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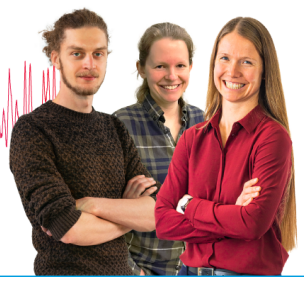
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Quantitative Assessment of Water Balance and its Components of Ahangaran Water Reservoir

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Abstract. The article aims to investigate the water balance of the Ahangaran reservoir, encompassing the analysis of evaporation from the reservoir's surface and filtration from its bottom to determine their respective quantities. One of the objectives of this study is to examine the relationship between water release from the reservoir, evaporation, transpiration loss from the reservoir's surface, and overall consumption.

Keywords: Reservoir, water balance, evaporation, filtration, water level, stream volume, water level, air temperature, atmospheric precipitation.

INTRODUCTION

It's known that the volume of water in reservoirs isn't constant. Its size fluctuates due to natural and human-induced factors that influence the inflow and outflow from reservoirs. The components of saturation and consumption within reservoirs constitute the water balance of these systems.

The elements that make up the water balance can be divided into two groups:

1) a group of saturating elements. This group includes:
– precipitation falling on the surface of the reservoir – X;
– water from rivers to reservoirs – U_i;
– underground water connected to the reservoir – U_{land};
– condensation of water vapor from the surface of the tank – K;
2) a group of consumable items. This group includes:
– evaporation from the surface of the water in the tank – Z;
– runoff from the reservoir – U_o;
– water flowing down to the bottom of the tank bowl – U_f;
– for the use of the reservoir for national agricultural purposes, drainage waters – q.

Taking into account the above, the equation of the water balance of reservoirs for a certain time (month, year, long-term) can be written as follows:

$$\mathrm{X} + U_i + U_{land} + K = Z + U_o + U_f + q \pm \Delta W \quad (1)$$

here: $\pm \Delta W$ – it represents the change in the volume of water in the reservoir over the studied period (month, year, multi-year period). All expressions in the equation are expressed in units of volume (m^3, km^3). The water balance of the Ahangaran reservoir depends on the quantitative changes of all the organizers listed above. However, not all of them are equally important for the water balance of the reservoir.

In particular, the saturation of water formed as a result of condensation of water vapor (K) on the surface of the reservoir, the elements of which make up the input part of the water balance, is relatively small in comparison with the volume of water that accumulates in the Ahangaran reservoir. Therefore, there is no need to take into account its values in practical calculations. The Ahangaran reservoir may also have a condition similar to the above in the elements of the output part of the water balance.

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MATERIALS AND METHODS

The organizers of the water balance of the Ahangaran reservoir divided it into 2 main entrances and exits and expressed the water balance of the Ahangaran reservoir in the form of the following equation:

$$\sum I = \sum O + (\pm W) \pm \Delta W \quad (2)$$

here: $\sum I$ is the sum of the total amount of water or tributaries poured into the Akhangaran reservoir during the reporting period is; O is the total amount of water consumed from the Dongaron reservoir during the reporting period, or the sum of the components consumed; W is change in the volume of the Akhangaran reservoir during the reporting period; ΔW is the amount of residual water.

The reservoir water balance equation can be written as input and output components as follows:

$$\sum I = U_R + U_{side} + X \quad (3)$$

$$\sum O = U_o + Z + F \quad (4)$$

here: U_R is the water consumption from the Ahangaran River is estimated at.; U_{side} is the consumption of water that enters the Ahangaran reservoir from the side; X is the Atmospheric precipitation falling on the water surface of the Ahangaran reservoir; U_o is the amount of water discharged from the reservoir drain device is; Z is the amount of water spent on evaporation from the surface of the Ahangaran reservoir; F is the amount of water lost from the base of the Ahangaran reservoir during filtration.

Atmospheric precipitation. When calculating the water balance of the Ahangaran reservoir, data on the average long-term precipitation of the Angren meteorological observation point are used.

Evaporation. The amount of water used for evaporation in reservoirs depends on the evaporation area (water surface area) and climatic conditions (primarily evaporation conditions). Therefore, the method of reducing the amount of water lost during evaporation is based on the maximum possible reduction in the surface area of the tank.

To reduce the amount of water lost during evaporation from the surface of the tank, the surface area of the tank is reduced by surrounding it with risers. However, in small reservoirs around it, trees are planted that weaken the wind speed and, thus, reduce evaporation from the water surface.

The monthly evaporation layer (E_0, mm) from the surface of a reservoir located in flat and mountainous areas is determined according to the data of the ggi-3000 evaporator as follows:

$$E_0 = 0.14 \cdot T\,(e_0 - e_{200}) \cdot (1 + 0.72 \cdot U_{200}) \quad (5)$$

For reservoirs in mountainous areas:

$$E_0 = 0.19 \cdot T\,(e_0 - e_{200}) \cdot (1 + 0.51 \cdot U_{200}) \quad (6)$$

here: T is the number of days in a month; e_0 is elasticity of saturated water vapor; e_{200} is absolute humidity; U_{200} is wind speed at a height of 200 cm above water level, m/s.

We determined the amount of water lost during evaporation from the surface of the reservoir by the following expression:

$$Z = \frac{E \cdot F}{1000}; \text{mln. m}^3 \quad (7)$$

here: F is the surface area of the tank is., km^2; E is the monthly evaporation thickness, mm; transition coefficient from 1000 mm to M.

Evaporation water losses are calculated for the surface area (F) of the tank for each month.

Filtering. The bottom of the tank consists of various soils, which mainly consist of two:

a) are divided into water-permeable and b) water-repellent soils. Self-compacting soils include rocks and dense clay soils with heavy mechanical composition. These soils are practically accepted only as waterproof soils. The filtering current acts through the pores of the ground soils, moving from the base of the structure to its other parts. However, in the case of silted reservoirs, the flow has a reflective effect on the speed and direction of movement.

Such an impact between the filtration flow and the reservoir is the main task of accounting for filtration to determine the forces and, in accordance with them, determine the shape and dimensions of the structure.

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There are two types of filter flow: under pressure and without pressure. A filter flow that does not have a free level is called a pressure movement, and a filter flow that has a free level is called a pressure-free movement.

The formula for calculating losses of filtered water:

$$V = \frac{\tau \cdot w}{100} \quad (8)$$

here: w is the tank capacity is., mln. m^3; τ is the average monthly losses from the reservoir, %.

RESULTS AND DISCUSSION

The volume of water in the tank is not always the same. Although it decreases in various ways (evaporation from the surface of water in reservoirs, suction into the bottom of the reservoir bowl), this decrease is compensated by water added to the reservoir, that is, by water coming from rivers and streams, as well as by precipitation. The main saturating element of the water balance of the Ahangaran reservoir, which we are studying, is the Ahangaran River. When the reservoir is saturated, there is also a proportion of precipitation and small shades. Depending on the dynamics of the flow flowing through these channels, the amount of water collected in reservoirs varies in different years. The flow of water discharged from the tank, absorption from the tank bowl, and evaporation from the water surface form the main consumable components of the tank.

In this work, we studied the water balance of the Ahangaran Reservoir in the period from 2010 to 2022. Initially, the data of the main feeder and consumables were summed up separately, and the elements of the input and output parts were calculated in units of volume by year and month to compile the water balance of the reservoir. The following are the primary data obtained by the organizers of the water balance of the Ahangaran reservoir for the specified years and the sequence of their use in the water balance equation.

TABLE 1. Elements of input part of water balance of Ahangaran Reservoir - Total consumption of water poured into Ahangaran reservoir, m^3/sec

Year/ Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
2010	7.6	13.4	31.5	80.32	80.73	34.5	13.3	5.73	2.7	1.92	8.35	8.4	24.0
2011	6.2	6.4	65.2	74.4	90.43	58.1	18.6	5.86	4.1	2.53	3.33	5.2	28.4
2012	4.6	13.3	22.4	74.46	79.26	25.1	8.48	2.4	2.9	11.0	10.9	5.6	21.7
2013	4.7	9.3	36.6	107.3	81.9	37.1	15.2	5.54	2.2	1.85	2.1	3.8	25.7
2014	3.8	5.2	30.1	39.49	52.2	12.9	4.39	1.9	1.6	10.3	17.41	7.2	15.6
2015	8.2	10.7	38.2	62.83	110.6	73.9	26.5	11.42	7.3	4.33	4.53	5.8	30.4
2016	7.4	15.8	49.2	105.1	98.69	65.6	22.2	7.97	8.0	8.37	7.57	2.8	33.2
2017	2.1	5.7	16.1	48	32.15	10.2	3.3	1.75	1.2	2.4	15.6	8.6	12.3
2018	6.2	5.8	21.4	111.5	90.08	46.4	14.4	4.17	2.7	2.45	5.42	5.1	26.3
2019	6.5	9.5	26.5	55.79	73.41	31.8	7.9	2.49	1.9	2.23	3.17	6.8	19.0
2020	5.8	6.5	23.5	60.43	108.3	39.7	10.2	1.33	0.8	4.89	8.15	6.3	23.0
2021	7.1	15.6	22.6	69.17	81	28.7	10.7	2.16	2	8.55	15.7	8.4	22.7
2022	8.8	10.9	26.1	109.5	126.1	47.5	14.6	3.76	2.4	6.39	2.47	3.4	30.2

The monthly values of the water consumption of rivers and streams, which are the main input of the reservoir water balance equation, were obtained. This information was obtained from the Ahangaran Reservoir Administration.

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TABLE 2. Elements of input part of Ahangaran reservoir water balance - Atmospheric precipitation, mm

Year/ Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
2010	101.2	60.9	150.9	39.2	28.0	16.0	27.2	23.3	0.0	46.0	125.8	120.8	739
2011	89.7	175.1	107.7	39.9	25.1	11.4	0.0	14.0	1.3	7.8	54.7	86.5	613
2012	116.2	71.8	91.5	42.8	25.7	11.2	5.8	0.0	29.9	82.6	66.3	59.4	603
2013	33.8	87.6	163.6	98.2	79.9	10.2	3.1	1.8	0.0	0.4	23.5	84.2	586
2014	32.0	95.5	38.1	80.8	13.3	0.0	18.6	0.0	13.2	115.2	86.3	76.8	570
2015	61.4	101.6	137.5	109.7	44.1	15.1	83.0	3.9	23.8	2.1	38.7	81.0	702
2016	101.2	199.6	48.0	81.0	85.8	55.4	5.0	0.7	27.1	26.9	17.1	29.3	677
2017	33.6	149.1	60.3	19.3	35.2	11.8	0.0	1.8	6.9	48.7	185.1	92.0	644
2018	52.2	105.6	134.8	60.0	23.5	38.1	16.2	0.0	0.0	11.5	106.8	107.7	656
2019	86.0	57.4	86.4	115.6	106.0	0.0	0.6	6.4	5.1	15.1	31.0	78.4	588
2020	151.4	67.7	80.9	125.4	26.1	2.2	0.0	0.0	3.3	67.9	93.5	40.6	659
2021	96.9	126.9	90.4	45.8	79.9	69.1	1.0	21.4	6.0	83.3	106.2	77.7	805
2022	84.1	6.4	142.3	36.3	103.9	12.5	37.8	17.3	7.5	46.8	45.0	129.9	670

The monthly data observed at the Angren Meteorological Station were selected for the calculation of atmospheric precipitation, the constituent of the water balance of the reservoir.

TABLE 3. Elements of outlet part of water balance of Ahangaran Reservoir - Water consumption from Ahangaran reservoir, m^3/sec

Year/ Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
2010	4.0	4.0	15.0	67.8	66.0	52.2	26.6	28.0	11.0	8.4	7.6	7.7	24.9
2011	5.3	11.1	49.4	46.2	80.6	59.5	30.1	26.7	7.1	10.6	7.3	5.7	28.3
2012	5.0	7.6	6.7	44.7	73.8	28.6	29.1	20.7	7.1	6.3	5.7	5.0	20.0
2013	4.9	4.5	23.9	96.7	73.3	39.9	35.1	22.3	12.3	11.0	8.0	4.1	28.0
2014	4.0	4.0	5.0	10.0	40.3	21.6	27.4	19.8	8.1	13.2	7.0	11.2	14.3
2015	4.0	4.0	13.6	56.2	103.6	77.2	41.6	34.2	15.1	19.4	5.1	5.0	31.6
2016	5.0	4.3	14.6	96.4	95.0	62.1	38.4	29.5	13.8	12.0	10.1	4.6	32.2
2017	4.0	4.0	4.0	20.3	27.7	19.5	21.3	17.7	6.1	7.1	4.0	4.6	11.7
2018	4.5	6.0	23.0	88.3	83.9	46.0	27.0	21.1	12.6	11.4	5.2	4.0	27.7
2019	4.0	4.0	7.6	41.0	68.0	33.2	28.9	21.9	12.1	9.3	6.8	4.0	20.1
2020	4.0	4.0	8.7	29.8	102.3	40.4	28.5	22.8	10.6	8.8	4.1	4.0	22.3
2021	4.0	7.3	18.6	42.9	73.6	30.7	29.5	22.6	8.3	8.1	6.0	10.2	21.8
2022	4.0	4.0	13.9	85.8	119.7	44.8	30.7	28.8	8.7	9.1	8.2	4.0	30.1

The main output component of the reservoir water balance equation is the quantity of water released from the reservoir. This information was also acquired from the Ahangaran Reservoir Administration. When computing

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evaporation from the water reservoir's surface, a factor in the outflow component of the reservoir, we initially determined the monthly evaporation depth from the reservoir surface using expression (5) (Table 4). Subsequently, the volume of water lost due to monthly evaporation from the reservoir was calculated based on the monthly evaporation depth and the reservoir's surface area.

While determining the volume of water lost to evaporation, it was considered that the reservoir's surface varies with its level and volume. In other words, the changes in the reservoir's surface area on a monthly basis were computed using the curved relationship equation between the reservoir's volume and surface area (Fig. 1). The volumetric values were derived by multiplying these monthly changes in surface area by the corresponding values of monthly evaporation depth.

TABLE 4. Elements of outlet part of water balance of Ahangaran Reservoir - Monthly evapotranspiration calculated based on GGI-3000.

	T, months											
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
T, day	31	28	31	30	31	30	31	31	30	31	30	31
U_{200}, *m/s*	0.98	1.11	1.43	1.57	1.62	1.5	1.34	1.43	1.25	1.05	0.94	0.98
e_0	7.7	8	10.1	15.8	20.4	26.3	30	28.5	23.4	16.5	12.1	8.6
e_{200}	5.61	5.73	7.64	10.67	11.85	13.05	15.78	15.09	10.88	8.88	7.34	5.7
$e_0 - e_{200}$	2.09	2.27	2.46	5.13	8.55	13.3	14.2	13.4	12.5	7.62	4.76	2.9
E_0, *mm*	18.5	18.9	25	52.7	94.9	133.8	140.8	136.5	116.7	68.9	40.1	25.6

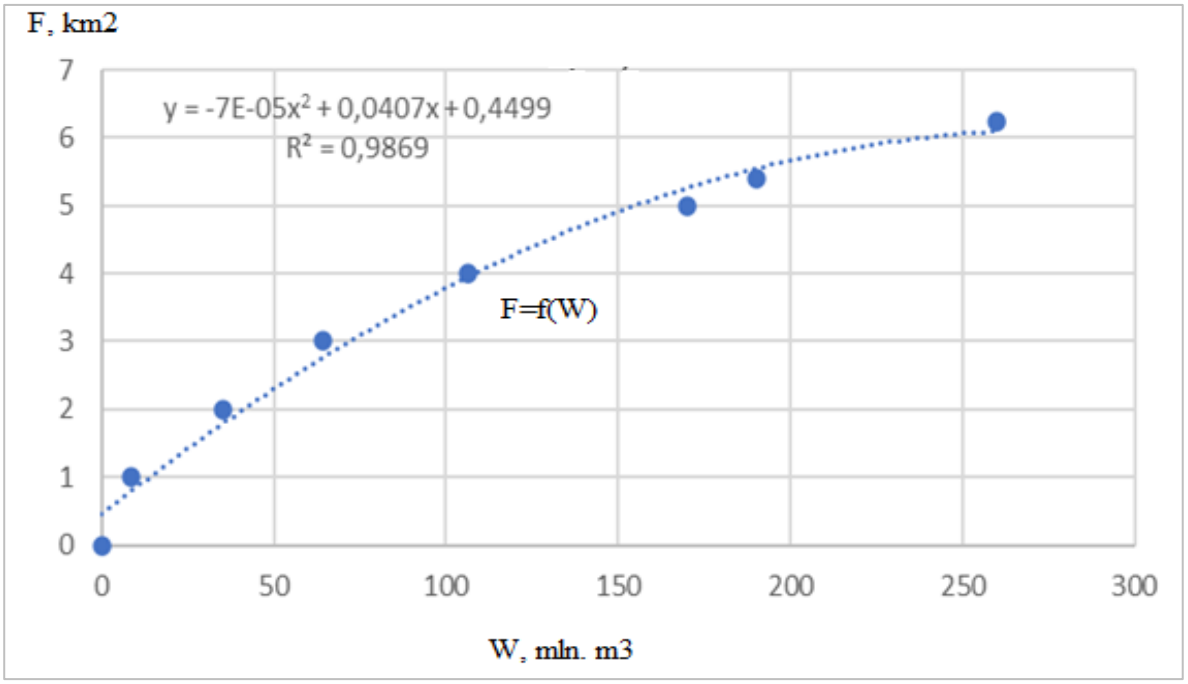


FIGURE 1. Graph and expression of relationship between water volume and water surface area Ahangaran reservoir.

When calculating the suction loss from the steel reservoir, we utilized the table depicting the relationship between the reservoir's size and suction loss (Table 5). Based on this table, a graph correlating reservoir volume and suction loss was plotted, and an equation describing this relationship was derived (Figure 2). Using this derived equation, we computed the monthly volume of water lost to suction from the reservoir, employing the monthly reservoir volume data. The calculation results are presented in Table 7.

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TABLE 5. Elements of outlet part of water balance of Ahangaran Reservoir - Filtration loss of water from iron reservoir.

H, cm	*W, mln. m³*	*τ*	$V = \frac{\tau \cdot w}{100}$, *mln. m³*
985	0	0	0
1010	13.095	0.157	0.021
1020	27.466	0.329	0.09
1030	46.92	0.563	0.26
1040	71.03	0.852	0.61
1050	103.23	1.24	1.28
1060	144.58	1.73	2.5
1070	194.65	2.34	4.55
1080	254.14	3.05	7.75

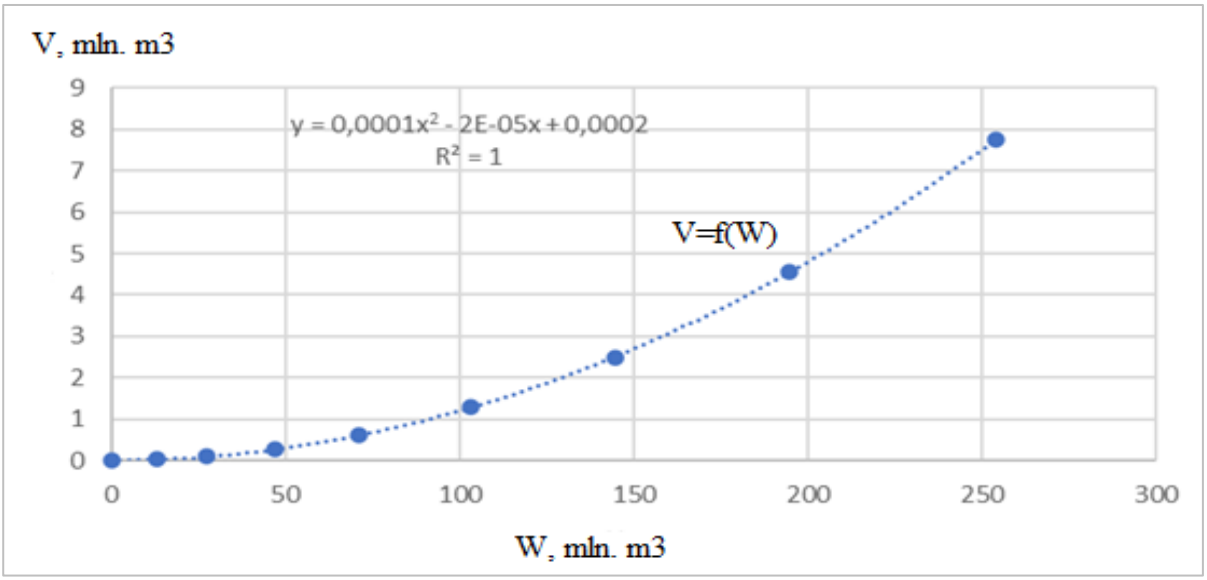


FIGURE 2. Graph of relationship between volume of water in reservoir and amount of water used for pumping from it and its expression.

TABLE 6. Components of water balance equation of Ahangaran reservoir expression in volume unit, mln. m^3

Years	Months												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
The total flow volume poured into the reservoir													
2010	20.6	32.4	84.4	208.0	216.4	89.4	35.6	15.4	7.0	5.1	21.6	22.6	758.6
2011	16.8	15.5	174.7	192.7	242.4	150.3	50.0	15.7	10.5	6.8	8.6	14.1	898.1
2012	12.6	32.2	60.1	192.9	212.4	65.1	22.7	6.4	7.5	29.5	28.3	15.1	684.9
2013	12.8	22.4	98.2	278.0	219.5	96.2	40.9	14.8	5.6	5.0	5.4	10.4	809.3
2014	10.3	12.6	80.6	102.3	139.9	33.5	11.8	5.1	4.2	27.7	45.1	19.2	492.4
2015	22.1	26.1	102.3	162.7	296.4	191.6	71.2	30.6	18.9	11.6	11.7	15.7	961.0
2016	19.9	38.3	131.9	272.1	264.5	169.9	59.4	21.4	20.8	22.4	19.6	7.6	1047.8

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Continuation of table 6.

Years	Months												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
The total flow volume poured into the reservoir													
2017	5.8	14.0	43.2	124.3	86.2	26.4	8.8	4.7	3.1	6.4	40.6	23.1	386.6
2018	16.6	14.2	57.4	288.9	241.4	120.4	38.5	11.2	7.0	6.6	14.0	13.9	830.1
2019	17.4	23.0	71.3	144.5	196.7	82.6	21.4	6.7	5.0	6.0	8.2	18.3	601.0
2020	15.8	15.8	63.1	156.5	290.4	103.0	27.4	3.6	2.1	13.1	21.1	17.0	728.8
2021	19.2	37.8	60.7	179.2	217.1	74.5	28.7	5.8	5.2	22.9	40.9	22.7	714.5
2022	23.6	26.4	70.0	283.6	338.1	123.3	39.2	10.1	6.2	17.1	6.4	9.6	953.6
Average	16.4	23.9	84.5	198.9	227.8	102.0	35.0	11.6	7.9	13.9	20.9	16.1	759.0
Atmospheric precipitation													
2010	0.40	0.27	0.07	0.21	0.16	0.09	0.14	0.10	0.00	0.14	0.39	0.38	2.35
2011	0.28	0.48	0.43	0.22	0.14	0.07	0.00	0.06	0.01	0.03	0.16	0.26	2.13
2012	0.34	0.25	0.41	0.24	0.15	0.06	0.03	0.00	0.10	0.30	0.27	0.25	2.41
2013	0.14	0.38	0.83	0.54	0.46	0.06	0.02	0.01	0.00	0.00	0.04	0.15	2.63
2014	0.06	0.18	0.15	0.44	0.08	0.00	0.09	0.00	0.04	0.31	0.30	0.25	1.88
2015	0.22	0.41	0.73	0.61	0.25	0.09	0.42	0.01	0.07	0.00	0.06	0.14	3.02
2016	0.20	0.56	0.24	0.44	0.48	0.31	0.03	0.00	0.09	0.08	0.05	0.08	2.57
2017	0.08	0.40	0.22	0.10	0.20	0.06	0.00	0.01	0.02	0.12	0.60	0.33	2.13
2018	0.19	0.39	0.48	0.32	0.13	0.21	0.08	0.00	0.00	0.03	0.27	0.29	2.39
2019	0.24	0.19	0.40	0.63	0.60	0.00	0.00	0.02	0.01	0.03	0.05	0.15	2.33
2020	0.32	0.16	0.29	0.67	0.15	0.01	0.00	0.00	0.01	0.17	0.27	0.12	2.16
2021	0.31	0.48	0.37	0.25	0.45	0.39	0.00	0.07	0.02	0.25	0.40	0.28	3.27
2022	0.34	0.03	0.58	0.19	0.57	0.07	0.20	0.07	0.02	0.12	0.10	0.26	2.54
Average	0.24	0.33	0.40	0.39	0.29	0.10	0.08	0.03	0.03	0.12	0.21	0.22	2.45

TABLE 7. Constituents of output part of water balance equation of Ahangaran reservoir expression in volume unit, mln. m^3.

Years	Months												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
The volume of flow released from the reservoir													
2010	10.7	9.7	40.2	175.5	176.9	135.1	71.2	75.0	28.5	22.5	19.8	20.7	785.8
2011	14.1	26.9	132.4	119.6	216.1	154.1	80.7	71.7	18.5	28.4	18.8	15.3	896.5
2012	13.4	18.4	18.0	115.7	197.9	74.1	78.1	55.6	18.3	16.9	14.8	13.4	634.5
2013	13.2	10.9	64.1	250.4	196.3	103.3	94.1	59.8	31.9	29.6	20.6	10.9	885.1
2014	10.7	9.7	13.3	26.0	108.1	56.0	73.5	53.2	21.1	35.5	18.1	29.9	455.1
2015	10.7	9.7	36.5	145.6	277.5	199.9	111.5	91.7	39.0	52.0	13.3	13.4	1000.7
2016	13.4	10.5	39.2	249.6	254.6	160.8	103.0	79.1	35.8	32.2	26.2	12.2	1016.5
2017	10.7	9.7	10.7	52.5	74.3	50.5	57.0	47.4	15.8	19.0	10.4	12.3	370.3
2018	12.0	14.4	61.6	228.6	224.7	119.2	72.4	56.4	32.7	30.6	13.5	10.7	877.1
2019	10.7	9.7	20.4	106.2	182.2	85.9	77.5	58.6	31.4	24.9	17.5	10.7	635.7
2020	10.6	9.7	23.2	77.2	274.0	104.6	76.2	61.1	27.5	23.6	10.5	10.7	709.0
2021	10.7	17.6	49.8	111.2	197.1	79.4	79.1	60.6	21.4	21.8	15.5	27.2	691.6
2022	10.7	9.7	37.4	222.1	320.7	116.0	82.4	77.3	22.6	24.4	21.2	10.7	955.3
Average	11.7	12.8	42.1	144.6	207.7	110.7	81.3	65.2	26.5	27.8	17.0	15.2	762.6

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Continuation of table 7.

Years	Months												Year
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Evaporation from the surface of the reservoir													
2010	0.07	0.08	0.01	0.28	0.55	0.77	0.75	0.56	0.42	0.21	0.12	0.08	3.91
2011	0.06	0.05	0.10	0.29	0.54	0.76	0.75	0.57	0.46	0.23	0.12	0.08	4.00
2012	0.05	0.07	0.11	0.29	0.55	0.76	0.68	0.50	0.40	0.25	0.16	0.11	3.94
2013	0.08	0.08	0.13	0.29	0.55	0.76	0.70	0.52	0.35	0.16	0.07	0.04	3.73
2014	0.03	0.03	0.10	0.29	0.55	0.75	0.65	0.47	0.34	0.18	0.14	0.08	3.63
2015	0.07	0.08	0.13	0.29	0.54	0.76	0.72	0.50	0.36	0.12	0.07	0.04	3.67
2016	0.04	0.05	0.13	0.29	0.53	0.76	0.72	0.52	0.40	0.21	0.11	0.07	3.82
2017	0.05	0.05	0.09	0.29	0.53	0.71	0.61	0.43	0.33	0.16	0.13	0.09	3.46
2018	0.07	0.07	0.09	0.28	0.52	0.74	0.70	0.54	0.39	0.18	0.10	0.07	3.74
2019	0.05	0.06	0.12	0.29	0.54	0.75	0.66	0.47	0.31	0.14	0.07	0.05	3.51
2020	0.04	0.04	0.09	0.28	0.54	0.75	0.69	0.49	0.33	0.17	0.11	0.08	3.62
2021	0.06	0.07	0.10	0.28	0.54	0.75	0.68	0.48	0.35	0.21	0.15	0.09	3.76
2022	0.07	0.08	0.10	0.27	0.52	0.76	0.75	0.53	0.34	0.18	0.09	0.05	3.74
Average	0.06	0.06	0.10	0.28	0.54	0.75	0.70	0.51	0.37	0.19	0.11	0.07	3.74
The volume of water lost by filtration from the reservoir													
2010	1.14	1.69	1.50	3.29	4.47	4.46	3.06	1.34	0.87	0.57	0.59	0.60	23.58
2011	0.63	0.43	1.20	3.39	4.09	4.28	3.06	1.37	1.18	0.75	0.55	0.52	21.45
2012	0.50	0.85	1.77	3.85	4.49	4.17	2.21	0.96	0.76	0.94	1.29	1.35	23.13
2013	1.34	1.61	2.60	3.61	4.47	4.19	2.36	1.06	0.56	0.25	0.13	0.13	22.31
2014	0.13	0.14	1.11	3.56	4.90	3.98	1.91	0.79	0.51	0.39	0.81	0.69	18.91
2015	0.91	1.26	3.12	3.69	4.35	4.06	2.61	0.95	0.59	0.11	0.11	0.12	21.86
2016	0.17	0.46	2.53	3.39	3.79	4.17	2.64	1.06	0.78	0.58	0.47	0.40	20.46
2017	0.34	0.39	0.92	3.35	3.87	3.01	1.51	0.64	0.45	0.29	0.66	0.88	16.30
2018	0.97	0.97	0.89	3.00	3.60	3.65	2.42	1.20	0.71	0.36	0.36	0.39	18.50
2019	0.46	0.67	1.91	3.43	4.06	3.94	2.01	0.80	0.39	0.19	0.11	0.16	18.13
2020	0.21	0.27	0.85	3.25	4.06	4.00	2.31	0.89	0.47	0.33	0.47	0.55	17.66
2021	0.67	1.02	1.25	3.31	4.04	3.86	2.15	0.83	0.56	0.57	1.00	0.92	20.17
2022	1.20	1.21	1.25	2.78	3.45	4.06	3.19	1.14	0.49	0.39	0.23	0.18	19.58
Average	0.66	0.84	1.57	3.33	4.07	3.99	2.49	1.03	0.63	0.44	0.50	0.51	20.06

TABLE 8. Water balance of Ahangaran reservoir, 2010-2022 (mln. m^3).

Years	Water balance components							The difference +/-
	Incoming water			Outgoing waters				
	Rivers and streams	Precipitation	Total amount	Released water	Evaporation	Filtration	Total amount	
2010	758.6	2.349	760.9	785.8	3.91	23.58	813.31	-52.41
2011	898.1	2.129	900.2	896.5	4.00	21.45	921.99	-21.79
2012	684.9	2.407	687.3	634.5	3.94	23.13	661.59	25.72
2013	809.3	2.625	811.9	885.1	3.73	22.31	911.18	-99.25
2014	492.4	1.882	494.3	455.1	3.63	18.91	477.61	16.70
2015	961.0	3.024	964.1	1000.7	3.67	21.86	1026.26	-62.21
2016	1047.8	2.565	1050.4	1016.5	3.82	20.46	1040.79	9.57
2017	386.6	2.132	388.7	370.3	3.46	16.30	390.05	-1.31
2018	830.1	2.393	832.5	877.1	3.74	18.50	899.39	-66.91
2019	601.0	2.329	603.4	635.7	3.51	18.13	657.32	-53.95
2020	728.8	2.161	730.9	709.0	3.62	17.66	730.26	0.66
2021	714.5	3.275	717.7	691.6	3.76	20.17	715.54	2.19
2022	953.6	2.537	956.1	955.3	3.74	19.58	978.58	-22.46
2010-2022	**759.0**	**2.4**	**761.4**	**762.6**	**3.73**	**20.16**	**786.45**	**-25.03**

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CONCLUSIONS

1. The information concerning the input and output components of the water balance of the Ahangaran reservoir has been summarized. Regarding the input section of the water balance, the total water consumption from the Ahangaran River and streams flowing into the reservoir, along with atmospheric precipitation, were determined. For the output section of the water balance, data included water usage from the reservoir, evaporation from its surface, and absorption loss from the reservoir bottom.

2. The water balance equation of the reservoir was analyzed for the period between 2010 and 2022. To express the water balance of the reservoir in volume indicators, the units of measurement for the components of the water balance were converted to a standardized unit of million cubic meters. Reservoir level curve, reservoir volume, and area curve graphs, along with their respective equations, were utilized for this unit conversion.

3. When studying the water balance of the Ahangaran reservoir from 2010 to 2022, the annual average amount of water from the main river was 759,0 million m^3, atmospheric precipitation was 2,4 million m^3, and the total multi-year average inflow equaled 761,4 million m^3. The values for the output part of the water balance totaled 786,45 million m^3, wherein the volume of water released from the reservoir dam was 762,6 million m^3, the annual average evaporation from the reservoir surface amounted to 3,73 million m^3, and absorption from the reservoir bottom accounted for an annual average loss of 20,16 million m^3.

4. The difference between the totals of the input and output components of the water balance averaged -25,03 million m^3 during the studied period. It was observed that the minimum value for the reservoir water balance was -99,25 million m^3 in 2013, while the maximum difference between incoming and outgoing water volumes was +25,72 million m^3 in 2012.

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