The concept of "scientific revolutions" in the Geoecology knowledge system

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Abstract. The current situation in the field of information support for solving the problem of sustainable development of regions, using the example and in the appendix to the "meta-knowledge" of Geoecology is examined in the paper. The purpose of the research is to develop "human-machine" systems for making optimal management decisions (strategic management of the processes of sustainable development of territories at the regional level). The object of research is active, including "conservative" and "dissipative", complex organized systems of the class "nature-society". The starting points of the methodology and management theory are the following concepts: the unified Field Theory (the end of the XX century), the theory new "scientific revolutions" (T. Kuhn, 1962), the "Concept of sustainable development" of regions (UN, 1993) and the "new theory of entropy" (A. N. Panchenkov, 1999). The leading scientific methods: "noosphere" theory (E. Le Roy and P. T. Chardin, 1927; Vernadsky V. I., 1933) and the approach of "geosystem" (F. Capra, 1991). The results of the research and their significance for the theory and practice of strategic management of territories at the global, regional and local levels of the planet's organization lead to the conclusion that it is necessary to move from differentiation of all available knowledge about Nature and Society ("mechanistic" thinking; object-oriented approach) to their full integration ("noospheric" thinking; normative approach). In the future, this will allow us to begin practical implementation of the development of Russia and the world based on the strategy and Concept of "noocracy".
Keywords: Geoecology, meta-knowledge, information support, sustainable development, strategic management

1 Introduction

It is known that when applied to various historical periods of society's development, all its reasonable practice, in relation to external forces of Nature, is reduced to the function "management" and the term "information" (along with energy and matter, it is always and will always be the initial Foundation of the state of the Universe for us) [1]. According to A. A. Lyapunov (60s of the XX century): "Management based on the transfer of information is

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an integral part of all life activities, moreover, management can be declared a characteristic property of life in a broad sense". Moreover, if we consider the global level of our being, the overall goal and result of the development of all the matter around us (or "noospherogenesis"; Moiseev, 1985) is a consistent "binding" of the free entropy of the Universe into its new organized and necessary forms for man today and in the future [1-3]. Hence, the goal of fundamental science, as a reasonable cognitive activity of society, is defined by the following statement of P. T. de Chardin: "... to think the world is not only to register it, but to give it a form of unity, which it would be deprived of if it were not thinkable" [4].

From epistemology and social practice we are know that science cannot develop successfully without regular methodological rethinking of its fundamental foundations [5]. This fact acquires special meaning and relevance at certain critical moments in the development of civilization, when there is a natural change in the initial scientific paradigms and ways of system representation of the world around it. Today, in the fields of Earth and Social Sciences, this is exactly the process we are seeing. Since the beginning of the new century there is a fundamental rethinking of the old paradigm (it has been known since the end of the XVIII century; I. Newton, 1687) and the transition to a new natural science knowledge and paradigm – "noospheric" thinking (E. Le Roy and P. T. de Chardin, 1927; Vernadsky V. I., 1933). Then follows unified Field Theory (ETP, the end of the XX century), the theory of new "scientific revolutions" (T. Kuhn, 1962 [5]) and the "Concept of sustainable development" of regions (CSD, in the abbreviation of the UN, 1993 [6]; in Russia, it was adopted three years later; see: "Decree of the President of the Russian Federation" No. 440 of 01.04.1996).

"Geoecology" (specialty 25.00.36 Higher Attestation Commission of Russian Federation), as a relatively young science (K. Troll, 1939), cannot stay away from these General changes in the system of natural science knowledge. Moreover, it should be the leading and defining area of scientific and practical activity in this sphere by right of the broadest complex nature of its object and subject of study. There is no need to prove this statement, as since 1927 and up to the present time (or for about a century!), the theory of the "noosphere" is considered by fundamental science only in the form of a "Gay hypothesis" (Dg. Lovelock and L. Margulis, 70s of the XX century). Unfortunately, it is still not perceiving by fundamental science as a new scientific Paradigm of the XXI century. For example, despite the considerable efforts of science, today it is not clear how to implement it in the current practice of managing the development of territories at different levels of the planet's organization, how to achieve the goal formulated in it, or at least objectively assess the degree of approximation to it?

2 Methodology, theory and research methods

The research methodology includes. The concept of "Pure reason" (I. Kant, 1781-1790) and the General laws of dialectics (G. Hegel, 1817). A New paradigm of the system representation of the world ("unified field theory", etc.; the end of the XX century); systematic and normative approaches (in terms of the study of "ratio", or a preliminary adequate study of "... for understanding of the reasonable beginning, principle, meaning of any phenomenon"; J. Huizinga, 1938 [7]). Initial theories. The theory of the "noosphere" (E. Le Roy, P. T. de Chardin, 1927; V. I. Vernadsky, 1933 [4], [8]) and General theory of systems (L. Bertalanfi, 1950 [9]). Fractal geometry of nature (B. Mandelbrot, 2002 [10]). The "geosystem" approach ("basic principles and criteria of system thinking", F. Capra, 1991 [11], as well as the unity of the "micro" and "macro" organizations of the world around us [12], [13]). The "New entropy theory" (A. N. Panchenkov, 1999 [14]) and other works. The conceptual apparatus is determining by next researches. The basics of the General theory of "cooperation" ("Theory of Morality-as-Cooperation") [15]. The concepts of "nookracy" ("…

as a new global society based on science and knowledge"). The "Knowledge Industry" and methods of technology "Reengineering" (T. Stonier, 1987; "...information as the most important input resource of modern production" [16]). The synergetics and dynamic theory of information [2]; "noospheric" thinking and ecological consciousness [17-24]. Methodically and technologically, all these elements together represent the "meta-knowledge" of Geoecology.

Research methods. The game Theory (J. Neumann, O. Morgenstern; 20s of the XX century); NBICS (nano-, bio-, info-, convergent, social and humanitarian technologies). GIS, GRID, "Blockchain" systems and technologies; BIGdata, neural networks, artificial intelligence systems (AI), self-learning systems (SLS), virtual models (VIM); games with Nature ("Game against Nature") and games with "non-zero-sum". In the course of the research all of them were supplemented and other previously known laws and regulations. For example, they include the "The mathematical theory of the struggle for existence" (In. Volterra, 1906), "plate tectonics" (A. Wegener, 1912), "the principle of minimum entropy growth" (L. Onzager, 30s of the XX century), the economic theory of "equilibrium" (according to D. Nash, 1950), "Exergy" (Z. Rant, 1956), laws and rules of ecological axiomatics (N. F. Reimers, 1994). In General, there are more than 150 of them.

3 The results of the study and their discussion

The initial methodological basis of the theory of "scientific revolutions" [5] is the words of A.I. Herzen about the destructive power of conservatism, as a phenomenon through which society always tries to preserve the established order, as the most convenient form of existence for it. At the same time known, that Nature, by the nature of its physical manifestation, is always "dual". Therefore, this is an extremely hazard phenomenon for the sphere of science, education and knowledge in General, since it can only lead to their intellectual stagnation. Based on this T. Kuhn in 1962 proposed an original model for the emergence of new scientific knowledge (the concept of "scientific revolutions" and the term "paradigm"). In it, they are considered by him in the form of "... a General mechanism for the development of science as an integral unity of "normal science" and "non-cumulative leaps" ("scientific revolutions") [25]. In the application to the field of information technology the most important definitions of the term "paradigm" are. 1. "A set of methodological and theoretical prerequisites that determine a specific scientific research". 2. "The method of setting problems and research methods that are dominant in science of a certain historical period". 3. "The basis for choosing problems, as well as a model for solving the tasks".

According to the generally in academic science accepted practice, the solution of all the declared scientific, technical and technological problems were carry out according to the following scheme: "object" <=> "subject" → "methods" of research. At the same time, the methods and technologies of "Knowledge Industry" and "Reengineering" were actively used [16]. That is operations were previously carry out to rethink and re-evaluate all known scientific achievements and modern approaches to the use of information technologies, which are necessary for making optimal decisions at the strategic level of management. As a result, the following directions and separate aspects of all stages of the study of the stated problem were highlight.

First of all, the definition of the term "management" was clarify from these positions. We know that in modern philosophy [25] it is understanding as certain mathematically and logically generalized "function" of any (inert and living, "conservative" and "dissipative", biological, technical, social) complex "systems" that provides practical implementation of the following aspects of their appearance, existence, functioning and development. 1. "Preservation of the structure – maintenance of the mode of activity"; 2. "Implementation of its program – development goals". At the same time, it was emphasis that this term is fully adequate to the theory of the "noosphere", the conceptual apparatus of strategic management and all other provisions of Section 2.

From the positions of the General theory of control of complex systems (N. Wiener, 1968; L. Bertalanfi, 1969; G. Haken, 1980; I. Prigogine, 1990 and others), the first-initial and fundamental-problem is the conscious choice of a modern scientific paradigm, within which it is assumed to study and solve all questions of the future optimal management of them. Today we know two scientific paradigms: "mechanistic" and "noospheric" thinking. As follows from synergetics and dynamic information theory, that the latter is always "a memorized choice of one option out of several possible and equal for laws" [2]. Thus, the choice of one of the two paradigms is inevitable. Hence, if we follow epistemology when studying the fundamental foundations of the CSD, it is clear that when the initial paradigm changes, our thinking about the phenomenon being study as such must also change a priori.

To explain the possible solution of this important question for the theory of CSD, we can use the principle of "correspondence" by N. Bohr, 2013. This principle states: "… the change of one natural science theory to another reveals not only a difference, but also a connection, a continuity between them that can be expressed with mathematical precision". Graphically, the General informational meaning of this principle is show in Figure 1, where the old and new paradigms are conventionally arranging in the form of two circles of different dimensions (they are designate as I, II).

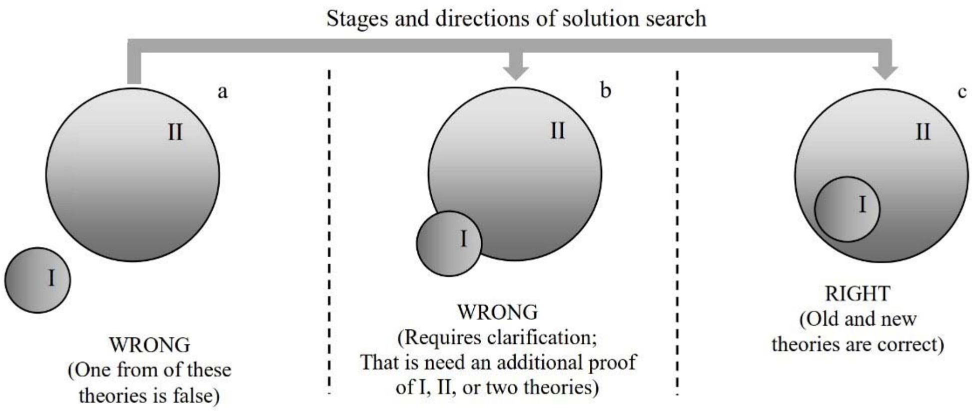

Fig. 1. Variants of three possible information states for two scientific paradigms or scientific theories

From Figure 1, it follows that full compliance with this principle is achieve only in the third variant of their information states, which we designated as "c". Here the main condition is mathematically provided and fully implemented: the "particulars" of the old paradigm or theory in relation to any "hypothetically" advanced and newly proposed form of scientific knowledge about Nature and Society.

The conceptual basis of modern "noospheric" thinking is determined both by the newest paradigm, and by the one that follows from it and all other natural science knowledge, such as [4], [6]. In Table 1 shows the main physical and informational characteristics of these two modern paradigms of system representation of the world ("thermodynamic" and "noospheric") [17]. Based on the system analysis and synthesis of its comparative characteristics, the following constructive was make the next conclusion: the physical and experimental proof of ETP and the "New entropy theory" [9] in their unity completely "cover" all the main (according to "ratio" – the original [7]) methodological and theoretical problems of CSD. Moreover, it should be particularly note that theoretically, as our knowledge expands, this transition to a new paradigm should increase by at least 6.8 times! (see: J. Wheeler's calculations of the Planck energy density of physical vacuum and nuclear matter [26-27]).

Hence, as the initial object in the study, Active Complex organized Systems (ACS) of the class "nature <=> society" are accepted: the subject – the concepts of "balance" and "Sustainable Development", CSD. Thus, physically ACS are mutually integrated integrity of systems and objects, the properties of which cannot be reduced to the properties of their constituent subsystems and are considered as living systems, where the main driving mechanism of functioning and development is conflict (under conditions of uncertainty). Hence, the practical implementation of CSD is methodically and technologically considered as a consistent transition of the research logic from descriptive to constructive and, further, to normative aspects of interaction between Nature and Society at all required (according to the input conditions for setting tasks) levels of management of global, regional and local nature management, but with their specification.

Thus, on the base of the principle of "complementarity" by N. Bohr (1913), the following concepts were defining. For the ACS, as the initial "object" of management, a system definition is given and the main functional property is high light: conflict under uncertainty, as well as a General area of knowledge (specialty 25.00.36 "Geoecology"). At the same time, "Geoecology" was defined as the field of knowledge about the forms of existence and limits of interaction of geospheric shells (or, according to A.D. Armand, 1968, – geosystems of the highest level of the planet's organization): cosmo - (or so-called "near", to the first point of Lagrange, cosmos), lito-, pedo-, hydro-, atmo-, bio-, anthropo-spheres.

For the "Geoecology", as a science in General, the following formula can be proposed: GP, LR (object-the planet's geospheres, subject – life-supporting resources); = > BS, NS (initial theories – biosphere and "noosphere"); → RV, UR (goal – equilibrium and sustainable development); GL, PH, LC (management levels – global, regional, local); KN (the main property of their functioning and development – conflict under uncertainty). According to our estimates, in order to make effective management decisions at any level – global, regional, or local – at least 24 separate theories, terms, and new concepts are need, outside of which the implementation of CSD is impossible in principle. For the "subject" of the study (technically and technologically – this is the future "automated decision-making systems", ASDM), a block of "meta-knowledge" of all natural Sciences of the Earth and Society was introduced. They represent logically (theoretically, methodically and technologically) connected knowledge of the highest level about the object, subject, problem (task) subdomains and methods of research of each of the complex of Earth Sciences, Society and natural science in General, the general objective function of which is aimed at making effective management decisions in the process of their mutual "co-evolution" (N. V. Timofeev-Resovsky, 1968).

As outcome, as a complete result of the research, the following target function was proposed for all levels and functional directions of management "decision–making" (DM): "min" of losses of initial natural matter with "max" of material and social benefits received. At the same time, the General material basis, including the entity to be study, is the concept of "entropy". Here, as an explanatory example, we can give the following well-known physical example. So according to S. Hawking, all reasonable scientific and practical activities of people at all times, by and large, can be reduced to a single scheme: this is a consistent "binding" of the free entropy of the Universe into its newly organized and necessary forms for man today and in the future [1].

Table 1. Basic physical and informational characteristics of the modern paradigms of system representation of the world

The "thermodynamic" paradigm ("object-oriented" approach)	The "noosphere" paradigm ("normative" approach)
Representation of nature in the form of pieces or individual resources rather than interactive processes.	Connection and interdependence of all phenomena and objects of living and inanimate nature, as well as processes occurring in it.
Simple linear (Euclidean) space:	Multidimensional nonlinear "space-time":
- world invariance, which preserves the measure (coordinates and momentum) when turning and transferring a material point;	- non-invariance of the world, in which the measure (coordinates and momentum) is not preserved when turning and transferring a material point; - non-invariance of the world, in which the measure (coordinates and momentum) is not preserved when turning and transferring a material point;
- negative meaning of entropy, perceived as a measure of disorder and chaos;	- the positive meaning of entropy when it is considered as a measure of the perfection of the structure, as a system architecture formulated in symbolic form;
- a typical "macro" approach; when managing objects, the "black box" principle is used, when only external processes – relative to the system – are considered and studied;	- "geosystem" ("macro –" + " micro –") approach, when both external and internal processes of functioning and development of complex systems are studied;
- the approach is fully adequate for the "conservative" systems known from synergetics;	- the approach is adequate for "dissipative" systems prevailing in nature and society (that is, far from the state of equilibrium, self-organizing and self-developing);
- provides to a certain extent a complete solution to the problems of "hard" (man-made) management;	- provides solutions to the problems of "hard" and" soft " (restoring the ecological balance) nature management;
- only deterministic and probabilistic (stochastic) statement of control problems is possible;	- deterministic, probabilistic, indefinite and game-theoretic statements of control problems are possible;
- implementation of computational operations of situational management is not possible.	- theoretically, it is possible to fully implement computational operations of situational (or system) management.

According to UN experts [6], CSD should include three main groups (or spheres of life and activity of society): current and future production, consumption, and state (human and environmental). In a broader of their context requires that the following 5 components of sustainable regional development are mutually linked: "production activity, consumption of natural resources, state of ecological systems, environmental quality and human welfare".

In 2017 at the Computing Center of the FEB RAS (Khabarovsk) the project "National concept of sustainable development (NCSD) for Russia" [22]. At the same time, even earlier, two new (informational) properties were developed (in addition to those proposed by F. Capra in 1991 [11], [19]; there are 14 of them in total): "Information complexity"; "Time factor". They are essential for information support of CSD and ACC at all, including strategic, levels of management of processes of sustainable development of regions (presented below in the same way as Table 1). In this case, the principles of "emergence" and "equifinality" were used by L. Bertalanfi, 1950 [9], as well as "heterorarchy" (F. Capra, 1991 [11]). As the highest measure of moral evaluation of "noospheric" thinking and all the results of calculating possible options for strategic management, the 7 main rules of confessional and cooperative behavior should serve [15]. The main methods for solving such problems are Games with Nature ("Game against Nature") and games without zero sum ("non-zero-sum").

In the information area of "management" ACS class "nature < = > society" there are two organizational levels (or information "subdomains"): "internal" and "external". The first is directly relate to the natural (physical) laws of the development of the Nature (including man, as the highest biological and social being, who is simultaneously both the "object" and the "subject" of management). The second – is determined by the level of thinking achieved at the moment, as well as the material and technical capabilities of Society as a whole.

Further, in the task subdomain of management, 7 classes (3 groups) of specific practical tasks were allocated: interpretation, diagnostics and monitoring, planning and reconstruction, forecasting, management (their grouping is associated with the possibility of using direct and reverse logical output in the ASDM). Thus under the term of "control" in General we should understand the information and two different research areas. First, the "strategic" control (here, in addition to the original data, the "entrance" of the optimization calculations should use known mathematical "scale relations"). The other is "tactical" (at the time of planning is short and medium-term management; here you can limit only the source data). It should be also note that the tasks of interpretation are among the most difficult for practical implementation, since they directly depend on the level of knowledge we have achieved of the surrounding world. The next two classes by definition do not require the use of any special methods for optimizing decision-making; in them, it is enough simply switch to the "scale of order" known from mathematics. All other classes of that problem may be directly solve without using a common objective function and a class of optimal control methods and models (under uncertainty).

15. Information complexity	
Research and analysis of the information state of active systems based on the study of the information characteristics of its individual parts. (The information complexity of the system is regulate by the information flows in its subsystems).	The study of active systems based on the generality of its information state, determined by the unity of its structure and the dynamics of processes occurring in it. (In active systems, each new structure is characterize by new processes and information flow, which is not reduce to a simple change due to newly acquired or lost functions of the system).
16. The time factor	
Time considered as the initial premise for the development of active systems as opposed to its self-organization; it is regulated by the plan and possible deadlines for its implementation. Optimization of the transition time from one system state to another is not provide. (Time is the initial parameter for system object management).	System management provides for the achievement of "attractor- structures"[a]. In this case, time is not the initial input parameter, but it is determined in the process of optimizing the structure of the transition of the active system from one state of the system to another. (Time is the "second" in relation to the structure of the transition).

[a] By the "attractor-structures" in the synergetics are understood as "... such real structures in open nonlinear media that are affected by the processes of evolution in these media as a result of attenuation of transient processes in them" (E. N. Knyazeva, S. P. Kurdyumov, 1992); [27-29].

Let us briefly consider the last statement on a conditional example of the structure of the main elements of sustainable development of regions, which is present in Figure 2 (here, as the source, materials were use: Virtual Laboratory Wiki. Electronic resource. URL: http://www.wikia.om/ finam.fm/ archive-view/3026/ (accessed 12.05.2014).

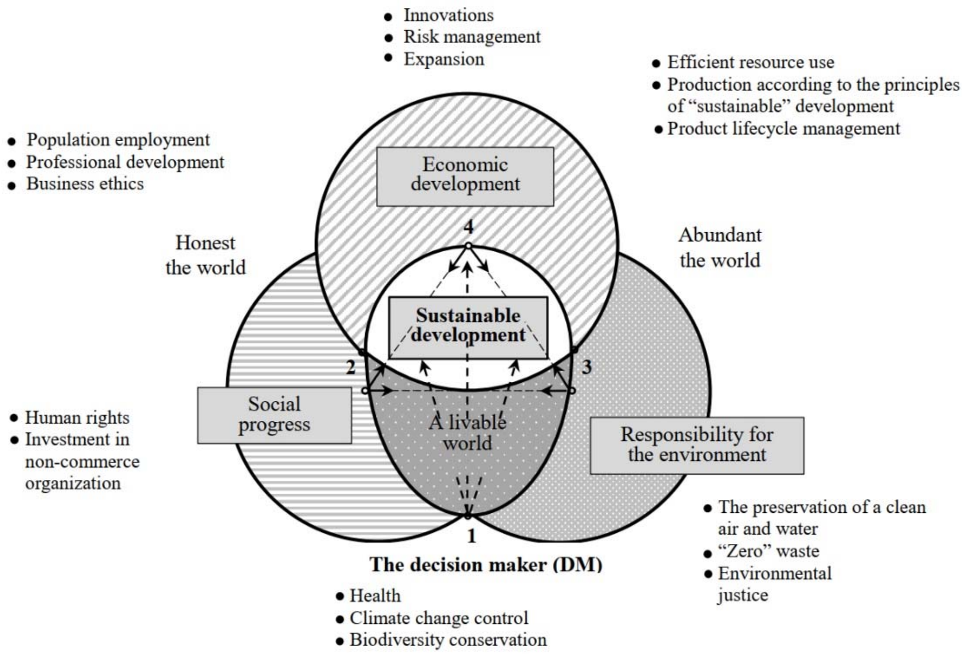

Fig. 2. Example of the General information structure of the scheme of sustainable development of regions

In this scheme, first, there are three initial blocks that determine the theoretical basis of the object of research: a complex organized system (ACS; in this case, its object restriction was introduced in the form of a complex "economy – population – nature"; EPN, Polumienko S. K. and others, 2008). Second. If graphically to highlight the centers of these blocks (relatively, it's dots 2-3-4), then in General the sustainable development (SD) can be reduce to a procedure of their movement in the direction of the possible bias to the center of the figure, or its unshaded region. On the Figure 2 marked by arrows pointing from positions of decision-makers (DM), the dynamics of the "desired movement" of his theoretical thought. Or as defined in formulas (1), (2); [19-22], see figure "Structure for algorithm of "meta-knowledge" of Geoecology" is technology and methods of the search of complex optimum. Third. The DM in this scheme is designated as point 1, and points 2-3 and the arc located between them, as well as the entire dark area of one of the directions of UR development ("habitable world") are taken as a phase (information) space of all theoretically possible (under uncertainty) his actions. Then they can all be considered as complex probabilistic events; this explains the "duality" of the positions of points 2-3. Then the entire process of optimal control of such a system and its results should theoretically be located inside a "closed region" bounded by three arcs and points 2-3-4.

Thus, for this level, the proposed control scheme provides for the process of forming a new "structure-attractor" on any territory (in principle, this is a physical analog of the term known from geography and ecology and the concept of "Ecological framework of the territory", EFT; the term was introduced by V. V. Vladimirov, 1982). Today we understand it as "a stable set structure of elements directly related to the ecological state of the territory of the "core" (or in the form of so-called "sustainable mode") of the "structure-attractor" of ACS class "nature" < = > "society". From it depends on their physical and informational state ensure their current level of the state of stability, balance and sustainable development in "space-time" (for more information, see: [17-24] and other works by the author). At the same time, this "core" by analogy with the known DNA and RNA "systems" as a special material structure, is "secondary", or "frame-primary". Therefore, the entire environmental policy of any territorial entities (global, regional, local levels) we propose to be consider as follows. First, all expenditures on "human" (Society) and environmental measures are investments in the future and a means of achieving competitive advantage [11]. Secondly, in the strategic management of such resources, the focus should be on the function of maintaining a stable state of the "core" of the studied systems (ACS). An example of calculating of the optimal solution, – in the form of a "saddle" point, – presented in [22] and [30].

4 Conclusions

1. The Resolution of the problem of information support for the processes of sustainable development of regions is essentially the result of a correct understanding, interpretation and calculation by each researcher of the initial beginning, essence, principle, meaning and purpose of CSD, as a constant dynamic process of development of the ACS class "nature <=> society". It should be bases on the transition to a new Concept of system representation of the world. In the future, this will significantly increase our fundamental knowledge of Nature and Society, as well as the environment of our planet as a whole.

2. New scientific approaches, methods and technologies for information support of optimal and effective decision-making are need for the practical implementation of the strategic management level CSD. Currently, they are not fully defined and developed yet. Today, fundamental science and computer science can offer the following promising areas of research. Game theory, including games with Nature ("Game against Nature") and games with "non-zero sum"; NBICS (nano-, bio-, info-, convergent and socio-humanitarian technologies), GIS, GRID, "Blockchain" systems and technologies, BIGdata, neural networks, artificial intelligence systems (AI), self-learning systems (SLS), virtual models (VIM).

3. According to our estimates, the development of VIM models that implement the concept of "neogeography" (E. Turner, 2006) and methods for solving games with "non-zero-sum") are most important for us now. The first allow you to move from 3-dimensional to multi-dimensional, including graphical, representation of data and knowledge of sustainable development processes in "space-time"; ("mixed" GIS-technologies, "vector" + "raster" representation of ACS; E. Turner, 2006). The second, it makes it possible to repeatedly reduce the time for solving large-scale (or BIGdata) and logically complex strategic management tasks, including significantly increasing their variability and optimal solutions. It is important that this "Arsenal" of information methods, models and technologies already allows effectively solve the problems of "balance" and "sustainable development" of any regions of our planet.

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