Global Journal of Researches in Engineering: J General Engineering
Volume 25 Issue 1 Version 1.0 Year 2025
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Methods for Calculating Changes in Long-Term Water Consumption and Forecasting the Hydrological Regime of the Canal Narpay

By Sayidov Malik Temirovich, M. B. Avezova, A. A. Ismatova, G. N. Khidirbayeva & Z. B. Dovlatov

Abstract- In 2010-2021, a change in the volume of water in the Narpay Canal and the formation of water at the source are predicted.

Introduction: The efficient use of water resources is becoming a priority for the countries of Central Asia as well. At the same time, important economic results can be achieved by determining the formation of water resources in rivers and canals and their optimal management. These tasks are carried out on the basis of operating procedures, modern forecasting programs and mathematical and statistical analysis [1, 5].

GJRE-J Classification: *LCC: TC409*

Strictly as per the compliance and regulations of:

Methods for Calculating Changes in Long-Term Water Consumption and Forecasting the Hydrological Regime of the Canal Narpay

Sayidov Malik Temirovich [α], M. B. Avezova [σ], A. A. Ismatova [ρ], G. N. Khidirbayeva [ω] & Z. B. Dovlatov [¥]

Abstract- **In 2010-2021, a change in the volume of water in the Narpay Canal and the formation of water at the source are predicted.**

I. Introduction

The efficient use of water resources is becoming a priority for the countries of Central Asia as well. At the same time, important economic results can be achieved by determining the formation of water resources in rivers and canals and their optimal management. These tasks are carried out on the basis of operating procedures, modern forecasting programs and mathematical and statistical analysis [1, 5].

The Narpay Canal is located in the Samarkand region of the Republic of Uzbekistan, with a total length of 130 km and an irrigated area of 42 thousand hectares. The water sources of the Narpay Canal are the Zarafshan and Karadarya rivers, and sometimes additional water is supplied from the Kattakurgan reservoir. This, in turn, creates great opportunities for the supply of sufficient and reliable water to the sown areas. The Kattakurgan Reservoir is also filled with water through the Zarafshan River. In this article, the analysis and forecasts of the volume of water taken from the water source to the main structure of the Narpay Canal were calculated based on the current state [2].

II. Materials and Methods

To determine the hydrological regime of the flow in the Narpay Canal, a systematic analysis of 12-year water discharge data from 2010 to 2021 was carried out, and a hydrograph was drawn. One of them is shown in Figure 1. Narpay for 2010-2021 Assessment of flow changes in canals is carried out by determining and assessing the average monthly values of long-term water flow from the water source.

According to Table 1, calculations show that from 2010 to 2021, the Narpay Canal received an average annual flow volume of 31 m^3/s at a flow rate of 44.7 m^3/s. In 2015 and 2018, compared to other years, the water consumption was lower and amounted to 31 cubic meters per second. At the beginning of the Narpay Canal, in June 2016, a maximum discharge of 150 m^3/s was observed, and again in June 2012, a maximum discharge of 144 m^3/s. These indicators explain that it was during these months that mudflows were observed or large volumes of water resources were released from the source into the canal. Determination of studies by average water discharge values increases the accuracy of the hydrological regime and allows for obtaining the correct result. Due to the additional supply of water from the Katta-Kurgan Reservoir to the Narpay Canal, the volume of water in the canal will be regulated and sufficient water will be supplied to consumers. The value of the long-term average maximum water discharge varies from 62 m^3/s to 42 m^3/s. The average long-term minimum water consumption varied from 15 m^3/s to 24 m^3/s. [6].

Author α: Senior Researcher, PhD, RIIWP, Uzbekistan. Head of the "Laboratory of Hydraulics of Rivers, Canals and Structures" of the Scientific Research Institute of Irrigation and Water Problems.
e-mail: sayidov.malik@mail.ru

Table 1: Average values and average annual value of average, maximum, and minimum water discharge from the Narpay Canal in 2010-2021. [3]

Year		Months												Average
		1	2	3	4	5	6	7	8	9	10	11	12	
2021	Average	2,5	20,8	19,9	37,8	30,5	74,6	92,1	54,6	43,3	44,8	31,1	4,4	38,0
	Max.	8	27,5	34,5	46,7	39	99,5	105,5	75,5	56,5	56,5	42	19,5	50,9
	Min.	2	8	7	17	5	37,3	68,9	42,3	39	40	22	0	24,0
2020	Average	1,9	6,9	42	28	37,7	73,6	74	77,5	38	24,3	33,3	8,7	37,2
	Max.	15	16,2	61	61	77	79	84	88,1	60,5	36	54	21	54,4
	Min.	0	0	10,4	0	0	66	43	60,5	22,5	19,5	2	2	18,8
2019	Average	1,2	4,6	27,2	38,9	36,7	50,4	88,4	66	32,7	34,9	26,6	4,7	34,4
	Max.	7	8	50	133	66	66	113,2	87	42	35	35	9	54,3
	Min.	0	0	0	0	9	38	45,1	33,2	18,1	33,2	9	0	15,5
2018	Average	5,7	0	23,9	40,6	43,5	41,1	56,6	69,2	41,5	33,7	22,5	2,2	31,7
	Max.	10	0	48	45	55	47,5	64	78	58	42	37	10	41,2
	Min.	0	0	0	35	37,5	30,5	28,3	58,9	10	10	4	0	17,9
2017	Average	0,1	2,7	27,7	50,2	72,3	67,9	72,6	66,9	38,4	34,8	31,9	5,3	39,2
	Max.	0,5	36,7	39,7	72	84,3	83,2	95,3	87,3	53,8	40	35	17	53,7
	Min.	0	0	6	14	2,3	62,8	62,3	47,8	25,9	28	20	0	22,4
2016	Average	11,4	7,8	35,4	25,7	45	74,5	83,1	62,6	34,8	37,5	25,7	9,7	37,8
	Max.	20,2	31,9	45	38,5	73,4	150,5	109,5	78,5	41	41,5	38,5	15	57,0
	Min.	0	0	16,8	16	30,5	45	68,5	41,5	34	33,5	0	0	23,8
2015	Average	0,4	0,1	19,4	35,3	34,8	55,7	72,6	53,8	41,1	34,5	17,9	7,3	31,1
	Max.	2	3	45	45	52	65,5	92	68	47	40	25	18,7	41,9
	Min.	0	0	0	20	26,6	35	54,6	39,8	34,8	23,5	0	0	19,5
2014	Average	0,1	1	31,9	32,3	40,1	72,8	71,1	47,7	43,1	45,8	21,8	3,3	34,3
	Max.	2	3,5	44,5	50	67	88	83	64,3	58,6	53,1	39,2	13	47,2
	Min.	0	0	2	25,1	30	57,1	51,6	25,2	33,4	38,6	10	0	22,8
2013	Average	0,5	0,6	26,6	37,3	51,7	76,8	80,3	73,2	46	37,8	27,7	2,7	38,4
	Max.	3,8	4	42,4	42,5	75,2	92,3	100,5	91,5	61,9	44	34	10,5	50,2
	Min.	0	0	4	31,5	32,9	66,2	63,5	55	20	29	12,5	0	26,2
2012	Average	0,8	0,8	14,9	58,5	57,4	83,9	103,1	87,5	35,4	36,2	27,1	5	42,6
	Max.	4	5,1	40,5	71,1	64,6	93,9	144,5	107	42	38	38	14,3	55,3
	Min.	0	0	0	6,5	32,8	62,6	73,1	33,5	29,5	30,5	14,3	0	23,6
2011	Average	0	0	30,8	52,5	61,6	67,4	67,9	54,1	28,4	39	16,9	1,9	35,0
	Max.	0	0	68,8	70,1	77,8	90,3	82,2	79,5	37,5	45	39,3	5,8	49,7
	Min.	0	0	0	29,8	46,8	49,8	57,2	39,8	11,4	29,6	5,8	0	22,5
2010	Average	5	3,7	20,6	63,8	71,2	85	79,4	77,8	44	34,8	37,3	13,7	44,7
	Max.	15,5	13,5	67	89	89	104,5	91,4	101,5	63,5	39,5	44,5	32	62,6
	Min.	0	0	0	41	29	61,8	71,5	51	31,5	17,7	32	2	28,1

Table 2: Calculations of the volume of water flowing and withdrawn from the Narpay Canal in 2010-2021 (billion cubic meters)

Year	Q Meters. Cubic/S	1 Year	1 Day	Min.	Sek.	Annual Water Volume (Billion.Meters.Cubic).
2021	38	365	24	60	60	1,20
2020	37,2	365	24	60	60	1,17
2019	34,4	365	24	60	60	1,08
2018	31,7	365	24	60	60	1,00
2017	39,2	365	24	60	60	1,24
2016	37,8	365	24	60	60	1,19
2015	31,1	365	24	60	60	0,98
2014	34,3	365	24	60	60	1,08
2013	38,4	365	24	60	60	1,21
2012	42,6	365	24	60	60	1,34
2011	35	365	24	60	60	1,10
2010	44,7	365	24	60	60	1,41

1- The table calculates the volume of water taken into the Narpay Canal in 2010-2021. During these years, a maximum of 1.41 billion cubic meters of water flowed into the canal from a minimum of 0.98 billion cubic meters. The results show that there are no sharp changes in the volume of water flow in the annual calculation. In low-water years, a current water deficit of up to 15% or 150 million cubic meters can be observed. The table shows that the recurrence of low-water years occurs once every 3 or 4 years. Water resources in the Narpay, Kattakurgan, and Pakhtachi districts of the Samarkand region are supplied through this canal in an average of 1.1 billion cubic meters per year.

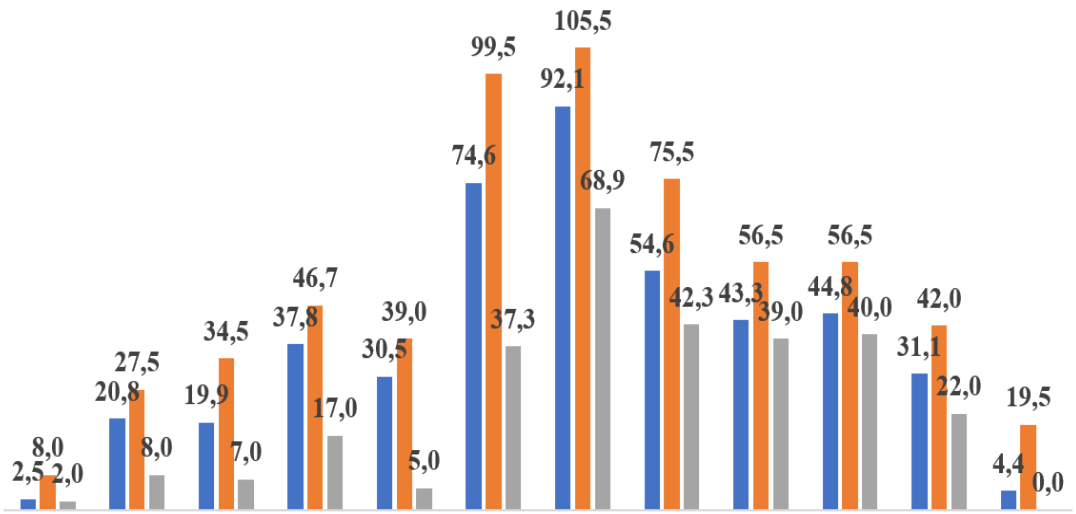

Figure 1: Average, maximum, and minimum water discharge from the Narpay Canal in 2021. months, m.cubic/s

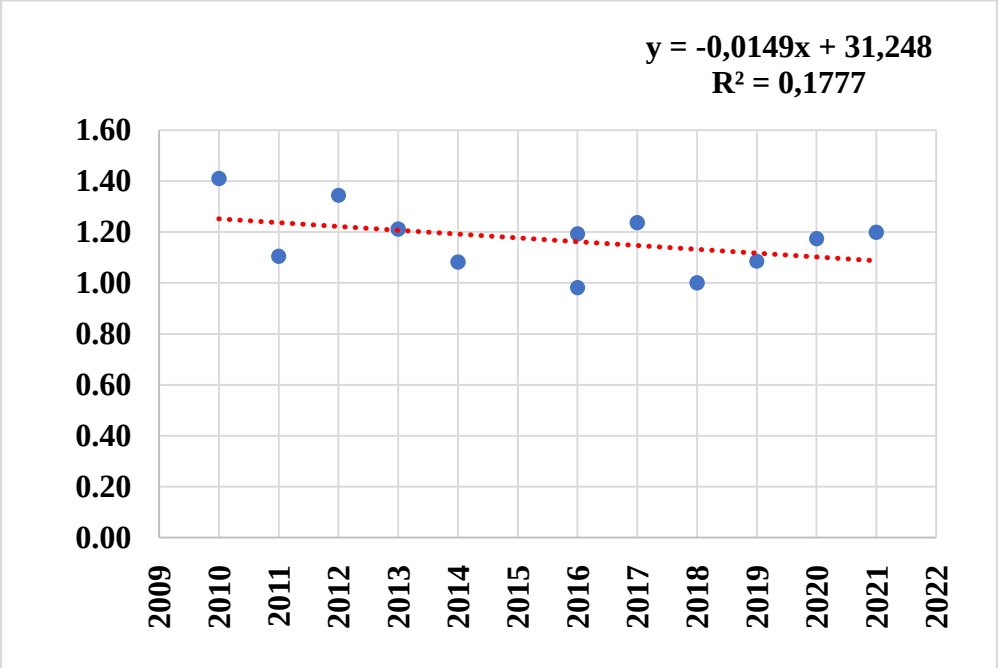

Figure 2: Years on the X axis, annual water volume on the Y axis, (billion cubic meters). Graph of the change in water volume over the years based on the results of Table 2

III. Results

Based on the results of the calculated water volume of the Narpay Canal for 2010-2021 in Table 2, a graph of Figure 2 is drawn. This graph, representing the change in water volume over the years, has a linear functional relationship and obeys the following equation [4, 7].

$$y = -0{,}0149x + 31{,}248 \quad R\hat{}2 = 0{,}177 \qquad (1)$$

where, the U axis represents water volume, and the X axis represents years.

Based on this equation 1, it is possible to determine the forecast of the volume of water formed and drawn into the Narpay Canal in the future. Currently, several programs for forecasting the formation of water resources are also used in practice. However, there are also statistical and mathematical methods for forecasting the formation of water resources. Using this method, we forecast the flow volume for any subsequent years. For example, for 2025, it is determined as follows.

$$y = -0{,}0149 * 2025 + 31{,}248 = 1{,}07\ млрд.м.куб$$

Table 3: Forecasts of the volume of water formed at the source of the Narpay Canal for 2025-2054, billion cubic meters, in years

Years	*Forecast, Water Volume, W,*	*Years*	*Forecast, Water Volume, W*	*Years*	*Forecast, Water Volume, W*
2025	1,0755	*2035*	0,9265	*2045*	0,7775
2026	1,0606	*2036*	0,9116	*2046*	0,7626
2027	1,0457	*2037*	0,8967	*2047*	0,7477
2028	1,0308	*2038*	0,8818	*2048*	0,7328
2029	1,0159	*2039*	0,8669	*2049*	0,7179
2030	1,001	*2040*	0,852	*2050*	0,703
2031	0,9861	*2041*	0,8371	*2051*	0,6881
2032	0,9712	*2042*	0,8222	*2052*	0,6732
2033	0,9563	*2043*	0,8073	*2053*	0,6583
2034	0,9414	*2044*	0,7924	*2054*	0,6434

IV. Conclusion

According to Figure 2 and Table 3, according to the red lines, the change in the annual water volume is decreasing. Table 3 presents forecasts for the period up to 2054. This table also shows a decrease in water volume in the future. By 2054, the annual flow volume will be 0.64 billion cubic meters. After 30 years, in 2054 there will be a decrease in water volume by 0.43 billion cubic meters or at least 40% compared to 2025. For the years after 2030, a maximum annual water volume of up to 1 billion cubic meters will be formed at this facility and will not exceed it.

These analyses were calculated using statistical and mathematical methods. In this case, if the laws of nature continue in this direction, these forecasts are considered valid in cases where there is no clear influence from the human factor or other factors.

At the minimum and average water flow of the canal, a decrease in water pressure in the middle and lower parts of the canal and an increase in the time of water delivery are observed, in these conditions, it is advisable to constantly introduce the procedure for alternating water intake from internal irrigation networks and sources.

In accordance with the procedures for the operation of canals, it is advisable to steadily regulate the level in the canal through water-retaining, outlet, and intake networks.

During the period of temporary suspension of water flow in the Narpay Canal in the autumn and winter, during the non-vegetation period, it is necessary to carry out measures to clean and strengthen the banks and channel. During this period, there is no need to supply water to water consumers. In this case, the canals are prepared for the growing season.

Using this mathematical method, it is possible to predict the formation of water resources in water sources.

Acknowledgement

This research is carried out based on the applied sciences grant of the Ministry of Water resource of the Republic of Uzbekistan No. 10/2024. Authors would like to thank to the Ministry for the financial support of the project.

References Références Referencias

1. Decree of the President of the Republic of Uzbekistan dated 11.09.2023 Decree of the President of the Republic of Uzbekistan No. DP-158 “On the Strategy “Uzbekistan - 2030.”
2. Decree of the President of the Republic of Uzbekistan dated 10.07.2020 No. DP-6024 “On Approving the Concept for the Development of Water Management of the Republic of Uzbekistan for 2020-2030.”
3. Sayidov, M. T., RIIWP, 10/2024 on the topic “Development of recommendations for reducing water losses through the efficient operation of large main canals and optimal management of water consumption”.
4. Sayidov, M. T., Dovlatov, Z. B., Khidirbayeva, G. N., Shodmonov, S. A. “Methods for Calculating Channel Processes Based on Correlation Analysis at the Tuyamuyun Hydropost of the Amu Darya River”. Power Technology and Engineering, Scopus journal. January, 2024, Volume 57, Issue 5, p.733-737.
5. Ivanova V. M., Kalinina V. N., Neshumova L. A., and Reshetnikova I. O., Mathematical Statistics [in Russian], Moscow 1975.
6. Sayidov M. T., Avezova M. B., Ismatova A. A., Khidirbayeva G. N., “Study of technical condition of channels, increasing operational efficiency and reconstruction works”. Vol. 36 No. 1 (2025): World scientific research journal, WSRJ, Volume-36, Issue-1. p.67-71.
7. Sayidov, M. T., Dovlatov, Z. B., Khidirbayeva, G. N., Shodmonov, S. A. “Methods of conducting correlation analysis and calculation in determining runoff processes in rivers and canals”. Copyright certificate No. DGU 26630 of the Intellectual Property Agency of the Republic of Uzbekistan, 2023.