The conceptual framework of time concept in assessing the environmental status in water facilities’ influence zones

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Abstract. The “Society” development at the present stage is characterized by a steady trend of limited natural resources, including water resources, in the limited conditions of further development, which determined a number of interconnected global problems (10), first four of which - Energy, Water, Food, Ecology are the most important problems. Without these problems’ solving it is impossible to solve the remaining 6 important problems. The water resources use in economic and other activities is interconnected with the existing and created water management facilities in the form of complex hydraulic structures within the basin geosystems with the initial ecological state, which should be determined and predicted. This methodological approach makes it possible to consider the alternative options when making the decisions on the water facilities’ location and creation in conjunction with the concept Time in assessing the ecological state in the basin geosystems spatial limits influence zones. The system mechanism operating within the basin geosystem under consideration and functioning as “Water Management Facility” as an “Activity Object” “AO”, as a class part NTE “NE – AO – P” provides the simultaneous ecological state “change” and “preservation” in space and time, where Time is a fundamental measure of environmental status. In Time flux ecological condition and unchanged past, speedy present and open future move forward under the “AO” and “NE” interaction process influence in the composition NTE “NE – AO – P”, which determines the Time concept when assessing the environmental status in the “AO” influence areas within the basin geosystem.

It was established that the ecological state in the “AO” influence zones in the composition NTE “NE – AO – P” varies from time from the accepted time source (construction start), which makes it possible to conclude: Time is the creation of new or nothing at all, and the ecological state in the «AO» influence zones is also the creation of a new one, as it is constantly changed and determined by irreversible processes.
Introduction
System Interconnection, Interaction, and Relationship (IIR) between the types of economic and other activities and natural environment (“NE”) within the basin geosystem under consideration, at the present stage of the “Society” development, is characterized by a steady upward trend in natural resources consumption (non-renewable up to 85%, renewable up to 15%), the most vital of which are water renewable resources, the consumption of which exceeds all the rest in quantitative mass resources used together [3]. It should be noted that the World Ocean mass, as the main water body of the Earth’s biosphere, is only about 0.02% of the Earth mass (5976*10²¹ kg) [environmental survey].

Water consumption growth in various spheres of the “Society” life is determined, on the one hand, by the vital need of all living organisms in the plant and animal world, modern technological processes for economic and other activities and, on the other hand, by the uniqueness of physicochemical natural properties formed by the Earth’s geological history (more than 4 billion years) [11]. Water uniqueness, as a natural resource is caused by many of its species (atmospheric, biological, river, underground, permafrost, mountain and polar glaciers, underground in the upper lithosphere layers, soil, swamp, lake, seas and the World Ocean), which are formed in the processes of global moisture circulation (5770.0 thousand km³) and are characterized by Time use and renewal, which ranges from several hours (species) to 10,000 years (permafrost) [9]. The paradigm of the “Society” modern development is characterized by a steady trend of limited natural resources, including water, in the limited conditions of further development, which has identified a number of interrelated global problems (10), the first 4 of which are highlighted - Energy, Water, Food, Ecology as the most important problems.

Energy, Water, Food (energy forms) and Ecology (like the movement of flows of substance, energy and information (SEI)) problems are the main ones, because the solution to the 6 remaining problems depends on the solution of the 4 global problems. The solar energy flow (178,000 TW) interconnection, as the main energy source on Earth, is determined by the global moisture circulation formation in the volume of 577 thousand km³, and the Food problem is solved by the Energy and Water flux, on which the PP ecological state traffic depends in the considered spatial limits of the basin geosystem.

The use of water resources in various technological processes of economic and other activities is inextricably interconnected with the use of existing and the creation of new water management facilities within the basin geosystems, which are caused by the initial environmental conditions, various kinds of phenomena (channel, exogenous, etc.) and therefore PP in the space under consideration should be determined and predicted. Such a methodological approach makes it possible to consider the alternative options in making the final decisions when placing and creating water facilities on the water-producing area of the hydrographic river network in conjunction with the concept Time for PP assessment in its influence zones of the basin geosystem considered space.

Materials and Methods
Water resources used in multi-purpose water supply systems (WSS) of the urban households and economic facilities, for example, to generate electricity on HPP, PSP, APP, TPP, formed in the spatial boundaries of river basin geosystems in the form of surface and underground runoff, where IIR of almost all vital population (“P”), flora and fauna processes takes place. Inalienable IIR in space and time of “Natural environment” (“NE”) with “Water Facilities” referred to as “Activity objects” (“AO”) and living “P” is considered in the NTE class “NE - AO - P”, the functioning of which is interconnected with the fundamental Time concept [1, 14-17].

The system mechanism operating within the spatial limits of the considered basin geosystem on which NTE “NE – AO – P” is located, provides simultaneous change and preservation of incoming flows SEI by preserving the changes’ direction in space and time. Therefore, it can be noted that the system mechanism operating according to the principle “Everything changes and remains unchanged”, in which all infinity and power are concentrated spacetime, represents a multidimensional flux [5, 24]. For the considered NTE “NE – AO – P” multidimensional flows are the Substances flows (aerial runoff, dissolved and undisolved substances, rocks, etc.), Energy (solar energy and other forms), Information (contained in the flows of matter and forms of energy), which are transformed under the
influence of natural and IIR technogenic processes and where Time is a fundamental measurement in PP influence “AO” zones evaluating, as an important factor in ensuring environmental safety (ES).

Within the basin geosystems where new NTE “NE – AO – P” and the systems of a higher hierarchical level Time flows continuously, where the present is constantly updated, the future is always open until it becomes the present, and the past always remains unchanged. In PP time flow the basin geosystem under consideration is determined as an unchanging past, a transient present and an open future moving forward under the influence of IIR natural processes with “AO” in the composition NTE “NE – AO – P”. These are the conceptual foundations of the concept accounting methodology Time in assessing the inevitable changes in “NE” under “AO” influence during its construction and subsequent operation, where “AO”, for example, a complex of hydraulic structures is considered (HSC) Zelenchukskaya HPP-PSP [14, 18]-22.

Results

Rating PP in the affected “AO” areas in the composition NTE “NE – AO – P” within the basin geosystem’s spatial boundaries in the Upper Kuban, the question: “what is the future expected?” is acute. This question contains a deeper meaning of the Time concept, which is a fundamental measurement, in particular, of PP assessment in the influence zones of the erected “AO” and then its functioning.

Based on the technological process system analysis of using water resources to generate electric energy on HPP-PSP it has been established that the past and the future play different roles. So, on the example of Zelenchukskaya HPP-PSP operating within the spatial boundaries of the basin geosystem in the Upper Kuban (Wb.h.s.=113300 km³, Ww.f.l.=3300 km², Watm.=110000 km³, Fwat.= 11000 km²) the past did not have a water flow intra-basin redistribution, the present has this redistribution, and the future is open for more complete redistributed flow use in the planned for construction Verkhne-Krasnogorskaya HPP and then Nizhne-Krasnogorskaya HPP, that causes the irreversibility phenomenon (Fig. 1.) [11-14].

Irreversibility in the aqueous runoff intra-basin redistribution processes makes certain changes to the natural hydrological processes in both the basin geosystems of the Bolshoi and Maly Zelenchuk rivers, and on the Kuban river section (17 km) from the alignment site of Zelenchukskaya HPP-PSP to the Ust-Dzhegutinsky reservoir (Figure 2) in the “AO” influence zones and the Upper Kuban basin geosystems.

It has been determined that IIR irreversibility processes between “AO” and “NE” in the composition NTE “NE – AO – P” in the Upper Kuban basin geosystem influence zones leads to actions and effects coordinated with time (coherence), covering all components and their constituent elements of NTE “NE – AO – P” and the basin geosystem of the Upper Kuban as a whole, within which the water resources are formed. Therefore, it can be noted that “Time Arrow” manifests itself clearly in the water flow formation processes within the Upper Kuban river hydrographic network (Fig. 3). So, the full flow of rivers and watercourses on a hydrographic river network varies depending on the formed hydrological processes and costs (m³/s) they change over the course of a year and long-term cycles, which causes the Irreversibility phenomenon. Irreversibility in the water flow movement processes on a hydrographic network in riverbeds and watercourses leads to such phenomena as the coast reformation, transportation of bottom and suspended sediments, etc. [5, 8].

In a systematic review of ongoing changes in “NE” under “AO” influence, PP, determined by the SEI flow intensity is formed, which determines the ES criteria - climatic, hydrological, geochemical, hydrobiological, ichthyological, bacteriological, faunistic, physical (radiation, noise, electromagnetic), health and quality of “P” life, as well as the exogenous geological processes (EGP) activation. The intensity and nature of the SEI flows movement in “AO” influence zones is manifested in Time, i.e. PP in the considered NTE “NE – AO – P” is changed with Time from the accepted Time source (start of construction). Hence, Time - is a creation of a new or nothing at all, but PP in “AO” influence zones is the also creation of a new one, as it is constantly changed and determined by the irreversible processes [9, 10].

Discussion
Irreversibility study in the IIR “AO” processes in the composition NTE “NE – AO – P” like “Time Arrows” PP important initial conditions, which will apply to the subsequent moments in time. Irreversibility for the class NTE “NE – AO – P” is considered on the basis of the second law of thermodynamics - the law of non-decreasing entropy [3].

In the deterministic description of IIR processes in the class NTE “NE – AO – P” “Time Arrow” determines the direction of ongoing changes in “NE” under “AO” influence. If the future PP in “AO” influence zones contained in the present (period of construction, initial operation), and the past (source PP) is included in the present, then “Time Arrow” determines the fact that time determines in itself a kind of constructor that interconnects past with present and future. In the considered spatial limits the “AO” influence zones in the Upper Kuban basin PP is changing, and Time flows in only one direction - from past to present, and further in future and rearrange past and future is impossible. The physical meaning of the connection between past and future due to the action of the second law of thermodynamics, which defines entropy as a barrier defining the available states from the forbidden states. Entropy change nature in the “AO” influence zones in a general sense, reflects the PP past, present and future. Sum of entropy changes in NTE “NE – AO – P” and in its external environment cannot decrease, i.e. the state in the natural components of the “AO” influence zones is impossible to return to the initial (initial to construction) state, for example, channel morphometric characteristics, etc. Entropy change is determined by the well-known equation of I. Prigogine [8]:

$$\frac{\partial S}{\partial t} = \frac{dS}{dt} = \frac{dS}{dt}$$

where $dS$ – is a complete change in entropy in the system over a period of time $\partial t$;

$dS$ – is the change in entropy in the system due to irreversible processes within the system or the production of entropy;

$deS$ – is entropy taken from the environment of the basin geosystem spatial limits and characterizes the energy exchange with the environment.

According to the second law of thermodynamics $dS$ is always positive as well $deS$ can be both positive and negative.

IIR Irreversibility processes between “AO” and “NE” in the composition NTE “NE – AO – P” zones of influence causes certain problems associated with ensuring ES, and on the other hand, the need to change the water use technology, for example, PSP construction in addition to HPP, as well as improving the design solutions. The spatial limits of the basin geosystem in this case, the Upper Kuban, where Zelenchukskaya HPP-PSP has been built and operates, acquires a temporary dimension - “Space Reduction”, when the new look of space and, accordingly, PP (the present) has some differences from the original (the past) appearance. The future appearance of space and its PP can be determined by the irreversibility process associated with entropy growth and ongoing environmental measures in the “AO” influence areas in the case under HSC Zelenchukskaya HPP-PSP consideration [9, 10, 13].

When evaluating PP in the “AO” influence zones as the experience of many-years monitoring research shows, there is a need to modify the approaches of time management depending on the functional purpose of individual structural elements and technological equipment, their time period of practical use. Created HSC Zelenchukskaya HPP-PSP and in the future Verkhnaya and Krasnogorskaya HPP (Fig. 1). Time it is expressed by the “emerging property” [2] and determines the development direction of NTE “NE – AO – P” within the spatial limits of the Upper Kuban basin geosystem. As a result of NTE “NE – AO – P” “Development”, a new qualitative and quantitative PP, in which Time will be an important indicator, the determining direction of “Development” as an irreversible directed and regular change in the “NE” hydropower facilities’ influence zones.

In IIR process research between the NTE “NE – AO – P” components two concepts are important - preservation and change. The connection between the concept “change” and the concept “preservation” pays attention to the fact that the “change” presence causes “preservation” lack, that is, to non-preservation. The concepts “preservation” and “change” can relate both to spaces, and to the motion forms in the form of explosives between the components in the composition NTE “NE – AO – P”.

$$\partial S = \frac{dS}{dt} = \frac{dS}{dt}$$
Therefore, it is important to establish what is preserved and what is changed. For the considered space of the “AO” influence zones’ characteristic is the presence of linear dimensions, and therefore “change” space is associated with a change in its geometric dimensions. The movement form “Preservation” (IIR processes) cannot be expressed in linear dimensions, since the predicate of the process or form of motion is the duration, that is, associated with time. This actually determines the difference in concepts. Space and movement forms, when space preservation can be characterized immutability by its size, which is not time and where there are two mutually exclusive assumptions - changes are not preservation and any preservation is not a change, and change is not preservation [9, 0, 12, 13].

Summary
“AO” influence zones’ natural environment ecological state assessment of the basin geosystem under consideration is the dominant factor in making the objectively sound decisions in the planned economic and other activities related to the water resources use.

The concept Time use in assessing the ecological state in the “AO” influence zones in the composition NTE “NE – AO – P” determines a certain novelty in the methodology for assessing and predicting the ecological state as an important dominant factor in ensuring environmental safety when using water resources in various technological schemes, for example, generating electric energy HPP, PSP, APP, TPP on irrigation and watering systems, etc.
Figure 1. The key plan for the Zelenchukskaya HPP-PSP, Verkhne-Krasnogorsk HPP, Nizhne-Krasnogorsk HPP and Ust-Dzhegutinsky reservoir location on the Kuban River

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