MAPPING THE REGIONAL SUSTAINABLE DEVELOPMENT

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Summary

Different opinions about the idea of "sustainable development" (SD) are discussed and the structure of SD indexes is suggested. The last one is based on one of the main methodological statements of the modern geography. It tells, that the basement of the complicated territorial systems or complexes are nature, population, economy. There are distinguished two main types of the original status of the studied regions:
  – Regions, where the necessity to solve the acute ecological problems force to address to the questions of SD. It means that here it is observed the leading role of ecological factor. More often these are regions of ecological hazards, low developed territories with the raw materials and resources specialization.
  – Regions where ecological problems are stocked in the tight knot of contradictions with the social-economic and ethno-cultural problems, that means that the "leading" factor hardly could be marked out.

It is obvious, that to these two situations must correspond the different orientation of the SD indexes. In first case the priority will be given to the exclusively ecological criterious, in second case – the complex system of indexes will be needed. There is suggested the structure of the system of the SD indexes for territories, which will be the specific framework on composing the model of SD.

The maps, or the system of maps or atlas are the more flexible instrument than the system of indexes, because they represent the territorial "reference" and spatial image of the objects and events. Map creation coming from the announced principals must base on the certain indexes, added as the characteristic of SD for the certain region. This makes us to substantiate the certain system of the SD indexes for the regional level.

Analysis shows, that in order to reach substantial completeness, it is useful to divide the indexes into 3 groups: – particular indexes of elements and components of the subsystems "nature" (characteristics of environmental conditions and resources), "population" (socio-demographic characteristics of different groups of the population), "economy" (characteristics of different branches);
- problematic (structural) indexes, characterizing interlinks between ecological conditions and social-economic conditions;
- general system indexes, giving the integrity to the whole set of indexes and characterizing as stability of every system, so as the degree of SD of the territory.

Each level is an informational model of SD of the region of different degree of integrity. Really, the problematic indexes are the certain generalization of particular and component indexes according synthetic "section" of the territory. The indexes of the highest third level sections characterize the most general characteristics of the regional system – general antropogenic load, environmental capacity of the economic system, stability, etc. More often

the base for indexes aggregation is territory. It characterizes the territorial order of data, which is important not only because of the unification of their collecting, but also because of definition of the optimal correspondence to the sizes of the studied systems.

Antropogenic-environmental areas of SD determine the boundaries of the elementar units for mapping. We understand such units as formations limited in time and space, created in result of certain social-economic activity of the population on the certain territory with its typical specifities of the geographical position and all specifities of the geographical environment including as purely antropogenic, so as purely environmental objects and events. The sections of the regional atlas of SD are discussed in details in special section.

Introduction.

Sustainable development (SD), which concept comes from the Stockholm UN Conference on Environment 1972, more often is defined as "development, which satisfies the today's needs, but not threaten the ability of the future generations to satisfy their own needs. (Our common future, 1989, p.50). For today there can be found some tens of different definitions of SD, in which this idea is concretized. The authors take one of most functional among them, accounting original nature conservation premises of appearance of the concept itself: "Stable society gives its members a possibility to reach high quality of life along with keeping the ecological equilibrium" (Care about the Earth, 1991, p.29).

On the way to SD it seems dangerous as extreme ecologism that can undermine the economic basement of civilization, so as extreme antropocentrism, under which it is enough only to correct a little bit the modern market economy. It is obvious, that the concept of SD itself was born in conditions of the global compromise. It tried to reconcile the differences in approaches between developed and developing countries, between ecological needs and economic basements of the modern society.

Under conditions of extremely contrary opinions on the possibility to realize the concept and speed of reaching the SD, it must be accounted that this is not an instantaneous process. That's why there is a need in a certain system of criterious characterizing the degree of SD.

The problem is complicated by the natural macro regional differences of the original positions while the probable transition to the SD. Particularly, traditional collisions insoluble for the developing countries till now are created by the high level of birth rate on the background of high mortality of population. Last years the population of Russia formed the specific type of reproduction, that does not correspond to the standard demographic scheme – decrease of birth rate together with increase of mortality and thickness (Kvasha, 1995). Russia has no till now the mature economic system. Less formed are the civil society backgrounds, backgrounds of the self-regulation of the territorial instances, which successful operating is considered by most scientists to be the necessary condition of SD.

The given considerations create great difficulties for mapping the SD. The methodological grounds for their overcoming must be the study of the experience of ecological-geographical cartography.

Cartographic backgrounds for the study of SD.

Within modern understanding the idea of the ecological-geographical cartography itself formed and started to be used widely in Russia by the end of 80th – beginning of 90th. Today it is considered to be the self-dependent and important section of thematic cartography. Modern ecological-geographical maps characterize the ecological status of organisms and environment and the factors determining them (Aerial-space..., 1995). There is a considerable experience in creation of those maps. It helps to make some conclusions:

I. Most investigators interpret the idea of the ecological-geographical maps widely predominantly from the anthropocentric positions.

II. Possibility to evaluate along with anthropocentric modality of ecological-geographical maps is their integral characteristic. Only the degree of subjectivism of evaluations changes.

III. Despite the practical importance of the regional component of sustainable development there are not enough special cartographic works on this theme.

In general it could be stated that possibility of cartography, methods of modelling and GIS for investigation of SD stays in the meantime unclaimed. The main reason for that is impossibility to use the accumulated information of ecological content in simple way. It must be modified. The non-traditional systems of territorial information must be formed for Russia (such as social monitoring, etc.). First of all it relates to revealing the danger to SD in the region.

Mapping the problems of SD of the territories becomes the natural stage within development of the ecological-geographical cartography which starts from the maps of environment conditions and resources and finishes with the maps devoted to the nature conservation, ecological problems, etc.

Let us distinguish the main problems of the SD mapping: -uncertainty of
the idea and concept of the SD itself;
- absence of clear commonly adopted criterios of the SD and the more so, as their system;
- lack of information, especially spatially localized, absence of the corresponding territorial systems of information;
-practical impossibility to compose the retrospective maps of the territory and difficulties in composing the predictive maps on the SD thematic;
- presence of the process of different scales and of different origin and multi-variability of boundaries of objects and events being of interest;
- impossibility at current stage to compose substantially the united map of the SD of the territory.

The last thesis is tightly connected with the ideas discussed in the work written by V.S. Tikunov and L.F. Yanvarieva (1995). According this it is reasonable to orient to creation of set of maps and atlases, devoted to SD for some territories.

The last one allows to tell about the perspectivity of the new branch of the ecological-geographical mapping of the SD. It has specific features and principals.

I. Usually by now cartography shows the results of human activity. Now the ahead of schedule mapping is needed for the transition to the sustainable development. It will allow to reorient the aims of development on the base of current forecasts and cartographic models.

II. It is necessary the certain compatibility with the main systems of indexes of the territorial development, being in use before (statistics, assessments of impacts on

environment, district planning, etc.). The requested degree of practical use of the results of mapping must be achieved by the presence of maps, characterizing the main spheres of activity (resource utilization, utilization of the main types of outbursts....., characteristics of natural environments and main branches of economy, etc.).

III.   The considerable flexibility of mapping must be provided. It relates to the number of maps and represented indexes, which can allow addition or replacement, integration or differentiation to the varying time-spatial scale of resolution and representation.

IV.   The integrity of mapping of the SD requests the representation of two main aspects – quality of life, social-economic status and ecological stability of development.

V.   The substantial nucleous of investigations devoted to SD is the ecological status of the territory. It means that the ecological structure determination for the region will be permanent subject of mapping.

VI.   Due to complexity and multi-aspectness of the problem the instantaneous process of mapping of the SD is impossible. Firstly mapping must base on the ecological component of the SD. For that there are necessary the cartographic assessments of the most important ecological problems. Further the mapping must go along two directions: more important and critical for every region natural conditions and resources and general indexes of SD.

Maps, or more precisely the system of maps or atlas, are more flexible instrument, than the system of indexes, because they represent the territorial "reference" and spatial image of the objects and events. Maps creation coming from the announced principles must base on the certain criterios taken as characteristic of the SD for the concrete region. This makes us to substantiate the certain system of the SD indexes for regional level. It will base on the experience gained by one of authors while studying the informational support of landuse, natural resources utilization and nature conservation (Tsapuk, 1995).

Substantiation of the system of the SD indexes.

On creating the system of the SD indexes, which could be used in cartography, it ought to account experience of such systems creation in geographical and cartographic practice. the analysis of home and foreign experience of modelling of the ecological specificities of the territories (Ecological-economic strategy..., 1990), ecological expertises and impact assessments of the environment (Grounds for ecological-geographical expertise, 1992), creation of regional planning schemes (Geoecological backgrounds..., 1989, recommendations on conservation..., 1986), statistics processing on environment (Statistics..., 1981, Concepts and methods..., 1991) allowed to come to the following conclusions:

I.   the most important for the working out the "developed" system of indexes are traditions and systems of data maintenance being formed earlier: Earlier they were created only for some types of natural resources (for example, forest resources).

II.   The most optimal in modern conditions are utilization of the componental system of indexes as the grounds. Utilization of the indexes in problematic areas and situations is also possible.

III.   it is necessary to strive for including within the system of indexes all main components of the system "nature-population-economy" in order to make them to reflect all multi-variability of situations and transformations.

IV.   The unified equivalent for the whole system of indexes can be the territory (as usual in the square units) which is the bearer of other resources and is itself the special type of resource (Alaev, 1983).

The concrete indexes and parameters of SD are being discussed in the whole world. One of the most developed system of indexes was suggested by three greatest international nature conservation organizations (Care about the Earth, 1991). It includes two main groups of parameters: quality of life and ecological stability. The first group includes such indexes of human society development as: life duration, profits per person, the level of education and indexes of rights and liberties of human being.

There are provided three main blocks of indexes for ecological component of the SD:
– conservation of life-providing ecosystems and biodiversity;
– consumption of renewable and non-renewable resources;
– load on ecological systems and allowed limits of the potential capacity of ecosystems.

The presidential Council on sustainable development in USA submitted to the discussion 10 national goals and, correspondingly, indexes of their reaching for adoption of the National plan of activities (Borosin, Perelet, 1995). The main indexes of SD belong to:
– provision of healthy environment;
– economic well-being;
– nature conservation;
– careful relation to the nature and resources;
– stability of local societies;

In Russia not long ago the Concept of transition to the SD has been adopted. It suggests the concrete indexes. They can be:
– the consumption norms of some types of resources per person;
– norms of creation of certain types of wastes;
-status of environments, ecosystems and protected territories (quality of the atmosphere, natural waters, square of lands in natural and transformed condition, types of organisms being endangered).

Let us outline that there are needed the society acceptable and easily fixed criterios of the SD. Among many alternative suggestions the priority is given to the relatively easily fixed characteristics such as biomass of vegetation, square of unchanged and transformed to a different degree societies and lands, extraction of the non-renewable resources, birth-rate and mortality, number of population on the territories with exceeded limits of permissible concentrations of the pollutants (Golitsin, 1995).

Basing on the mentioned above we can suppose the structure of indexes of the SD, which bases on one of the main methodological statements of the modern geography. It tells that the basis of the complicated territorial systems or complexes are nature, population and economy (Matrusov, 1993, Simonov et all, 1996).

It is reasonable to distinguish two main types of the original status of the regions:
– the Regions, where the necessity to solve the acute ecological problems force to address to the questions of SD. It means that the ecological factor is the leading one. Most often these regions are the regions of ecological hazard, low developed territories with raw materials and resources specialization.
– the Regions where ecological problems are stocked in the tight knot of contradictions with the social-economic and ethno-cultural problems, that means that the "leading" factor hardly could be marked out.

It is obvious, that to this two situations must correspond the different orientation of the SD indexes. In first case the priority will be given to the exclusively ecological criterious, in second case – it will be needed the complex system of indexes. Let us suggest the structure of the system of indexes of SD for the territories, which will serve as specific framework while composing the regional atlas of sustainable development.

Analysis shows, that in order to reach substantial completeness, it is useful to divide the indexes into 3 groups: – particular indexes of elements and components of the subsystems "nature" (characteristics of environmental conditions and resources), "population" (socio-demographic characteristics of different groups of the population), "economy" (characteristics of different branches);
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Each level is an informational model of SD of the region of different degree of integrity. Really, the problematic indexes are the certain generalization of particular and component indexes according synthetic "section" of the territory. The indexes of the highest third level sections characterize the most general characteristics of the regional system – general antropogenic load, environmental capacity of the economic system, stability, etc. More often the base for indexes aggregation is territory.

Territorial order of data.

Another side, determining the optimum informational massif is the data reference to the territory. The territorial order of data is important not only from the point of view of unification of their collecting, but also from the point of view of their optimal correspondence to the sizes of the studied systems.

Antropogenic-environmental areas of sustainable development (AEASD) define the boundaries of the elementar units of mapping. Under these units we will understand the limited in time and space formations, created as a result of the certain social-economic activity of the population on the certain territory with the typical characteristics of the geographical position and all specificities of geographical environment including as purely antropogenic, so as purely environmental objects and events. Idea about them formed on the basis of studies on distinguishing the natural-economic districts of the different hierarchical level (Neviazshskiy, 1980; Baklanov et al, 1984; Vorobieva et al, 1989). The characteristic of AEASD shows clearly that they are near to the "landuse", but the second term includes now more wide and deep sense. The term AEASD opens the way to the optimum organization of the territory from the point of view of sustainable development.

The existence of AEASD itself as the integral formation is connected with the fact that solution of ecological, economic or social problems separately appeared to be inferior. This leads to the necessity to distinguish on the Earth's surface the integral areas realizing this integrity (Neviazhskiy, Tikunov, 1991). Here rightfully appears the question how to define such areas? Do they exist in reality? The answer can be found in results of discussions on subjectivity and objectivity of regionalization or landscape distinguishing.

The AEASD can be put in the same raw. More they can be considered as real landscapes, although in modern understanding this is not right.

By our opinion the main is realization of them as indissoluble, deeply integrated formations, which can be dismembered only in order to study different aspects of life of their components.

The main index of their diagnosis is materially predetermined spatial structure being recognized on the remote sensing materials or geographical maps and being expressed in the structural-textural specifities of the territory. Analysis of the spatial structures is an instrument allowing to distinguish this integrities and determine the operational units of the different hierarchical level for investigations and management. Important is the following dialectics of investigation the theoretically defined AEASD which are recognized in reality. The experience of their recognition helps to correct the definition and content of the term "sustainable development". The special field studies are necessary, which have the aim to study environmental-economic structure of the territory exactly analogically to the field studies being carried out in order to discover the geological structure of the territory.

The special place is occupied by the the links determination between economic and social functioning on this or that territory and corresponding to them morphological features of the territory. In this case the possibility opens to study objectively the economic categories in their dynamic, which were considered before hand as categories alien to visualization.

The specific feature of the investigation is also that in our case we are identically interested in instrument and object. Due to these reasons concepts and concrete methods of many boundary disciplines and sciences being far from each other are integrated without "violence" due to integrity of the object itself and synthetic approach to their usage.

According the specifities of the territory and tasks of mapping the modification of indexes and choice of the hierarchical level of their time-spatial reference can be realized. So, for the conditions of the Center of the Russia it is necessary the block of special indexes for urban territories.

The set of maps or the regional atlas of SD is reasonable to be created in traditional form and in the form of GIS version. The last one will allow to renew and add new information into the atlas, and implementation of mathematic-cartogrpahic and imitation models of transition of the region to the SD.

The methods of the modelling of the SD.

Orienting in different variants of thematic content we get also many varieties of methods for creation of maps of SD with their specific features, defining the technology. That's why we have chance to stop on only some points, being typical and specific to the maps of this kind.

So, for obtaining integral characteristics, giving the substantial information on different territorial units there are used statistical algorithms of classification on the basis of complexes characterizing SD indexes. The number of algorithms of classifications and their types is great. Among them there are as automatic classifications ("without teacher"), so as classifications "with teacher", which allow "to teach computer" on the chosen standards of any principal of grouping of antopogenic-environemental systems or their components with further differentiation of the whole set according the same criterios, which can be even intuitive, not

formalized. In geography all models of classification (as automatic, so as "with teacher") include subtypes. In this way for typology there are useful models, accounting homogeneity of original units, being united in one group. For assessing classification along with the condition of homogeneity it is necessary to use the hierarchical order between each other for the groups being formed. In some cases typological and evaluation characteristics serve as the grounds for characteristics of SD.

It is reasonable in classification of the systems, characterizing the complicated environmental-social-economic complexes to use methods of the theory of fuzzy sets. This theory, being suggested by L.A. Zade (1965) and developed by other authors, supposes possibility to refer the territorial units not only to one of the classes (as standard algorithms of multi-dimentional classifications), but simultaneously to some classes with different affiliation functions (in case of the transition character of units). Such classification is reasonable, when in reality the boundaries between classes have unclear, transitional character. This must be accounted on mathematical modelling and be reflected properly on maps of SD. The washed boundaries are considered sometimes as common feature (Trofimov, Solodukho, 1986; Rolland-May, 1987) and of course it must be accounted while creation of maps of SD.

Creation of SD maps with their great variety of thematical content must be connected with questions of multi-variability of modelling. The multi variability can be expressed at any stage of modelling – at the stage of its information support, data processing and representation of results of modelling (Tikunov, 1990). It is possible the usage of different massifs of data at the stage of information support for characterization of one event. It is important for characterization of abstract ideas, such as "sustainable development". This characteristic can not be determined by one strictly fixed set of indexes, because for example different investigators characterize SD in their own way. It is possible to use different systems of original indexes, being processed according one algorithm with one type of representation of the results of modelling used on maps in order to make the reliability of final conclusions dependent on only information support of modelling.

The second way of multi-variability expression in particular can be connected with the possibility to process one information massive according different algorithms. In this case it ought to control that all algorithms reflect rightly the sense of the modelling events, that is represented at one of the examples in the work (Tikunov, 1985). It is necessary to account the accuracy of the obtaining results on using of all algorithms, which must be about the same. It is important for obtaining the integral final result. To the contrary we must relate to the results with the certain degree of trust (confidence), accounting them with different "weight", although such evaluation itself is not simple. The parallel usage of some mathematical methods for obtaining of one final variant becomes more and more popular. It is predetermined the more wide extent of computers and modification of the programs' libraries, oriented to the modelling.

The third way of multi-variability is connected with possibility to represent results of the modelling through different types of cartographic representation. The language of the map is so rich and flexible, that inspite of the multicenturies history of its usage, till today new types of representation of events on maps appear and the process obviously will continue in future, especially while characterization of SD. The certain advance in working out the new types of representation is connected with automization of cartographic images visualization on the basis of GIS technologies.

The dynamic of social, economic and ecological-geographical situation stimulate the development of mapping of SD for different time periods. Often for right evaluation of the situation it is necessary the knowledge of the object's status in the far past.

The cartography of SD in its great part means the development of typology of situations, evaluations of status and their prediction in time and space. We must outline that it is oriented not only to the fixation of situation in present, but it gives possibility to predict its changes depending on the development of industry and its infrastructure, changes in social sphere, etc. The great number of maps on this theme will became necessary for decision making, addressed to the optimization of landuse, nature conservation and management of social and economic processes.

Working out the structure of the atlas of sustainable development.

Now in Jaroslavl district there is being worked out the structure of the atlas of sustainable development. This atlas must include the main directions of ecological cartography:
-- environmental conditions and resources, conditions influencing the modern ecological situation, bio and landscape diversity; -- antropogenic impacts and changes in environment, natural and antropogenic risks;
-- medical-ecological and geochemical situation, health of the population;
-- nature conservation and resource conservation measures; -- social-economic aspects of the SD of the local societies; -- ecological stability, problematic areas and situations; -- strategy of transition to SD.
The atlas envisages the following levels of mapping:
  – over-regional (1:2,500,000 – 1:1,000,000);
  – regional (1:1,500,000 – 1:500,000);
  – municipal (administrative districts and large cities) (1:500,000 – 1: 100,000);
  – local (industrial knots, small and middle towns, problematic territories, regions of ecological crisis, etc.) (1:100,000 and larger).

Introduction of the first over-regional territorial level is predetermined by the necessity to evaluate the place of certain region in the territorial structure of the higher class. Some input maps will correspond to the certain level. The expected scales are given for the hardcopy of maps on correspond within the conditions of Jaroslavl area to the standard paper sizes A3 and A4.

The possible requests to the atlas include the request to the geoinformational base and requests to the cartographic design. For the first the most important are the territorial and substantial completeness of information for the certain scale and level of knowledge and also parameters of data quality – reliability and accuracy. As soon as the level of studiness of the territories permanently increases. The possibility must be provided to renew the maps (appearance of the new versions). While maps' designing it is necessary to strive to obviousness, readability and accessibility of maps. The perception of geoecological information must be facilitated by the qualitative arranging and clear structure of the atlas (Complex regional atlases, 1976).

The following sections of the regional atlas are presented in details:

Introduction

The maps representing general geographic position, ecological and social-economic status of the region (4–5 maps).

Components of natural, social and economic systems

Impacts, use, changes and stability of natural resources and environments.
Population number and density, birth rate, labor forces. Profits, profit per person
Maps, characterizing the main branches of economy and landuse (25–35 maps).

The problems of sustainable development.

Maps of the most important ecological and social-economic problems of the region. In conditions of Verkhnevolzshie first of all this is urbanization, flooding, eutrophication of the surface waters, pollution of environment with hard metals, deterioration of lands, ecologically predetermined thickness.

Maps of ecological problematic areas, including about all large and middle towns of the area, the zone of water reservoirs.

Maps of critical landuse types, problems of recreation, limits of permissible ecological capacity of the territory, landscape diversity, species of organisms and ecosystems, ecological framework and system of protected territories.

Problems of health of population (critical types of thickness, infant mortality, early pregnancy and abortion, etc.).

Problems of employment, and societal-political stability (violent crimes, civil activity, the profitable gap between rich and poor groups of population, etc.). Investments into the future (educational level and development, woman status, protection of childhood) (30–40 maps).

Integral maps.

Maps of the general pollution of the territory, general antropogenic load, stability of landscapes, ecological risk.

Maps of the general environmental capacity, technogenic outbursts... and wastes. Health (duration of life, thickness), societal-political stability, "stable" profit per person. The resulting map of the degree of SD of the territory (10 maps).

In a short variant the set of SD maps can include only maps of the last section of the atlas, but from the methodical point of view it will be better to create maps for all sections. In result the atlas must be the interrelated system, including analytical, complex and synthetic maps.

Today one of the authors is occupied in realization on the basis of the suggested concept some sheets of the SD atlas of Jaroslavl area (Russia).

The concept of the SD atlas of the region is being realized in practice within the informational-graphic system (IGS) "Terra". "Terra" is worked out on the order of the authorities of Jaroslavl area and now it is the first stage of creation of the integral territorial cadastre of

Jaroslavl area as a part of the integral state cadastre of Russia. For today the multi-layer electronic maps of Jaroslavl area are realized within the IGS "Terra" (the basic scale is 1:100,000, for the territories of towns – 1:10,000). Along with that the data base is being created, corresponding to the certain layers of maps (forests, road infrastructure, settlements, administrative districts, building objects, etc.).

The concrete working through the possibilities of the atlas creation and testing of the IGS "Terra" are carried out on creations of electronic versions of two maps, which thematic was chosen with account of the present data and theoretical approaches. These are the questions of antropogenic load on environment and general pollution of the territory.

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