Basics of Methodology of Creating and Developing the Class of Natural Engineering Systems in Water Resources Management

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Abstract.- This study uses the system approach as a method of describing the relations and interaction among natural and technogenic objects and the people to elaborate the basics of the methodology of creating and developing the Natural Environment-Object of Activity-Population (NENV-OA-PPL) class of natural engineering systems (NES) for managing water resources in various branches of economy. The methodological basics elaborated for the class of natural engineering systems in question have been translated into practice in designing, building, and running water-management facilities, referred to as objects of activity, in conformity with applicable regulatory environmental requirements in effect. The basic system notions defined for the considered class of systems according to the study results are structure, component, element, and the paramount role of the whole that includes the notions of natural and technogenic constituents and environmental acceptability. The study results were time-tested in the course of designing and building the Zelenchukskaya Hydroelectric-Pumped Storage Power Plant (HPSPP) located in the basin geosystem of the Upper Kuban in the Karachay-Cherkess Republic in the North Caucasus.

Keywords: system; natural environment; object of activities; monitoring; environmental status; water quality.

Fundamentos metodológicos para la creación y desarrollo de clase de sistemas de ingeniería natural en la gestión de recursos hídricos

Resumen.- Este estudio utiliza el enfoque sistémico como método de descripción de las relaciones e interacción entre los objetos naturales y tecnogénicos y las personas para elaborar los conceptos básicos de la metodología de creación y desarrollo de la clase Entorno natural-Objeto de actividad-Población (NENV OA-PPL) de sistemas de ingeniería natural (NES) para la gestión de los recursos hídricos en diversas ramas de la economía.Los fundamentos metodológicos elaborados para la clase de sistemas de ingeniería natural en cuestión se han llevado a la práctica en el diseño, la construcción y el funcionamiento de las instalaciones de gestión del agua, denominadas objetos de actividad, de conformidad con los requisitos ambientales reglamentarios aplicables en vigor.Las nociones de sistema básico definidas para la clase considerada de acuerdo con los resultados del estudio son estructura, componente, elemento y el papel primordial del todo que incluye las nociones de constituyentes naturales y tecnogénicas y aceptabilidad ambiental.Los resultados del estudio fueron probados en el curso del diseño y construcción de la Central Hidroeléctrica de Almacenamiento por Bombeo Zelenchukskaya ubicada en el geosistema de cuenca del Alto Kubán en la República de Karachay-Cherkess en el Cáucaso Norte.

Palabras clave: sistema; entorno natural; objeto de actividades; monitoreo; estatus ambiental; calidad del agua.

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1. Introduction

As noted by Michael E. Webber in 1990 [1], modern paradigms of social development in the Man-Nature-Society global system are characterized by ten interlinked issues enumerated hereafter in the descending order of priority: *Energy, Water, Food, Ecology, Poverty, War and Terrorism, Diseases, Education, Democracy, and Population*. The most important of them are the ones related to *energy, water, food, and ecology* without resolving which the other six will be impossible to resolve either.

If to proceed from the system-level relation among energy, water, food, and ecology, the issue with water as a renewable natural resource is shaped at the system level by two circumstances. On the one hand, it is shaped by the natural global moisture cycle in an amount of 5777×10^3 km^3; this cycle is continuously repeated due to an influx of solar energy of 13,500 TW [2], that reaches the terrestrial surface with an area of $149{,}1 \times 10^6$ km^2 and the World Ocean with an area of $361{,}1 \times 10^6$ km^2.

On the other hand, the cycle is shaped by modern technologies of utilizing water resources in multiple kinds of economic activity, where the main areas of water consumption and utilization are, respectively, the multipurpose water supply of urban households and populated localities, agricultural production in irrigated lands and farming; electricity generation at hydropower plants (HPP), pumped storage power plants (PSPP), combined heat power plants (CHPP), and nuclear power plants (NPP), industrial manufacturing.

The quantitative indices of natural hydrological processes observed from the hierarchical level of the global formation of water resources within the Earth's biosphere $W_{bserth} = 1 \times 10^{10}$ km^2 to regional basin geosystems, for example, in the North Caucasus in the South of Russia, including the geosystems of such rivers as Kuban (with water catchment area $F_{wtctch} = 57{,}900$ km^2), Terek $F_{wtctch} = 43{,}200$ km^2, and Lower Don $F_{wtctch} = 105{,}100$ km^2, are shaped depending on global hydrological processes registered in dry, medium-, and high-water years. The economic activities practiced in the confines of the basin geosystems largely shape the considered region's environmental state (ENVST) as a factor of environmental safety (ENVS) and quality of water resources in use [3, 4, 5, 6, 7, 8, 9, 10, 11, 12]. At the system level of energy and entropy, the environmental safety in the considered space of the basin geosystem is determined by the kind and intensity of *matter, energy, and information streams* from natural objects and economic facilities as sources determined by system-level integrated environmental monitoring [13]. As shown by the daily realities of economic activity, the utilization of water resources in actual production and engineering processes determines the relations and interaction within the natural environment of the basin geosystem in the form of its biotic and abiotic components, technogenic waterworks facilities represented by various kinds of hydraulic structures (impounding reservoirs, water intakes, etc.) called objects of activity, and the population living in the basin geosystem's territory [14, 15, 16]. The system-level relations and interaction between the natural environment and the vital necessities of the population determine a particular class of natural engineering systems called Natural Environment-Object of Activity-Population systems (Figure 1). Their influence extends to vast spaces in the ground layers of the atmosphere at heights of up to 10 km, where rain and snow are formed ($W_{(atm.)} = F_{wtctch} \cdot 10$ km^3, upper earth crust layers down to 300 m in depth ($W_{(lts.)} = F_{wtctch} \cdot 0,3km^3$, where the subterranean flow of water is formed that runs into the fluvial network of the water catchment territory. This spatial interaction among the objects of activity, the natural environment, and the population determines the distinctness of the considered class of natural engineering systems. This distinctness requires conducting respective methodological studies for resolving the complicated issues of ensuring a sustainable level of environmental safety in the influence domains of the object of activity as a factor shaping the health and living standards of the population.

2. Materials and Methods

Methodologically, the creation and development of the NENV-OA-PPL class of natural engineering systems is based on system analysis, as a method of analyzing management arrangements, and system-based approach, as a way to create and use

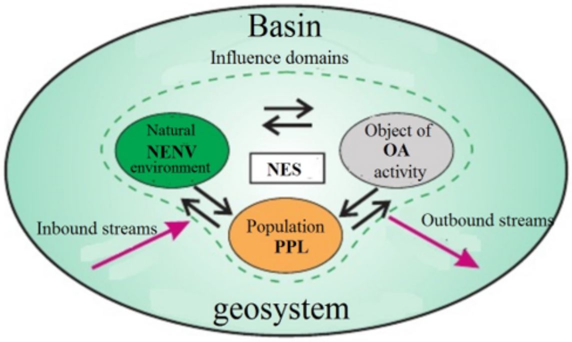

Figure 1: NENV-OA-PPL NES

as normative the description of the considered system, where water resource utilization objects are considered part of the NENV-OA-PPL natural engineering systems. Both, system analysis and system approach used in studying the NENV-OA-PPL class of natural engineering systems are based on the core notion in which a part is not perceived without perceiving the whole and is measured against the whole.

The system is a very broad notion covering combinations of interrelations and interaction, organization, etc. The first person is ever known to use it was Aristotle. The underlying ideas of the systems theory are found in Hegel's works and confine to the following: the whole is something bigger than the sum of its parts and determines their nature; parts cannot be perceived if considered beyond the whole; they are interdependent and involved in permanent interrelations [3].

The study of NENV-OA-PPL natural engineering systems involves considering the natural environment proper, the object of activity as a set of various types of hydraulic facilities, and vital necessities of the population living within the basin geosystem, where the quantitative and qualitative indicators of its water resources are shaped [4, 5, 17, 13, 8, 10, 1, 11, 18].

To understand the relations and interaction among the components of the considered system and their constituent elements, it is necessary to apply a certain methodology, where the analogy method and physical modeling play a certain role. For example, this method is applied to scaled-down models in the studying of design withdrawal of amounts of water from a water facility. The analogy method is based on the main idea of equivalence between an actual and an abstract system. This relation of equivalence sheds light on the identical aspects in their behavior.

The basis of the methodology (BM) of creating and developing the NENV-OA-PPL class of natural engineering systems must have axiomatic prerequisites, which makes it necessary to form such by meeting the following conditions [4, 5, 19, 8, 11, 20]:

1. existence,
2. multitude of structural formations,
3. unity,
4. sufficiency

Proceeding from the modern requirements on ensuring environmental safety in the domains of influence of the object of activity, that extend to the entire territory of the basin geosystem, where quantitative and qualitative water resource indicators are formed, it is necessary to conduct a set of studies for evaluating the influence of objects of activity on quantitatively and qualitatively determined natural environments.

The procedure of evaluating environmental effects (EEE) as the technogenic component, that is related to and interacts with the natural component as part of NENV-OA-PPL NES, involves using the system-level integrated environmental monitoring process chart (Figure 2), tested and certified in the building of the Zelenchukskaya HPSPP and operation of irrigation systems in the basin of river Kuban in the Stavropol' krai. The system-level integrated environmental monitoring stipulates geochemical, atmochemical, lithochemical, hydrochemical, biochemical, and geobotanical tests based on which the integral evaluation of ES in OA influence domains is formed.

The aspects that are considered as part of the natural constituent as a component of the natural environment are the kinds of influence on the soil cover, hydrosphere of the fluvial network within the limits of the water catchment area, in the surface layers of the atmosphere, and the Earth crust's upper layers of down to 30 m in depth.

The aspects that are considered as part of the technogenic constituent as a component of

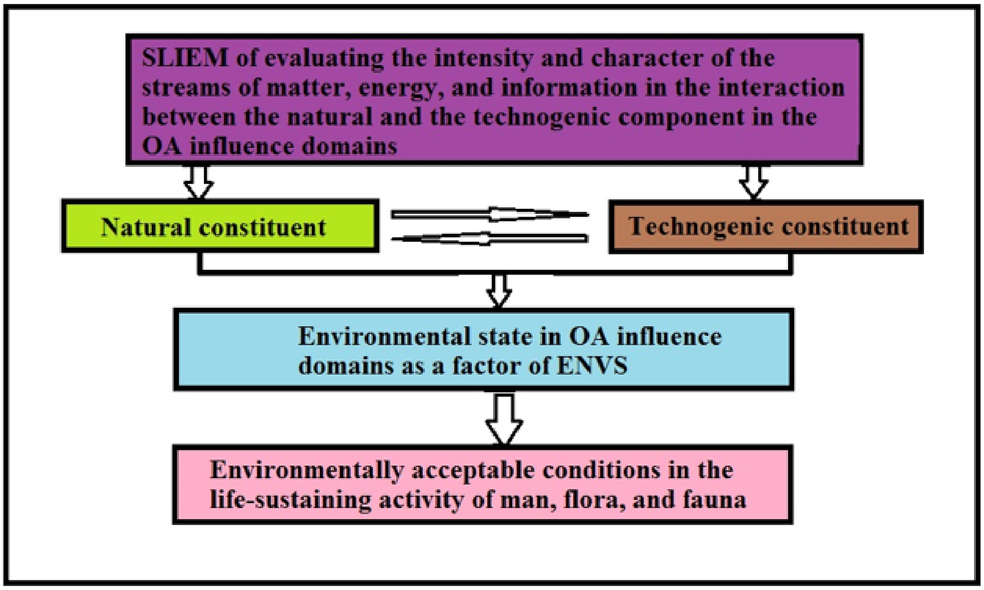

Figure 2: Process chart of conducting the system-level integrated environmental monitoring for evaluating the environmental state in the influence domains of the object of activity (technogenic constituent) interacting with the natural environment (natural constituent) as part of NENV-OA-PPL natural engineering systems

the natural enviroment are a set of hydraulic engineering structures intended for regulating the water runoff and using it in practice in epy production and engineering processes of economic activities.

3. Results

The notion of the system, where a part can not be perceived without perceiving the whole and is measured against it, is the basic notion formed in the methodology for the NENV-OA-PPL class of natural engineering systems for utilizing water resources in various process flow charts of economic activity.

In the NENV-OA-PPL class of natural engineering systems, a part is considered a separate component with its elements, for example, a natural environment with a diversity of biotic elements of fauna and such abiotic elements as atmosphere, upper earth crust levels, soil mantle, fluvial network, the changes in which under the influence of the technogenic component of OA are analyzed within the framework of the NENV-OA-PPL natural engineering system. The interaction and relations among the components of this system are managed following the main principle of system-level integrity. This principle determines the prevalence of the whole over its parts and is the core and dominant feature in the working processes of this system within the spatial confines of the considered basin geosystem [21, 22, 23, 15, 13, 24].

The system-level conditions [25, 21, 3] formulated for validating the theoretical basics of the methodology for the NENV-OA-PPL class of natural engineering systems are exposed below.

- Condition (1) shapes the very existence of this natural engineering system as its fundamental feature; therefore, we characterize the system's existence through its forms in space or as time, or as the motion of matter, energy, and information streams, or as various combinations of these three forms.
- Condition (2) determines the multitude of natural (biotic and abiotic) and technogenic components in the form of various engineering structures, buildings, etc. This condition has to be taken into account when building NENV-OA-PPL natural engineering systems.
- Condition (3) is unity and can be understood

in two ways: on the one hand, as the relation between natural and technogenic components that favors the generation of additive, unadditive, additive-unadditive properties new to both, them taken separately and in their totality; on the other hand, they can be understood as separate components. This condition is of fundamental significance.

- Condition (4) is sufficiency understood in the sense in which the need for a sufficient amount of material (and conditions) for creating something is discussed.

The parameters and characteristics [21, 22, 23, 26, 27] determined based on the elaborated system-level integrated environmental monitoring methodology applied in building and the initial phase of running the Zelenchukskaya HPSPP and by the example of the basin geosystem of the Upper Kuban, with spatial confines $W_{bngs} = 113{,}300\,\text{km}^3$, water catchment area $F_{(wtctch.)} = 11 \times 10^2\,\text{km}^2$, near-terrestrial atmospheric layers $W_{(atm.)} = 11 \times 10^4\,\text{km}^3$, and upper earth crust $W_{(ercr.)} = 3{,}3 \times 10^3\,\text{km}^3$ are exposed below.

1. The nature and kinds of technogenic effects on the natural environment were determined against the respective classification features and characterized by the supply to and withdrawal from the ambient medium. These parameters were used to determine the boundaries of influence domains (I-V) and their division in low-active (I), active (II-IV), and very active (III-IV). The environmental safety levels in influence domains I-V of the object of activity were evaluated by determining quantitative ($\prod_j$) and qualitative ($\prod_i$) criteria indicators of the environmental state as a factor of environmental safety.

2. The dust burden on the water catchment territory of the Upper Kuban was measured (Figure 1).

3. Aggregate atmochemical pollution of the air basin in the Upper Kuban.

4. According to the evaluation of their state, the surface waters within the fluvial network of the Upper Kuban met utility and drinking water supply requirements.

5. The influence of the Zelenchukskaya HPSPP on the soil mantle and underlying rock does not lead to irreversible processes in the humic layer formation.

6. The protection level of the subterranean waters in the upper earth crust layers, where the subterranean water flow forms within the water catchment territory of the fluvial network of the Upper Kuban, was evaluated as well.

7. The environmental state (Figure 3) as a factor of environmental safety within the basin geosystem of the Upper Kuban [2], where the population numbers 350K people, was exposed to integral estimation. The estimation results were used to measure the severity of environmental issues across the municipal entities in the water catchment territory according to the five-grade scale, with 1, 2, 3, 4, and 5 points indicating satisfactory, high, critical, crisis, and catastrophic severity, respectively.

4. Discussion

The main condition for the sustainable performance and development of the NENV-OA-PPL class of natural engineering systems is that the considered natural engineering system is located in the natural environment surrounded, in its respect, by the basin geosystems of higher hierarchical levels to the Earth's biosphere. The analogy between the mechanisms and principles of the Earth's biospheric structures and the principles effective in local basin geosystems, within which NENV-OA-PPL natural engineering systems work, is considered as the working assumption of the methodological basics for studying and developing the class of systems in question [19]. As shown by analyzing more than ten thousand active objects of

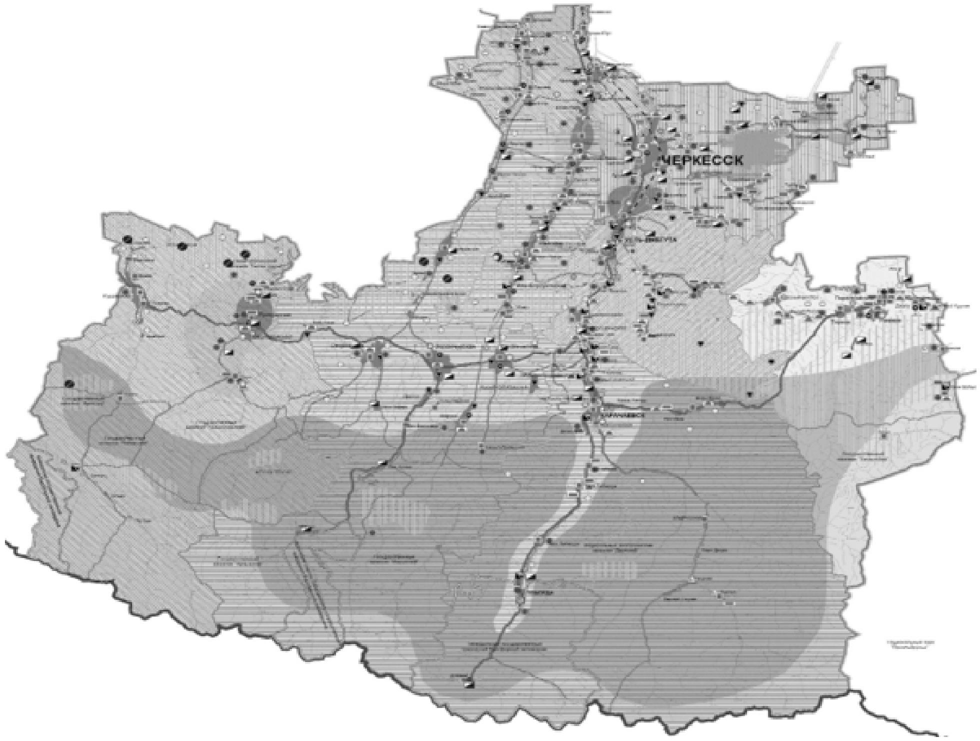

Figure 3: Integral assessment of environmental state within the basin geosystem of the Upper Kuban

activity within the confines of the basin geosystems of rivers Kuban $W_{BGC} = 597{,}49 \times 10^3\ \mathrm{km}^3$), Terek ($W_B GT \; = \; 4439 \times 10^3\ \mathrm{km}^3$), and Lower Don $W_B GLD = 1040,3e3km^3$), where a steady growth in water consumption is observed, the NENV-OA-PPL natural engineering system considered at the system level is determined as a certain pattern of regular communication and interaction among the natural environment, the object of activity, and the residing population. This system-level regularity in the relations among the natural and technogenic components and the population as part of the considered natural engineering system is formed in the phase of making project-based decisions about building objects of activity in the fluvial network for ensuring the targeted management of water resources utilization. At the spatiotemporal level, the management of water resource formation and utilization determines the system integrity principle that preconditions the prevalence of the whole over the parts of the considered system. The paramount role of integrity for NENV-OA-PPL natural engineering is core to the interaction and relations both, within the system and between the system and the ambient medium [2, 28]. The activity of NENV-OA-PPL natural engineering systems stipulates the set of intrasystem changes in natural structural formations (fluvial network, surface layers of the atmosphere, upper earth crust layers, vegetation, etc.), where the environment must hold the leading role in the interaction and relations with objects of activity. The environment's leading role within a basin geosystem is possible on the condition that the environment's objective reality is optimally epitomized.

In NENV-OA-PPL natural engineering systems, this reality is understood as the active framework of control from outside for maintaining the development within OA influence domains and, respectively, through maintaining the paramount role of the whole played by the hydrological processes that form water runoff within the spatial confines of a basin geosystem as part of basin geosystems of higher levels in the hierarchy of the Earth's biosphere. The system interaction and relations between the spatial confines of a particular basin geosystem and the basin geosystems of higher hierarchical levels in the global moisture cycle determine the prevalence of the whole over its components and their elements that belong to the considered NENV-OA-PPL natural engineering system. This prevalence shows in the subordination of individual parts to the system's overall performance in the environment [22, 23, 26, 27, 18].

The system-level principles distinguished according to the results of the system analysis of the interaction and relations among the natural environment, objects of activity, and population within active NENV-OA-PPL natural engineering systems work as follows:

- integrity determines the impossibility of reducing a system's properties to the sum of properties of the whole;
- structuredness determines the possibility of describing a system through networks of interaction and relations among its components, the dependence of each component with elements, properties, and relations on its place within the spatial confines of a basin geosystem and functions performed within the whole;
- hierarchy, where each component of the system is one of the components of the system of a higher hierarchical level;
- multiplicity of descriptions of the considered system means that, to study appropriately, it is necessary to build a multitude of various models each of which will describe a certain aspect of the system.

We should note that the core and dominant operational principle among all of the identified system principles in the considered class of systems is the paramount role of the whole that determines the control from outside over the interaction and relations among the system's components [3, 29, 30, 31, 32, 16, 20].

The notion of the paramount role of the whole formulated while developing the basics of the methodology of the class of systems in question is formulated below. The paramount role of the whole in NENV-OA-PPL natural engineering systems determines the dominant influence of natural moisture cycles in basin systems of higher hierarchical levels within the Earth's biosphere on the formation of water runoff in the influence domains of an object of activity and the consistent purposeful utilization of a part of water runoff in production and engineering processes of economic activities by creating the Object-of-Activity complex that interacts with and is related to the Natural Environment and the residing Population.

According to the study results, the basic system notions for developing the methodology of creating NENV-OA-PPL natural engineering systems have been determined that reflect the essential properties of the relations among the natural environment, objects of activity, and population for all of their contradictions and in the development within the considered system.

The notion of structure in NENV-OA-PPL natural engineering systems indicates those things, that remain relatively unchanged after the transformations related to the water runoff formation within a basin geosystem, and their purposeful utilization. The structure of a NENV-OA-PPL natural engineering system is determined by its function, by the location of the natural environment and technogenic objects of activity relative to the water facility, and, timewise, by the ordered position and state of these components in space and across the seasons within the basin geosystem.

The notion of a component includes abiotic (climate, hydrosphere, atmosphere, upper earth crust layers, soil mantle) and biotic (flora and fauna) constituents, technogenic constituents in the form of objects of activity, and social constituents represented by the people living in the OA influence domains.

The notion of an element is presented as an indivisible part involved in interactions and relations within a considered component.

These basic notions were used to formulate the following spatiotemporal features of the NES in question as axiomatic assumptions [4, 6, 33, 9, 34, 35].

- The properties of the NENV-OA-PPL class of natural engineering systems show in the interaction and relations among the objects of activity, natural environment, and population within the spatial confines of the basin geosystem, where water resources are formed;
- The system's properties, in general, are not reduced to the sum of the properties of its parts, i.e., objects of activity, natural environment, population, and their elements;
- The NENV-OA-PPL class of natural engineering systems is open to the influence of the ambient natural medium within the spatial confines of the considered basin geosystem that is part of systems of higher hierarchical system levels;
- The steady rise in the capabilities of NENV-OA-PPL natural engineering systems affects the ambient natural medium and socio-economic environment within the spatial confines of the basin geosystem;
- The population has an integral demand for utilizing water resources in its life-sustaining and economic activities;
- There is a steady trend for expanded opportunities for ensuring an increase in the system's effective capacity (P) by adopting more advanced technologies of utilizing water resources with a better performance coefficient;
- There is a steady trend for a decelerated growth in lost capacity (G) in the system due to its rising P;
- A better resource efficiency and reduced energy costs in the phases of project-based decision making, building, and operation;
- The position of objects of activity within the spatial confines of the basin geosystem determines the spatial structure of the NENV-OA-PPL class of natural engineering systems;
- The temporal structure shows in pragmatically operating the objects of activity across the seasons;
- The functional structure is determined by the objects of activity in their purposeful interaction and relations with the natural environment and the people living within the spatial confines of the basin geosystem, depending on specific water consumers and users.

The interrelation of the natural processes of water runoff formation within the confines of the basin geosystem under the influence of hydrological processes in the systems of higher hierarchical levels related to the global moisture cycle determine the natural constituent of the prevalence of the whole over the natural and technogenic components in the considered NENV-OA-PPL natural engineering systems. The technogenic constituent of the prevalent role of the whole is determined by the intrasystem relations and interaction among the objects of activity, natural environment, and population, which determines the spatial boundaries of the OA influence domains within the local basin geosystem [4, 5, 17, 6, 8, 10].

The natural constituent of the paramount role of the whole is originally formed by the global moisture cycle within the Earth's biosphere and uses hierarchical system interrelations to reach local basin geosystems, in which NENV-OA-PPL natural engineering systems are functional.

The system-level relations among the processes that take place in the Earth's biosphere and form natural processes, hydrological ones included, within basin geosystems of lower hierarchical levels, determine the natural constituent of the paramount role of the whole in the water runoff formation in NENV-OA-PPL natural engineering systems. It should be noted that the hydrological processes formed within spatial confines of basin geosystems at different hierarchical levels depend on concrete natural factors of location on the Earth's surface.

The technogenic constituent of the paramount role of the whole in the purposeful operation of objects of activity included in NENV-OA-PPL natural engineering systems is the subsequent system-level link in the sequence of practically utilizing water resources in various production and engineering processes of economic activities. As shown by field and laboratory test results, this constituent fully depends on the performance, design, and other characteristics of OA, which is important to consider in design decision making [3, 23, 4, 5, 17, 8, 10, 11, 12, 24].

The performance dependence of the objects of activity included in NENV-OA-PPL natural engineering systems on the paramount role of the whole is determined by environmental acceptability (EA) that is a peculiar copy of a natural system, in the transformation of energy forms with entropy growth on the wane [8]. The environmental acceptability of objects of activity is manifested in design fineness and performance reliability in various modes of running these objects as part of NENV-OA-PPL natural engineering systems and, at the system level, in maintaining and regulating the intensity of matter, energy, and information streams within the spatial confines of a basin geosystem, which allows maintaining the paramount role of the integrity of the technogenic component. According to the investigation results and in furtherance of the notion of the technogenic constituent of the prevalent role of integrity, the functional and constructional environmental acceptability of objects of activity as parts of NENV-OA-PPL natural engineering systems can be characterized by the following conceptual assumptions [3, 4, 5, 6, 33, 8, 10, 11].

1. The environmental acceptability of objects of activity depends on the design fineness of hydraulic facilities in use, related structures, including fish protection and passing works as well as functional and auxiliary buildings;
2. Environmental acceptability is characterized by the interaction and relations between the objects of activity and the natural environment, which shapes the environmental state under the influence of changes produced in the motion of matter, energy, and information streams;
3. Environmental acceptability depends on the resource intensity and energy efficiency of the production and engineering processes related to the building and operation of objects of activity;
4. Environmental safety is the main indicator used in assessing objects of activity for environmental acceptability proceeding from the cause-consequence logic of interaction and relations between the objects of activity and the natural environment within the spatial confines of influence domains;
5. Environmental acceptability attends self-organization as the all-purpose model of interrelated transformations in the natural environment under the influence of objects of activity included in NENV-OA-PPL natural engineering systems;
6. The environmental acceptability of objects of activity facilitates the dominant role of natural transformations in the natural environment and reduction in the pace of entropy growth rates;
7. The environmental acceptability of objects of activity included in NENV-OA-PPL natural engineering systems facilitates the adaptation and adjustment of the object-of-activity design parts to the ambient medium via structural transformations in the natural environment;
8. Environmental acceptability is interlinked with self-organization in terms of enhancement of the structural parts of objects of activity included in NENV-OA-PPL natural engineering systems;
9. The environmental acceptability of objects of activity as part of NENV-OA-PPL natural engineering systems is characterized by quantitative and qualitative design and performance indicators;
10. The environmental acceptability of objects of activity as part of NENV-OA-PPL natural engineering systems is assessed by system-level integrated environmental monitoring.

The object of activity in a NENV-OA-PPL natural engineering system is the core technogenic component that closes on itself in the influence domains of certain spatial confines of the basic geosystem in the causal relation with environmental acceptability and forms an environmental state manifested in environmental safety as an important factor of preserving the health and living standards of people, flora, and fauna.

5. Conclusions

We have elaborated the basics of the methodology of creating and developing the NENV-OA-PPL class of natural engineering systems inalienably linked with the issues of energy, water, food, and ecology, proceeding from the unity of action among nature, the economic activities are undertaken to utilize water resources, and the current issue with water as a renewable natural resource that comes second among the four most important issues of energy, water, food, and ecology. The basics of the methodology in question have been elaborated by system analysis, system approach, and system-level integrated environmental monitoring conducted to evaluate the kind of effects produced by the objects of activity already and being built in the North Caucasus and rely on the results of studying the relations and interaction among the technogenic components of the objects of activity, the natural components of the natural environment, and the population residing in the considered confines of the basin geosystem as part of the NENV-OA-PPL natural engineering system.

Methodologically, the basics of the methodology of creating and developing the NENV-OA-PPL class of natural engineering systems rely on the system analysis and system approach used to validate the fundamental principles of the paramount role of whole, integrity, structuredness, hierarchy, and multiplicity; the basic notions of structure, component, and elements; the basic indicators [14], and the conceptual assumptions on environmental acceptability in the interaction between the object of activity and the population, which forms environmental states in the influence domains of objects of activity as a factor shaping the health and living standards of the population.

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