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SERIES OF EVALUATION MAPS OF NATURAL CONDITIONS AND RESOURCES FOR PREPARING TERRITORY FOR DEVELOPMENT

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The Soviet period in the development of productive forces in Siberia is characterized by the increase in size and capacity, complication of structure and dynamics in territory development, both in the long-settled and in the virgin areas, in Asiatic Russia, which are called pioneer regions (Kosmachev, 1974).

Understanding territory as one of the forms of the existence of bodies and forces in Nature, organizing the development of society, with each year we attach greater significance to the systematized cartographic provision not only of the settled, but also the developing economic regions. At the given stage in the development of productive forces, systematization is expressed first of all in the creation of series of thematic maps and atlases, united by the idea of consecutive interpretation of initial materials about territorial combinations of natural conditions and resources in accordance with the general economic aim and definite scientific-productive targets.

Only such subordination of geographical researches to an important problem, connected with people's economy, leads to the compilation of a series of "actively working" maps of the natural-resource potential of the region. Being, first of all, spatial models, evaluation maps and series of thematic maps (more complicated models) demand a clearly formulated task - "anthropocentric" setting of the problem. This makes the formalization of initial materials easier, both in the structural - in the form of mathematic formulae and symbols - and in the spatial plan - as maps of the dynamics and connections.

At the present time inventory and evaluation maps are used for creating the information basis of the large economic

district and separate territorial-productive complexes (TPC). The former are qualitative and quantitative characterizations of biosphere elements, as the aim of their compilation is - the reflection of the greatest possible volume of information about the natural objectives per unit of useful map space.

In the process of compiling evaluation maps of natural conditions and resources, definite productive problems are put forward and solved about the organization of territory for the optimum utilization of its natural resource base which is considered a prerequisite for the formation of TPC. Defining the latter, N.N.Kolosovsky stressed the following position: the combination of productions is effective only when it corresponds to the combination of the natural conditions and resources in the region (Kolosovsky, 1958). Therefore, when creating spatial models of the biosphere elements and their territorial aggregates, it is expedient, first of all, to keep in mind the functions that are carried out by them either in the present or in the future: raw material, environment-forming, aesthetic, etc. It is quite natural that maps and series of maps with such purposes are applcable only at a certain stage in the preparation of information for the development of territory in a definite natural-economic situation. That is why their compilation and publication must be carried out in a very short period of time and not require great additional labour expenditures.

As for evaluation maps, the speed and cheapness of their compilation are conditioned by the introduction of mathematical methods and automatization in the process of information processing (Kelner and others, 1972; Mikhailov and others, 1975). In the process of compiling inventory maps the most difficult thing is the collection and primary processing of initial data, in connection with which operative series of evaluation maps are compiled with the help of materials obtained by distance methods which are being more and more frequently applied to research (Salitshev, 1975; Orlov, 1975).

However, series of evaluation maps of natural conditions and resources, as a model of natural-resource potential and a system of organizing activity in space and time, must decide not only operative problems, but, in accordance with the general purpose, serve as the basis for long-term planning and geographical prognosis (Ilyina, 1976).

The practice of economic geographical investigations, carried out by the department of economic evaluation of natural resources at the Institute of Geography of Siberia and the Far East, in districts adjoining the construction of the Baikal-Amur Railway showed that the effectiveness of exploiting the natural-resource potential without detriment to the surrounding environment to a great extent is predetermined by the degree of provision of territory with systematized cartographical information. The latter, expressed by series of evaluation

maps and resource maps in our investigations (Mikhailov and others, 1975; Ilyina, 1975), must satisfy certain demands, the chief among which are: 1) calculation of specific natural-economic conditions in pioneer regions; 2) subordination of all maps to a single aim in people's economy - the formation of TPC; 3) close relationship with a complex programme for developing the economic district.

The foregoing territories - the Ob North and the zone near the Baikal-Amur Railway (BAM)- are typical districts of pioneer development, possessing all positive and negative features of intensive anthropogenic influence of man on the natural complex. The most detailed analysis of the peculiarities of pioneer districts is given in the work by K.P.Kosmachev (1974). Summing up the specific features of the developing regions of Siberia and the Far East, one must stress the fact that they are united by a relatively high vulnerability of biosphere elements and their territorial combinations, extreme reactivity and low capability of natural complexes towards reestablishment of destroyed regimes.

On the other hand, during the post-war five-year plans, in the economic development of the examined regions qualitative shifts took place: 1 - from the stage of developing traditional branches of economy (hunting, fishing reindeer breeding, etc., with elements of recreation and intensive geological-survey works to a stage of mass technically-equipped economic development; 2 - from nidial development of primarily extensive character, to an intensive formation and increasing power of TPC.

The first of the named stages in the development of large regions in Siberia is characterized by such a usage of natural conditions and resources when the reestablishment of distrubed natural regimes (as a result of inflow or withdrawal of matter or energy from the balance of the natural complex) takes place spontaneously, that is, in the given stage Nature provides reliably for the resistance of the natural complex to all kinds of anthropogenic influences. At this stage it is expedient to create inventory maps - a fund of initial data about the natural environment of the region.

Problems of cartographical provision of territory undergoing mass nidial development are completely different. First, here it is necessary to issue small-scale evaluation maps for strategic purposes (Ilyina, 1975), good for decades: for 1990, 2000, and so on. On the basis of a series of such maps in the scale 1:2 500 000 and smaller, maps-hypotheses and forecast maps are made up for the development of a large economic region (Gusev and Saushkin, 1970; Ilyina, 1976).

Secondly, in places of intensive anthropogenic influences on the natural environment, where felling for chief utilization, cutting work, melioration, and where the disturbance of the energy and mass-exchange exceeds the critical parameters, large-

scale mapping is essential, as it portrays the interaction of natural complexes with anthropogenic factors. Such maps, naturally, will not be able to stop the process of development on a definite model plot, but they will serve as bases for the classification of natural systems on the principle of their resistance to different kinds of technical constructions.

And, at last, the third stage (intensive formation of TPC) is characterized by a sharp rise in demands for operative evaluation and resource maps, chiefly on a largescale.

Thus, the second stage of development is the most interesting from the scientific point of view, and the most responsible from the standpoint of applied investigations, the result of which must become a map-programme for rational nature utilization.

The following may be considered the tasks of evaluation mapping:

1) calculation and classification of the elements of the biosphere (compilation of inventory lists, classification according to natural and raw material principles, making up maps of areals, distribution, and supplies);

2) evaluation of raw material role of natural components (determination of potential and actual resources, elaboration of cadastres, compilation of a resource map of per-element characteristics and territorial combinations of natural resources);

3) evaluation of the environment-forming role of spatial aggregates of biosphere elements with regard for climate-forming, soil-protection, and water-conservation functions in the distribution of productive forces with the following utilization of the natural resource potential:

4) characterization of the degree of the participation of landscape types in the formation of living conditions for the population in developing regions (local recreation, creation of greenery, collateral (sideline) usage of forest, and so on);

5) determination of intensity of anthropogenic influences on natural complexes (qualitative and quantitative characteristics of force and speed of development processes);

6) comparison of the development intensity with the stability of territorial combinations of natural conditions and resources in connection with the change in raw material and environment-forming role of the latter in the process of economic development by 1980, 1985, 1990, 2000;

7) inventory and selection of measures for reestablishment of landscapes in typical (key) plots and in places with extremal natural-economic phenomena (dam-frost, tunnel-seismology, and etc.).

8) construction of optimization models of the rational utilization of territorial-combinations of natural conditions and resources in the composition of regional inter-branch programmes (for example, the creation of maps showing possibility, necessity, and expediency of the development, or maps of turns,

marginal loads and effectiveness of drawing separate areas into the economic turnover, etc.

The first task in the cartographic provision of pioneer regions is chiefly carried out by compiling inventory maps of soils, vegetation, landscapes, and other spatial models of universal (many-purpose) aim and utilization.

Our experience of working in Western Siberia, for example, showed that the geobotanical map (types of plant associations) may serve as the information baseline for compiling series of eight evaluation maps: woodedness, timber supplies, resources of food, medicinal, and technical plants, evaluation of fodder lands, resources of wild berry-bearing and cedar nut-bearing areas (Mikhailov and others, 1975; Ilyina, 1975).

Simultaneous to the geobotanical map, in the process of compiling a resource map of per-element (natural-definite) characteristics and a map of territorial combinations of natural resources, other sources of information were used; literature, fund, field. Evaluation of raw material data was carried out in order to generalize odd and diverse materials, to bring them to commensurable indices, followed by tying up to territory. On the basis of the elaborated cadastres, the system of transformational coefficients, and with the help of statistics methods of processing initial materials, the comparison of the latter was achieved and it became possible to portray the indices on the map in accordance with the legend of the baseline map.

The experience of evaluational interpretation of data about the distribution and supply of natural resources and their territorial combinations with the following compilation of resource maps was published more than once (Mikhailov and others, 1975; Ilyina, 1975; etc), that is why here we shall only emphasize the fact that, contrary to the already known maps of natural resources, characteristics are shown by isolines on the new maps. This method lacks many defects that are inherent to other ways of reflecting phenomena which occupy large spaces. However, up till now it has only been applied to the portrayal of continual phenomena. In order to use the advantages of this method, it was necessary to transform discreet indices into a continuous density field in mapping. This was achieved by working out a system of coefficients. The compiled isoline maps of natural resources successfully combine such important qualities as scope, visuality, and metricity.

On the basis of evaluation and resource maps it is necessary to compile maps of the economic evaluation of separate species, a resource group of genetically or economically related species and territorial combinations of resource types.

We do not interpret economic evaluation as a sum of natural, technical, and economic characteristics regardless of place, time, and purpose, but as a values expression of the economic gain, received as a result of the exploitation of

the whole set of usefulness per area unit to a time unit on the given level of productive force development. That is why the series of maps for Western Siberia, for example, contain only maps of the economic evaluation of actual resources (Ilyina, 1975).

A monetary unit, characterizing the economic evaluation of natural resources, is calculated by the difference between the closing and direct expenditures, that is, the differential rent. When compiling economic evaluation maps, it was necessary to determine the quantitative dependencies between expenditures on development and the exploitation of each separate type of resource and its supplies per area or productivity unit. The value of economic gain is calculated according to a formula, and is then connected with the basis, that is, the corresponding resource map (Ilyina, 1975).

An extremely important stage in the investigation of pioneer regions is the compilation of evaluation maps of environment-forming functions of natural components and their territorial combinations. The matrix for evaluating natural complexes, worked out by us (the fragment of which is shown), makes it possible to compare the relative cost of various useful items in landscapes before distinguishing the territories connected with definite economic purposes on maps (Table 1).

The evaluation of the raw material and environment-forming role of natural conditions and resources on the maps of the series is done with regard for renewal and exhaustion, possibilities for single and multiple, interrelated and competitive utilization of separate natural objectives and their spatial aggregates. Evaluation maps of natural conditions may be made up by numbers or according to summary potential.

The next stage in the works is the creation of maps of the interaction of natural complexes (systems) and anthropogenic influences. A group of maps is attached which characterizes the intensity of the impact on the natural environment in conformity to the development perspectives, also a group of maps, characterizing the resistance of natural combinations of biosphere elements to technical constructions and other kinds of man's activities. At this stage in the investigation, difficulties exist in correlating indices, reflecting qualitative and quantitative characteristics in processes of natural or economic origin. In spite of the evident genetic differences, in our evaluation-mapping investigation, both processes are subordinated to the solution of economic problems, that is why in their "entirety" and "opposition" (according to Marx) they act as indivisible, interrelated and interacting ones.

The results of interinfluences of natural and anthropogenic phenomena may be considered changes in the energy and matter balances in the natural system on the whole, or changes in the proximity of ties in the regimes of energy and mass turnover between subsystems of various taxonomic ranks. For

Matrix to the evaluation map of taiga comple xes in the zone of BAM for 1980 (fragment)

Table 1

Taiga complexes with predomination	Raw material groups				Environment-forming functions			Recreational functions	
	Wood	Cedar-wood plant resources	fodder	Industrial fauna	Climate-forming	Water-conservation	Soil-protection	Local significance	Inter-district significance
Larches	5	5	4	5	5	5	5	4	4
Pines	5	5	3	5	5	5	5	5	5
Siberian cedar	5	5	1	5	5	5	4	5	5
Firs and spruce	5	5	1	4	5	5	5	5	5
Birches	4	5	2	5	5	5	5	5	5
Aspens	3	3	1	4	5	5	5	3	3
Sparse forest	2	5	5	5	4	4	5	4	1
Felling 2-3 years	1	5	4	5	1	1	1	4	1
Felling (old)	1	3	3	4	4	4	4	1	1

Categories of evaluation:

5 - exploitation economically profitable (necessary),
4 - exploitation economically expedient (possible),
3 - exploitation in the given stage economically unprofitable,
2 - exploitation undesirable
1 - not exploited

calculating the mapped units, a metric matrix-table of a diagonal type was worked out (a fragment of which is represented by the column "Potential" in Table 2).

The matrix permits mutual placement of quantitative characteristics of natural complexes with anthropogenic influences in such a way that it becomes possible to determine the system's limits of resistance to influences and the threshold of intensity (force and speed) on the part of the anthropogenic factor.

When working with a matrix, one must consider the temporal and spatial levels of the mapped objectives.

Recurrent and area correlational ties in objectives of interaction allow to forsee, in general, the rate and scale

Table 2

Matrix to the map of interaction between natural systems and anthropogenic factors
(fragment)

Vectors-columns	Vectors-lines
Immanent properties of natural systems - NS	Immanent properties of anthropogenic factors - AGF
1. Genesis NS	1. Genesis AGF
2. Age NS	2. Age AGF (period of action)
3. Sizes NS	3. Sizes AGF (area of action)
4. Potential NS (resistance)	4. Potential AGF (intensity)
M - mega - 10^6 K - kilo - 10^3 da - deca - 10	M - mega - 10^6 K - kilo - 10^3 da - deca - 10
Elementary unit reflecting resistance of energy or matter balance of NS in calories or kilograms per time unit to area unit.	Quantity of inflowing or withdrawal (+ or -, cal or kg) of energy or matter in a unit of time per area unit, after which relative equilibrium of energy and mass turnover in NS is not reestablished.
d - deci - 10^{-1} m - milli - 10^{-3} M - micro - 10^{-6}	d - deci - 10^{-1} m - milli - 10^{-3} M - micro - 10^{-6}

of the development of the interaction process, the direction, and quantitative character of responsive reactions (Ilyina, 1976).

Data obtained from the matrix allow to carry out a variant of the classification of natural systems (complexes) and anthropogenic factors on a representative basis.

It seems especially perspective to use correlation coefficients, which were received with the aid of a matrix, as mapped units to compile a map of the rational utilization of natural conditions and resources in a large district of pioneer development. Such a map-programme will differentiate the territory with account for the optimum exploitation of the natural resource potential and minimum detriment to the surrounding environment. From the natural aspect, the leading factor in regionalization will be the grouping of natural complexes according to the principle of possible or allowed limitation (threshold) values of the intensity of anthropogenic influences. From the economic standpoint, the value of the economic gain acts as the leading principle. This value is obtained as a result of the exploitation of territorial combinations of natural conditions and resources on the given level in the development of the region's productive forces, as well as in the perspective for the year 2000.

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