

Methodological foundations of the philosophical content of the systemic concepts of “ecological state” and “environmental security” in the use of water resources

V.L. Bondarenko¹, A.I. Ilyasov², E.D. Khetsuriani^{3,4}, M.I. Shtavdaker^{1,*}, and T.E. Khetsuriani^{4,5}

¹Novocherkassk Engineering and Land Reclamation Institute of Don State Agrarian University, 111, Pushkinskaya str., Novocherkassk, Rostov region, 346428, Russian Federation

²WTL (USA) branch in Asia at 7a, Novatorov str., Moscow. 2 Navigator Business Center

³M.I. Platov South Russian State Polytechnic University (NPI), 132, Prosveshcheniya str., Novocherkassk, 346400, Russian Federation

⁴Don State Technical University (DSTU), 1, Gagarin Square, Rostov-on-Don, 344003, Rostov region, Russian Federation

⁵Federal State Budgetary Educational Institution of Higher Education "Rostov State Medical University" of the Ministry of Health of the Russian Federation, Nakhichevansky Lane, 29, Rostov-on-Don, Rostov region, 344022, Russian Federation

Abstract. The purpose of this paper is to assess the philosophical categorical meaning of the concepts of “ecological state” and “environmental security” in the space and time of zones of influence of a water management facility, hereinafter referred to as the “Object of Activity” as part of the natural technical system “Natural Environment-Object of Activity-Population”, related to the use of water resources in a particular branch of economic activity. It should be noted that the concept of the “ecological state” in the considered space and time of the river basin geosystem, where quantitative and qualitative indicators of water resources are formed, determines the most important factor in the life of the “Population” living in the zones of influence of the “Object of Activity” – “environmental security”. The formation of scientific thinking in the field of the use of water resources in various branches of economic activity determined the creation and development of a class of natural and technical systems, in which the central technogenic component is different types of hydraulic structures, making certain changes in the natural processes of relationship, interaction and interrelation of biotic and abiotic elements among themselves as part of the “Natural Environment” and the life of the “Population”, forming an “ecological state” as a factor of “environmental security. The systemic concepts of “ecological state” and “environmental security” are the most important basis in the scientific assessment of the level of technogenic impact of the “Object of Activity” on “Natural Environments” within the spatial limits of basin geosystems when making practical decisions.

Keywords: system, system approach, environmental state, environmental security, behavior, structure

1 Introduction

Such system concepts as *system, system approach, component, element, system analysis and synthesis, behavior and structure, structure and organization* are currently used in the creation and development of the foundations of technical theory (FTT) of the class of natural and technical systems “Natural Environment-Object of Activity-Population” (NE-OA-P) on the use of water resources in various technological processes of economic activity related to a very special and important type of activity [1]. It should be noted that the above system concepts have become general scientific and general technical in their status with their philosophical generalization [2].

For the considered NE-OA-P class, the concept *System* forms a special unity with the natural environment within the spatial limits of the river basin geosystem, where quantitative and qualitative indicators of water resources are

formed and almost all types of economic activities are carried out [3].

The combination and interaction between the components and the elements included in them as part of the NE-OA-P has a special behavior as part of a more complex basin geosystem, which stands higher in the hierarchical series. One of the most important processes of interaction, relationship and interrelation studied between OA and NE and living P in the zones of influence is the assessment of the changes made in the intensity and direction of movement of the flows of matter, energy and information (MEI), defining and forming the “ecological state”, on which all life processes in the animal and plant world depend, where the main ones are life processes of the P determined by the qualitative indicators of human health. Consequently, the concept of the ecological state in the considered space and time of the zones of influence of the OA basin geosystem determines the need to assess the philosophical value of its categoricity [4].

* Corresponding author: shtawkader.marya@yandex.ru

2 Results

As the real development process of the concepts *system*, *system approach*, *system analysis and synthesis* and other system concepts shows, the concept of the ecological state acquires a general scientific and general technical status in environmental research and, in particular, a very important direction related to the assessment of the impact of OA on the environment (EIA) as a modern regulatory requirement to ensure the vital activity of the P, animal and plant life defined by the concept of environmental security [5].

The concept of the ecological state formed by the technogenic component of the OA in the zones of its influence are determined by the nature, intensity of movement of MEI flows in the considered space of the basin geosystem, which affects almost all processes in natural environments (atmosphere; hydrographic river network; in the upper layers of the lithosphere, where underground runoff draining into the river network is formed; soil cover with underlying rocks), which determine the vital activity of the P, flora and fauna both on land and in water bodies (various types of fish, etc.) [6].

At the level of philosophical reflection of the current reality in the ongoing processes of the AO relationship, interaction and interrelation with components in the NE-OA-P class includes, first of all, natural changes in the space and time of the basin geosystem under consideration, which, on the one hand, enrich the content of the already used concepts of *system*, *system approach*, *component*, *element*, *system analysis and synthesis*, *behavior*, *structure and organization*, and on the other hand, substantiates the philosophical content of the concept of the ecological state. The philosophical justification of the concept of the ecological state is determined by the necessary condition for the development of environmental science, both in the field of the use of water resources and in other branches of economic activity [7].

To substantiate the philosophical content of the concept of ecological state, it was necessary to establish its invariant value in various cases of its use in environmental studies of the processes of relationship, interaction and interrelation of various technogenic components, for example, a reservoir hydrosystem, an industrial enterprise, an irrigation system (IS), a major traffic route, etc. with natural environments in their zones of influence.

The OA operation as part of the NE-OA-P, for example, in the form of a reservoir hydrosystem, forms a special unity with the environment, which expresses the ecological state in the zones of influence, determined by quantitative and qualitative indicators of the intensity and direction of movement in space and time of MEI flows. Thus, the concept of the ecological state in the zones of influence of the Object of Activity will be considered in the future as the intensity and direction of movement of flows of matter, energy and information created by the processes of relationship, interaction and interrelation of the Object of Activity in the space and time of the basin geosystem with the Natural Environments and the Population [8].

The fact that the NE-OA-P forms a special unity with the natural environment in the space and time of the basin geosystem is an important and fundamental moment of the concept of the ecological state: its study as the processes of relationship, interaction and interrelation of the OA with the

NE and P as the system in interaction with the environment. The systematic study of the processes of relationship, interaction and interrelation, the OA with the NE and the P is performed in order to assess the ecological state as an important factor of the environmental security in the zones of the OA influence.

Hence, the NE-OA-P is not only a certain whole made up of particular interacting components, but such a set of components are formed by their processes of relationship, interaction and interrelation of the ecological state, both in the zones of influence of the OA system under consideration, and to a certain extent in basin geosystems that are higher in the hierarchical series. Based on the concept of the *system*, the study of assessing the concept of the ecological state considers something other than the relationship, interaction and interrelation of the OA with the NE and P, which is determined by individual qualitative and quantitative indicators, and in an integrated form is expressed by the ecological state in the considered space of the basin geosystem. Consequently, it is the highlighted points in the definition of the concept of the ecological state that make up a certain basis for any variations of this concept in the considered NE-OA-P class. The combination of the concept of the ecological state in the NE-OA-P class with the concepts of the ecological state in other systems, where, for example, an industrial facility, a transport system, etc. will act as a technogenic component, will make it possible to obtain a general scientific and general meteorological concept of the ecological state [9].

Material formation in the form of the OA as part of the NE-OA-P is in constant interaction with other material formations in the form of various elements of the NE (hydrographic river network, geological environment at the base of the pressure front of the reservoir hydrosystem, surface atmosphere layers, etc.), living P and at the same time the interaction changes to a certain extent and accordingly is in the state of motion.

The study of the processes of movement of material formation, its changes, determine the study of the behavior of material formation. But the subject of knowledge can also be what moves without considering how nothing is being studied. Such knowledge is associated with the study of the sphere of the structure of material formation. Therefore, what a researcher can turn into an object of knowledge refers either to the sphere of behavior of material formation, or to the sphere of its structure, or to the relationship of the “unity of behavior and structure”, where the unity is the conditionality of behavior by structure [10].

Behavior is one of the sides of the object of study as a system: the side associated with the movement and change of this object and its interaction with other objects that together constitute the environment for the studied object of the system. Motion, various changes in the studied object are the results of its relationship, interaction and interrelation with the environment, and for the studied objects – the spatial limits of the basin geosystem.

In philosophical meaning *behavior* is a concept that fixes the universal moments of objective reality as a change in material education, for example, OA and NE under the influence of MEI moving flows from both natural and technogenic objects. The *behavior* of material formation objectively reflects the unity of the two sides: changes and inevitable impacts. The category *behavior* reflecting the

relationship of opposite sides in some sense represents the synthesis of such opposite categories as “cause” and “consequence” when the approach to the object of study as a system begins to dominate. The concept of the *structure* of material formation (OA, NE) opposite to behavior determines the unity of opposites: a set of elements that are part of the OA and NE components and the combination of connections between them – structures that integrate components and their elements as part of the considered NE-OA-P class.

Based on the results of the systematic analysis and synthesis of categorical concepts of the *behavior* and *structure*, the relationship between the unity of behavior and structure, changes and inevitable impacts of the “cause and effect”, a plurality of elements included in the components of the NE-OA-P, a set of connections between them, structures that perform integration in the processes of relationship, interaction and interrelation between the components of the considered system, the category concept of the ecological state determines the dynamics of the intensity and direction of movement of MEI flows arising in the processes of relationship, interaction and interrelation of the OA with the NE and the living P in the considered space of the basin geosystem. In philosophical consideration, the concept of the ecological state reflects an objective picture of inevitable changes in the natural processes of the relationship, interaction and interrelation of biotic, abiotic elements among themselves in the natural component of the NE, as well as in the life of the living P in the zones of influence of the OA under construction or operated as part of the NE-OA-P [11].

Thus, in the categorical philosophical understanding, the ecological state in space and time in the zones of influence of the Object of Activity is determined by the processes of relationship, interaction and interrelation of natural and technogenic components with each other, which determines certain changes in the direction and intensity of movement of flows of matter, energy and information, which are quantitatively and qualitatively regulated by the following: maximum permissible concentrations (MPC); maximum permissible levels (MPL); maximum permissible emissions (MPE); maximum permissible discharges (MPD); maximum permissible water flow rates from a water body (MPF).

The categorical concept of the ecological state in the considered space and time of the basin geosystem under the influence of the OA determines the most important systemic factor – environmental security, which, in turn, determines the protection of the natural environment and vital human interests from the possible negative impact of economic activities related to the use of water resources, as well as in the event of natural and technogenic emergencies at water facilities.

With regard to economic activities on the use of water resources in various industries, environmental security is the state of protection facilities in the zones of influence of the OA when affected by the flows of matter, energy, information in the processes of relationship, interaction and interrelation of technogenic elements that are part of the OA (a complex of various types of hydraulic structures) with Natural Environments and the living Population, which does not exceed the maximum permissible regulatory values of MPC, MPL, MPE, MPD, MPF [12].

Environmental security as a concept of the philosophical category acquires practical understanding in the system Object of Protection – Source of Environmental Hazard – Protective Measures (OP-SEH-PM), where Population or the Natural Environments can act as the OP in the zones of influence of the Object of Activity

For the considered type of economic activity related to the use of water resources at the Zelenchukskaya HPP-PSPP, the environmental security within the spatial limits of the zones of influence of the complex of hydraulic engineering structures (CHES) is determined by the Environmental State under the influence of continuous flows of matter, energy and information from the processes of interaction of the CHES with the Natural Environment and the Population. The term Environmental Security includes an extensive concept, which raises the need for specificity when it will work to the full extent. Based on the example of the use of water resources for the generation of electric energy at the HPP-PSPP, Environmental Security in the zones of influence of the CHES mainly affects the permissible values of MPL, MPD, and MPF and acquires practical understanding in the OP-SEH-PM system. In the OP-SEH-PM system the object of protection (OP) is understood as the natural environments (atmosphere, hydrosphere, upper layers of the lithosphere, soil cover), the population living in the zones of influence of the CHES. The CHES ensuring the use of water resources for the generation of electric energy at the HPP-PSPP is understood as the “Source of Environmental Hazard” (SEH). The “Protective Measures” (PM) is a set of environmental protection measures aimed at reducing the technogenic impact on the environment in the zones of CHES influence. The general view of the OP-SEH-PM system is shown schematically in Fig. 1.

The use of water resources at the HPP-PSPP, which is associated with the construction of new or reconstructions of the existing CHES utilizes an important concept – the level of ecological suitability of design decisions. As noted in work [6], the ecological suitability of any technology and a design solution is determined by indicators of resource intensity of renewable and non-renewable natural material and energy resources.

Based on the formulated concepts of *Environmental Security*, *Ecological State*, *Ecological Suitability* in space and time in the zones of CHES influence as part of the OA within the NE-OA-P, the Environmental Security Criteria (ESC) determine indicators (quantitative and qualitative) $P_i P_j$ of environmental admissibility (impact) of the OA on natural processes of self-regulation in natural environments without causing negative degradation in space and time.

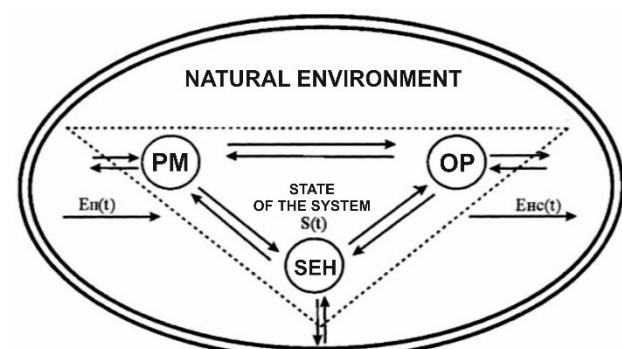


Fig. 1. Model of interaction of the OP-SEH-PM system components [13].

The justification of the impact zones of the Object of Activity is considered on the example of CHES and the buildings of the Zelenchukskaya HPP-PSPP, which is located within the spatial limits of the basin geosystem of the Upper Kuban on the territory of the Karachay-Cherkess Republic (KCR).

Based on the unity of Nature's actions within the Earth's biosphere and technological processes of using water resources to generate electric energy at the Zelenchukskaya HPP-PSPP, it is necessary to emphasize the relationship in the processes of converting the energy forms, in the considered example – the radiation energy of the sun, into the potential energy of the water flow and further into electrical energy with a certain efficiency, according to the laws of thermodynamics. It is important to note that 20 % (35.600 TW) of solar energy reaching the Earth's land surface ($149.1 \times 10^6 \text{ km}^2$) and the Earth's World Ocean ($361.1 \times 10^6 \text{ km}^2$) are spent:

- for global hydrological processes of moisture turnover and for processes of photosynthesis of the plant world of the Earth – less than 1 % (1780 TW) [7];
- for the interrelation, interrelation and interrelation of the Object of Activity in the processes of regulating the in-basin redistribution of water runoff from local sections of basin geosystems of rivers Bolshaya Zelenchuk ($F_{\text{вод}}=779 \text{ km}^2$, $W_{\text{атм}}=7790 \text{ km}^3$, $W_{\text{нит}}=233,7 \text{ km}^3$), Marukha ($F_{\text{вод}}=336 \text{ km}^2$, $W_{\text{атм}}=3360 \text{ km}^3$, $W_{\text{нит}}=100.8 \text{ km}^3$), and Aksout ($F_{\text{вод}}=509 \text{ km}^2$, $W_{\text{атм}}=5090 \text{ km}^3$, $W_{\text{нит}}=152.7 \text{ km}^3$) which are carried out within the spatial limits of the basin geosystem of the Upper Kuban ($F_{\text{вод}}=11.0 \times 10^3 \text{ km}^2$, $W_{\text{атм}}=110 \times 10^3 \text{ km}^3$, $W_{\text{нит}}=3.3 \times 10^3 \text{ km}^3$), which is an elementary part of the Earth's biosphere, within which global processes of moisture turnover occur under the influence of continuous solar energy flows.

3 Conclusion

Based on the results of methodological studies of the systemic concepts of the ecological state and the environmental security in the use of water resources in various branches of economic activity, the philosophical categorical understanding of the concepts of the ecological state and environmental security was assessed, based on which the systemic definitions of the concepts of the ecological state and environmental security were formed for the Objects of Activity as part of the NE-OA-P class.

References

1. V.L. Bondarenko, *Nature management: territories of basin geosystems*, textbook, under the general editor I.S. Rumyantseva (Rostov-on-Don, Mart Publishing Center, 2010)
2. V.L. Bondarenko, V.V. Gutenev, V.V. Privalenko, E.S. Polyakov, Environmental impact assessment (EIA) in the design of the water management complex of the Zelenchuk hydroelectric power station. *Theoret. and appl. Ecol.* **1**, 47–54 (2007)
3. V.L. Bondarenko, V.B. Dyachenko, Theoretical foundations of safety level of water-supporting hydraulic structures. *Water industry of Rus.* **3(2)**, 159–162 (2001)
4. M.I. Budyko, A.B. Avakyan, *Global ecology* (Moscow, Thought, 1977)
5. S.L. Vendrov, *On the question of research on the interaction of large hydroelectric facilities and water management systems with the environment* (Moscow, Hydroproject, 1979)
6. V.A. Volosukhin, V.L. Bondarenko, *Construction systems for the protection of water resources using fabric constructions* [Monograph] (Novocherkassk, Kolorit, 2008)
7. K.S. Losev, *Environmental problems and prospects for the sustainable development of Russia in the 21st century* (Moscow, Kosmosinform, 2001)
8. N.N. Moiseev, *Man and the Noosphere* (Moscow, Young Guard, 1992)
9. G. Nikolis, I. Prigozhin, *Self-organization in non-equilibrium systems* (Moscow, Mir, 1979)
10. I. Prigozhin, *Non-equilibrium statistical mechanics* (Moscow, Mir, 1964)
11. W.R. Ashby, General systems theory as a new scientific discipline. In: *Research on the general theory of systems* (Moscow, 1969)
12. L. Bertalanffy, An outline of General System Theory. *British J. for the Philos. of Sci.* **1** (1950)
13. A.M. Chernyaev (ed.), *River basins* (Yekaterinburg, Agroecology, 1999)