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Strategizing of social, ecological and economic systems under conditions of the blur of background information

Abstract

The article describes characteristic feature of information resources in social, ecological and economic systems as a methodological basis for their efficient management; reveals the essence and sources of information of the blur of social, ecological and economic processes that determine the ambiguity of their assessment and variability of administrative decisions on maintaining sustainable development and coordinated interaction of these processes.

Keywords: social, ecological and economic geosystems, the blur of information, ambiguity of their assessment, variability and efficiency of management, coordinated interaction of social, ecological and economic geosystems.
JEL Classification: M10, Q01.

Introduction

Objective. The objective of the study was to determine the nature of information resources of social, ecological and economic geosystems as a methodological basis for their efficient management; disclose the nature, dynamics, range of motion, algorithms of interaction, uncertainty factors and variability of managerial decisions under the conditions of the informational blur of social, ecological and economic processes; to formulate the approaches to their assessment in order to promote the strategizing of their sustainable development and coordinated interaction.

Concept and results. To achieve this, we made use of L. Zadeh fuzzy sets and algorithms method, based on the concept of membership function μ (x), which characterizes the degree of connectivity element "x" to a particular fuzzy set. In this case, we assumed that the problem of managerial decision making under uncertainty (including the evaluation problem) can hardly be reduced to strictly written mathematical problems. It is necessary to eliminate or reduce the uncertainty introducing certain hypotheses, for example, in the form of a fuzzy set and fuzzy relationships membership function. When evaluating territories and organizing their efficient strategizing it means that the procedure can not take the nature of a completely formal logical managerial algorithm, but to a great extend must rely on logic and meaningful approaches and methods of managerial decision making analysis.

In this analysis, we made use of an informal and semi-formal research instrument, which is based on systematic, communicative and synergetic techniques, as well as methods of the theory of expert assessments, fuzzy set theory and exercitation of compromise managerial decision making theory, which made it possible to come to the following results: to give the definition of social, ecological and economic system as objects of strategizing, to specify approaches to evaluation of these systems in the framework of the theory of fuzzy sets theory and the theory of compromise managerial decision making, assessment algorithms of social, ecological and economic systems and their strategizing on the basis of sustainable development and coordinated interaction.

Originality. The originality of the research lies in the fact that social, ecological and economic geosystems are considered as complex, hierarchical systems, self-organized, organized and non-equilibrium systems with natural, economic and social subsystems that are in direct and indirect interrelations. Non-quantitative parameters and relationships act as an important characteristic feature of these subsystems, making its qualitative evaluation rather challenging. Therefore, the proposed L. Zadeh fuzzy sets theory and exercitation of compromise decision making theory can be regarded as one of the possible solutions to this problem in Russia.

1. Problem statement

The existence of social, economic, ecological and other resources and contacts in different areas makes it possible to put up the question of complexity, communication and synergy of these formations. They form complex, multi functional, non-equilibrium dynamic social, ecological and economic systems.

Any system can be considered as an element of a higher order, while its elements can act as systems of a lower order.

A hierarchical pattern, a multilevel factor characterizes the structure and morphology of a system, its behavior and functioning: certain levels of the system are responsible for definite aspects of its behavior, and a joint functioning is the result of interaction of all its aspects and levels.

Real life structures and formations compose natural systems (e.g. population, biogeocenosis and bio-

sphere). The broader concept has the notion "geographical system" ("geosystem"). It is a geographical formation consisting of a holistic set of interrelated, interacting components of the geographical environment.

The same as the definition of an abstract system, the concept of a geosystem does not have a generally accepted definition. All the approaches that are used in defining the system in general can be acceptable in regard to the geosystem as well. Nevertheless in a geosystem there are some peculiarities. Their components are the elements of the environment, economy and population. Interactions among them are realized through overcoming distances and on which a territoriality ratio is specified linking the territorial localization of elements with their individual properties. An essential attribute of a geosystem is its boundary. The territoriality ratio is the most important type of geosystems relations.

The second part of the definition of a geosystem points to specific features of the system's territoriality: the ratio of territorial ordering of the parts or elements of the system, being the part of the Earth, the Earth's surface, the geographical environment, etc.

The term "geosystem" is used to define:

- natural geographical formations;
- complex formations involving both the elements of nature, population and economy (geographical integrity of systems in this case is determined by direct, indirect and transformed links of economy, population and nature);
- both natural and socio-economic formations;
- all objects in the branches of knowledge, connected with the Earth sciences.

The examples of geosystems are: a geographic shell, a geographical landscape, a territorial and industrial complex (TIC), a system of settlement, biogeocoenosis, natural and technical systems, etc.

An adjective that defines its "specific character" is added to the term, e.g. "natural geosystem", "socio-economic geosystem", etc., when characterizing objects belonging to this or that sub-class.

Three models of geosystems (separately or together) are used for their analysis:

- a monosystem model in which components of nature or economy act as elements of a geosystem;
- a polysystem model, in which elements of a geosystem are elements of a lower rank;
- a dynamic model, in which the condition of a geosystem, its temporary modifications are regarded as its elements.

It is significant to note here that if the territory is developed, then there exits a spatial social, ecological and economic system, organized by a human being. Its parameters depend on the amount of population and on the level of development of productive forces of the society. Being developed (reclaimed), for the human being this area becomes not only a "place of staying" – its spatial structure is an expression of complicated processes of exchange of matter and energy between the population and the nature complex represented by social, biological and economic exchange of a human being, nature and public production.

The reclaimed areas constitute converted complexes of a geographic shell – a geomedium of a human being. Essentially, biological and industrial elements of interaction of the population with the environment lead to the development of a holistic formations: "population-economy-nature", i.e. social, ecological and economic systems, in which their social forms correspond to a sum-total of labor and culture potential of people. The culture potential of people consists of historical, moral, ethic, political and educational potential.

Inside every social system or in relations among its element mental and livelihood activities in different forms take place. The social form of a geosystem grows and evolves on three basic parameters: on certain vital functions, due to which a relevant human community exists; the territory in which these functions are carried out; and institutional structures, providing the implementation of all the necessary vital functions in the given area and at the given existing sum-total of population (i.e. the combination of a number, quality and social composition of the latter). Neither society never and nowhere exists beyond its reference to this or that territory.

Social medium is always organized in this or that way, has non-equilibrium and a dynamic form of development. Its organization is formed to carry out special activities, although later it gains an established degree of autonomy from that for the sake of which it was created. At the core of a society lies the need for the reproduction of its existence, its being. The activities are inevitably tied to a specific time and space, and thus the organization of a social medium itself for such activities, and the forms, structures of this organization are also associated with this territory and its features. That is why it is considered to be more reasonable to define social geosystems as social and territorial forms of their realization.

A social and territorial geosystem can be defined generally as an organized in a certain way (sponta-

neously or intentionally) for long-term, independent life-sustaining activity, for maintaining its existence as an integral social organism and (or) its development on this territory social medium, which is stable, according to ethnic and religious and other features and dynamically non-equilibrium.

The most important quality characteristics of this definition in the first place is the historical time scale that under current conditions can last several decades, or the length of life and activities of at least two generations of people. Another characteristic is relatively high – during this period of time, in accordance with its scale and criteria – the stability of national, religious, cultural background or the core of a society. This does not mean that some specific characteristics of the population can not be changed within certain, often quite wide limits. Some sort of evolution in national, religious, social composition of the population is inevitable. But the basic characteristics, the so called fractals, that make it possible to call this country or region, for example, Orthodox or Muslim, Russian or otherwise, etc., must remain on the whole the same or unchanged.

The self-sufficiency of the medium existence anticipates not economic or other kind of its seclusion from the world – such isolation either takes place or not – but its existence as one aggregate during the periods specified above, even if some of its history the given social medium was in position of someone's colony, protectorate, area, etc.

2. Research tools of strategizing processes of social, economic, ecological geosystems

A broad range of research papers (Postaliuk et al., 2013; Rozanova, 2012; Vladimirov et al., 2009) is devoted to the study of regional social and economic systems.

The questions of communication and synergy of socio-ecological-economic geosystems, dynamics and non-equilibrium of their development in a certain area and at a certain time, are not analyzed deep enough. This necessitates the development, first of all, the tool for their research, which will help to ensure productive evaluation of communication peculiarities and self-organization of the given geosystems.

Social, ecological and economic geosystems (SEEG) mean an interrelated self-organization of elements of public, natural, industrial, demographic and institutional character, specifically functioning in a certain area at a certain period of time. Territory and time dependent SEEG can be of different scale rates. Accordingly, their studies are divided into large-, medium- and small-scale ones.

Large-scale studies are generally used for the analysis of individual elements and components of social and economic systems, for example, for the study of certain enterprises, institutions, associations, etc. In this case, along with the identification of the role and place of the object in a territorial system, its functions and external relations a lot of attention is paid to the internal structure, technical and economic indices, etc.

Medium-scale researches deal with the study of meso- and microsystems: administrative and economic regions, economic sub-districts and neighborhoods. They focus mainly on an integrated territorial system and its industrial, territorial and functional structure. Its separate elements are analyzed in general, on the whole, not taking into account internal structures. They are taken for "a black box", inputs and outputs of elements are exposed to analysis.

Small-scale studies include holistic microsystems, most often economic areas; sometimes the whole supersystem of the national economy is analyzed.

A SEEG is a socially, ecologically and economically effective combination of the elements of a society, nature and business, involved in regional processes of social reproduction, functioning and developing on a definite territory as the links of the chain of geographical disintegration and labor integration. SEEGs are dynamic, open, complex, non-equilibrium and multilevel systems. They are in constant motion, operation and development.

3. Structures and substructures of SEEG strategizing objects

The following interacting and self-organizing subsystems, as has been stated above, can be identified within SEEG: social, ecological and economic. In the structure of the latter we can distinguish substructures depending on the aims of the research: population and its expansion, natural resources, recreational, industrial and production infrastructural, institutional and sector, etc. Numerous social, economic, ecological, informational and other types of links are formed among them. In the process of purposeful activity of population and manifestation of these links organically holistic integrated SEEGs are formed. Their properties are not additive to the mere sum of properties of their constituent subsystems. Each of them, being relatively independent, often turns out to be a subject of research, forecasting and planning. But it should always be borne in mind that their diversified livelihoods and full implementation of internal potentials are possible only if integration and dialectical unity of SEEG are achieved. Therefore

complex investigations and forecasting of main tendencies and features of SEEG development become particularly relevant. The following features are characteristic of SEEG:

1. Humane goal orientation on future development.
2. Territorial community of people.
3. Organic social and economic integrity.
4. Complex composition of elements belonging to functional and structural subsystems of different levels.
5. Operation and development in the process of regional (local) social reproduction, acting as an integral component of social division of labor, including the geographical disintegration and labor integration.
6. Interconnectedness and interdependence of space-time combination of elements, which gives a certain economic, environmental and social effect.
7. SEEG forecasting, planning and control.

SEEG have their own resources, found in the nature, resource, industry, social and other subsystems. Regional and local processes of social reproduction emerge in a SEEG on the basis of its own resources and on resources coming from outside. They are driven by the needs of society as a whole, as well as directly by the needs of SEEG themselves.

Every SEEG has an external environment. Spatial-temporal borders act as SEEG boundaries. They are determined by regional and local processes of public reproduction, internal social and economic links that are tighter and more constant than external ones.

4. Motivation for SEEG functioning and development

SEEG belong to a class of dynamic systems. They are characterized by constant changes in space and time, progressive functioning and development. The terms "functioning" and "development" are closely related. They reflect the dynamics of systems; at the same time, there are differences between them, as functioning is a process of quantitative changes and accumulation only, whereas development is a qualitative transformation of SEEG as well.

Functioning is understood as SEEG's life-sustaining activity, development is understood as the formation of qualitatively new systems and the conversion of already existing ones. SEEG development always means interaction connected with functioning. It focuses on advanced components and relationships that arise in the systems. SEEG functioning in life processes is the basis of development; it is in the process of functioning, when conditions and opportunities for the transition of systems to a higher stage of development and improvement evoke. The important characteristics of SEEG development process are continuity, direction and irreversibility.

Main SEEG motives and evolution sources are their internal heterogeneity, non-equilibrium, multilevel structure and contradictions. Spatial-temporal combination of SEEG in all spheres of life activity of people, all its subsystems, structures and sub structures in processes of various quality, consistent and inconsistent interactions and self-organizations creates necessary conditions for the emergence of internal contradictions within holistic SEEGs.

One of the most important SEEG qualities is its openness. It presupposes a plenty of links and relationships among society, nature and business. Systems exchange raw materials, fuel, energy, goods, population, services, ideas, innovations, etc. A SEEG operates with the help of its interaction with the environment, which sometimes directly and more often indirectly influences the development of systems. However, that influence of environment should not be overemphasized. The specific character, the structure and the nature of systems are determined primarily by the intrinsic nature of elements and components that form these systems, the nature of their internal relations. External impacts are always deflected through the SEEG inner implication.

5. Contradictions of SEEG strategizing

All internal contradictions according to the degree of their influence on functioning and development of SEEG can be divided into three groups:

1. The contradiction between productive forces and production relations.
2. The contradictions between regional and local reproductive processes, distribution and exchange relations, etc.
3. The contradictions occurring in the result of differences in the dynamics of functioning and spatial organization of subsystems.

Other inner conflicts play an important role in the development of SEEG. Among them in the first place are contradictions inside conjugated functional structural subsystems. These contradictions are due to a different level structure and disparity (misfit) of subsystems, different dynamics and rhythms of their functioning, specific relationships of territorial organization of elements. They are escalated by the departmental membership, lack of agreements among individual forecasts and general plans of development.

Within a SEEG structure, there are significant differences and certain contradictions between substantive basis of its nature and public attitude towards it in different place and time rhythms of

functioning of natural and social components. In the process of SEEG functioning, their natural resource basis is gradually depleted, especially that resource, which cannot be renewed, and at the same time it is filled up with technology-related and anthropogenic objects. In the development of SEEG it is the period of complications in ecological situations and lack of their own natural resources, which often leads to a change in SEEG structures and functions.

Contradictions in functioning and spatial organization of subsystems that differ in their degree of dynamic response contribute to that. A production subsystem and a production infrastructure are among the most dynamic ones. In their development and spatial organization they are subject to the goals and strategies of development of a holistic SEEG, and at the same time act as initiators of progressive changes in the functioning and location of less mobile, more inertial subsystems, such as the resettlement of population, recreational, social systems, infra-structure, etc. This phenomenon must be taken into account when making all kinds of economic and geographic forecasts.

A special group of contradictions in subsystems occurs in the process of their spatial organization within a SEEG. Strengthening of spatial concentration and integration of society contributes to economy-cut in the sphere of land ownership, to reduction of time and transportation expenses, improvements in economic efficiency, etc. The contradictions of this group are closely intertwined with the contradictions of concentration and dispersion, contraction and diffusion, agglomeration and deagglomeration, etc.

6. Stage strategizing of SEEG functioning and development

The SEEG development is characterized by certain stages. In the development of SEEG the following stages can be pointed out: origin, formation, maturity, stabilization, transformation. At the first stage the creation of top-priority components of the life of the society takes place – infrastructure and manu-facturing objects, communities, labor groups and others. At the next stage economic and social structural formations evolve. The stage of maturity is characterized by internal integrity and harmony of functional subsystems and components, by setting up combined and integrative structural formations. This stage develops into a stage of stabilization with the spatial and time discordance of structures, the occurrence of conflict situations. The SEED, being at this stage, continues to function thanks to a response rate of the holistic system and certain subsystems.

A conflict situation grows up and leads to the need of SEED transformation with the change of its structure and profile, and sometimes – with the change of its boundaries. The next SEEG spiral development takes place on the basis of previous development passing the same stages, with the exception of the stage of origin. Each of SEEG stages of development features a new quality, expressed in the structure and functions of the SEEG.

One of the most devastating and dangerous contradiction of SEEG development is the contradiction of inconsistent interrelation between the degree of dynamic sustainability and dynamic transformation of SEEG structural elements – social, ecological and economic, especially natural geo-systems, including living organisms (life forms) and man-induced impacts.

The increase in the scope and the intensity of human activity in modern conditions are inextricably connected with the escalation of an impact on the environmental. The imperfection of the technology, which is used, the methods of industrial and environmental management also lead to a reduction of environmental capacity on global level as well as on regional and national levels.

7. Selection and estimation of SEEG strategizing priorities under the conditions of the blur of the background information

Already at the beginning of the 20th century V. Vernadsky compared human activity with a global geological process. Even now it is difficult to predict the severity of those changes in nature that it will produce in the nature. Up to now, all the structures in industry and agriculture were created at the expense of the destruction of structures in the biosphere (Postaliuk et al., 2013).

Incorrect or ill-defined goals, set by a human being or a society, have deleterious effect on all SEEG levels: "population-economy-nature". Moreover, if human goals are left behind, such an impact is destructive to the environment, because it does not clearly fix fundamental limits to technological "progress", or its expansion, to be precise. That is why, in our opinion, the development of all science and technology can hardly be considered only consistently progressive. Contemporary influence of the economy on population is also not always positive. Actually, science and technology development in some structural interrelations in ESSG is inconsistent and has gone far beyond the man's control, which is reflected in all spheres of public life, starting with its orientation.

Priority in this situation should be given to ecological approach to interrelation and development of structural element of SEEG, where an impetus to start the above mentioned processes is given. It is stipulated by the fact that a SEEG as is an interactive,

non-equilibrium set of connections between the elements of nature and economy that far exceed the intensity of links directed from the outside and is in SEEG, or itself the sum of its elements. Therefore, the evaluation SEEG with certain positions and in accordance with the intended purpose is one of the most important problems of modern science and largely determines its constructive potential.

Thus, SEEG environmental evaluation: natural conditions and resources of the area, its labor, industrial, agricultural, transport, scientific, technical and other capabilities is widely in common practice at present. The evaluations of the kind facilitate the identification and understanding of the mechanism of the most fundamental processes that shape the SEEG structure and in this way define the basics of the territorial organization of a society.

However, numerous research works devoted to the evaluation of any territory components from certain positions do not have, strictly speaking, a common methodological basis. Therefore, the evaluation of one and the same SEEG object by different researchers may lead to different and even disparate results. Even more important is the question of common, unbiased and independent of previously defined goals, approaches to SEEG evaluation, methodological and practical ways to implement these approaches.

The importance of the development of these problems leaves no doubt, because it would actually make it possible to describe the procedure for estimating SEEG and its results in the general concepts and terms, a kind of "universal language", and largely automate calculation efforts related to ESSG evaluation.

Within this overall approach and its initial conceptual scheme model of the problem and its solutions, methods of research – all that is called a paradigm – it becomes possible to compare the results of the evaluation of different SEEG (from the standpoint of the same purpose), and thanks to that, get new material for further research. Strictly speaking, a common approach to a SEEG evaluation makes it possible to compare the data of the same SEEG, but from different perspectives. The meaning and practical benefits of such a comparison may be different, but there are no formal barriers to it, as all figures are a result obtained according to the same algorithmic scheme.

The blurring of SEEG as objects, phenomena and processes often comes from those of their characteristics, which are difficult to calculate (or beyond calculation at all) or for some reason can not be measured with sufficient accuracy.

In many cases, goals and restrictions can not be presented in a quantitative form. These statements are unclear, have a blurred character. Similar formulations may include: blurred purpose – "x" should be significantly larger than "a", blurred restriction – "w" should be approximately in the range from about from A to B. In formalizing vague terms (such as "large", "approximately") and other vague provisions the regulations, proposed by L. Zadeh in his theory of fuzzy sets and algorithms, are used.

Fundamental in this theory is the concept of membership function $\mu(x)$, which characterizes the degree of membership of a particular element "x" to a certain fuzzy set. Decision making problems under the situation of uncertainty (including the evaluation problem) can not basically be reduced to strictly mathematical problems – it is necessary in any way to eliminate uncertainty by introducing certain hypotheses, such as the function of fuzzy set membership or blurred relationship (Vladimirov et al., 2009).

The main task here is to formalize as much as possible, that part of the initial information, which has a semi-quantitative or qualitative nature and thus creates uncertainty. In a decision making theory, multi criteria problems are generally considered, in which there are many conflicting goals (or criteria) and it is necessary to find the most preferred embodiment of the solution according to the relative importance of these goals.

Consequently, the problem of evaluation under uncertainty conditions, immanently inherent to the object under evaluation, is not, strictly speaking, a mathematical one, but thanks to mathematics there is a real opportunity to embrace the diversity and originality of the problem and to develop operating procedures to obtain those variants of assessment that the subject of evaluation is really interested in.

For SEEG evaluation problems this means that an evaluation procedure can not have the character of a completely formal logic algorithm, but should be mainly based on logical and meaningful approaches and methods of analysis.

Quite reasonable is the desire to obtain quantitative evaluations, but at the same time, the blur nature of the object under evaluation restricts the use of strict formal methods. One possible way out of this contradiction lies in the handling of the informal and semi-formal research instrument, which is based primarily on the methods of the theory of expertise and the theory of fuzzy set, as well as on the methods of compromise (Haken, 1985). The proposed methods have two characteristics:

1. They are approximate by nature and in this sense correspond to features of objects of SEEG modeling with their blurred nature and the qualitative character of many relationships.
2. Unlike many well-known mathematical models of some definite SEEG or its structural elements, the proposed methods are feasible, i.e., there are no fundamental obstacles to their practical implementation.

Those activities, which are intuitive and procedurally not formed, usually focus on either troubleshooting or solution of the problem (i.e. either excludes all options or chooses one of them). But our life often dictates increasingly complex situations, including compromise ones. One can not ignore the fact that human activities are found not only in a situation of complete certainty and understanding of the processes, but also in situations of being completely in the dark about forthcoming events. In addition to these circumstances, the decision making process there can be such cases, when the importance of results are determined by the event probability (i.e., when risk can not be eliminated), or situations where there is no information about the probability of events, i.e. there is uncertainty in a problem statement.

For SEEG evaluation problems this means that evaluation procedure can not have the character of a completely formal quantitative algorithm, and must rely on logical and meaningful approaches and methods of analysis, based on the characteristics and patterns of integrated, holistic thinking. This approach can be seen in the interpretation of a principle, well-known in a general theory of systems, the principle of an external addition, according to which if the object of great complexity the study of results requires meaningful control and decisions that are taken informally about the adjustment (reconciliation) of the results.

The most justified way how to solve the problems of SEEG evaluation seems not to be in the working out a sophisticated formal instrument, but in the use of logical, meaningful techniques and methods that make it possible to obtain nontrivial results with a minimum of mathematical resources.

At the same time, in order to ensure comparability of the results of different estimation procedures it is essential to ensure uniform rules (not necessarily mathematically expressed) and the generally accepted operational sequence, i.e. a unified evaluator. Even under conditions of uncertainty, resulting from the blurred nature of primary information about the object under evaluation, there is a chance of coming across a significant formal element in the evaluation procedure itself. The main task here is to formalize that part of the initial information, which has a semi-quantitative or even a qualitative nature as much as possible and therefore creates uncertainty.

Multi criteria problems in which there are many conflicting objectives (or criteria) are generally considered in a decision making theory. The task is to find the most preferred option for the solution according to the relative importance of these goals. An important role in solution of these problems goes to preferences made by a decision maker, his ideas about the significance of this or that goal, information about certain objects. At the same time there is a group of problems in which it is necessary to make decisions in strict sequence at a certain period of time; at every stage of the decision making process there can be different criteria or goals; the resources of the decision maker are common and limited during the entire time interval.

The hypothesis definition is an area of a meaningful analysis and in fact is a procedure of the formalization of informal situations. Hence the possibility to encode the information about the properties of the object under studies, goals and results after the adoption of a decision into a mathematical model emerges. Consequently, the problem of evaluation under the conditions of uncertainty, immanently present in the object of evaluation is not, strictly speaking, a mathematical one, but thanks to mathematics there is a real opportunity to embrace the diversity and originality of the problem and to develop operating procedures to obtain those variants of evaluation that really interest the subject of evaluation.

The blur of SEEG as objects, phenomena and processes of evaluation very often stems from those of their characteristics, which are difficult to express quantitatively or for some reasons can not be measured with sufficient accuracy. The result in both cases is the same – a degree of uncertainty in the conditions of the problem under studies.

At the same time, these characteristics are usually quite well comparable in the ordinal scale of measurements. This means that with respect to each pair of structural objects in SEEG – carriers of some quality – it is almost always possible to specify which of them has this quality to a greater extent, or to state that the objects in this sense are equivalent.

Thus, preference relation on virtually any characteristic feature from those, which these objects have, may be set to the set of similar SEEG objects; in other words, the SEEG objects can be arranged according to this or that criterion.

There are two types of preference relations. The first type is characterized by preferences that can be measured on an ordinal scale, i.e. only the fact of preference (or equivalency) of one object to another is stated. It is so-called non-metrized preference relations. The second type involves not only the disclosure of preference or equivalency of one object to another, but also some quantitative evaluation of the intensity (strength) of preference. It is the so-called metrized preference relations.

In order to make the estimation formula complete it is necessary also to name specific conditions under which the interaction between the subject and the object of evaluation – geographical, political and others take place, i.e. the evaluation in any case should be spatially and historically relative, since only in this case it becomes possible its correct interpretation and skillful use.

8. The estimation algorithm in SEEG strategizing

The proposed procedure of the estimation of territories in the framework of exercitation in compromise has algorithmic nature and consists of several stages.

1. At this stage a certain goal of SEEG estimation is formulated. The goals may be very different and determined by the needs of the subject under evaluation: the evaluation of the level of suitability of its territory and its separate parts to accommodate any objects, the evaluation of the level of environmental hazard posed by different fields of industry, and combinations thereof, the level of rationality of regional systems for environmental management, for migrants and in more broad sense – the evaluation of the potential for socio-economic development. This may also include the evaluation of recreational, migration and other attractiveness of individual districts and areas, as well as the evaluation of peculiarities of the distribution of demand for certain goods and services, etc. on this territory.
2. The range of factors and conditions that are essential from the point of view of a stated goal is defined. Practically, this means that on the basis of informal observations and meaningful analysis of the problem, a list of characteristics (not necessarily quantitative) determining the values of the required evaluations is set. The number of identified significant factors is marked by m.
3. As the importance of various factors in the formation of the desired estimates can be different, the factors are arranged in accordance with the understandings of the subject under evaluation of the relative importance of the factors for the final result. In solving various practical problems it is often required to determine the coefficients of the relative importance of the evaluation criteria of the objects. For this purpose, various methods are used: direct numerical evaluation, evaluation in points, ranking, Churchman-Akofa method, the method of frequency preferences; Thurstone method, linear convolution of criteria.

All methods for determining the coefficients of relative importance are using subjective information, given to them by experts and decision-makers. In this regard, there are no obvious comparison criteria of such methods and rationale for their selection is associated with certain difficulties.

As a measure of the consistency of experts the averaged criteria value of scattering coefficients $D(i, j)$ average, is adopted, calculated on the basis of information provided by individual experts, i.e. dispersion averaged according to n criteria:

$$D(i, j) \text{ average} = D(i, j) / n. \quad (1)$$

The method that ensures the lowest dispersion should be taken as the best one. Thus, all methods under consideration are arranged. Besides, when comparing the methods the time required for the communication with experts is taken into account.

4. Based on certain conditions of SEEG and on meaningful (informal) analysis of these conditions, as well as on the required accuracy and possibilities of subjects under evaluation, SEEG is subdivided into its components – Operational Geosystem Units (OGU). They represent an elementary geosystem cell corresponding to the lower limit of divisibility in this particular case. The subdivision may correspond to SEEG existing administrative and territorial structure that greatly streamlining the initial information and its use.

$$A = \{ a_k , k = 1, n\}, \quad (2)$$

where "n" denotes the allocated OGU number, and "A" denotes the set of all selected OGU

5. For each of the selected in Section 2 OGU factors, A is arranged according to the degree of possession of OGU properties that this factor describes. As a result, m mono factor adjustments will be on set A, each of which describes a geosystem distribution of any of the significant factors shaping the desired evaluation. We denote V_{ki} rank (place) k-th ranked by OGU according to the i-th basis ($k = 1, n$, $i = 1, m$). The obtained baseline information can be given in the form of a table.

For all factors $i = 1, m$ matrices of pair wise comparisons are constructed:

$B_i = b_{ikj}\, nxn,$ (3)

where 1 if *rki* > *rji*; b_{ikj} = 0 if *rki* > *rji*; -1 if *rki* > *rji.*

B_i matrices have the property of anti symmetric character, i.e. *bikj* =-*bijk* for all $i = 1, m$ and $j, k = 1, n$, so it suffices to calculate only the elements located above the main diagonal.

6. A SEEG, regarded as a set of OGU is analyzed from the point of view of consistency of spatial distribution of factors under studies. In a case when matching is significant, i.e. factors largely operate in one direction. It is a pronounced differentiation of values of the required assessment on the territory. Otherwise, such an analysis will identify those factors that contribute to leveling of geosystem differences in evaluation values, i.e. the question of getting the solution of a really high quality is real.

To evaluate the degree of similarity of factors for each pair of OGU the concept of the measure of proximity of preference relations, calculated in an ordinal scale can be used. Such a measure of proximity is often based on the notion of distance between two rankings. The degree of mutual consistency of distribution for each pair of factors can be set by using the notion of the standard distance between the two adjustments, and the degree of consistency of distribution of all factors at the same time – by using the concordance coefficient.

With their help, the matrix of coherence factors is built and their generalized coefficients are calculated.

7. A multi factorial (resulting) adjustment of set *A*, based on private, i.e. mono factorial adjustment, is defined. The resulting adjustment determined as a compromise one and it takes into account the impact of all factors according to their relative importance, as is set out in section 3.
8. Values of proximity measures between a compromise adjustment and each of mono factorial adjustments are defined.
9. For each OGU the measure of the "quality" of this OGU from the position of reached compromise is determined. It reflects its place in the aggregate values of the required evaluation.

The resulting vector represents the desired evaluation, describing geosystem distribution of evaluation values, or, what is the same – the differentiation of evaluation within the observed SEEG limits.

These are the fundamentals of the theory of compromise decision making in relation to the problem of SEEG evaluation. Interpreting interactions in geosystems as the interaction and collision of competing interests of individual elements, subsystems and hierarchical levels, it presents new opportunities for meaningful analysis, which is so important in the socio-ecological-economic studies of geosystems, because identification, description and coordination of interests are clearly associated with the study of driving forces and motives that cause interaction and the goals pursued by each subject – by a holder of interests.

The most important here is that the proposed approach supplies common positions for the consideration of many social, ecological and economic processes and phenomena resulting from the existence of certain contradictions (in the broadest sense of the word) among any SEEG objects and in accordance with it to single out unique approach to the solution of many social, ecological and economic problems of sustainable development of geosystems.

9. Key figures of SEEG sustainable development strategizing

There are already several indices for the evaluation of a sustainable development of SEEG, which can be viewed at different hierarchical levels: global, national, regional, local, industry-specific, etc., though the final solution of an index system development is still far from being identified. We think that the priority should be given to global indices, on the basis of which national, regional, local, and other indices can be formed.

The comparison of the most important indices of the development of Russia and their correlation with the maximum critical values in the early 21st century is presented in Table 1 (Trofimov and Khuzeev, 1991).

Table 1. Some indices of sustainable development for Russia and their relationship with the maximum critical exponents in the early 21st century

No.	Index	Maximum critical value	Russia in the early 21st century	Expectable social and political implications
1	The level of industrial production	30-40%	47%	The deindustrialization of the country
2	Percent of imported articles of foodstuff	30%	40 -50%	Strategic dependence of the country on imports
3	Percent in the export of manufacturing production	45%	12%	Colonial raw structure of the economy
4	Percent in the export of high-technology production	10-15%	1%	Technological inferiority of the economy
5	Percent in GDP of government subsidies into science	2%	0,42%	Destruction of the scientific and technical potential

Table 1 (cont.). Some indices of sustainable development for Russia and their relationship with the maximum critical exponents in the early 21st century

No.	Index	Maximum critical value	Russia in the early 21st century	Expectable social and political implications
6	Proportion of income of 10% of the richest and the poorest citizens	10:1	14:1	Growing antagonism of the social structure
7	Percent of population that live below poverty line	10%	25-40%	The lumpenization of the population
8	Correlation between the lowest and average wages	1:3	1:10	Deskilling and pauperization of labor
9	Unemployment level	5- 6%	7 - 9%	The growth of socially destitute population
10	Conventional coefficient of depopulation	1	1.63	The excess of mortality rate over the birth rate
11	The total fertility rate	2.14-2.15	1.39	The deficiency of a simple replacement rate
12	Average expectancy life of the population	75-79	65	Reduction in the viability of the country
13	Percent of people aged over 65 in the total population	7%	11%	The aging of the population
14	Revenue receipts for environmental safety, % to GDP	5% (Germany)	0,1%	The threat of ecological disaster
15	Environmental losses, % to GDP	5%	15-20%	A life-threatening of the environment
16	Environmental costs	5%	2%	Ecology degradation
17	Amount of crime per 100 people	5-6	6-6.5	The criminalization of social relations
18	Alcohol consumption, 1 l per person a year	8	15.5	Physical degradation of the population
19	The number of suicides per 100 thousand people	3 (in Russia till 1917)	42 (1995)	Frustration of mass consciousness
20	Mental disorders prevalence rate per 1000 people	284 (1992) 360 (2010)	280 (1992) 354 (2010)	The destruction of the personality

According to the table, the indices of sustainable development at the national level are divided into the indices of environmental, economic and social spheres. Their analysis shows that most of the indices exceeded critical values in Russia at the beginning of the 21st century. This indicates serious problems in sustainable development in environmental, social and economic spheres of Russian society at that period of time.

Of course, the proposed indices should be viewed as a preliminary scheme and the characteristics of their condition in Russian society in that time are explained by contradictions, resulting from the difficulties connecting with the fact that Russia shifted to market economy. Besides, the indices still need a certain weight (priority of importance) in terms of a particular group.

For many of the indices their spatial distribution is rather crucial, so in the process of implementing the strategy of sustainable development an important role should be played by geographic information systems (GIS), including cadastral registers of natural phenomena and spatial characteristics of economy, population and social sphere.

Great importance in this case is applied to the justification of regional indices of environmental management, the justification of integrated indices of regional sustainable development, the use of ecological and economic balances as forms of integrated territorial cadastral registers of natural resources, development of methodological principles and approaches of using GDP indices at the regional level, taking into account environmental factors ("green" GDP) for a record-keeping system and social evaluation of natural resources and ecological benefits.

Conclusion

In modern conditions, when a wide expansion of interdisciplinary research is becoming more and more urgent, this general approach is timely and can become very useful. In particular, it provides an opportunity to develop a common methodological apparatus, which is not associated with any specific features of certain social, environmental and economic problems in formal meaning; and therefore makes it possible to obtain results in a kind of "universal language", without which it is difficult to imagine the further development of complex social, environmental and economic studies.

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