Methodology of New Ideas Formation in Water Resources Utilization Technology

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Abstract. Modern societal development, both at the level of the global system “Nature-Society-Person” and at the level of local watershed geosystems, is characterized by the increasing relevance of all aspects of the society interaction with multifaceted types of economic activity and Nature, which are expressed in the form of 10 major problems, of which the first three are the most important - Energy, Water and Food, as the solution of the remaining 7 problems (ecology, poverty, terrorism and war, diseases, education, population demography and democracy) is impossible without the solution of the first three [1, 3]. The systemic causal relationship between the problems of Energy, Water and Food causes a "dominant problem" over these problems, both at the planetary level of the Earth’s biosphere and at the level of local watershed geosystems, for example, the Kuban river, the Terek river, the Lower Don river and others, within the spatial limits of which almost all types of economic and other activities are conducted, including the water resources utilization in the agricultural industry.

1. Introduction
The systemic role of the “dominant problem” in economic and other activities related to the water resources utilization, the quantitative and qualitative indicators of which are formed within the spatial limits of local watershed geosystems, is manifested by the purposefulness of interconnection, interaction and interrelation (III) processes of the Energy, Water and Food problems among themselves, in the furtherance of this goal, while ensuring consistent trend in the efficient use of the resource potential in the form of the solar radiation, aqueous run-off (surface, underground), climatic geomorphologic, geological, hydrogeologic and other natural characteristics, as well as socio-economic conditions in the considered space and time.

2. Relevance
Analysis of the results of the water resources utilization research at irrigation/water distribution systems (IWDS) of the Great Stavropol Canal (GSC) on the area of 366.6 thousand hectares and with the length of 666 km. (according to the project 1,700 km.) shows that the role of the dominant
problem over the problems of Energy, Water and Food is underestimated in full, which causes the vulnerability in relation to various phenomena of the economic activity branches development in the areas of influence of existing water projects in the form of a hydraulic engineering structures complex (HESC) of various types and life-sustaining activity of the population. Thus, as exemplified by the water resources utilization within the areas of influence of the GSC water projects, the interrelation of the problems of Energy, Water and Food to obtain the required amount of agricultural products on irrigated lands requires a certain amount of Energy, Water volumes in the production of crop growing and animal agriculture products and their subsequent processing it becomes possible to obtain the necessary food products - Food, where the role of the “dominant problem” in the processes of three major problems mutual interaction between each other. As established by studies in the IWDS sites GSC-1, GSC-2, GSC-3 and GSC-4, within which there are operating about 6,000 thousand HES, Which do not use the energy resource water flow potential to generate electrical energy at small HEP, in the amount of 600 million kWh annually. At IWDS GSC-4, there are practically not used the terrain geomorphologic characteristics expressing the difference in grades (from 70 m and more) between the carrier canal and the location of individual sections of irrigation systems [5].

3. Formulation of the problem
On the basis of the objectively existing interrelation of the Energy, Water and Food problems and Ecology, which is standing on the fourth place according to the significance of the problem, the water resources utilization in limited conditions refers to the particular type of economic activity, which makes it necessary to develop a methodology for the research of the issues of the development of applied technologies and creation of new technologies for the water resources utilization, for example, in agricultural industry and other industries. It has been established that the initial core principle in the development of the water-environmental problems research methodology is to use the generally accepted statement - “think globally and act locally” [4]. According to this statement, all the Water in the solar system originates from a giant primary cloud of gas and dust, which more than four billion years ago collapsed quickly, forming the solar system. In this cloud there were in abundance present hydrogen and oxygen, which make up water (H2O). On planet Earth the World Ocean occupies more than two thirds (FWO = 361.1 million km 2) of its surface (FE = 149.1 million km 2), whose mass is about 0.02% of the Earth mass (5976 × 10 21 kg.), and taking into account the water contained in its mantle - 0.04% [4]. The global hydrological cycle under the influence of solar energy fluxes (35,600 TW) within the Earth’s biosphere (WEB = 1 × 1010 km 3) is 577 thousand km 3, 72 thousand km 3 of which come from land-based watershed geosystems (Fland = 149 million km 2), and 505 thousand km 3 come from the World Ocean (FWO = 361 million km 2). All types of environmental waters on Earth, which are used and renewed in the process of global hydrological cycle, are interconnected with each other. It should be noted that the uniqueness of water (H2O) as a natural mineral is that water does not lose its physical essence, but only changes its qualitative composition because of pollutants during its use in various technological processes of economic activity [6,7].

4. The theoretical part
On the basis of objectively existing restrictive conditions for the run-off formation within the local watershed geosystems under consideration and the consistent trend in the agricultural industry development based on the irrigated agriculture, the systemic and convergent approaches and new technologies for the water resources utilization are required. In turn, new technologies in solving of the water resources utilization problems require new ideas that contribute to the growth of society’s capabilities in meeting the vital and necessary needs of present and future generations in accordance with the fundamental laws of Nature and ecologically sustainable development (ESD) [9, 10].

As the researches show, the problem of water resources utilization both in agricultural industry and in other branches of economic activity is systemic in nature and its solution requires new ideas and new knowledge from the sidelines of science and practice, using the systemic and convergent approaches.
The systemic approach to the existing and created natural-engineering systems (NES) "Natural environment - Object of Activity - Population" ("NE-OA-P") in the water resources utilization is considered as orderliness and integrity, where the system integrity is determined by the dominant role of integrity over its components - "NE", "OA" and "P" [2].

In the methodology for the formation of new ideas on the water resources utilization in various sectors of the economic activity, it is reasonable to proceed from the fundamentals of the systematic approach to the study of the III processes between natural and anthropogenic components in the composition of the NES "NE-OA-P" with further system analysis and synthesis of the research results and using the basic principles of the convergent approach (system-structured, system-communicative, system-integrative) as a tool for the creation of new technologies in water consumption and water resources management.

On the basis of the objective current systems concept of the dominant role of the whole in the considered NES "NE-OA-P" in the relationship of the dominant problems of Energy, Water and Food, the New Ideas put forward should form the consistent trend to more complete use of the inter-system resource potential, for example, by building of small HEP, using of micro-HEP for sprinkler machines, etc.

What role does the principle of the dominant role of the whole play?

The dominant role of the whole in the system under consideration, related to the formation and water resources utilization, is manifested in the interrelation of processes of the water resources formation at the level of the global biosphere system of the Earth, within the spatial limits of which the global hydrological cycle is accomplished and the spatial limits of the local watershed geosystems as elementary parts of the Earth's biosphere. The formation of water resources at the level of the global system of the Earth’s biosphere determines the processes of the water resources formation and utilization at the level of local watershed geosystems within which almost all types of economic and other activities, including agricultural industry, etc. are conducted. Such a III of the global system of the Earth’s biosphere with local watershed geosystems defines the principle of “the dominant role of the whole”, according to which the processes of water resources formation at the hierarchical level of the above system determine the processes of aqueous run-off formation in systems of a lower hierarchical level, like NES “NE-OA-P”.

Thus, in the development of an important area of economic activity for the water resources utilization there is a very complex and ambitious problem of the creation of new technologies and systems for the water resources utilization in technological processes of the agricultural industry, multi-purpose water supply of municipal service and facilities, industrial and technical water supply of TPP, HPP, NPP, the electric energy generation at HEP and other industries [7].

5. Practical significance, research results

The basis of the watershed principle of the water resources formation and utilization processes management the creation of New technologies and systems of water consumption and water resources management becomes possible in the presence of the consistent trend to put forward the New Ideas to improve existing and create new structural solutions in the “Objects of Activity” functioning as part of NES “NE-OA-P”. In the causal relationship the creation of New or the improvement of existing systems and technologies for the water resources management, water consumption becomes possible if we consider the technological processes of the water resources utilization in unity with the processes of transformation in natural environments (atmosphere, hydrosphere, upper layers of the lithosphere and pedosphere), which determine the consistency of the water resources formation in the considered spatial limits of the watershed geosystems. The current technological processes in the systems of multi-purpose water supply of municipal service and facilities and settlements, industrial production and agricultural industry, technical water supply of TPP, HPP, NPP and water resources management at HEP include the following stages: - regulation and intra-watershed redistribution of the river run-off (surface and underground) within the spatial limits of the watershed geosystem under consideration; organization of the water intake of the design water discharge (Q m³/s) from the water
source; transportation of these amounts of water to the water consumer or water user and the water resources use in technological schemes by a specific user [2, 3]. This unity of the natural processes of the water resources formation both in the spatial limits of the Earth’s biosphere and at the level of the local watershed geosystem with the technological processes of the water consumption and the water resources management is based on the principles of the “system integrity”, “objective reality reflection”, “vital reasonable reality”, “ecological suitability” [2, 4].

The principle of "system integrity" in existing and created NES “NE-OA-P” within the local watershed geosystems is determined by the integrity, which has its own internal structure, consisting of the III between each other of the constituent natural components (biotic, abiotic), anthropogenic component (HESC, associated buildings and structures) and the resident "Population" in the areas of influence of the "Object of Activity", performing the purposeful functions concerning the water resources utilization [2].

The “objective reality reflection” is determined by the ability of the “Object of Activity” to adapt to the ambient environment within the spatial limits of the watershed geosystem with the formation of an “Ecological State” in the areas of its influence [3].

In the “Object of Activity” III processes with natural environment the unity of the functional actions of the anthropogenic component with the natural transformation processes in the natural components (biotic, abiotic) is manifested, for example, in the hydrosphere of the catchment area is determined by the reflection of objective processes during the surface and underground run-off formation. The reflection of the reality of natural transformation in natural processes is determined by the depth of cognition and ability to reproduce, by analogy, the actions of natural processes in constructive and technological schemes of the water resources utilization. It should be noted that if there are positive achievements in cognition, then in the formation of the ability to reflect the reality of natural transformation processes in natural environments in the applied technologies and systems of water resources utilization there are certain problems associated with the imperfection of structural solutions in the used HES and various auxiliary structures, for example, fish protection, etc. [3, 12].

The “vital reasonable demand” of the "Object of Activity" in the considered spatial limits of the watershed geosystem, as a system of a higher hierarchical level in relation to NES “NE-OA-P” is caused by the deviation of the "Ecological State" vector of the system of a lower level from the vector "Ecological State" of the system of a higher hierarchical level. With a significant deviation of environmental indicators in the areas of influence of the “Object of Activity” as a part of NES “NE-OA-P” from the environmental indicators of the “maternal” ecosystem of the watershed geosystem, i.e. when leaving the band of the co-evolution (adaptation) to the natural factors of the external environment, which can later cause irreversible degradation processes in the life-supporting natural environment [4].

In the development of the systems concept of the dominant role of the whole from the highest hierarchical level of the Earth’s biosphere, within which the global hydrological cycle takes place, to the level of the local watershed geosystem, as an elementary part of the Earth’s biosphere, the “Ecological Suitability” of “Objects of Activity” as a part of NES “NE-OA-P” becomes of particular importance in the technological processes of the water resources utilization [2].

The ecological suitability of the “Objects of Activity”, as a central concept in the considered NES “NE-OA-P”, is determined by the system-constructive property that ensures the consistent trend in the use of renewable energy sources, modern achievements in the field of fundamental and application-oriented sciences, experience of the practical application of new structural solutions in the creation and improvement of the used HES and various auxiliary structures. In the development of the concept of "Ecological Suitability" of the "Objects of Activity" in the composition of NES "NE-OA-P" represents a kind of "copy" of the natural system, in which there are processes of the energy forms transformation with the consistent trend to reduce the growth rate of entropy which is expressed by the constructive perfection, the functional reliability under various modes of interaction of the “Object of Activity” with “Natural Environments”, in particular with the “Natural Aquatic Environment” of a water body, and in the system mechanism the provision of the “preservation” in the “trend of a decrease in the
growth rate of "entropy" and “change” in the intensity of flows of matter, energy, information (MEI) in the areas of influence.

In the methodology for the formation of New Ideas related to the water resources utilization, as it is established by the results of research, it is important to proceed from the systems concept of the dominant role of the whole in NES “NE-OA-P”, in which the “Object of Activity” as an anthropogenic component, requires continuous improvement in terms of reducing the use of non-renewable resources, replacing them with renewable ones during construction and subsequent operation periods, taking into account the increasing environmental requirements for rational water resources utilization in technological processes, preservation of the bioresources variety on water bodies, reduction of the surface and underground waters pollution, creating the favorable environmental situation in the life-sustaining activity of the "Population". On the basis of the systems concept of the dominant role of the whole of the concept of “ecological suitability” as the dominant factor in the formation of New ideas for the constructive improvement of the “Objects of Activity” the conceptual statements in the “Ecological Suitability” (ES) concept development were formulated [2, 10].

1. The ES of the “Objects of Activity” depends on the constructive perfection of the used HES types, related structures such as fish protection, fish pass structures, etc., as well as functional and auxiliary buildings;
2. The ES is characterized by the processes of the III interconnection of the "Object of activity" with "NE", which form the "Ecological State" under the influence of the changes in the movement of MEI flows;
3. The ES depends on resource intensity, energy efficiency in the technological processes of the “Object of Activity” construction and operation;
4. The key indicator in the causal logic of the "Object of Activity" III with "NE" within the spatial limits of the areas of influence at the assessment of the "Object of Activity" ES is the "Ecological state";
5. The ES accompanies the processes of self-organization, as a universal model of the interrelated transformations in the “NE” under the influence of the “Object of Activity” as a part of NES “NE-OA-P”;
6. The “Object of Activity” ES contributes to the dominance of natural transformation processes in the “NE” and to a decrease in the rate of growth of the entropy level;
7. The “Object of Activity” ES as a part of NES “NE-OA-P” contributes to the adjusting and adaptation of the structural elements of the “Object of Activity” to the surrounding environment through structural transformations in the “NE”;
8. The ES is interconnected with the self-organization processes to improve the structural elements of the “Object of Activity” as a part of NES “NE-OA-P”;
9. The “Object of Activity” ES as a part of NES “NE-OA-P” is characterized by the constructive and functional quantitative and qualitative indicators;
10. The assessment of the level of the “Object of Activity” ES as a part of NES “NE-OA-P” is determined by the system complex environmental monitoring (SCEM).

Based on the results of research and experience in the water resources utilization in the sectors of economic activity the most promising areas for proposing new ideas have been determined [1,3]:

1. Ideas related to the use of renewable energy sources (RES) in technological processes of the water resources utilization;
2. Ideas related to the process of formation of environmental waters and their practical utilization in technological processes of agricultural industry and industrial production, multi-purpose water supply systems for municipal infrastructure and settlements;
3. Ideas for treatment of livestock farms wastewaters, as a type of waste that can be used as a necessary resource in the agricultural industry on irrigated lands;
4. Ideas associated with the use of new materials in the creation of new and improvement of existing HES constructions, allowing to reduce the resources costs;
5. Ideas associated with the use of state-of-the-art IT solutions for receiving, transmitting, processing and using the obtained information in the specific practical tasks solving, for example, ensuring the hydrological environmental safety in areas of the “Objects of Activity” influence during the floods carrying.

6. Conclusions
On the basis of the systems concept of the dominant role of the whole in the development of the formulated concept of the “ecological suitability” as the dominant factor in the creative process of the formation of New Ideas on the basis of the research results there was substantiated a number of conceptual statements which should contribute to the creation of more advanced structural solutions in the “Objects of Activity” and technologies of more sustainable utilization of water resources.

Many years’ experience in creating new structural solutions in technological processes of the water resources utilization shows that new ideas, when they achieve a systemic beneficial effect in the considered industry, should have the opportunity to make the way “from the drafting board” to the practical implementation of existing and newly created technological schemes of the water resources utilization.

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