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Changes under anthropogenic activity in the hydrochemical regime during the period of high water of Zeravshan River

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ABSTRACT: The article compares the water quality parameters of the Zeravshan River with the July high-water studies and compares the July hydro chemical indicators for many years.

KEY WORDS: Water consumption, mineralization, nitrite ions, chemical consumption of oxygen (CHCO), phenols, copper, water pollution index, statistical analysis.

I. INTRODUCTION

Zeravshan River is a transboundary river with neighboring Tajikistan and its total length is 781 km [4]. Of this total, 373 km are on the territory of Uzbekistan. Currently, there are 11 hydrochemical monitoring stations on the river, seven of which are located in Samarkand region, two in Navoi region and 2 in Bukhara region. The density of the observation network in the Zeravshan River from the Ravatkhoja point to the city of Navoi is 3 points per 100 km [5].
However, the longest distance between the checkpoints is 97 km from the Navoi (lower) observation point and Bukhara (upper), and the distance between the Khatirchi observation station and Navoi (upper) is 93 km. The distance between Navoi (upper) observation points, where the hydrochemical parameters of the river are twice as high as permissible maximum allowable concentration (MAC) values, is quite remote. It can be seen that the river requires an increase in the number of checkpoints (Figure 1).

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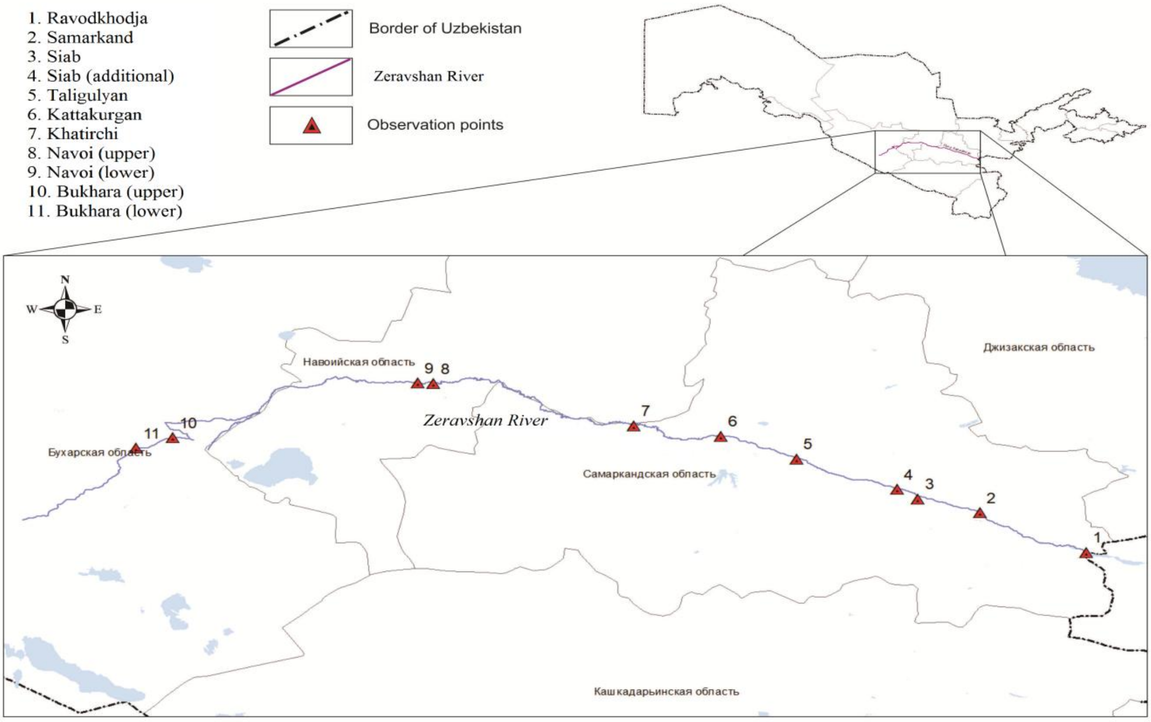

Figure 1. Map of Zeravshan River water quality monitoring points

In the hydrological regime of the Zeravshan River, there are two periods - spring-summer high water and autumn-winter periods. The bulk of the river flows during the period of high water. The river period of high water begins in mid-spring and lasts until September [1]. The annual flow of the Zeravshan River (1985-2017) is very unevenly distributed, in summer months water consumption reaches 158.3 m^3/sec and an average of 23.81 m^3/sec in winter (Figure 2) [2].

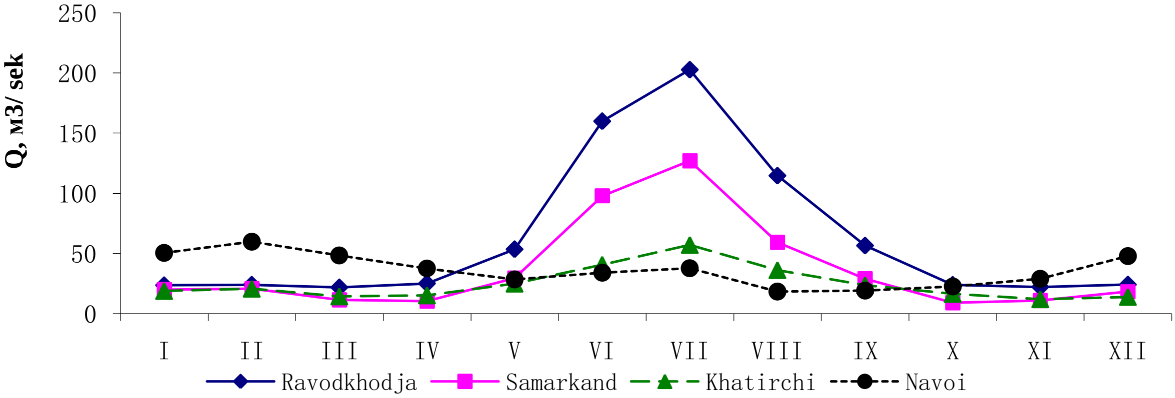

Figure 2. Water consumption at observation points of the Zeravshan River

The largest monthly water consumption of the Zeravshan River is observed in the hottest month of July, while the minimum mineralization of river water is also observed during the months of high flood and high-water periods [3]. And hydrological changes in river water require the study of how river water quality (hydro chemical parameters) changes.

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II. MATERIALS AND METHODS

Therefore, the article explores the basin hydrochemical performance of the river from the Zeravshan River in July 2018 based on data from a July 2018 water quality assessment and the Uzhydromet annual perennial (1998–2018) above the permissible maximum allowable concentration (MAC) values. Water samples were collected directly from 11 observation points, and hydrochemical analysis was carried out in the Surface Water Research Laboratory of the Department for the Study and Monitoring of Environmental Pollution of Uzhydromet.

III. RESULTS AND DISCUSSION

The results of a July 2018 study show that the minimum mineralization in river water is 165 mg/dm^3 at the Samarkand observation station and the highest mineralization is 2410 mg/dm^3 at the Bukhara (upper) observation station. According to the average annual Uzhydromet analysis (1998-2018), the minimum mineralization in river water is 209 mg/dm^3 at the Samarkand observation station and the highest mineralization is 2588 mg/dm^3 at the Bukhara (lower) observation station (Figure 3).

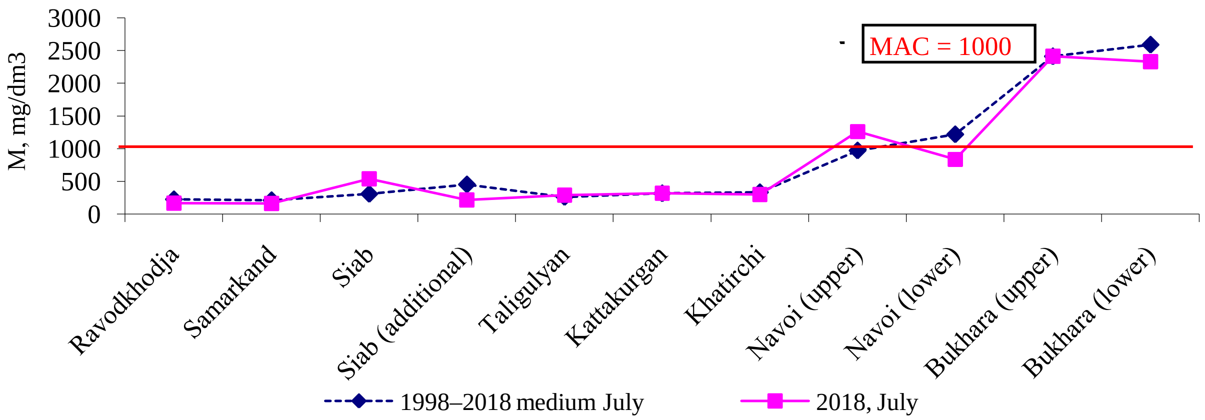

Figure 3. Changes in mineralization in the Zeravshan River

The mineralization of the Zeravshan River in July exceeded the maximum allowable concentration (MAC=1000 mg/dm^3) at Navoi (upper), Bukhara (upper) and Bukhara (lower) observation points. In July, the average perennial increase in maximum allowable concentration (MAC) from Navoi (lower) observation points to Bukhara (lower) observation points.

Currently, the river flows through the collector and drainage waters at the upper and lower points of the river in Bukhara [6]. Therefore, the mineralization points at the observation points are high.

The minimum amount of nitrite ions in river water is 0.005 mg/dm^3 at the Kattakurgan monitoring station as of July 2018, while the highest nitrite ions are 0.08 mg/dm^3 at the Siab observation station. According to the long-term (1998-2018) analysis, the lowest nitrite ions in the river water are 0.01 mg/dm^3 at the Kattakurgan observation station and the highest nitrite ions are 0.159 mg/dm^3 at the Siab (additional) observation station. (Figure 4).

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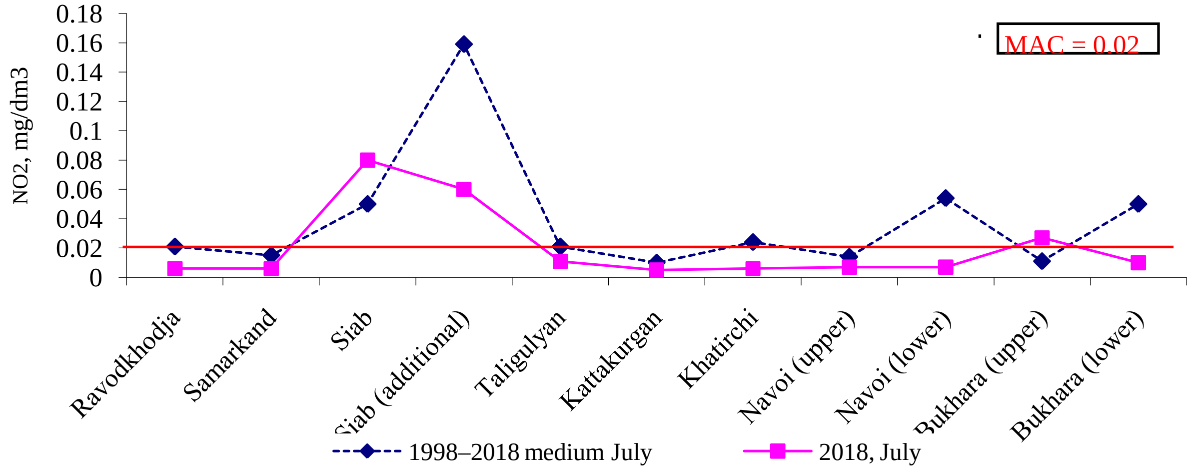

Figure 4. Changes in the amount of nitrite ions in Zeravshan river water

According to the data, 15-22 kg/ha of nitrogen (14-22 % of the fertilizer volume) and 3-4 kg/ha of phosphorus are washed out of the irrigated area during the vegetation season [7]. The rate of nitrogen deposition in the Zeravshan River is 6 times higher than maximum allowable concentration (MAC=0.02 mg/dm^3) at the Siab and Siab (additional) observation points. In the field study, uncontrolled sewage was observed following the Siab checkpoint.

The minimum amount of chemical consumption oxygen (ChCO) in river water is 1.42 mgO/dm^3 in July 2018 at the Samarkand observation, the highest oxygen consumption is 20.3 mgO/dm^3 at the Bukhara (lower) observation station. According to the long-term (1998-2018) analysis, the minimum oxygen consumption in river water is 3.21 mgO/dm^3 at the Samarkand observation station, the highest oxygen consumption is 30.4 mgO/dm^3 at the Bukhara (lower) observation station (Figure 5).

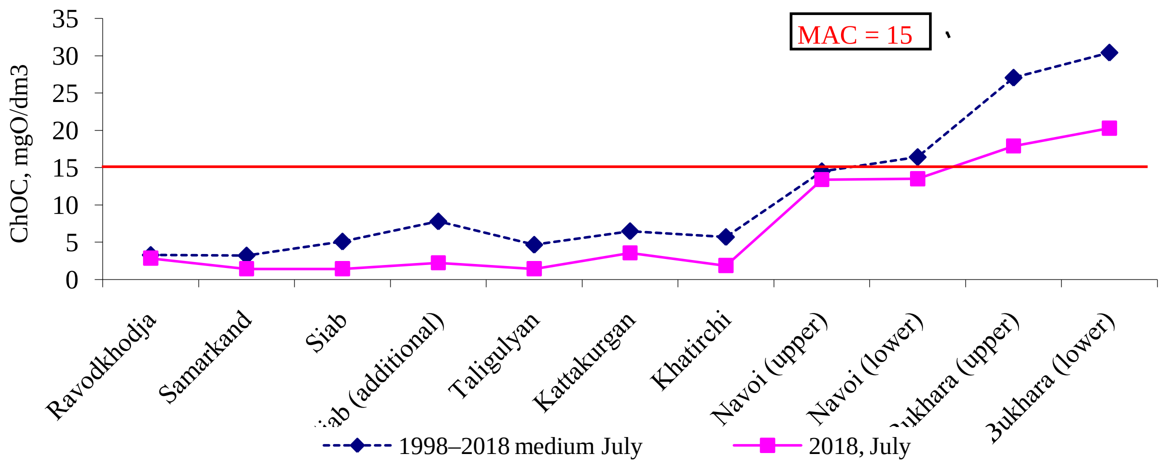

Figure 5. Changes in Chemical Oxygen Consumption (ChOC) in Zeravshan River

Chemical consumption of oxygen determines the organic contamination of water [4] and is mainly caused by sewage from public utilities and industrial sectors. Chemical consumption of oxygen has increased from the Navoi (upper) observation point of the river to the Bukhara (lower) observation point.

The minimum amount of phenol in river water as of July 2018 is 0.003 mg/dm^3 at Khatirchi observation station, and the maximum Phenol content is 0.015 mg/dm^3 at the Navoi (lower) observation point. According to the long-term (1998-2018) analysis, the lowest phenol content in river water is 0.001 mg/dm^3 at the Ravodkhodja checkpoint and the highest phenol content is 0.007 mg/dm^3 at the Siab (additional) monitoring point (Figure 6).

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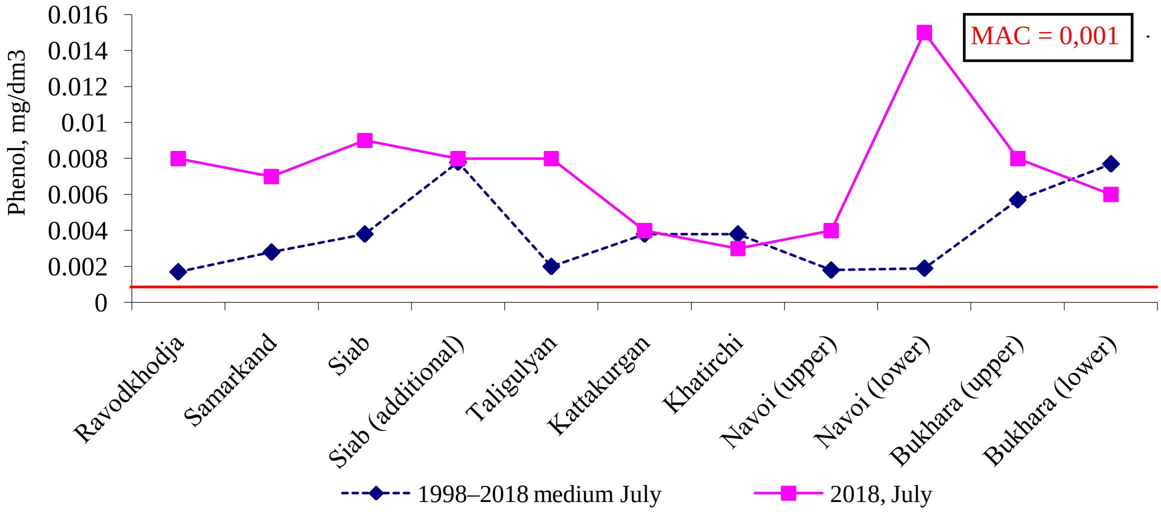

Figure 6. Changes in phenol content in Zeravshan River

The high phenol content above the permissible limits is explained by natural and anthropogenic effects. 15 times more than the permissible limit at the Navoi (lower) checkpoint (July 2018). The average long-term (1998–2018) is 7 times higher in the Siab (additional) checkpoint in July. Generally, phenols come into river water from industrial and industrial enterprises, and such contamination results in a violation of river sanitation and river biogenic conditions.

The minimum amount of copper in river water is 0.97 mkg/dm^3 at the Bukhara (upper) monitoring station for July 2018, with the highest copper content in the Siab observation station 4.52 mkg/dm^3. The minimum copper content in river water is 1.07 mkg/dm^3 at the Samarkand observation, and the highest copper concentration is 1.83 mkg/dm^3 at the Khatirchi observation (Figure 7).

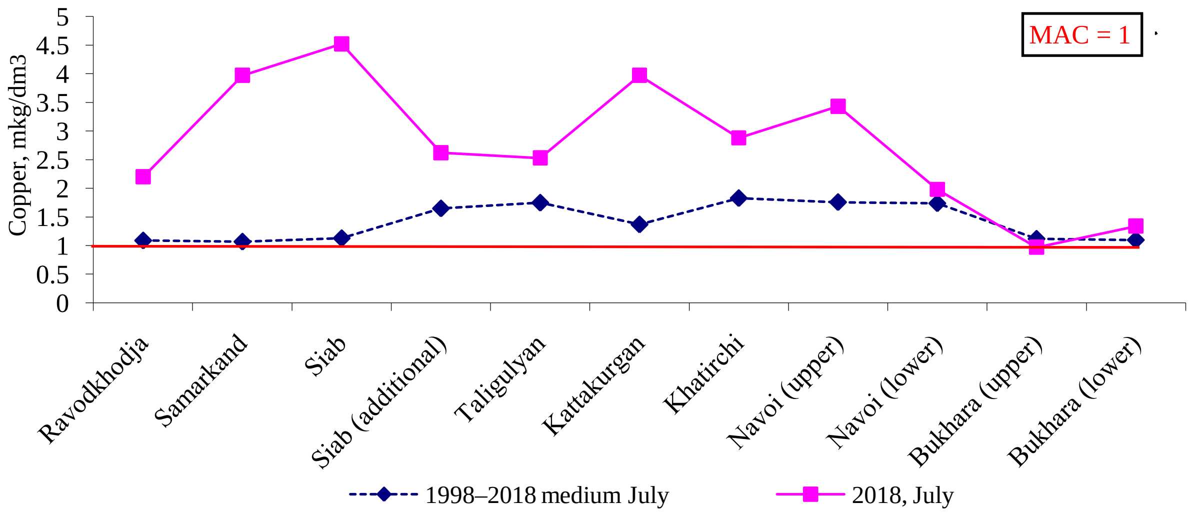

Figure 7. Changes in copper content in Zeravshan river

According to the study, the concentration of copper in the Zeravshan River in Uzbekistan, from the Ravodkhodja checkpoint to the Bukhara (lower) observation point, is very high. As of July 2018, 4.5 times exceeded the mean maximum allowable concentration (MAC=1 mkg/dm^3) by July 1.8 times [8]. In the upper reaches of the river are the effluents of the Tajik gold ores and the Anzob mining and processing plant and agricultural wastewater. According to the Samarkand State University, the concentration of antimony (Sb) from heavy metals is also very high [9].

For a comprehensive assessment of the water quality of the Zeravshan River as of July 2018, 6 hydrochemical

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indicators and water pollution index with respect to dissolved oxygen content, biological oxygen demand and permissible concentration were determined. According to researches, Ravodkhodja observation station III (partly polluted), Samarkand observation station IV (low polluted), Siab observation station IV (poorly polluted), Siab (additional) pollution station IV (poorly polluted), IV (low polluted) at Taligulyan observation station III (partly contaminated) at Kattakurgan observation point, III (partly contaminated) at Khatirchi observation station, III (partly contaminated) at Navoi (upper) observation point, IV (poorly polluted) at Navoi (lower) observation point, Bukhara (upper) IV (less contaminated), class III (partly contaminated) at Bukhara (lower) observation point (Table 1).

Table 1. Zeravshan River Pollution Index (July 2018)

Points	Ravodkhodja	Samarkand	Siab	Siab (additional)	Taligulyan	Kattakurgan	Khatirchi	Navoi (upper)	Navoi (lower)	Bukhara (upper)	Bukhara (lower)
№	1	2	3	4	5	6	7	8	9	10	11
2018 July	1,95 III	2,06 IV	3,17 IV	2,46 IV	2,16 IV	1,56 III	1,23 III	1,7 III	2,52 IV	2,44 IV	1,93 III

Water purification is the limit and it is impossible to contaminate it with uncontrolled and uncontrolled flow, whereas 20 to 30 m^3 of pure water is required for mixing 1 m3 of untreated sewage into suitable water [10]. Despite the fact that the Zeravshan River is full-blown, water pollution does not have the potential to turn it into suitable water within the limits of self-cleaning.

STATISTICAL ANALYSIS.

Therefore, it is necessary to take into account the deviation of the results of the analysis from the mean. It is well known to us that the greater the repetitive analysis, the higher the probability of approaching the mean value to the actual value [11]. The mean deviations from the repeated analysis are significantly different from the true values, although they are close to the four repeated values. The analyzes were performed 4 times (July 2018) on mineralization, nitrite ion, chemical consumption of oxygen, phenols, copper. In four of the results from quantitative analysis, the values were developed using a mathematical statistical method (Table 2).

TABLE CONTENTS:

Average indicator for 2018 July – $X = \sum Xi / n$

Standard deviation – $S = \sqrt{\frac{(X_1 - X)^2}{n-1}}$

Relative standard deviation – $Sr = S / X * 100$

Average standard deviation - $S_x = \frac{S}{\sqrt{n}}$

Reliability interval - $ts_x = s_x t * 0{,}95$

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Table 2. Statistical analysis of the water of the Zeravshan River

Points	The average indicator in July 2018	Standard deviation	Relative standard deviation	Average standard deviation	Reliability interval	Confidence interval % (deviation)	Confidence interval (-)	Confidence interval (+)
Mineralization, (mg/dm^3)								
Ravodkhodja	165	1,82	1,1	0,91	2,9	1,75	162,09	170,9
Samarkand	161	1,5	0,93	0,75	2,38	1,48	158,6	163,3
Siab	538	1	0,18	0,5	1,59	0,29	536,4	539,5
Siab (additional)	216	2,08	0,96	1,04	3,3	1,53	212,6	219,3
Taligulyan	289	1,73	0,59	0,86	2,75	0,95	286,2	291,7
Kattakurgan	319	1,82	0,57	0,91	2,9	0,91	316,09	321,9
Khatirchi	298	1,41	0,47	0,7	2,24	0,75	295,7	300,2
Navoi (upper)	1259	3,36	0,26	1,68	5,35	0,42	1253,6	1264,3
Navoi (lower)	834	3,91	0,46	1,95	6,22	0,74	827,7	840,2
Bukhara (upper)	2410	0,81	0,03	0,4	1,29	0,22	2404,6	2415,3
Bukhara (lower)	2325	1,41	0,06	0,7	2,24	0,16	2321,2	2328,7
Nitrate ion (mg/dm^3)								
Ravodkhodja	0,006	0,00018	3,04	9,13	0,00029	4,83	0,0057	0,0062
Samarkand	0,006	0,00014	2,35	7,07	0,00022	3,74	0,0057	0,0062
Siab	0,08	0,0018	2,28	0,0009	0,0029	3,62	0,077	0,082
Siab (additional)	0,06	0,00081	1,36	0,0004	0,0012	2,16	0,058	0,061
Taligulyan	0,011	0,0001	0,94	5,188	0,00016	1,49	0,01	0,011
Kattakurgan	0,005	0,00011	2,36	5,921	0,00018	3,76	0,0048	0,0051
Khatirchi	0,006	0,00018	3,04	9,13	0,00029	4,83	0,0057	0,0062
Navoi (upper)	0,007	0,00018	2,6	9,13	0,00029	4,14	0,0067	0,0072
Navoi (lower)	0,007	0,00014	2,02	7,07	0,00022	3,21	0,0067	0,0072
Bukhara (upper)	0,027	0,00041	1,54	0,0002	0,00066	2,45	0,026	0,027
Bukhara (lower)	0,01	8,165	0,81	4,08	0,00012	1,29	0,0098	0,0101
Phenols (mg/dm^3)								
Ravodkhodja	0,008	0,00014	1,76	7,07	0,00022	2,81	0,0077	0,0082
Samarkand	0,007	0,00018	2,6	9,12	0,00029	4,14	0,0067	0,0072
Siab	0,009	0,00018	2,02	9,12	0,00029	3,22	0,0087	0,0092
Siab (additional)	0,008	0,00017	2,16	8,66	0,00027	3,44	0,00772	0,0082
Taligulyan	0,008	0,00011	1,44	5,77	0,00018	2,29	0,00781	0,0081
Kattakurgan	0,004	8,165	2,04	4,08	0,00012	3,24	0,0038	0,0041
Khatirchi	0,003	8,16	2,72	4,08	0,00013	4,32	0,00287	0,0031
Navoi (upper)	0,004	8,16	2,04	4,08	0,00013	3,24	0,00387	0,0041
Navoi (lower)	0,015	0,0004	2,72	0,0002	0,00064	4,32	0,0143	0,015
Bukhara (upper)	0,008	8,16	1,02	4,08	0,00013	1,62	0,0078	0,0081
Bukhara (lower)	0,006	8,165	1,36	4,08	0,00012	2,16	0,0058	0,0061
Chemical Consumption of Oxygen in mgO/dm^3								
Ravodkhodja	2,84	0,024	0,862	0,012	0,038	1,37	2,8	2,87
Samarkand	1,42	0,017	1,2	0,0085	0,027	1,91	1,39	1,44
Siab	1,42	0,017	1,2	0,0085	0,027	1,91	1,39	1,44

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Siab (additional)	2,22	0,015	0,675	0,0075	0,023	1,07	2,19	2,24
Taligulyan	1,42	0,0095	0,674	0,0047	0,015	1,07	1,4	1,43
Kattakurgan	3,55	0,018	0,514	0,0091	0,029	0,81	3,52	3,57
Khatirchi	1,85	0,017	0,92	0,0085	0,027	1,46	1,82	1,87
Navoi (upper)	13,4	0,216	1,61	0,108	0,343	2,56	13,05	13,7
Navoi (lower)	13,5	0,258	1,91	0,129	0,41	3,04	13,08	13,9
Bukhara (upper)	17,9	0,23	1,29	0,115	0,367	2,05	17,53	18,2
Bukhara (lower)	20,3	0,141	0,69	0,07	0,224	1,1	20,07	20,5
Copper, mkg/dm^3								
Ravodkhodja	2,2	0,0081	0,37	0,004	0,012	0,59	2,18	2,21
Samarkand	3,97	0,023	0,58	0,011	0,036	0,92	3,93	4
Siab	4,52	0,018	0,4	0,009	0,029	0,64	4,49	4,54
Siab (additional)	2,62	0,023	0,88	0,011	0,036	1,4	2,58	2,65
Taligulyan	2,53	0,016	0,64	0,008	0,025	1,02	2,5	2,55
Kattakurgan	3,97	0,023	0,58	0,011	0,036	0,92	3,93	4
Khatirchi	2,88	0,0081	0,28	0,004	0,012	0,45	2,86	2,89
Navoi (upper)	3,43	0,025	0,75	0,012	0,041	1,19	3,38	3,47
Navoi (lower)	1,98	0,011	0,58	0,005	0,018	0,92	1,96	1,99
Bukhara (upper)	0,97	0,0081	0,84	0,004	0,012	1,33	0,95	0,98
Bukhara (lower)	1,34	0,0115	0,86	0,005	0,018	1,37	1,32	1,35

The last value is V to find the calculated mean confidence threshold. D. Ponomarev multiplied by the corresponding coefficient given in column 0.95 from the student table in page 34 of Part II of Analytical Chemistry [8].

Relative error in confidence interval% (deviation) - ts_x,%

The accuracy of the obtained mean intervals (from + to -) is guaranteed.

As can be seen from the table above, there is little error in the statistical analysis of mineralization, nitrite ion, chemical consumption of oxygen, phenols, and copper. The reliability of laboratory tests is 95%.

IV.CONCLUSION

The Zeravshan River is an anthropogenic river, that is, it uses excessive use of chemicals (nitrate, phosphate, pesticides) in agriculture, and discharges wastewater in industrial and industrial areas (heavy metals, toxic substances, nitrogen compounds), household (inorganic and inorganic) wastewater discharges to the river. This results in heavy pollution of the river. The mineralization, phenols, and chemical oxygen consumption have increased dramatically since Navoi (upper) monitoring station. The river is contaminated by sewage from the collectors of Siab, Taligulyan, Chegonak and sewage from Navoiazot and Navoi thermal power plants.

In addition, the sewage has a significant impact on the water quality of the Zeravshan River.

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