nd levels, beginning from planning and coordination of aero- and space survey works and finishing manufacturing of the base and standard information for all customers and consumers, including "branch" (having functions of cartographic and geodetic activity) the ministries and departments. «Branch» the ministries and departments are allocated with functions of the user of the base and standard information which is created by branch of a geodesy and cartography as a basis for the further technological adaptation, addition and its transformation under the requirements in the necessary thematic information.

The structure of division and streamlining of departmental functions on technological levels is fixed by standard legal certificates. Carrying out of re-structuring of the branch enterprises of cartographic and geodetic activity in technological directions that will provide exceptions duplication is supposed also and to raise quality of works. Organizational-functional distribution of cartographic and geodetic works will demand restoration of system of demands from the ministries and departments with development of the mechanism of formation of the state order for creation of the cartographic and geodetic information.

With a view of division of functions and powers of the government and centralization of productive and economic and scientific and technical activity association of industrial making branch of a geodesy and cartography in uniform industrial-technological corporation, and the enterprises and the organizations of a scientific and technical field of activity and organizations the holders of fund in the scientific and technical centre is provided.

Realization of conceptual positions is supposed to spend to three stages .

At the first stage (2010 – 2012) it is planned:

1. To finish creation of a modern high-precision geodetic network with actualization of maps and updating of federal cartographic and geodetic funds.
2. To carry out working out of domestic space cartographical complexes of remote sounding of the Earth with system territorial the distributed points of reception and preliminary processing of the space information.
3. To execute working out of technological, normative and technical and standard legal maintenance on introduction of three-level system of creation of the cartographic and geodetic information.



4. To spend the All-Russia inventory of all set of the geospatial information created by different departments, with working out of uniform federal bank of the geoinformation metadata with system of the open and wide access for all consumers.
5. To carry out organizational actions for integration transformations of industrial-technological and scientific and technical components of branch of a geodesy and cartography in two large centres, industrial and scientific and technical appointment.

At the second stage (2013-2016) it is planned:

1. To make transfer of cartographic and geodetic manufacture into innovative three-level system with working off of the mechanism of reception of demands and formations of the state order for creation of various kinds of the geospatial information for all consumers.
2. To spend a complex of organizational-technological actions for creation on all territory of the Russian Federation of the new high-precision base (basic) cartographic and geodetic information, in the form of an according to plan-high-rise substantiation and digital ortophotomaps, with characteristics of qualitative and of accuracy are not worse scale maps 1:25 000.
3. To develop and finish introduction for all central, federal and municipal controls, planning, economic activities, defence and safety of a uniform Russian infrastructure of the spatial data.

At the third stage (2017-2020) it is planned:

1. To finish transition from system of periodic updating of the cartographic and geodetic information to its complex continuous monitoring with formation necessary the information for the consumer «with orientation to the client» in an operative regime - «under the order».
2. To carry out, on the basis of carrying out of an active administrative, financial and protectionist policy, working out and wide introduction of domestic technological, technical and program, information means of cartographic and geodetic activity.
3. To make full and definitive transfer of branch into new information and technological base with creation of conditions of Russian and its international competitiveness in the market of geoinformation services.

Thus, in the Concept on the basis of the analysis of a current state of branch of a geodesy and cartography with revealing of the basic problems of functioning, directions of its development are defined:

1. Working out and information-technological maintenance of three-level system of creation of the cartographic and geodetic information with modernization and rationing of the "economical" manufacture providing improvement of quality and an exception of duplication of works.
2. Actualization of the normative and technical maintenance directed on effective functioning of perspective system of manufacture of the cartographic and geodetic information and coordinating interactions with other "branch" ministries and departments.
3. Construction of the innovative organizational-functional structure defining a head role of branch, its interaction with other "branch" departments and functional division of administrative and economic powers with integration of industrial-technological and scientific and technical activity.

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### **Biographical notes**

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