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METHODS AND RESULTS OF NATURAL INSPECTIONS OF BYELORUSSIAN WATER OBJECTS AS SOURCES OF TECHNOGENIC CHARACTER EMERGENCY SITUATIONS.

Methodology and results of Belarus artificial water bodies' field surveys were presented. Based on these results potential risk coefficient for hydrodynamic accidents possibility estimation was counted. Belarus water bodies were classified as potential sources of natural emergencies.

Introduction. Inspection of artificial water reservoirs of the Republic of Belarus and evaluation of technical condition of the pressure head front constructions have been carried out by the group of authors in research work "The development of methods, algorithms and software for assessment of damages from emergency situations on water objects of the Republic of Belarus and "Scientific emergency safety and protection".

Now there are over 150 artificial water objects (reservoirs) in operation in the Republic of Belarus. The term of operation of the majority of them exceeds 30–40 years. According to the statements of a number of specialists the probability of hydraulic engineering failures on such objects may grow.

Main part. From September, 2005 to November 2010 natural researches of the 35 reservoirs of the Republic of Belarus have been carried out by the authors of the article. All geomorphological areas and basins of the main rivers with the location of reservoirs have been inspected. Researches were carried out for the purpose of identification of damages and deformations of hydraulic engineering constructions of the pressure head front and their reasons and technical conditions have been under consideration. The research also included:

- inspections of shore strengthening constructions and pressure head riding slopes of earth dams and places of their adjunction to radical shores of reservoirs in the upper pool;
- supervision over condition of water waste constructions (absence or disrepair of mechanisms of lifting gates and their directors, existence of ferro-concrete and metal construction damages);
- visual supervision over filtrational deformations in the downstream of hydroshemes (existence of suffozion carrying out the soil of the basis and dam body).

The parameters according to which the technical condition of constructions evaluation was done

were chosen according to the "Rules of technical operation of ponds and small reservoirs" [2].

By the results of the inspections evaluation of the possibility of HECTARE by means of the calculation of factors of the potential danger (CPD) characterizing the condition of shore strengthening, water waste constructions, pressure head riding slopes and places of their adjunction to radical shore and water waste constructions has been carried out.

The method of ranging offered by A. N. Razinkov in his work [3] was taken as the basis for the evaluation of potential danger, and the method Voronezh State university staff had used for division of the Voronezh region territory on classes of danger [4] has been also taken into consideration.

CPD characterizing the condition of pressure head riding slopes and places of their adjunction to radical shores and water waste constructions, has been determined by the following formula:

$$K_1 = L_p / L_{lg} \quad (1)$$

where L_p – length of the damaged site of a pressure head riding slope, m; L_{lt} – total length of a dam, m.

CPD characterizing the condition of shore strengthening constructions, has been determined by the following formula:

$$K_2 = S_p / S_{lt}, \quad (2)$$

where S_p – the area of the destroyed plates of fastening, or the plates having through cracks, sq.m; S_{lt} – the total area of plate fastenings, sq.m.

CPD characterizing the condition of water waste constructions, has been determined by the following formula:

$$K_3 = N_n / N_g, \quad (3)$$

where N_n – the number of spillway damages; N_g – the total number of possible damages of the spillway.

Table 1

Boundary values of KPO

Boundary values			Class characteristics
K_1	K_2	K_3	
0–0.270	0–0.310	0–0.250	I – the safe
0.270–0.540	0.310–0.620	0.250–0.500	II – moderately dangerous
0.540–0.810	0.620–0.930	0.500–0.750	III – dangerous
0.810 and more	0.930 and more	0.750 and more	IV – extremely dangerous

Table 2

Distribution of the surveyed reservoirs on KPO

Distribution of reservoirs depending on KPO, (piece/%)			
K_1	K_2	K_3	K
31/85.7	26/74.2	10/28.5	8/22.9
0/0	7/20	9/25.7	11/31.4
4/11.4	1/2.9	15/42.9	14/40
1/2.9	1/2.9	1/2.9	2/5.7

Note. A number of different reservoirs attributed to various classes, are given, their percentage from total of the surveyed reservoirs in dominator.

On the received meanings of K_1 , K_2 and K_3 , and taking into consideration(4), the class of potential danger of the possibility of HECTARE on a reservoir with the account of the technical condition of the pressure head front constructions has been defined:

$$K = \max (K_1, K_2, K_3). \tag{4}$$

The received values (meanings) of CPD have been broken into n intervals the number of which has been determined by the formula

$$n = 5 \lg N, \tag{5}$$

where N – the number of the surveyed reservoirs.

The size of intervals has been determined by the following formula:

$$A = (K_{\max} - K_{\min}) / n, \tag{6}$$

where $K_{\max(\min)}$ – the maximum (minimum) of CPD value.

Then experimental probability according to the following formula has been formulated.

$$P_{on} = m_i / N, \tag{7}$$

where m_i – a number of values (meanings) in each interval.

On the received number of coefficients plotting curve probabilities according to Y. N. Artemyev's method [5] has been carried out.

According to this curve probabilities three fractions 25, 50 and 75% have been found that allowed to divide the sample into four equally probable classes. The characteristics and borders of the classes are given in Table 1.

The analysis of the received data on the generalized class of potential danger made possible to establish that from all surveyed reservoirs 22.9% are regarded as a safe class; 31.4% –as moderately dangerous class; 40% – dangerous and 5.7% – extremely-dangerous (Table 2).

The data provided in Table 2 states that the greatest danger is represented by the water waste constructions the technical condition of which will not allow to pass high waters of high security(flooding) in time and can lead to a water modulation through the dam crest. According to the factor of K_3 Mlynoksk and Chigirinsk reservoirs were considered to belong to extremely dangerous class.

Natural inspection materials on HECTARE consequences on the Mlynovsk reservoir are given in the pictures *a* and *b*.

Conclusion. Thus, according to the natural inspections of the water reservoirs of the Republic of Belarus KPO characterizing technical conditions of the pressure head front, and also the possibility of HECTARE are offered.

On these factors curves of the accumulated probabilities were given on the basis of which four classes of potential danger of reservoirs were picked out. Results of the calculation of CPD on 35 reservoirs were received and their distribution on classes of potential danger was carried out.

Elaborated factors were used as the events initiating emergence of HECTARE, and were included in the refusals for calculation of accident probability on hydraulic engineering constructions.

*a**b*

Consequences of НЕСТARE on the Mlynoksk reservoir (inspection 4/29/2010):
a – view of left-bank part of the dam; *b* – view of the spillway from the upper pool

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