

SPACE CARTOGRAPHY: EXPERIENCE OF DESIGN AND CREATION OF REGION SERIES OF NATIONAL-RESOURCE MAPS IN THE STATE CENTRE "PRIRODA". METHODS. TECHNOLOGY. USE.

Yuri P. Kienko, Yuri G. Kel'ner, Vladimir A. Sushchenya
State Scientific-Research and Production Center "Priroda", Russia

Abstract

Here in this report we integrate our design experience and creation of regional programs on information supplying of managing the territories of Russia and foreign countries. We are analyzing problems of methods, technology and using of thematic maps in the system of the territory bodies on planning, managing, design, forecast and expertise, and also problems of cartographic data changes regarding modern computer technology on the base of Geological Information System (GIS) - of management.

1. Introduction

Space photo survey is the most powerful information source that is today widely used in national economy of our country and all around the world. Its development forms a new cartographic technology named as Complex Study and Mapping of Natural Resources and Environment Conditions (CSMNR) which is aimed to satisfy informational demands of national economy.

Space photo survey materials (SPS) of different areas of the world that are received from Russian satellites serve as an important source of actual information for design and creation of thematic maps simultaneously in several spatial-scale levels: local, district, regional. To extend the development of space mapping, State Centre "Priroda" makes different kinds of processing of space photo survey materials by general technology providing the executors of different fields with initial and transformed information, and also renders methodical assistance in use and application of space photo survey materials.

Now we actively design new maps with different thematic content and up-date the old ones with the aid of space information. The series of natural-resources maps are more actual and vitally important and characterize the newest condition of natural resources, degree of their exploit and standard of modern territory development regarding anthropogenic influences. The map series are often created by operationally-rapid approach according to methods of State Centre "Priroda" and are a source of unique complex information, which is oriented to provide solving the most difficult territory problems connected with projects, planning, forecasting and managing of nature use.

Being received, CSMNR products carries out an important social function and develops information to provide territories with centralized resources and economical management. The first experiments of using SPS materials in matter of studying natural resources were done in conditions of difficult to access territories - highlands and deserts (Pamir, Tadzhikistan, Kyzylkumy, Kalmykia). They showed the necessity of complex solution of mapped territories problems where deficiency of spatial information keeps back the level of their economical assimilation. The information about volume of works which were carried out under CSMNR programs are shown in a Table 1.

Management of resources that are a subject to anthropogenic influence, and their restoration - is a new thematic direction demanded large information flows. Materials of

natural-resources map series start to provide the implementation of this social function. Today we have received positive results for the territories of Russia and 'IS and also for some foreign countries. It was worked out more than 260 thematic maps of actual content. It is imprinted last resources and environment changes in such maps that promotes raise of quality of information providing economical authorities to take coordinated decisions on large and small territories. It gives a hope to form a new approach to solve ecological problems, established on principles of mutual responsibility of map designers and ones taking decisions.

At present the necessity in natural-resources information is going to the frames of poor developed areas. It is also concentrated and most large demand in regions of intensive development, where it has united common and complicated problems of solving the territory tasks of energy, mining, town-planning and also estimation of lands in cycles of agricultural and civiculture use, which need to take unordinary and complex determinations.

The purpose of this report is to show massive layers of territory information that are concentrated in natural-resources maps series of regions and to attract to them more intent of wide range of users, who decides the problems of designing, managing, using and forecasting of natural resources of territories in frames of modern GIS technologies.

At present stage of researches all CSMNR programs are been working out by State Centre "Priroda" in co-operation with interested branch organizations and groups of scientific institutes.

2. Main puproses and tasks

Realization of region CSMNR programs are on different stages and is to be done based on Scientific-Technical Projects (STP). These programs stipulate common solution of complex problem tasks, including:

- 1) Making of series of entailed thematic territory maps in agreed scale, which characterize in whole volume its natural-resources potential;
- 2) Working out recommendations about rational development natural-resource potential;
- 3) Compilation of concluding notes to maps as an information base for possible solution of economical and ecological problems;
- 4) Introduction of cartographic elaboration results into practice of regional GIS.

Regional specific features and direction of works onscientific-methodical accompanying of CSMNR are defined by stages of STP realization. Implementation of CSMNR purposes and tasks guarantees complex information provision of any territory which is formed on system landscape approach as a base for theory of structure and development of geographical environment, its ecology and conditions of natural resources forming. Thus, during process of CSMNR program executing territory cadastre of modern conditions of natural resources and ecology is creating, which contains a most complete volume of data characterizing resource reproduction and forming environment functions of territory, their stability to some set of factors of anthropogenic press.

3. Working areas, volumes and stages

Planning of STP CSMNR works now is carried out for regions of prospective economical reclamation. Sequence of planning is defined by intensity of territory use, its natural-resource

potential and ecology situation in region. First of all the most large economical areas of Russia are concern to this:

- 1) Non-Black Earth Zone;
- 2) South of European part;
- 3) Caspian Sea Region (oil extracting complex);
- 4) West Siberia (oil and gas-extracting complex);
- 5) Middle Siberia;
- 6) East Siberia and Far East.

Table 1.

List of work volumes, that were fulfilled under CSMNR programm

Works Region	Square (Thousand sq. km)	Quantity of maps	Scale	Year	Condition of series
1. Kalmykia	76,1	20	1:500000	1978-91	1-published 2,3- prepared
2. Stavropol'ski Krai	80,6	21	1:500000	1980-91	preparation
3. Tverskaia obl.	84,1	20	1:500000	1983-86	prep./publ.
4. Novgorodskaia obl.	55,3	4/17	1:500000	1988-90	preparation
5. Smoleskaia obl.	5,6	7	1:200000	1977	prep./copied
6. Samarskaia obl.	53,6	4	1:200000	1993-94	compilation
7. Arkhangel'skaia obl.	587,4	18	1:500000	1992-94	compilation
8. Krasnojarski	384,0	12/17	1:500000	1986-90	comp./prep.
9. Pribaikal'e	20,0	9	1:500000	1977-90	comp./prep.
	1350,0	34/88			
Former Soviet Republics					
10. Tadzhikistan	143,1	30	1:500000	1977-84	issue
11. Central Pamir	8,0	23	1:100000	1976-83	issue
12. Uzbekistan	447,4	20	1:500000	1983-87	comp./prep.
13. Kirgizia	198,5	29	1:500000	1983-87	comp./prep.
14. Kyzylkum	64,0	9	1:500000	1976-77	copied
15. Kazakhsnan		5/6	1:500000	1988-91	comp.
16. Lake Sevan		6	1:200000	1984-88	issue
17. Gruzia	69,7	14	1:200000	1988-89, 90	comp./prep.
18. Belorussia Soligorski area	2,1	11	1:100000	1978-79	copied
	860,0	153			
Total:	2.210,0	36/241			

Design of CSMNR works, creation of STP is done in the regions, where the spade-works have been implemented on technical-economical basis of CSMNR taking into account accepted decisions of directing authorities or having received offers from local bodies. Here are also the regions and territories, which complex mapping of natural resources are determined by State or branch scientific and technical programs.

To the development and finishing CSMNR works stage, that are implementing based on STP, refers all spade-works on scientific and methodical accompanying including up-dating of topographical maps, creating standard topographical base (STB), author's works, and also all types of industry editing-compiling works and preparing maps to publication. In this stage of realization of STP CSMNR there are works in the following regions: Novgorodskaja, Arkhangel'skaia, Magadanskaia oblasti, Kalmykia (the third stage), Krasnoiariski Krai.

On introduction the CSMNR results stage it is to be done practical using of final cartographic materials for solving specific tasks in regions by Branches of National Economy and by territory Authorities of managing and planning. During the period this final CSMNR materials are introducing into practice and are widely used at places.

I. Tadzhikistan

26 titles of thematic maps were issued in 1976-1980. The materials were sent to more than 300 organizations of the Republic, and also to the other ministries and departments.

II. Kalmykia

10 titles of maps were issued in 1978-1985. The maps are widely used by organizations of the Republic as an information reference materials for solving managing and design tasks, and also in education process in different institutes of Republic.

III. Tverskaia (Kalininskaia) oblast' (1983-1986)

It was designed and prepared for publishing 20 maps of natural resources content and 32 inside maps. Before the print run under decision of co-ordination council are used in author's works for practical solving the first time task in management, planning and design. Besides, 12 sets of maps series were given to project and branch institutes of Rusrña. Heavy blow of Perestroika period referred to final stage of the series creation. Destroying period of State system stopped printing works with Vinnitskaia Kartograficheskaia Fabrika (Ukraine). We have received 11 proof maps.

IV. Stavropol'ski Krai (1980-84,88)

The same fortune stroked author's map models of 28 titles, which were stipulated by CSMNR program of this region, which were prepared for printing in cartographic factory. Today we have no funds for their publication. Copies from originals are used in practice.

4. Method

Method is a key word during all CSMNR work stages. Method is a search of new and main direction that shows the way head. Principal task in this search is to find the key to solution of unlimited number of "codes" of space images, which are used for receiving information on map subject. Contrary to the other researchers, who use automatical methods, we pay paramount attention to creative approach and appreciate analytical beginning that is resulted from visual photointerpretation.

As well as in all great number of problems one can do nothing without system and principles during photo-interpretation. The system approach is accepted as a working hypothesis and based on landscape analysis. Meaning of landscape as a system of interacting nature components on an appointed section of a territory is very close to the meanings of ecology system and geosystem. It allows widely combine biotic and abiotic components data, to use their signs characters and connections between them, solving

problems of biosphere level. So, chosen landscape-indication method allows us to solve the widest range of environmental tasks.

This long analysis process may be schematically divided into steps - stages of reliability. There are four of them.

The first one is a preliminary reliability stage is started in laboratory conditions. According to primary analysis results of a photo it is created preliminary framework of slightly systematized data or their combinations on map subject, which demand further explanations. And we imperceptibly come to the second stage of searching the additional details of data received by other methods and other specialists-predecessors. There is its own range of details and data for each map. Most of them could be taken from different sources of information, literature data, other maps. It is created a thematic frame of interpretation as a result of analytic research - correct preimage of future thematic map - preliminary thematic map.

The third reliability stage is a field verification, field examination of the results of laboratory interpretation and preliminary thematic map data. There is a comparatively short period (1-2 months) during which it takes place data collection confirming laboratory conclusions, clearing up "white spots", unclear or questionable fields and receive true data. The fourth reliability stage is a final system analysis of materials for authors model of the map and whole legend and its scientific-editorial control. On this stage the thematic map receives estimation of experts. The map is born.

This is a technological scheme of works with one map. However the working process of series of thematic maps creation goes in a different way. Some words about this to imagine the process of realization CSMNR program in more detail. First, we work out scientific and technical project(STP) with estimation of volume, term and budget of works. Program of map series bases on it, researching group is formed to fulfil the program and after that each author concentrates on his own map. About this it was said before.

5. Method problems

What difficulties appear on this way? There are some more typical:

1. To overcome methodological barrier of researching groups in photointerpretation process.
2. To form the confidence of researches and users to space information sources.
3. To extend and up-date the content of traditional thematic maps and create the new ones by inflow.
4. Use and employ thematic map data in practice by territory and economy management.

Solution of these and other methodical problems was done simultaneously by producing of new normative documents and practical manuals. During period of realization of regional CSMNR programs more than 30 normative documents were worked out in process of scientific and methodical accompanying in scientific departments of State Centre "Priroda". It was published 18 scientific works, monographs and manuals on problems of regional CSMNR methods. All this allowed in short time to form regional work groups of numbers of leading specialists of State Centre "Priroda" and other organizations and departments.

So, during creating the natural resources map series of Tverskaia oblast' in 1983-1985 the group of 142 specialists was busy. In this period there was worked out 20 natural-resources maps in scale 1:500.000 and 32 inside-maps in scale 1:1.500.000 adding the contents

of basic scale maps. The following number of specialists took part in author's map models creation:

1. Scientific director of program, main editor of series	1
2. Executive editors	3
3. Scientific editors	19
4. Author's group of thematic-specialists	58
5. Leading editors of method accompanying group	5
6. Technical editors	7
7. Independent scientific experts	20
8. Experts of applied directions of science	20
9. Cartographers-designers	12
10. Member of permanent scientific council	17

All current methodic problems were discussed on scientific seminars, school-seminars; the most sharp disagreements were discussed on Scientific and Technical Council. Its decisions became a law. The main guide of methodic line was a group of head organization - State Centre "Priroda", that was responsible for quality of products, for choosing of specialists, for the date of work making, adjusted interdepartmental connections; organized field works, airborne observations, provided living conditions during field works. All this allowed provisional group to support creative unit and mutual understanding.

Often the problems raised there, were unexpected. For example, working through content of traditional geological maps, being made always for specialists, as a rule run against narrow interpretation of map content in its new state for wide range of users. In the end of discussion, for example, instead of one map "Peat sources" was created a map series "Peat and lake silt" and 5 inside maps which were of applied character in using and employin the peat, placing of peat enterprises and etc. It was difficult to work with map of natural deposits, contents of which had to be made more actual taking into account present demands of building and use new data about building materials.

We have met and successfully overcame one more methodic difficulty of this series. It is a technology problem of co-ordinating the map series between them. We should say, that use of space information makes it easy to solve this difficult problem. For this purpose it was created auxiliary map of base natural resource contours in accordance with the scale of the base maps. Its content became base nature counters - flood-plains, bodies of swamps, forests taken from space photos. Most of them till now was drawn and interpreted in different ways on author's map models. So, outline of swamp, that was taken as a base, without changes stayed on all 19 series maps, through its content changed every time. Forest boundaries were presented on 9 maps of land resources. Drawing of flood-plain boundaries controlled contents of 11 maps of mineral and land resources and so on.

6. Technology and use of maps

The works are technically done by stages. They have determined in practice of realization of CSMNR programs as following:

1. Organization and design of works.
2. Development of author's works and scientific and methodical accompanying.
3. Editorial and compilation works and preparing for publication.
4. Publication, receiving and using of products.

On organizational-preparation stage it has to be done all works provided with initial information, photos, auxiliary maps from branch funds; availability of normative materials

and state standards and requirements to map series is also had to be taken into account. All this is shown in technical and economical report (TER) which is sent to customer to be studied and added. On the base of TER it is worked out scientific and technical project (STP) which contains all necessary charters for estimation of volume, dates and kind of works and expenses for their financing. STP is co-ordinated with all future executors and customers, is discussed at representative meeting and is confirmed by directing authority. All works are to be done in accordance with approved STP and plan-schedule of works.

Development of author's works and their scientific and methodical assistance is to be done based on approved STP or signed by customer agreement on the base of STP. Development and realization of CSMNR program in different regions of our country is done according to methodical directions of State Centre "Priroda" under management of scientific and methodical group headed by project leader. On the stage of realization of project the leader takes the functions of main editor of map series and scientific director of CSMNR program. The scientific and methodical assistance group prepares all normative requirements to used materials, carries out control over process and quality of works, make reports to the customer about final materials and add conclusions of independent experts.

On this stage it is also prepared author collective, author groups of map executors - the main creative body, with which the methodical assistance group collaborates and makes author's map programs, works out legends and puts them for discussion at Scientific and Technical Council to be confirmed. Author's works consists of collection and analysis of information, of space photos interpretation, creation of author map model and its field control. The works should be completed by signing the final report at scientific council and are introduced in production. For editorial-preparation and compilation stage we recommend to make co-ordinations of author's materials with accordance to frame of base natural outlines and general map series program and author's programs of co-ordinated maps. Editorial-compilation works and preparation for publishing are implemented in production process or by special editorial-compilation group outside State Centre "Priroda" correctly executing directions or instructions of responsible or leading editor.

In process of carrying out scientific and research, experimental and production works in different regions of Russia the whole number of methodical and normative materials was made by State Centre "Priroda" which are destined to provide field of works on implementation of regional CSMNR program. Such document are: 1. Practical recommendations on CSMNR (1984).

2. Guide technical materials on CSMNR of NBEZ, Western, Eastern Siberia, Zabaikal'e; (1985).

3. Programs, Legend projects and conventional signs for basic maps of CSMNR series 1:200.000 - 1:1.000.000 scales; (1987).

4. Editing and natural resources maps designing recommendations; (1987).

5. Methodical recommendation on surface water maps designing in 1:500.000 scale; (1987).

6. Methodical recommendations on natural fodder resources map in 1:500.000 scale; (1988,1990).

7. Technology instructions; (1986-1988).

8. Basic statuses CSMNR; (1989).

9. Program of supplying measures on CSMNR executors by scientific-methodical and normative-technical documentation respective till 2000; (1989).

10. Temporal regulations about scientific-methodical supplyment and works accompanying on former URSS CSMNR; (1989).

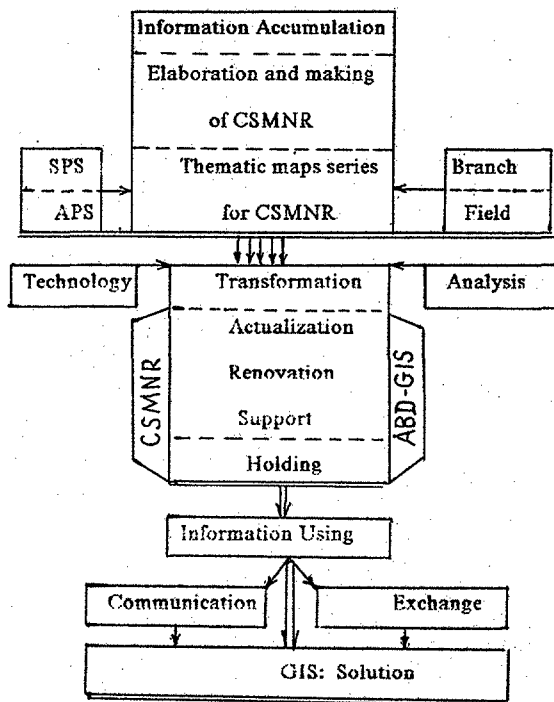


Figure 1.

Technological framework of CSMNR for GIS

11. Methodical recommendations for using SPS under revealing ore-controlled structures for the aim of CSMNR of Siberia and Far East; (1990).
12. Methodical recommendations for choosing and using SPS for the aim of thematic (author's) works of CSMNR; (1990).
13. Methodical recommendations for carrying out complex field works for the aim of CSMNR; (1990).
14. Scientific-methodical recommendations for composition of the map "Meliorative status of the lands of Kalmykia" in the 1:200,000 scale and larger; (1990).
15. Methodical recommendations of economical efficiency assessment of the works for cartographical cadastre making on the instance of the works carried out on Tajikistan and Kalmykia regions; (1990).

The main concern of map creators and chief editor is: how to use the thematic maps in future, how to apply them for solution of one or another tasks. The first and all the next introduction stages of cartographic materials (up to 1990) - the CSMNR products - were of "hand" (manual and visual) kind of use. Paper map was read from a sheet to receive the information. All plans of introduction of CSMNR works were connected with expenditures for map publishing, print run and printing technology.

At the beginning of 1990th it took place appreciable improvement in technology of map creation. It was reflected by international cartographic forums and conferences which were held by ICA (Budapest 1989, Birmingham 1991 and so on), where the new technologies were demonstrated most brightly and weightily. Digital technologies penetrated deeply into cartographic process. Thematic map began its change into digital analogue and to exist for users in two versions: paper (published on factory or printed on printer) and electronic, that may be presented on display. Computer map has changed into analysis instrument and personal information source.

Counting this, in technological scheme of creation of author's map models under CSMNR programs there is experimental stage of transformation cartographic information into cartographic data base GIS. Transforming contents of cartographic figures and legends into system of classification of thematic information we receive a new instrument of information management, that is more rapid and convenient, (see Figure 1). New technology also demanded acceleration of data processing of space photos, their scanning and digitizing and further transformation. Today, we may say, that we closely met problems to choose the newest technologies for design and creation GIS of a region.

In such statement the GIS problem becomes the main instrument of absorption and consumption of cartographic information in most different forms. The main task of GIS is to provide and receive efficient analysis using cartographic data base; without this map series co-ordination this problem is difficult to solved. On example of creating and design GIS of Arkhangel'skaia oblast' we have very much understood this organic unity of cartographic information with computer technology. Dividing information layers of one map we use this data coinciding them with information of layers of another map, we get an opportunity to create new informational product or to solve arising questions by circuit "question - answer". In a whole, all questions and processes of collection, keeping, processing and data analysis to create maps in this stage are presented differently by structure. We consider that the stages of keeping, transformation and use of information in the GIS structure are the main.