Information Support Strategic Management Processes
Environmental Policy of Cities

S L Turkov

1Computer center of the far Eastern branch of the Russian Academy of Sciences, 65 Kim Yu Chen str., Khabarovsk, 680000, Russia
E-mail: slturkov@gmail.com

Abstract. In the report presents some methodological and applied issues of information support for strategic management processes environmental policy of cities, which, within the framework of the National concept of sustainable development of Russia (1996) relate to the lowest level of its system organization. The purpose and the main direction of using the results is the development of “human-machine” planning systems (or support) for optimal management decisions for regional and local structures of environmental management. The research methodology based on the new paradigm of system representation of the world, the theory of “noosphere” by P. T. de Chardin, E. Le Roy (1927), V. I. Vernadsky (1933), a “new theory of entropy” by A. N. Panchenkov (1999). Object of research – the Active Complex organized Systems (ACS) class “nature-society”; subjects – concept and conditions of “equilibrium” and “Sustainable Development” (CSD in the abbreviation UN, 1993) such systems. Research methods – game-theoretic modeling and “Games against Nature”: antagonistic, coalition, cooperative, strategic, situational, etc., which required by the conditions of setting tasks, games. In the simulation, this will ensure the full integration of all currently available natural science knowledge, as well as the ability to perform computational operations others organizational management systems of the class “nature-society”. For that in this study suggests a new “geosystem” approach to the study of sustainable development problems in urban environmental policy, which includes the possibilities of both external (“technogenic”) and internal (or “soft”, that is, maintaining and restoring the ecological balance) management of Nature and Society.

1. Introduction
At present, the main task for our civilization is to solve the problem of sustainable economic and social development; in the context of the future global world order, it was discuss in the well-known documents of the Commission of G. H. Brundtland (1967). But it was only in 1993 that it was finalized and approved by the world community in the form of the "Concept of sustainable development" (CSD in the UN abbreviation, 1995) and adopted by a number of countries (in the USA in 1993, in Russia three years later) as official doctrines of their state development.

Technologically and organizationally, it is generally accepted that in CSD to distinguish three territorial levels of management: global, regional, and local. At the same time, CSD based on the principles of “unity” and “consistency” of the world around us (N. Bohr, V. Heisenberg, 1913, 1927; L. Bertalanffy, 1950). It is also known, that according to the methodological basis for making optimal control decisions [1-10], they are a consistently connected system (in the form of an unlimited...
complete base of natural science knowledge according to the scheme: “object” \( \Rightarrow \) “subject” \( \Rightarrow \) “methods” of research). But in terms of information support, each of them should differ significantly from each other in terms of methods, methods, technologies and algorithms for decision-making in a variety of emerging and acceptable situations, development strategies and in application to specific territorial levels, objects and management systems, as well as their temporal and spatial (dynamic and multidimensional) parameters and characteristics.

Today in the our country uses only the old “mechanistic” paradigm of the system representation of the world when planning and forecasting processes for managing the environmental policy of cities, which in principle does not allow to correctly solution of the main methodological problems formulated in the CSD: “balance” and “sustainable development” [11-14]. It does not answer the questions of how to implement it in the current practice of managing territories of different levels of the planet's organization, how to achieve the goal formulated in it, or at least objectively assess the degree of approach to it. Today it is becoming more and more obvious that such thinking is already seriously blocking the further development of fundamental science, and it itself in this field of knowledge requires a fundamental methodological, theoretical and technological rethinking.

2. Source materials and research methods
Theoretically and methodically, the source materials for the development of the study “Information support of environmental policy management processes in urban settlements” are similar to those adopted in the project “NCSD of Russia” (see: links to author's publications in the “Introduction” section). Thus, his methodology is define by the term “noosphere” (according to E. Le Roy and P. T. de Chardin, 1927): “... 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” [2, pp. 197-198]. And also the theory of the “noosphere” V. I. Vernadsky, 1933, or the following well-known classical definition of it: “... on a qualitatively new form of organization that arises from the interaction of nature and society, which is characterized by the connection of the laws of nature with the laws of thinking and socio-economic laws of society development”.

The General scheme and technology of cognition provided for the implementation of the logical scheme accepted in fundamental science (see: 1. Introduction). At the same time, as a complete result of the study, the following target function is proposed for all levels and functional areas of management decision – making: “min” of losses of the original natural matter, while “max” of the received material and social benefits. Its practical implementation is methodically and technologically considered in the form of a sequential 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 concretization. It is the active complex organized (ACS) systems of the “nature-society” class in the Appendix to the problems of strategic management of environmental policy of urban territories.

The main method of research is the “system” approach (in its qualitative evolution towards the “geosystem” component); it is simultaneous and consecutive “internal” and “external” management of the processes of functioning and development of the “nature-society” ACS; States of “equilibrium” and “sustainable development”. Research methods: mathematical devices of game theory (GT); game-theoretic modeling; “Game against Nature”, antagonistic, coalition, cooperative, strategic and other games, as well as methods of strategic pattern recognition (PR). When modeling, this ensures the full integration of all currently available natural science knowledge, as well as the ability to perform computational operations of situational management of the “nature-society” ACS.

As special theories and research methods used: “General theory of systems” L. Bertalanffy [15], “Dynamic theory of information” [16], “System control” theory [3], the new theory of entropy [5], Cybernetics [1], synergetics [17] and stochastic systems theory [18], as well as experience and practice in the study of complex fields of knowledge [19]. Information methods and technology for solving the problems: NBICS, GIS, GRID and “Blockchain” technologies; BIG-data, neural networks, artificial
intelligence systems (AIS), self-learning systems (SOMS), virtual models (VIM); strategy games with “non-zero-sum”.

3. The results of the study and their discussions

From the point of view of the theory and management methods of the “nature-society” ACS [15], [1], 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 issues of future optimal management of them. Today we know two scientific paradigms: “mechanistic”(I. Newton, 1687) and “noospheric” (P. T. de Chardin, E. Le Roy, 1927; V. I. Vernadsky, 1933) thinking; T. Kuhn considered this transition in the form of “... the concept of scientific revolutions as a paradigm shift” [20, p. 354]. Hence, if we follow epistemology when studying the fundamental foundations of the course, the conclusion becomes obvious: when the initial paradigm changes, our thinking about the phenomenon under study should also change a priori [11].

It follows from synergetics and dynamic information theory that the latter is always “... a memorized choice of one option from several possible and equal ones” [16, p. 13]. Thus, the choice of one of the two paradigms is inevitable. Without going into the rather complex details of this issue (further on, see the principle of “complementarity” by N. Bohr, 1913), it should be noted here that on the basis of “humanistic” thinking, the initial problems: “equilibrium” and “sustainable development” – have not been solved by fundamental science for the entire past period, that is, more than 90 years. Meanwhile, it is known that theoretically the measure of possible expansion of our knowledge in the transition to a new “noospheric” paradigm should grow by 6.8 times! (see: J. Wheeler's calculations of the Planck energy density of physical vacuum and nuclear matter [7, pp. 55-133]).

To explain the possible solution of this issue, which is important for the CSD theory and, consequently, for the information support of urban environmental policy management processes, it is possible only on the base of the well-known principle of “compliance” by N. Bohr, 2013. It state: “... the change of one natural science theory to another reveals not only a difference, but also a connection, a continuity between them, which can be expressed with mathematical precision”. Graphically, the General informational meaning of this principle is shown in Fig. 1, where the old and the new paradigms are conventionally formed by us in the form of two circles of different dimensions, which are indicated by the Roman numerals I and II.

![Figure 1](image)

**Figure 1.** Variants of three possible information states for two scientific paradigm or scientific theories.

From this figure, it follows that full compliance with this principle is achieved only in last variants of their information (or, in the physical sense, phase) States, when the main condition is mathematically provided and fully implemented: the “particulars” of the old paradigm or theory in relation to any “hypothetically” moved and newly proposed form of scientific knowledge. It is known
that the conceptual basis of modern “noospheric” thinking is determined both by the newest paradigm, that is, by the theory corresponding to it, and by the theory that follows from it and all other natural scientific knowledge. The latter, according to UN experts (1985), includes three main groups (or spheres of life and activity of society): current and future production, consumption, state (human and environment). In a broader context, it requires the following 5 components of sustainable regional development to be mutually linked: “... production activities, consumption of natural resources, state of ecological systems, environmental quality and human welfare” [21].

Thus, all these listed elements together should be reduce to one logically and theoretically connected block of knowledge, which we classify as “Metaknowledge” of all natural Sciences about the Earth and Society. Here we can provide the following definition of this newly introduced term. They represent logically (theoretically, methodically and technologically) related knowledge of the highest level about the object, subject, problem subdomains and research methods of each of the complex of Earth Sciences, Society and natural science in General, the objective function of which is aimed at making effective management decisions in the process of their mutual “coevolution” (N. V. Timofeev-Resovsky, 1968).

Table 1. Principles and criteria of system thinking, the most important properties of complex organized systems [11, pp. 40-41].

| The “thermodynamic” paradigm (“object-oriented” approach) | The “noosphere” paradigm (“normative” approach) |
|----------------------------------------------------------|--------------------------------------------------|
| 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 a new structure is characterize by the new processes and information flow, which not reduced to a simple change due to newly acquired or lost system functions). |
| 16. The time factor                                        |                                                  |
| Time is consider as an initial premise for the development of active systems as opposed to its self-organization; it is regulate 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 “structures-attractors”; in this case, the 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 “secondly” in relation to the structure of the transition). |

* Under “Structures-attractors” in synergetics are understand 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 transients in them” [4, p.7].

The main physical and informational characteristics of modern paradigms of the system representation of the world are consider in [11, Table 1, pp. 38-41]. The main principles and criteria of
system thinking, the most important properties of active systems are present in the same place (in the Appendix to it and according to [3, pp. 5-9]); their tabular form of material presentation made by us. In addition, in 2009, in addition to the 14 already known principles and criteria, 2 more were developed, which are fundamentally important for the information support of CSD at all levels of management (they are separately presented in Table 1); see also Principle “13. Environmental concept” in [11].

All of the above allowed us to significant clarify the basic concepts and definitions of the methodology and theory of CSD: field of knowledge, main specialty, object, subject and methods of research, etc. [11]. Thus for the first two were defined: “Geoecology”; specialty 25.00.36 (in the classification of the higher attestation Commission of the Russian Federation). Then, for the latter, the following formula was proposed (ACS “nature-society”): GP, LR (object – the planet’s Geospheres, subject – life-supporting resources); = > BS, NS (initial theories – biosphere and noosphere); → GB, SD (goal-balance and sustainable development); GL, RN, LC (levels of management – global, regional, local); KN (the main property of their functioning and development: conflict in conditions of uncertainty). According to our estimates, to make effective management decisions at any level, at least 24 separate theories, terms and new concepts are needed, without which the implementation of CSD basically impossible [11, pp. 19-20].

It is characteristic that in this scheme – in contrast to its definition proposed by E. Haeckel (“the science of the relations of organisms to the environment”, 1866) – “ecology” (according to A. Tensley, 1935) is considered as the science of physical, chemical and biological forms of existence of living and inanimate matter (including the “near” space). N. F. Reimers, V. I. Bulatov and others call it a “big ecology” or “mega-ecology”; today it has no fundamental theoretical basics. And “Geoecology” – as a 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 organization of the planet: Cosmo- (or the so-called “near”, to the first Lagrange point, cosmos), lito -, pedo -, hydro -, atmo -, bio -, anthropo – spheres).

In modern epistemology, the term “management” is understand as a dynamics (in “space-time”) “... function of organized systems (biological, technical, social), ensuring the preservation of their structure, maintaining the mode of activity, implementing its program, goals” [20, p. 496]. It is easy to note that this definition fully corresponds to the main initial messages of the “noosphere” theory and the General target function of the CSD, which is technologically subject to future management. For example, it follows that the first two functions relate to the state of “equilibrium”, and the second – to the “sustainable development” of all complex organizational systems at any level of their organization. Hence, the General criterion of optimality for them is: “min” of losses of the original natural matter, while “max” of socially necessary material goods. At the same time, as the highest measure of moral assessment (or “noospheric” thinking; see: [11, p. 31]) and all the results of calculating possible options for strategic management, can serve as 7 basic rules of confessional and cooperative behavior [22].

In the information area of the ACS “management”, there are two organizational levels (or information “subdomains”): “internal” and “external”. The first is directly tied to the natural (physical) laws of Nature (including man as the highest biological and social beings, which is how “object” and “subject” control); the second is determined by the achieved at the moment the level of his thinking, as well as material and technical capacities of Society as a whole.

In the work of the author [12], based on the mathematical justification of the “new theory of entropy” [5], the following elements of the initial technological structure of the strategic management process of the ACS class “nature-society” were developed for all levels (global, regional, local).

1. Based on the General definition of the term “management” [20], according to the functional principle, two consistently related, but independent, levels are identified for the ACS: “balance” (preservation of their structure, maintenance of the mode of activity) and “sustainable development” (implementation of its program, goals).
2. The General goal function of control; at the global level, the ultimate goal and outcome of the development of all the matter around us (or “noospherogenesis” [19]) is the sequential “binding” of the free entropy of the Universe into its organizational and human-required forms [10].

3. General structure “meta-knowledge” of the Geoecology algorithm – from the initial formulation of the problem to the practical implementation of the all optimization schemes for making management decisions [12].

4. Two main control schemes (for the “micro” or “internal” (natural) level of organization of newly created systems, and for the “macro” or “external” (“technogenic”) level of ACS management; (see: [11. Fig. 3, 4], as well as the initial information game-theoretic matrix for making control decisions [4. Fig. 3]). At the same time, for 3-dimensional graphical methods of presenting data, knowledge and solutions, the well-known application software package “Statistics” 17.0 was use; for examples of solutions, see: ibid. Fig. 4, 5).

5. Two main formulas (1, 2) that represent a General management model and a method for calculating the optimal management decision-making [12].

6. Architecture of an automated system for making (or supporting) management decisions (ASMD) in the field of regional environmental management. Its methodological basis is determine by the well-known principle of “equifinality” by L. Bertalanffy, 1950: “... a system can achieve the same final state under different initial conditions” (this position is consider by us as the main way to achieve the optimality of its functioning and development).

Further, in the task subdomain of national and local management, 7 classes (3 groups) of practical tasks were identified: interpretation, diagnostics and monitoring, planning and reconstruction, forecasting, situational and strategic management (their grouping is associated with the possibility of using direct and reverse logical inference in the ASMD). At the same time, the tasks of interpretation are among the most difficult to implement in practice, since they directly depend on the level of knowledge of the surrounding world that we have achieved. The following two classes by definition do not require the use of any methods for optimizing decision-making; they simply switch to the “order scale” known from mathematics (this is what is widely used today in the current practice of urban settlement management in our country). All other classes of problems not be used directly solved without using a common objective function and a class of optimal control methods and models.

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 initial materials, we used [23]; its main elements was test in relation to the strategic management level of urban environmental policy in 2018-2019 [14].

In this scheme, first, there are three initial blocks determine the theoretical basis of the object of research: a complex organized system (ACC); in this case, its object restriction was introduce in the form of a complex “economy-population-nature”; EPN [24].

Secondly, if you want graphically highlight the centers of these blocks (conventionally, these are points 2-3-4); then in General the process of sustainable development can be reduced to the procedure of their movement in the direction of the greatest possible shift to the center of the drawing. That is, to its unshaded area (in Fig. 2 it is indicated by arrows pointing, from the standpoint of decision makers (DM), the dynamics of the “desired movement” of his theoretical thoughts), or as define in formulas (1), (2). Future on it will be the structure of algorithm of “meta-knowledge” for “Geoecology”, or technology and methods of the search of complex optimum.

Thirdly, if the DM in this diagram is designate as point 1, and points 2-3 and the arc located between them, as well as the entire dark area of one of the SD development directions. They is take as the information space of all theoretically possible actions of the DM. Then all of them can be consider as complex probabilistic events (under conditions of uncertainty (under conditions of uncertainty). 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.
Figure 2. One possible examples of information support strategic management for processes environmental policy of cities.

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 analogue of the known term from geography and ecology and the concept of “Ecological framework of the territory”, EFT; introduced by V. V. Vladimirov in 1982). Today we understand it: “A stable set of elements of the “core” (so-called “sustainable modes”) that are directly related to the ecological state of the territory») “structure-attractor” of the ACS, which physically and informatively ensure its balance and sustainable development in “space-time”; (for more information, see: Fig. 3, b/n, 4 and the text in [11, pp. 25-30]). At the same time, by analogy with the known DNA and RNA, the “system”, as a special material structure, is “secondary”, and the “framework” is “primary”. Therefore, the entire environmental policy of cities propose to be consider in the following way. Firstly, expenditures in the “person” (Society) and in environmental measures are investments in the future and a means of achieving competitive advantage. [3]. Secondly, in the strategic management of such resources, the main attention should be focused on the function of maintaining the stable state of the “core” of the studied systems (ACS), including for any urban areas. An example of calculating the optimal solution – in the form of a “saddle” point – presented in [12].

4. Conclusions

According to the need for a preliminary adequate study of the “... initial beginning, principle, meaning” of any phenomenon (“ratio” [8]), all three levels of management must meet the conditions. 1. To be logically, physically and mathematically related to each other. 2). The Full dynamics of the functioning and development of any systems is determined by the unity of methods and technologies for making strategic management decisions by all individuals, organizations and the state as a whole.

When making optimal decisions in the field of urban environmental policy management, the following methods and procedures are technologically most preferable: game-theoretic modeling; “games against Nature”; and “non-zero-sum” strategy games [22]. They allow the most complete use
of the most modern technological solutions in this area of management: NBICS, GIS, GRID and Blockchain technologies, BIGdata and neural networks.

The General results of the study show that without a methodological transition in the natural Sciences from traditional ("mechanistic") to the new ("noospheric") thinking, the correct solution of all theoretical and practical problems of CSD is by definition impossible, which is clearly confirmed by many years of experience in solving them. For practice today, we need to use the term of "noocracy", or a new global society, where the power of reason, based on science and knowledge, will prevail.

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