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Calculation Analysis of Water Loss Due to Evaporation in Tolimarjon and Hisorak Reservoirs

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Abstract: Today, special attention is paid to conducting targeted scientific research aimed at developing reliable and effective methods of predicting the useful volume of water reservoirs. In this regard, improvement of the methods of estimating the size of water reservoirs and development of recommendations, taking into account the change in the useful volume of water reservoirs as a result of exploitation, are defined as important tasks. From the results of the research, it will be possible to accurately estimate the volume of water in the reservoir by taking into account the evaporation from the water surface when calculating the water balance in the Talimarjon and Hisorak reservoirs, by quickly determining the volume of water coming out of the reservoir, and by determining the volume of siltation of the reservoir.

Keywords: Water reservoirs, exploitation, literature, Calculation, monitoring data.

Research Paper

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Evaporation from the surface of the water reservoir is determined mainly according to the GHI formula [3], which, as recognized in the literature, allows to determine the evaporation from the surface of water bodies with sufficient accuracy [2].

$E=0,14\,n\,(\ell_0-\ell_{200})\,(1+0,72U_{200})$

n - the number of days in the estimated time;
ℓ_0 – Maximum humidity of water vapor on the surface of the reservoir, mb (millibar);
ℓ_{200} - The average value of water vapor pressure at a height of 200 cm (absolute air humidity), mb;
U_{200} - The average value of the wind speed above the reservoir at a height of 200 cm, m/s.

We also used the formula for mountainous are as:
$E=0,19n(\ell_0-\ell_{200})\,(1+0,51U_{200})$

Calculations are carried out using long-term monitoring data of the weather station.

RESULTS AND DISCUSSION

To determine the maximum air humidity, the temperature of the surface layer of the water reservoir is needed. The temperature of the surface layer of the water reservoir can be determined through observational work or equations connecting it to the morphometric parameters affecting it. Taking into account the monthly air temperature and wind direction, the following equation that determines the temperature in the surface layer of the reservoir and shows the connection between the air temperature is given..

$$t_{suv}=0.78\cdot t_{havo}+0.17\cdot \overline{t}_{havo}-0.19\cdot\frac{\overline{h}}{h_{MDS}}\left[\left(t_{havo}\right)_{n+1}-\left(t_{havo}\right)_{n-1}\right] \quad \ldots\ldots\ldots\ldots\ (1)$$

Here:

t_{suv} and t_{havo} - monthly temperature of water and air, °C;

$\overline{t}_{havo}$ - average annual air temperature, °C;

$(t_{havo})_{n+1}$ and $(t_{havo})_{n-1}$ - the average monthly air temperature of the month before and after the month under consideration, °C;

$\bar{h}$ - average monthly depth of the reservoir, m;

h_{MDS} - the average depth of the reservoir in MDS, m;

The recommended formula for calculating the average monthly temperature of the surface layer of the reservoir includes three factors that affect the water temperature, namely;

- Average monthly and average annual air temperature;
- Rise and fall of air temperature over time;
- Takes into account the change of reservoir depth depending on the water level over time.

Based on the formula recommended above, the calculation results of the average monthly temperature of the water surface layer for the Talimarjon reservoir located in the plain and mountainous areas in 2020-2022 are presented in the following tables 1, 2 and 3.

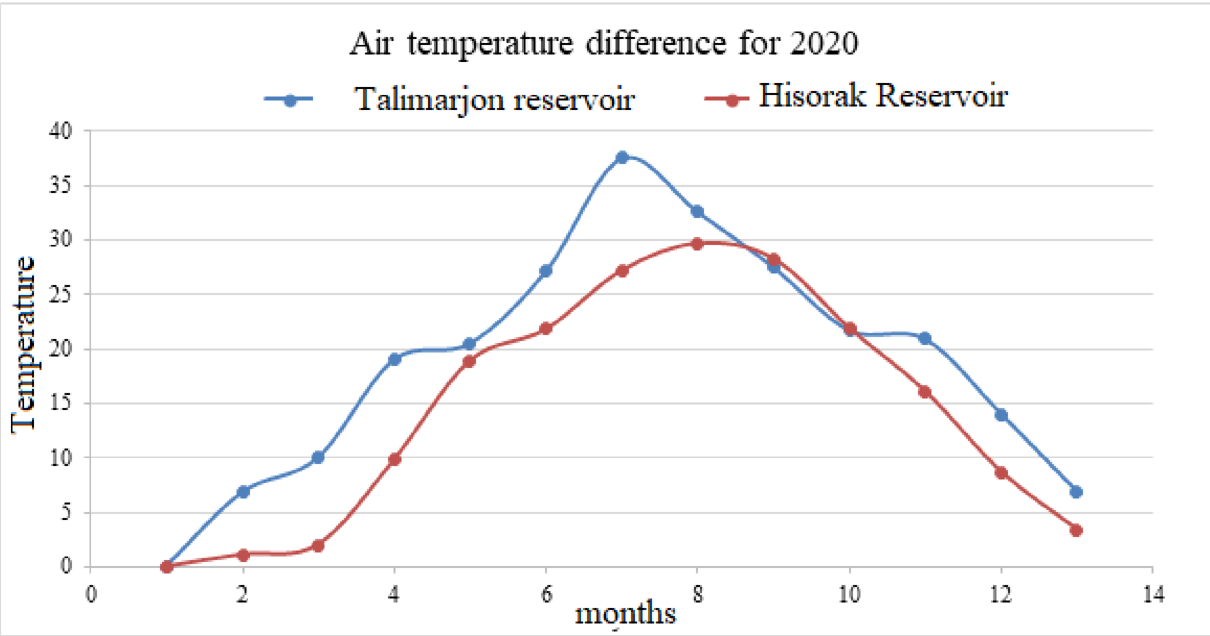
Table 1: Average monthly temperature of Talimarjon and Hisorak reservoirs and water surface layer

2020 year

Indicators	**Months**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average air temperature,°C	6,8	10	19	20,5	27,1	37,5	32,6	27,5	21,7	20,9	14	6,87
The temperature of the water in the reservoir,°C $T_{возд}=0,78*t_{возд}+0,17*t_{возд}-0,19*h/h_{нпу}((t_{возд})n+1-(t_{возд})n-1)$	8,76	11,34	18,37	19,48	24,69	32,74	28,82	24,89	20,38	19,77	14,32	8,81

2020 year

Indicators	**Months**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average air temperature,°C	1,1	2	9,8	18,9	21,8	27,2	29,7	28,3	21,9	16,1	8,7	3,4
The temperature of the water in the reservoir,°C $T_{возд}=0,78*t_{возд}+0,17*t_{возд}-0,19*h/h_{нпу}((t_{возд})n+1-(t_{возд})n-1)$	3,49	4,27	10,41	17,48	19,71	23,92	25,83	24,67	19,65	15,12	9,35	5,28



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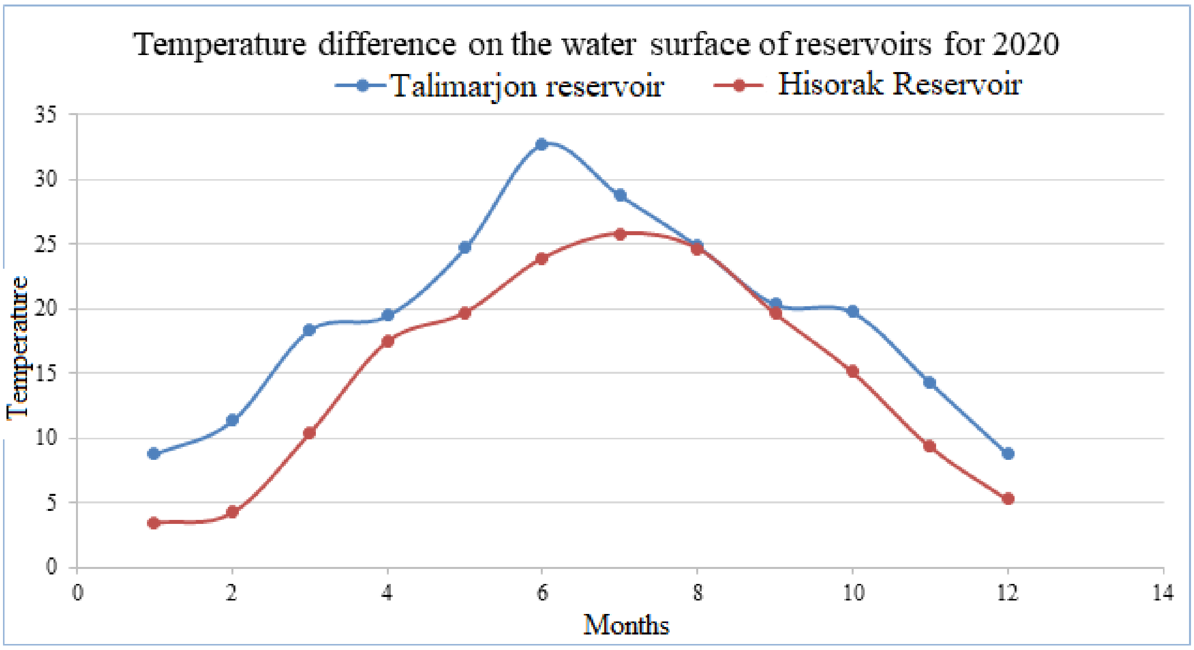

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Figure 1: Graphical information showing a) air temperature and b) temperature difference on the water surface of the reservoirs in Talimarjon and Hisorak reservoirs in 2020

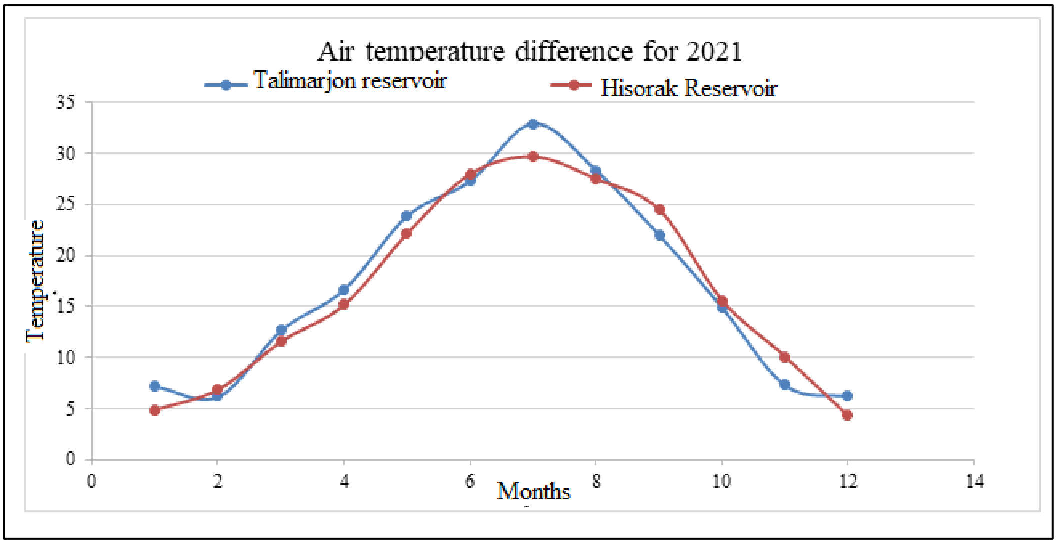
Table 2: Average monthly temperature of Talimarjon and Hisorak reservoirs and water surface layer

2021 year

Indicators	**Months**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average air temperature,ºC	7,2	6,2	12,7	16,7	23,9	27,3	32,9	28,3	22	14,9	7,3	6,2
The temperature of the water in the reservoir,ºC $T_{\text{возд}}=0,78*t_{\text{возд}}+0,17*t_{\text{возд}} - 0,19*h/h_{\text{нпу}}((t_{\text{возд}})n+1-(t_{\text{возд}})n-1)$	8,52	7,79	12,93	16,03	21,65	24,29	28,58	24,95	20,06	14,49	8,58	7,74

2021 year

Indicators	**Months**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average air temperature,ºC	4,9	6,9	11,6	15,2	22,2	28	29,7	27,5	24,5	15,6	10,1	4,3
The temperature of the water in the reservoir,ºC $T_{\text{возд}}=0,78*t_{\text{возд}}+0,17*t_{\text{возд}} - 0,19*h/h_{\text{нпу}}((t_{\text{возд}})n+1-(t_{\text{возд}})n-1)$	6,68	8,27	11,94	14,88	20,41	24,84	25,99	24,18	21,72	14,74	10,52	6,09



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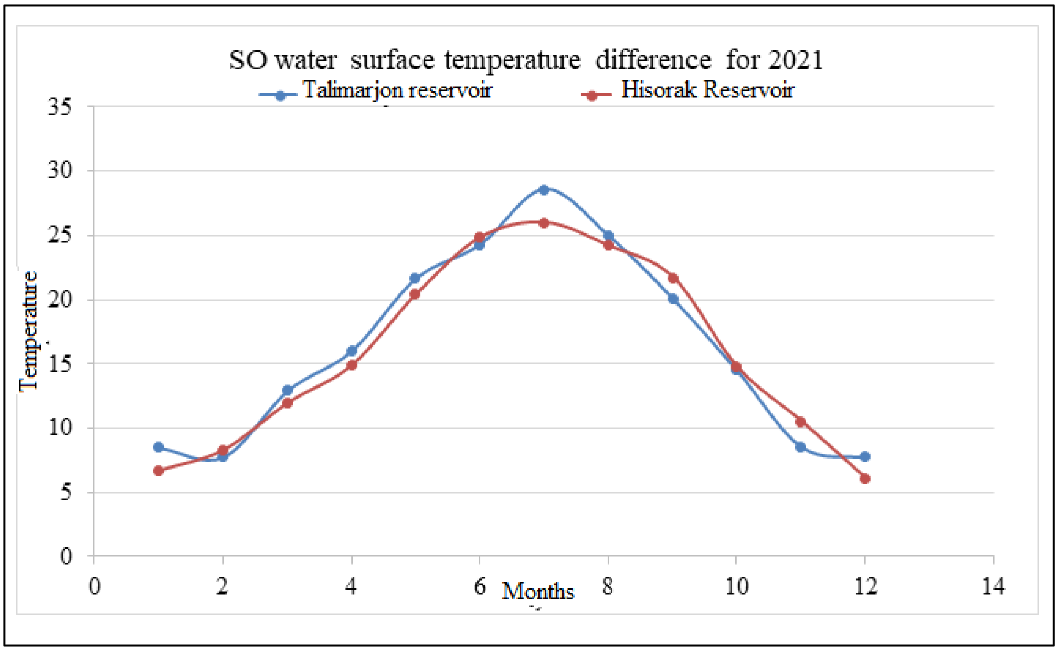


b)

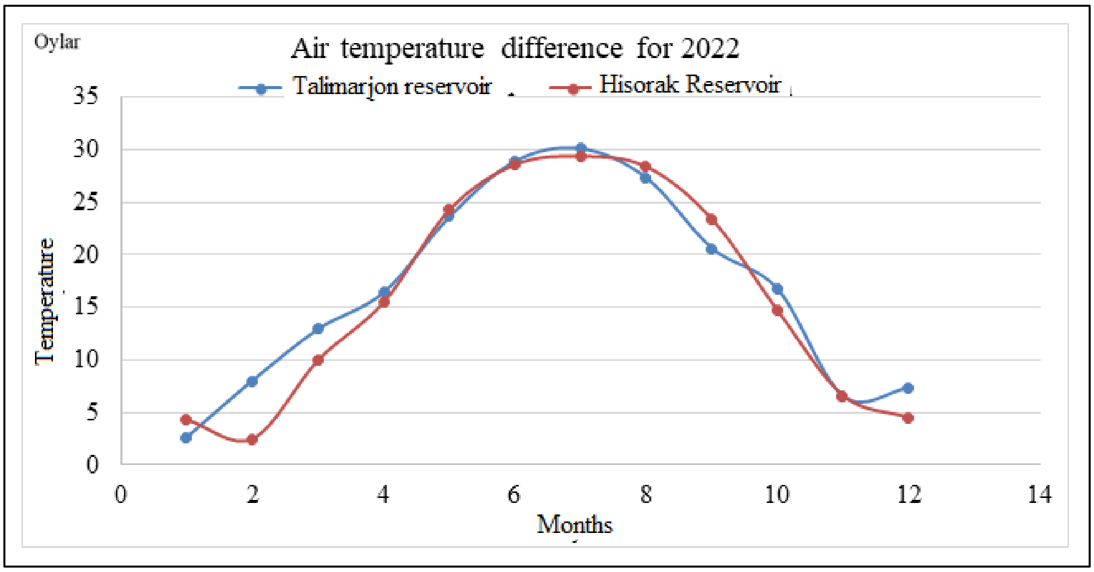
Figure 2: Graphical information showing a) air temperature and b) temperature difference on the water surface of the reservoirs in Talimarjon and Hisorak reservoirs in 2021

Table 3: Average monthly temperature of Talimarjon and Hisorak reservoirs and water surface layer
2022 year

Indicators	**Oylar**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average air temperature,ºC	2,6	8	12,9	16,4	23,6	28,9	30,1	27,3	20,6	16,7	6,5	7,3
The temperature of the water in the reservoir,ºC $T_{возд}=0,78*t_{возд}+0,17*t_{возд} - 0,19*h/h_{нпу}((t_{возд})n+1-(t_{возд})n-1)$	4,87	9,15	12,98	15,71	21,33	25,43	26,31	24,11	18,9	15,8	7,88	8,52

2022 year

Indicators	Oylar											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average air temperature,°C	4,3	2,5	10	15,5	24,3	28,6	29,4	28,4	23,4	14,7	6,6	4,5
The temperature of the water in the reservoir,°C $T_{возд}=0,78*t_{возд}+0,17*t_{возд} - 0,19*h/h_{нпу}((t_{возд})n+1-(t_{возд})n-1)$	6,04	4,77	10,76	15,08	21,94	25,14	25,65	24,77	20,77	13,95	7,8	6,14



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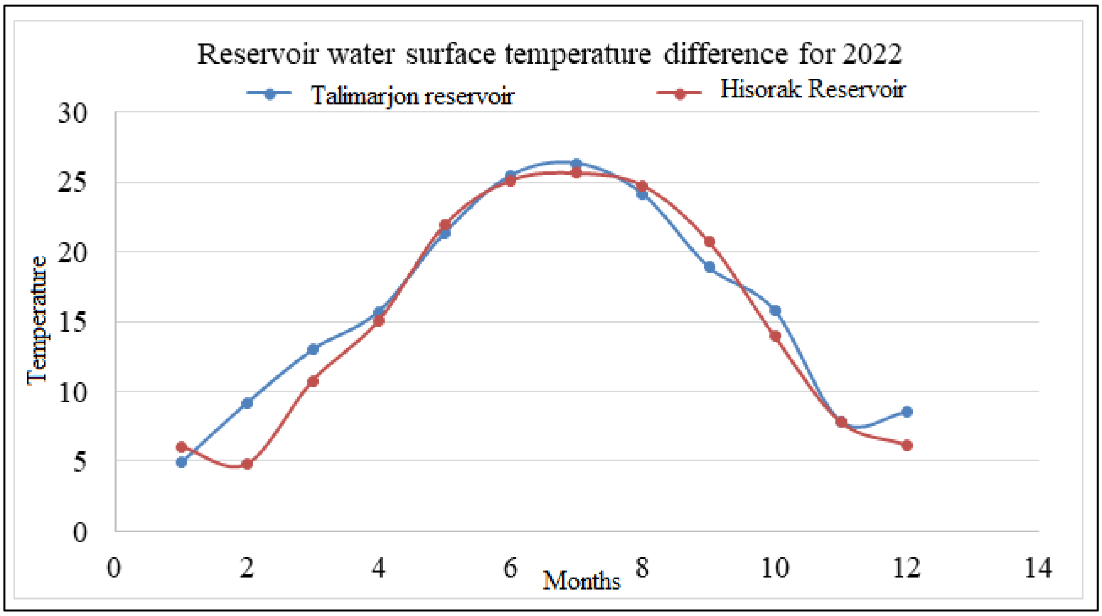

b)

Figure 3: Graphical information showing a) air temperature and b) temperature difference on the water surface of the reservoirs in Talimarjon and Hisorak reservoirs in 2022

Based on the formula (1) given above, the calculation results of the average monthly temperature of the water surface layer for the years 2020-2022 for Hisorak reservoir located in the mountainous area and Talimarjon reservoir in the plain are presented in the above table. It can be seen from the given graphs that in the relatively cold months of the year, the water surface temperature of the water reservoirs located in the mountains and plains is higher than the air temperature.

Temperatures on the surface of the water are definitely lower than the water reservoirs located in mountainous regions.

We should emphasize that, based on the graphs in the above pictures 1, 2 and 3, the difference between the temperature of the air and the temperature of the water surface is 4-7 ^{0}C.

Evaporation from the surface of the reservoir is determined based on calculations and observations. In order to determine the calculated amount of evaporation, using the recommended method, the air temperature, absolute air humidity and wind speed measured at the meteorological station are determined, or the air temperature, absolute air humidity and wind speed measured with the help of thermometers, psychrometers and anemometers are obtained.

Isparitel (isparomer GGI-3000, etc.) is used to determine evaporation based on observations.

The amount of evaporation on the surface of the water reservoir determined by both methods is used to determine the volume of water lost from the water reservoir (during operation of the water reservoir).

The volume of water lost to evaporation from the reservoir is determined by the following formula.

$W_{bug'}$ = E * F ……………. (2)

Here;
E - evaporation size, mm;
F – reservoir surface area.

The surface area of the reservoir is obtained from the graph of the connection to the water level of the reservoir.

The average monthly amount of evaporation is obtained from tables 1, 2 and 3.

The volume of water lost to evaporation of the cited Ta'limarjon and Hisorak reservoirs was presented in the form of a table and a graph. (Table 4 and 4.1 and Figure 4 and 4.1).

We can provide the following methods of determining evaporation for the situation where there are no long-term data of water surface temperature monitoring in water reservoirs.

Evaporation from the surface of the water reservoir was mainly determined by the following formula GGI [3], which is presented in the literature and allows to determine the evaporation with a high degree of accuracy, depending on the characteristics of water bodies [2].

$$E = 0{,}14\, n\,(\ell_0 - \ell_{200})\,(1 + 0{,}72U_{200}) \quad .. (3)$$

n - the number of days in the calculated time;
ℓ_0 - the average value of the maximum water vapor pressure, MB, calculated by the temperature of the water surface in the reservoir;
ℓ_{200} - the average value of water vapor pressure (absolute air humidity) at a height of 200 cm above the reservoir, in MB;
U_{200} - the average value of the wind speed above the water body at a height of 200 cm, m/s.

The following formula is used to determine the amount of evaporation in mountainous areas.

$$E = 0{,}19n(\ell_0 - \ell_{200})\,(1 + 0{,}51U_{200}) \ \ldots (4)$$

The annual observation data of the weather station was used here.

The maximum air humidity is determined by the temperature of the surface layer of water. The temperature of the water surface is one of the main factors that determine the intensity of evaporation.

Some of the water reservoirs have information on the temperature of the surface layer of water, but for the rest of the water reservoirs, such information is not available. We propose a formula for determining the temperature of the surface layer of water in a reservoir based on the average monthly air temperature calculated from observations at a weather station located near this reservoir, the coefficients in it may change.

Based on the formulas (3) and (4) above, the calculation of evaporation from the surface of the reservoir in the months of the reservoirs is given (Tables 4 and 4.1), the multiplication of the evaporated water by the surface of the reservoir is the vapor from the reservoir gives the connection given in the formula (2), that is, the surfaces of the water reservoir at changing depths also change.

The amount of evaporation from the surface of reservoirs directly depends on the depth of the reservoirs and the location of the reservoir on the horizon, that is, the greater the depth of the reservoirs and the smaller the spreading width, the lower the width of the reservoir water surface and the water surface temperature. which, in turn, causes a decrease in evaporation from the water surface of the reservoir. If the depth of water in reservoirs is small and the spreading width is large, as a result, the temperature of the water surface in the reservoir and the surface area of the water will be large, as a result, evaporation from the water surface will also be large.

Table 4: Average annual water loss by evaporation from the Talimarjon reservoir, by month (mm)

2022 for the Talimarjon reservoir									0,14	0,72		
n	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
Indicators	**Months**											
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
1	2	3	4	5	6	7	8	9	10	11	12	13
Air temperature, ºC	2,6	8	12,9	16,4	23,6	28,9	30,1	27,3	20,6	16,7	6,5	7,3
The temperature of the water in the reservoir, ºC ºC $T_{вод}=0,78*t_{возд}+0,17*t_{возд}$ $-0,19*h/h_{нпу}((t_{возд})n+1-(t_{возд})n-1)$	4,87	9,15	12,98	15,71	21,33	25,43	26,31	24,11	18,9	15,8	7,88	8,52
Maximum air humidity, GPA, L_0	7,6	8,5	11	17,001	24.6	33,4	35,8	33	25,8	18,8	12,5	9,8
Absolute air humidity, GPA, L_{200}	6,12	5,9	9,1	12,3	15,6	13,2	17,1	13,5	12,01	9,23	7,2	5,4
Wind speed, V_{200}, m/s	2,8	3,1	3,2	3,1	3,2	3,6	3,9	3,3	2,8	2,6	2,7	2,6
Evaporation, mm	19,37	34,12	27,24	63,81	103,24	304,75	309,05	285,71	174,68	119,29	65,53	54,84
Total annual evaporation, mm.												1561,64

Table 4.1: Average annual water loss by evaporation from the Hisorak reservoir, by month (mm)

2022 for the Hisorak Reservoir									0,19	0,51		
n	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
Indicators	**Months**											
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
1	2	3	4	5	6	7	8	9	10	11	12	13
Air temperature, ºC	4,3	2,5	10	15,5	24,3	28,6	29,4	28,4	23,4	14,7	6,6	4,5
The temperature of the water in the reservoir, ºC ºC $T_{вод}=0,78*t_{возд}+0,17*t_{возд}$ $-0,19*h/h_{нпу}((t_{возд})n+1-(t_{возд})n-1)$	6,04	4,77	10,76	15,08	21,94	25,14	25,65	24,77	20,77	13,95	7,8	6,14
Maximum air humidity, GPA, L_0	8,9	9	11	16,4	21,2	27,8	32,7	31	24,4	17,3	13,3	10,1
Absolute air humidity, GPA, L_{200}	4,85	4,9	7,6	10,7	11,4	10,9	12,6	12,2	9,8	8,4	6,5	6,1
Wind speed, V_{200}, m/s	1,37	1,44	1,51	1,6	1,7	1,71	1,73	1,58	1,42	1,33	1,3	1,37
Evaporation, mm	40,52	39,18	35,45	59,00	107,77	180,34	222,84	199,96	143,49	87,98	64,46	40,02
Total annual evaporation, mm.												1221,01

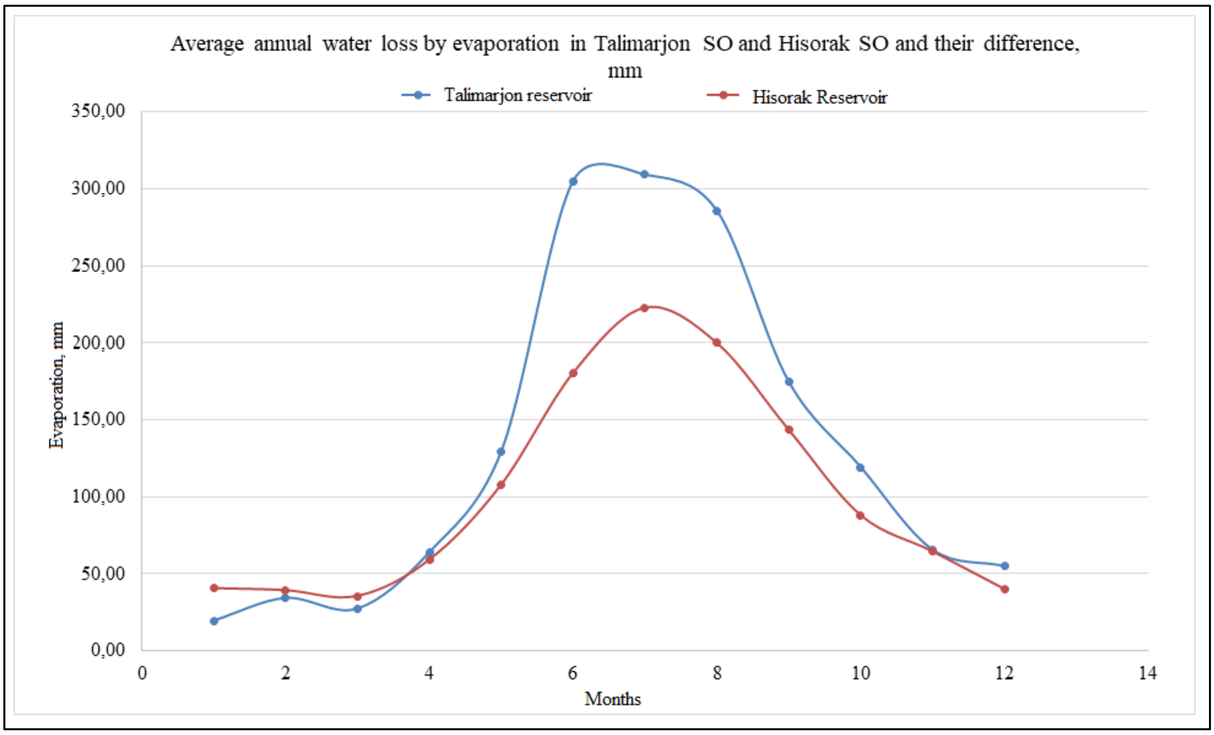

Figure 4: Graphic representation of average annual water loss through evaporation in Talimarjon reservoir and Hisorak reservoir

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