Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 5, 2956-2960

Probability-Statistical Model Of Reliability And Efficiency Of Irrigation Channels

I.E.Mahmudov , N.K.Murodov , A.A.Mirzaev , U.T.Jovliev , U.A.Sadiev , Sh.M.Musaev , A.Rajabov , J.J.Narziev , M.O.Roziev

Professor, Ministry of Water Resources of the Republic of Uzbekistan, Uzbekistan.
Phd, Scientific Research Institute of Irrigation and Water Problems, Uzbekistan.
Phd student, Jizzakh Polytechnic Institute, Uzbekistan.

Abstract

The article describes the results of field studies of the state of reliability and efficiency of large irrigation channels in the Tashkent region. The assessment and analysis of the probability-statistical model of reliability and efficiency of the Chirchik-Bozsuv diversion. These data allow the development and implementation of organizational, technical and repair activities aimed at improving their operational reliability and efficiency of the Lower-Bozsuv HPP-22 and Lower-Bozsuv HPP-23 hydropower facilities.

Keywords: diversion channel, probability-statistical model, hydropower tract, concrete canvas cover, hydropower facilities.

Introduction

According to theoretical and field researches, due to existing scientific and technical problems in the Chirchik-Bozsuv diversion channel hydropower tract, an average of 1.2-1.3 km^3/year of water resources (within the limits of the Republic of Uzbekistan) is discharged into the Republic of Kazakhstan via the Syrdarya River. At the same time, due to the obsolescence of technological equipment at the Lower Bozsuv HPPs №4 and №6, which were built and commissioned in the 1950s, water resources flowed into the Syrdarya River through the channel without being used for electricity generation [1,2].

Probability-statistical model of reliable and efficient operation of the project channel route to Mirzachul area, to prevent loses from discharging 1.2-1.3 km^3/year of water resources to the Republic of Kazakhstan via the Syrdarya River due to technological losses from the derivation channel.

The reliability of the design channel is determined by the parameters that characterize its hydraulic efficiency, technical condition and accident-free operation. We will consider the determination of the value of the coefficient of possible reduction of the normative parameters of the project channel with ground and concrete cover.

The main parameters of the project channel are the roughness coefficient n, the efficiency of the channel ϵ, the technical condition of the channel $\overline{\sigma}$. The coefficient of water permeability of the channel is $\ni^1$, the following $\ni^1 = \frac{Q_{proj}}{Q_{prob}} \approx \frac{n_{proj}}{n_{prob}}$, where: : Q_{prob} – probable water consumption in the channel, Q_{proj}.– projected (calculated) water consumption, n_{proj} – design roughness coefficient, n_{prob}– probable value of roughness coefficient (Table 1).

Table 1. Probability values of water permeability and efficiency of the project channel

№	Channel part	Water consumption, m^3/s		Coefficient of roughness		$\exists^1 \approx \frac{n_{proj}}{n_{prob}}$	ϵ_{proj}	ϵ_{prob}	$\bar{\sigma} = \frac{\epsilon_{prob}}{\epsilon_{proj}}$
		Q_{prob}	Q_{proj}	n_{prob}	n_{proj}				
1.	Grounded cover	25	25,2	0,024	0,023	95,8	0,71	0,65	0,92
2.	Concrete canvas cover	25	25,2	0,0119	0,012	99,2	0,85	0,80	0,94

Materials and Methods. Probability-statistical model of reliability of the design channel consists of the sum of reliability probabilities of channel sections: double-walled and concrete-canvas parts. In addition, the operational reliability of the channel will depend on the number of water intakes and other hydraulic structures in the project channel and their technical characteristics. Therefore, the probability of accident-free operation of the projected channel is equal to the product of the probabilities of the channel sections and their hydraulic structures [3].

$$P(t) = \left[P_{gr.cover}(t) \cdot P_{con-canvas}(t)\right] \cdot HTS_1(t) \cdot \ldots \cdot HTS_n(t) = \left[P_{gr.cover}(t) \cdot P_{con-canvas}(t)\right] \cdot \prod_{i=1}^{n} HTS_i(t) \quad (1)$$

Here: $P_{gr.cover}(t)$– probability of accident-free operation of the grounded cover part of the channel; $P_{con-canvas}(t)$– probability of accident-free operation of the concrete-canvas covered part of the channel; $HTS_i(t)$ – probability of accident-free operation of hydrotechnical structures in the channel.

Results and Discussions. The probability of providing the design (calculated) water capacity during operation is expressed by the following formula:

$$P_1 = F\left[\frac{(1-\alpha_0)Q_{proj} - Q_{prob}}{\sqrt{\sigma^2_{Q_{proj}} + \sigma^2_{Q_{prob}}}}\right] \quad (2)$$

Here: $F(t)$ – normal distribution function (Laplace function) $F(x) = \frac{\exp\left(-\frac{x^2}{2}\right)}{\sqrt{2 \cdot \bar{\sigma}}}$; α_0– the coefficient of possible decrease in the water permeability of the channel, $\sigma_{Q_{лой.}}$, $\sigma_{Q_{эк}}$– corresponding to the mean square error of water consumption.

Table 2. Probability of providing design (calculated) water capacity during operation (grounded cover part of the channel)

$\sigma^2_{Q_{proj}}$	$\sigma^2_{Q_{prob}}$	α_0	Q_{proj}	Q_{prob}	F	P_1
0,2	0,37	0,03	25,2	25	-0,75	0,56

Table 3. Probability of providing design (calculated) water capacity during operation (concrete-canvas covered part of the channel)

$\sigma^2_{Q_{prob}}$	σ^2_{prob}	α_0	Q_{proj}	Q_{prob}	F	P_1
0,45	0,50	0,03	25,2	25	-0,573	0,62

According to the normative documents, the efficiency of the projected channel should not be less than 0.93.

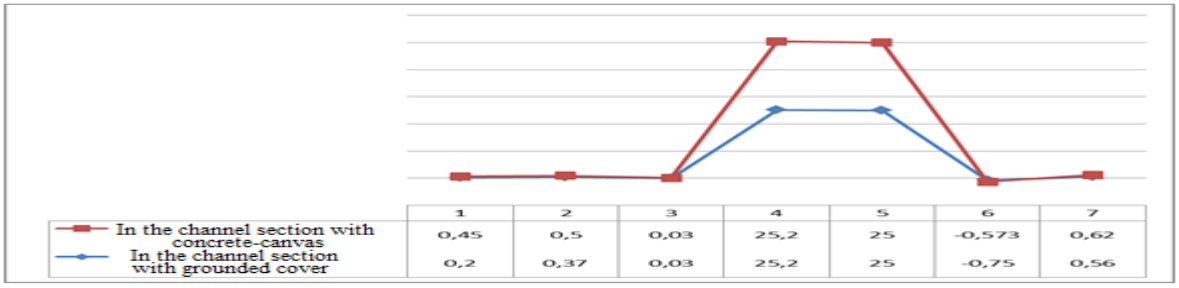


Figure 1. Probability of providing design (calculated) water capacity during operation

The probability of providing the required efficiency during operation is expressed by the following formula:

$$P_2 = F\left[\frac{(1-\beta_0)\cdot\epsilon_{proj}-\epsilon_{prob}}{\sqrt{\sigma^2_{\epsilon_{proj}}+\sigma^2_{\epsilon_{prob}}}}\right] \quad (3)$$

Here: β_0– Efficiency's allowable load reduction coefficient, $\sigma_{\epsilon_{proj}}$, $\sigma_{\epsilon_{prob}}$– the mean quadratic error of the useful work coefficient accordingly.

Table 4. Probability of providing design (calculated) water capacity during operation (grounded cover part of the channel)

σεproj2	σεprob2	β0	εproj	εprob	F	P2
1,2	1,4	0,015	0,71	0,65	0,03	0,71

Table 5. Probability of providing design (calculated) water capacity during operation (concrete-canvas covered part of the channel)

$\sigma^2_{\epsilon_{proj}}$	σ^2_{prob}	β_0	ϵ_{proj}	ϵ_{prob}	F	P_2
0,81	0,55	0,035	0,85	0,80	0,017	0,73

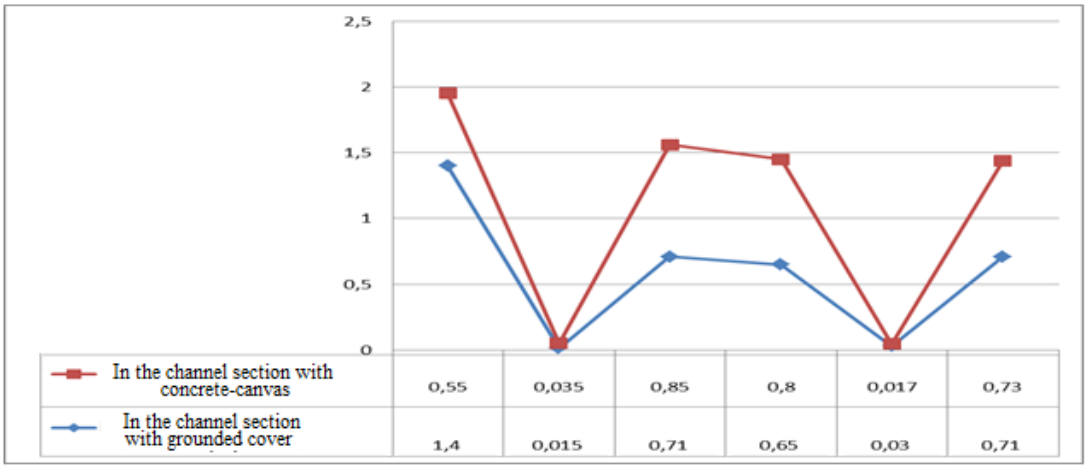


Figure 2. Probability of providing the required efficiency ratio during operation

Verification of probability-statistical models of reliability of the project channel will be carried out in the part of the derivation channel between Lower-Bozsuv HPP-22 and Lower-Bozsuv HPP-23 hydropower facilities.

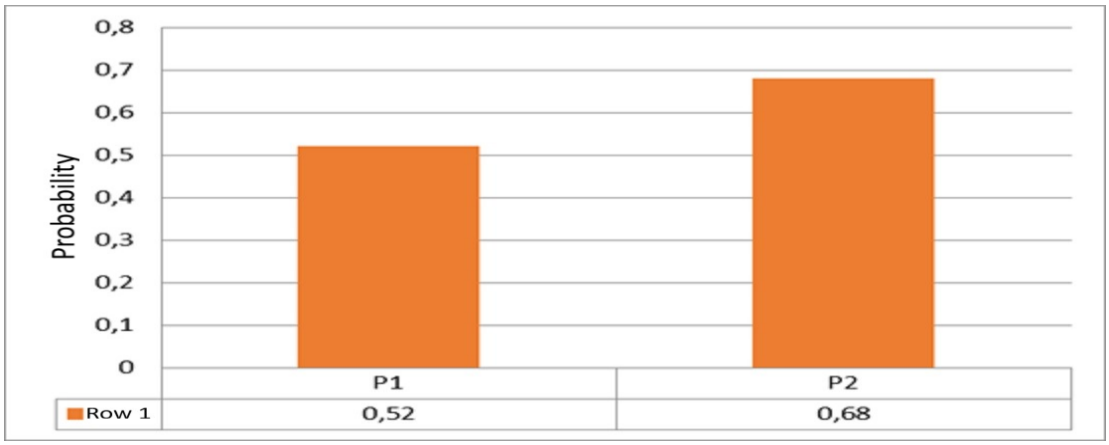
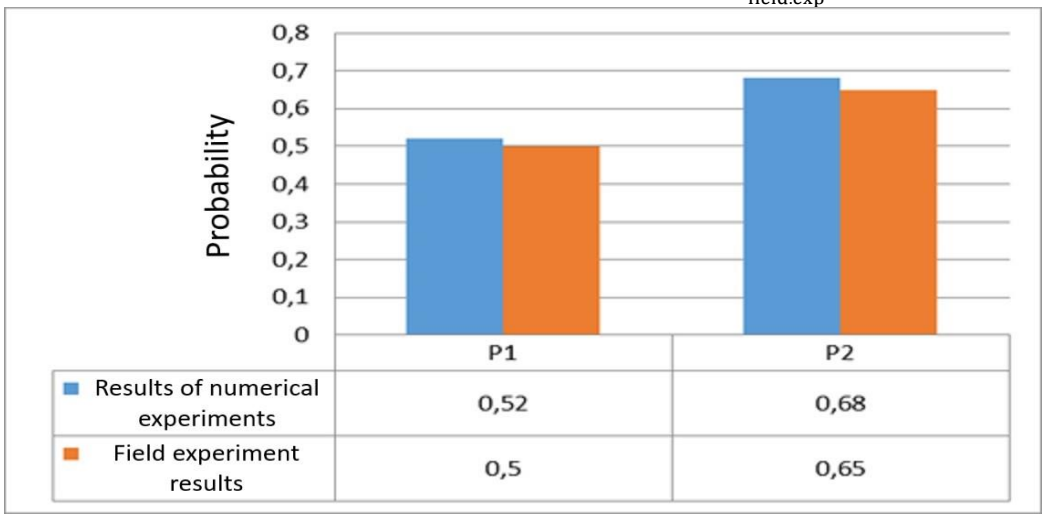


Figure 3. Probabilities of water permeability (P1) and efficiency of the derivation channel between Lower-Bozsuv HPP-22 and Lower-Bozsuv HPP-23 hydropower facilities (P2)

After performing a numerical experiment using formulas (2) and (3) using the data in Table 1. The results of the numerical experiment are shown in figure 4.

We calculate the comparison error with the formula: $\Delta = \frac{|\Delta_{num.exp} - \Delta_{field.exp}|}{\Delta_{field.exp}} 100\%$



Conclusion:

A comparison of the numerical and experimental results shows that the formula for the probability of providing the design (calculated) water capacity during operation (2) and the formula for the probability of providing the required efficiency during operation (3) are adequate.

REFERENCES:

1. I.E.Mahmudov, N.Muradov, G.Bekmamadova Evaluation of the Management and Use of water resources in the Middle Reaches of the Syrdarya Basin (Chirchik-Akhangaran-Keles irrigation District)//Advanced Engineering Forum;
2. Mahmudov I.E., Chen Xi, Jilili Abuduwaili, Khamraev Sh.R., Mahmudov E.J., Kuziyev R.K., Sadiev U.A., Murodov N.K., Ernazarov A.I., Dolidudko A.I. «Research of agro-ameliorative parameters of the territory of the basin of the river Amudarya in the conditions of climate change in Central Asia», Monograph. Tashkent. 320 p, 2019. (in Russian)
3. I.E.Mahmudov, N Muradov “Evalution of the management and Use of Water Resources in the Middle Reaches of the Syrdarya Basin”//Trans Tech Publications, Switzerland, 75-80, 2016;
4. И.Махмудов, Э.Казаков “Hydraulic Modeling of Transient Water Movement in the Downstream of the Uchkurgan Hydroelectric Station” International Journal of Advanced Research in Science, Engineering and Technology Vol. 7, Issue 6, June 2020, 14137-14140 P.
5. И.Махмудов, Э.Казаков “Гидравлическая модель регулирования колебаний уровня воды в Большом Наманганском канале” Россия журнал «Гидротехника» №3(60), 52-54ст. 2020г.
6. И.Махмудов, Э.Казаков Natural Studies of Velocity Field of the Water Flow for the Big Namangan Channel/ International Journal of Advanced Research in Science, Engineering and Technology Vol. 7, Issue 8 , August 2020.09.24.
7. Sadiev U. A. oth. Modeling of water resource managementprocesses in river basins (on the example ofthe basin of the Kashkadarya river) //International Journal of Advanced Research in Science, EngineeringandTechnology. – 2018. – Т. 5. – С. 5481-5487.
8. Махмудов И.Э., Махмудова Д.Э., Курбонов А.И. Гидравлическая модель конвективного влаго-солепереноса в грунтах при орошении сельхозкультур //Проблемы механики. – 2012. – №. 1. – С. 33-36.
9. Ernazarovna M. D., Sattorovich B. E. Assessment of Water Quality Of Small Rivers Of The Syrdarya Basins For The Safe Water Use //PalArch's Journal of Archaeology of Egypt/Egyptology. – 2020. – Т. 17. – №. 7. – С. 9901-9910.
10. Махмудова Д. Э., Машрапов Б. О. Современное состояние функционирования систем канализации в узбекистане environmental protection against pollution by domestic drain in uzbekistan //ISSN1694-5298 Подписной индекс 77341 Журнал зарегистрирован в Российском индексе научного цитирования с 2014 года Подписан 16.12. 2019. – 2019. – С. 668.
11. Khaydar D. et al. Investigation of crop evapotranspiration and irrigation water

requirement in the lower Amu Darya River Basin, Central Asia //Journal of Arid Land. – 2021. – Т. 13. – №. 1. – С. 23-39.
12. Karshiev R. Z. et al. DETERMINATION OF THE OPTIMAL HYDROMODULE OF IRRIGATION NETWORK FOR DRIP IRRIGATION //Irrigation and Melioration. – 2021. – Т. 2021. – №. 1. – С. 24-28.
13. Karshiev R. et al. Hydraulic calculation of reliability and safety parameters of the irrigation network and its hydraulic facilities //E3S Web of Conferences. – EDP Sciences, 2021. – Т. 264.
14. Махмудов И. Э., Мамутов Р. А., Мусаев Ш. М. ГИДРАВЛИЧЕСКАЯ МОДЕЛЬ УПРАВЛЕНИЯ ДИНАМИКОЙ ПАРАМЕТРОВ ИНФИЛЬТРАЦИОННОГО ПОТОКА В ЗОНЕ УВЛАЖНЕНИЯ ПРИ БОРОЗДОВОМ ПОЛИВЕ СЕЛЬСКОХОЗЯЙСТВЕННЫХ КУЛЬТУР //Главный редактор: Ахметов Сайранбек Махсутович, д-р техн. наук; Заместитель главного редактора: Ахмеднабиев Расул Магомедович, канд. техн. наук; Члены редакционной коллегии. – 2021. – С. 42.
15. Махмудов И. Э., Палуанов Д. Т., Эрназаров А. Т. СВОБОДНОЕ РАСТЕКАНИЕ ПОТОКА ВОДЫ ПРИ ОТСУТСТВИИ ПОВЕРХНОСТНОГО СБРОСА //Материаловедение. – 2013. – №. 1. – С. 82-85.
16. Ergash Kazakov, Uktam Jovliev, Gulomzhon Yakubov. Extension of tubular water discharge limitations with water flow extinguishers. INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 8, ISSUE 12, DECEMBER 2019 ISSN 2277-8616. https://www.ijstr.org/final-print/dec2019/Extension-Of-Tubular-Water-Discharge-Limitations-With-Water-Flow-Extinguishers.pdf
17. Jasurbek Narziev, Bhaskar Nikam, Furqat Gapparov. Infrastructure mapping and performance assessment of irrigation system using GIS and remote sensing. International Scientific Conference “Construction Mechanics, Hydraulics and Water Resources Engineering” (CONMECHYDRO - 2021). Hydraulics of Structures, Hydraulic Engineering and Land Reclamation Construction. E3S Web of Conferences 264, 03005 (2021) https://doi.org/10.1051/e3sconf/202126403005.
18. Narziev J.J., Maxmudov I.E., Paluanov D.T., Ernazarov A.I. Assessment of Probability Reliability of Hydro technical Structures during Operation Period. International Journal of Innovative Analyses and Emerging Technology e-ISSN: 2792-4025. Volume: 2 Issue: 1. http://openaccessjournals.eu/index.php/ijiaet/article/view/949.