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Assessment of Ecological Safety in Zones of Influence of Water Intake Technological Complex of Multipurpose Water Supply Systems

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Abstract. The use of water resources in various types of economic activity (EA) of industrial and agricultural production, the generation of electrical energy at a nuclear power plant (NPP), the State District Power Plant (SDPP), a thermal power plant (TPP), a hydroelectric power station (HES), communal sphere, water supply and sanitation of urban households, etc. is inherently associated with existing and under construction new water intake technological complexes ("WITC"). In the development of the class of natural-technical systems (NTS) "Natural Environment-Object of Activity-Population" ("NE-OA-P") on the use of water resources in the multifaceted types of economic and other activities, giving the results of theoretical studies of a specialized type "NTS" in where the component "NE" means the natural water environment (NWE) of a water body as a source of the multi-purpose water supply system (MWS) of the objects of urban households, settlements, enterprises of the fuel and energy complex (TPP, HES, NPP); Under the "OA" water intake technological complex (WITC) is considered, which includes various for the functional purpose of hydraulic structures (HS) and devices for ensuring the selection of estimated water flow (Qm³/s) with an environmentally safe level of protection of the water environment of the water body in the zones of influence of the WITC and the functional work of the treatment facilities in the composition of the MWS; under the "P" is MWS that provides water of normative quality to specific water consumers

1. Introduction

The use of water resources in various types of economic activity (EA) of industrial and agricultural production, the generation of electrical energy at a nuclear power plant (NPP), the State District Power Plant (SDPP), a thermal power plant (TPP), a hydroelectric power station (HES), communal sphere, water supply and sanitation of urban households, etc. is inherently associated with existing and under construction new water intake technological complexes ("WITC"), which include a complex of



various on the functional purpose of design solutions, providing a normative level of protection of water environment of the water body from the technogenic impact . [1,7,8]. System analysis and system approach, as the methodology for the design of natural-technical systems (NTS) "Natural water environment (NWE) -Water intake technological complex (WITC) - Multipurpose water supply systems (MWS)" ("NWE-WITC-MWS"), is necessitated introduction of "WITC" in the "NWE" water body for the purpose of meeting the vital needs of the municipal economy in the drinking water supply of the population, as well as the needs of various industrial enterprises. [5, 6, 9].

2. Materials and Methods

Based on the results of long-term studies of existing "WITC" multi-purpose water supply systems (MWS) in the Lower Don basin from Kalach city on the river Don to the city of Azov, the main types of changes in the zones of influence of "WITC" were established. So, under the influence of "WITC" the dominant species is the hydraulic structure of the water flow in the active zone of influence. Full-scale and laboratory hydraulic studies established that a change in the hydraulic structure of the water flow in the active zone of influence of "WITC" contributes to the activation of the processes associated with: the ingress of juvenile fish into the MWS; the arrival of suspended and bottom silts, dreissena, river plankton and flowering algae; sludge-ice phenomena, in combination, which significantly reduce the functional efficiency of the treatment facilities and create the ecological damage to the river ichthyofauna. [2,3,4]. To ensure the normative level of environmental safety (ES) in the zones of influence on existing and generated WITC productivity from 1 m³/s to 100 m³/s, the Aleksandrovsky WITC of multipurpose water supply systems in the Rostov region is considered as the base object of the research.

Problem of Water, as a renewable natural resource, defines its use in EA urban economy, industry, agricultural production, and not less important condition of character and views of the impact of existing "WITC" on water objects and their spatial limits basin geosystems, where both quantitative and qualitative indicators of water resources are formed depending on the ecological state (ES) of the space in question, as a factor determining ecological safety in a water body [7, 10, 11].

The investigation of the inter-linkage, interaction and interrelations ("III") "WITC" processes with natural environments was carried out within the basin geosystem of the Lower Don, where more than 100 WITCs of different capacities operate, it was established that the WITC impact zones in their spatially temporal analysis are different in nature, boundaries and time of influence.

Proceeding from the principle of unity action of a nature and EA's ongoing systemic consideration of the III "WITC" processes with the water environment of the water body and to a certain extent with the spatial limits of the basin geosystem in question, it was necessary to justify the influence boundaries of WITC's zones. [12,16,18].

To assess the level of protection of the natural environment in water objects as an integral factor in ensuring environmental safety, complex studies were carried out at the existing WITC to determine the boundaries of zones of influence on the operating "WITC" in the lower reaches of the river Don.

3. Results

Based on the results of hydrochemical analysis of river water in the area of the river Don (Fw = 100 thousand km²), the amount of water by 65-70% is formed in the spatial processes of the basin geosystem (W bg.d. = 1030 thousand km³). Consequently, the boundary of the low-active zone of influence of the "WITC" located in the alignment of Rostov-on-Don is determined by the boundaries of the catchment area of the Lower Don basin, where the river runoff (surface, underground) is formed. Within the low-activity zone of influence (1) in the channel of the river flow under the influence of 'WITC' an active zone of influence is formed (2), characterized by changes in the hydraulic structure of the channel flow. In the active zone of influence (2), as the results of complex studies show, young fish of various species, dreissena, aquatic vegetation, plankton, suspended and bottom silts are actively moving in the direction to the location of the water intake windows "WITC" [7, 11, 19].

Sludge-ice phenomena, as temporary phenomena, appear within the boundaries of a strongly active zone of influence (3), the nature of the impact of which is determined by observational studies.

Based on the system analysis of the results of research into the nature and types of exposure of the "WITC" to the water environment of a water object, characteristic zones of influence were identified that determined their classification characteristics: low-active, active and strongly active zones of influence. [6, 12, 20].

The low-active zone of influence 1 is determined by the processes of formation of quantitative and qualitative indicators of water resources within the spatial limits of the basin geosystem under consideration.

The active zone of influence 2 is determined by changes in the hydraulic structure of the river flow, under the influence of which the young fish, dreissena, aquatic vegetation, plankton, suspended and bottom silts are activated in the direction of the water intake windows "WITC".

The strongly active zone of influence 3 is determined by sludge-ice phenomena within the local boundary of the "WITC" on the water surface of the water body.

The ecological state in the zones of influence (1-3) "WITC" and, accordingly, ES based on the results of the research, the following conceptual statements are formed:

-ES in the zones of influence of "WITC" is interconnected with the processes of vital activity of the population in the city economy and the ongoing processes in natural environments of the spatial limits of the basin geosystem under consideration;

-ES on the water body is formed by the design solutions "WITC" and, accordingly, the level of their environmental applicability (EA);

-The "ES" violation in the "WITC" influence zones in the systemic examination is a consequence of the manifestation of the cause-effect chain of the prerequisites that are formed at the stages of the WITC construction and operation design in the NTC "NWE-WITC-MWS";

- the links of the cause and effect chain of ES violation in the system "Protection Object-Source of Environmental Hazard-Protective Measures" ("PO-SEH-PM") is "WITC" not meeting environmental and structural requirements.

4. Conclusions

Based on the results of system studies, the assessment of the nature of the "WITC" impact within the NTC "NWE-WITC-MWS" made a classification characteristic of the zones of influence.

The production approbation of the results of the research was carried out on the Aleksandrovsky WITC in Rostov on the Don of the water intake "MWS" in the lower reaches of the river Don.

5. References

- [1] Khetsuriani E D, Fesenko L N, Kostyukov V P, Khesuriani T E 2017 Obtaining regression equations and assessing their adequacy for the analysis of field studies *Obtaining regression equations and evaluating their adequacy for analysis of field studies data*. (Norwegian Journal of Development of the International Science.) vol 2 **9** 69-72
- [2] Khetsuriani E D, Kostyukov V P, Larin D S, Khesuriani T E 2017 Obtaining an adequate mathematical model of the results of studies on the effectiveness of fish protection *Determination of an adequate mathematical model of research results on determining fish protection efficiency* Znanstvena misel vol 1 **9** 89-93
- [3] Hecuriaia E D, Fesenko L N, Terikov A S, Lapina I A, Khesuriani T E 2016 Energy-saving technologies for improving the ecological safety of water reservoirs *Prospects for the development of the construction complex: materials X International. scientific-practical Conf. "Perspectives of development of scientific and technical cooperation of the countries participating in the Eurasian Economic Union"* (Astrakhan. state. arch.-builds. un-t. - Astrakhan, 2016) 110-113
- [4] Khetsuriani E D, Kostyukov V P, Ugrovatova E G 2016 Hydrological Studies on the River Don-the-Alexandrovsky OSV Water-Intake Facilities *Procedia Engineering* vol 150 (2nd

- International Conference on Industrial Engineering, ICIE 2016; Chelyabinsk Russian Federation; 19 May 2016 through 20 May 2016) 2358-2363
- [5] Hetsuriani E D, Hecuriani T E 2016 Measures to combat eutrophication of water bodies *Priority tasks and strategies for the development of agricultural sciences: Sat. sci. tr. on the basis of the Intern. scientific-practical. Conf., May 25, 2016 / FTSNiO EVENSIS* 11-13
 - [6] Bondarenko V L, Gutenev V V, Privalenko V V, Polyakov E S 2007 Environmental impact assessment (EIA) in the design of the water management complex of the Zelenchukskaya HPP *Theoretical and applied ecology* **1** 47-54
 - [7] Bondarenko V L 2010 Environmental engineering: the territory of basin geosystems: *Textbook. allowance (a: Publishing center "Mart")* 527
 - [8] Bondarenko V L, Privalenko V V, Kuvalkin A V and others. 2007 Evaluation of the impact on the environment (EIA) in the design of the water management complex of the Zelenchukskaya HPP *Theoretical and Applied Ecology* **1** 47-54
 - [9] Bondarenko V L, Privalenko V V, Kuvalkin A V, Polyakov V S, Pryganov SG 2009 Solution of environmental problems in the design of hydraulic structures (on the example of the basin geosystem of the Upper Kuban) *Southern Scientific Center of the Russian Academy of Sciences* 309
 - [10] Water resources of the USSR and their use 1987 L., *Gidrometeoizdat* 302
 - [11] Chernyaeva A M 1986 Water gathering Water management in the catchment area ED *Ekaterinburg, publishing house "Victor"* 1994 160 p *Reservoirs and their impact on the environment* M., Science 367
 - [12] Saeta Yu E 1990 Geochemistry of the environment Ed.. *Nedra*
 - [13] Kovalchuk M V 2010 From synthesis in science - to convergence in education *Educational policy* **11** 12 (49-50)
 - [14] Bondarenko V L, Semenova E A, Nikolenko D A, Klimenko O V 2016 Natural and technical systems in the use of water resources: the territory of basin geosystems (scientific monograph) *Novocherkassk Engineering and Meliorative Institute. A.K. Kortunov FGBOU HPE "DGAU"; Federal State Educational Institution of Higher Professional Education North-Caucasian Federal University; Volgograd State University of Architecture and Civil Engineering. - Novocherkassk: YURPU (NPI)* 200
 - [15] Bondarenko V L, Semenova E A, Aliferov A V, Klimenko O V 2017 Ecological safety in construction. Engineering and environmental surveys in the complex of surveys for the construction of water management facilities (scientific monograph) *Novocherkassk Engineering and Melioration Institute. A.K. Kortunov FGBOU VO Donskoy State Pedagogical University Novocherkassk; YURGPU (NPI)* 280
 - [16] Bondarenko V L, Semenova E A, Aliferov A V, Klimenko O V 2017 Methodology of formation of new ideas in technological processes of water resources use *Bulletin of Volgograd State Architectural and Construction University. Series: Construction and architecture* vol 50 (69) 73-79
 - [17] Stefanenko I V, Semenova E A, Klimenko O V, Bondarenko V A 2018 Fundamentals of Methodology of Development of the Technical Theory of Natural and Technical Systems in Use of Water Resources *Applied Mechanics and Materials* vol 875 141-144
 - [18] Nikolis G, Prigogine I 1979 Self-organization in non-equilibrium systems (Moscow: Mir) 440 p
 - [19] Odum Yu 1987 Fundamentals of Ecology Yu. Odum; trans. with English (Moscow: Mir) 40 - 60
 - [20] Privalenko V V, Minkina T M, Bondarenko V L Ecological safety in construction