Published in the Slovak Republic
Russian Journal of Biological Research
Has been issued since 2014.
E-ISSN: 2413-7413
2018, 5(1): 20-26

DOI: 10.13187/ejbr.2018.1.20
www.ejournal23.com

Ecological Monitoring of the River Khrami Water and Anthropogenic Load

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Abstract

The river Khrami, a right tributary of the Kura river, has vital importance for Kvemo Kartli region. The river Khrami irrigates thousand hectares of arable land and is used as drinking water in the villages. That is why, it is very important to maintain its ecological relevance.

Based on the monitoring data from 2016-2017, it can be concluded, the ecological condition of the river Khrami is highly affected by one of its tributaries – the Mashavera river. The Mashavera river flows in the vicinity of mining quarries. The water of the river Khrami is of hydrocarbonate – type, high in calcium. The nitrogen level and biological oxygen consumption do not exceed the permissible limit. The soluble forms of the heavy metals change but their concentration do not exceed the permissible limit which is conditioned due to the high pH of the river water, which hydrolyzes heavy metals and their main part precipitates on the bottom and the rest is sorbed on floating debris. The anthropogenic substances in the riverThe anthropogenic substances in the river Khrami, are transformed into non-toxic admixtures due to chemical, physical-chemical and biological processes. Organic and biogenic substances are oxygenated or consumed by life forms. Due to this or the process, called self-purification, the ecological condition of the river is satisfactory.

Keywords:The Khrami river, heavy metals, biogenic compounds, hydrochemistry, main ions of natural water, anthropogenic pollution.

1. Introduction

The river Khrami is a righttributary of the Kura river and flows in Eastern Georgia. The river Khrami originates in the Trialeti range and flows into a deep valley. It is 201 km long, water basin is 8340².km, its average consumption is 51 cubic meter/second,maximum consumption448 cubic meter/second. It is fed by snow, does not freeze in winter and its lower part is used for irrigation. The Tsalka Reservoir and three hydroelectric power plants are built on the Khrami.Its tributaries – the Debeda and Mashavera rivers have important impact on its structure (Gigineishvili, 1987).

The river Khrami is an important water source for KvemoKartli and nearly its every cubic meter is registered. Today, the water of the river Khrami is used as drinking water in many villages and even more villages plan to use it for the same purpose (Mchedluri, 2009). Thousand hectares of arable landis irrigated by the river Khrami and thousand hectares more are planned to be, dispite the growing irrigation water scarcity. The villages “linked” to the river Khrami, are settled

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with Azeri population, who are mainly engaged in agriculture, as the main source of their income, and the river flow reduction threatens their basic food security.

2. Materials and methods

Chemical analyzes of the river Liakhvi water were carried out using modern methods, which meet and come into compliance with European standards, such as ion-selection chromatography – ICS-1000) ISO100304-1: 2007; Spectrometer – SPECORD 205ISO7150-1: 2010; Membrane filtration – ISO9308-1, ISO 7899-2; Atomic absorption spectrometer – ICP-MS; Portable Field Office HORIBA-10 (ISO 6058:1984; ISO 6059:1984; ISO 9297:1989).

3. Results and discussion

The monitoring of the river Khrami water was conducted seasonally in 2016-2017. The research was conducted at two sites: Khrami – Imiri (№1) and Khrami– Red Bridge (№2), and the samples were taken in four different seasons of the year (winter, spring, summer and autumn).

The physical-chemical characteristics, such as – t°C, pH; hydrochemical parameters-salinity, transparency, mineralization, dissolved oxygen (Do) and so on; biogenic elements – NO_2^-, NO_3^-, NH_4^+, PO_4^{3}; main ions of natural water – Na^+,K^+, Ca^{2+}, Mg^{2+}, Cl-,SO_4^{2}, HCO_3^-) and heavy metals - Fe,Cu,Zn,Mn,Pb) were measured in the samples. The findings are given in the Tables 1, 2 and Figures 1-2.

Table 1. The river Khrami water hydrochemical research findings (2016)

Description	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khram iImiri
№	1	2	1	2	1	2	1	2
Time of taking samples	winter	winter	spring	spring	summer	summer	autumn	autumn
Temperature. t°C	5.46	6.5	13.1	11.8	23.8	21.8	6.9	6.6
Hardness. mg. eq/l	4.41	3.77	3.67	3.96	4.42	3.70	3.86	3.30
Smell. degree	0	0	0	0	0	0	0	0
Transparency. cm	10	10	9	7	11	11	11	10
Weighed up particles mg/l	-	-	70.2	125.2	-	-	-	-
pH	8.41	8.24	8.58	8.36	8.1	8.30	7.83	8.11
Carbonate. mg/l	2.1	1.5	3.3	2.4	1.2	2.4	-	-
Dissolved oxygen mgO_2/l	11.5	11.8	9.8	9.8	5.8	5.16	11.3	10.7
Oxygen saturation level%	111	116	96	95	70	61.2	91	85
Biochemical Oxygen $demand_5$. mgO_2/l	1.56	0.79	0.63	0.87	1.49	2.16	2,08	1,34
NNitrite NitrogenmgN/l	0.041	<0.001	0.022	0.048	0.011	0.002	0.020	0.039
Nitrate Nitrogen. mgN/l	2.289	2.211	1.312	1.744	1.623	0.214	2.178	1.955
Ammoniacal nitrogen. mgN/l	0.322	0.331	0.159	0.421	0.268	0.281	0.262	0.211
Phosphate. mgP/l	<0.001	<0.001	1.112	0.038	0.041	0.144	0.062	0.256
Sulphates.mgSO_4^{--}/l	71.22	43.91	0.040	36.11	89.64	35.51	71.78	50.15

Chlorides. mgCl/l	10.70	8.47	44.52	6.99	12.86	8.28	10.18	8.05
Fluorine.mg/l	0.006	0.150	6.242	0.186	0.322	0.155	0.122	0.141
Hydrocarbonates mg HCO_3/l	223.04	198.20	188.82	206.92	234.55	230.16	227.9	166.49
Potassium.mg/l	1.7	1.4	1.2	1.1	1.8	1.5	1.4	1.2
Sodium.mg/l	25.5	18.5	14.6	10.5	22.5	12.9	26.6	15.8
Calcium. mg/l	60.01	51.28	52.93	56.73	68.56	46.44	56.62	46.55
Magnesium. mg/l	14.84	16.58	14.24	15.22	12.88	12.82	14.80	12.96

Table 2. The river Khrami water hydrochemical research findings (2017)

Description	**Khrami Red Bridge**	**Khram iImiri**	**Khrami Red Bridge**	**Khrami Imiri**	**Khrami Red Bridge**	**Khrami Imiri**	**Khrami Red Bridge**	**Khrami Imiri**
№	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Time of taking samples	**winter**	**winter**	**spring**	**spring**	**summer**	**summer**	**autumn**	**autumn**
Temperature. t°C	6.12	6.18	13.2	12.4	22.6	20.2	6.1	6.5
Hardness. mg. eq/l	3.98	3.47	4.27	3.86	4.12	3.20	3.66	3.32
Smell. Degree	0	0	0	0	0	0	0	0
Transparency. cm	8	8.5	9.1	8	10	11	9	10
Weighed up particles. mg/l	-	-	70.2	125.2	-	-	-	-
pH	8.11	8.15	8.28	8.30	8.12	8.15	7.88	8.10
Carbonate. mg/l	2.2	1.9	3.1	2.6	1.4	2.5	-	-
Dissolved oxygen. mg O_2/l	11.0	11.3	9.1	8.8	5.2	5.12	11.2	11.0
Oxygen saturation level %	102	114	94	93	68	61.0	90	82
Biochemical Oxygen demand$_5$ (BOD) mg O_2/l	1.55	0.89	0.66	0.89	1.52	2.33	2,16	1,58
NNitrite Nitrogen. mgN/l	0.052	0.002	0.025	0.066	0.018	0.004	0.024	0.044
Nitrate Nitrogen. mgN/l	2.423	2.231	1.328	1.735	1.539	0.211	2.188	2.244
Ammoniacal nitrogen. mg N/l	0.342	0.334	0.163	0.577	0.382	0.488	0.274	0.308
Phosphate. mg P/l	<0.001	0.055	1.114	0.048	0.046	0.126	0.066	0.288
Sulphates.mg SO_4^{--}/l	75.68	49.22	48.34	39.66	99.34	47.54	78.73	54.66
Chlorides. mgCl/l	12.70	8.44	19.59	6.90	12.88	7.36	11.19	8.04

Fluorine. mg/l	0.084	0.282	5.148	1.180	0.4 28	0.178	0.128	0.152
Hydrocarbonates. Mg HCO_3/l	221.14	198.25	180.82	206.98	220.50	239.30	230.8	168.28
Potassium. mg/l	1.8	1.6	1.6	1.7	1.6	1.4	1.2	1.8
Sodium.mg/l	18.5	17.6	14.8	10.5	22.6	18.5	18.0	17.5
Calcium. mg/l	62.78	48.28	44.96	58.11	68.44	56.14	55.13	56.51
Magnesium. mg/l	12.38	18.55	14.44	17.36	14.80	11.82	12.88	12.33

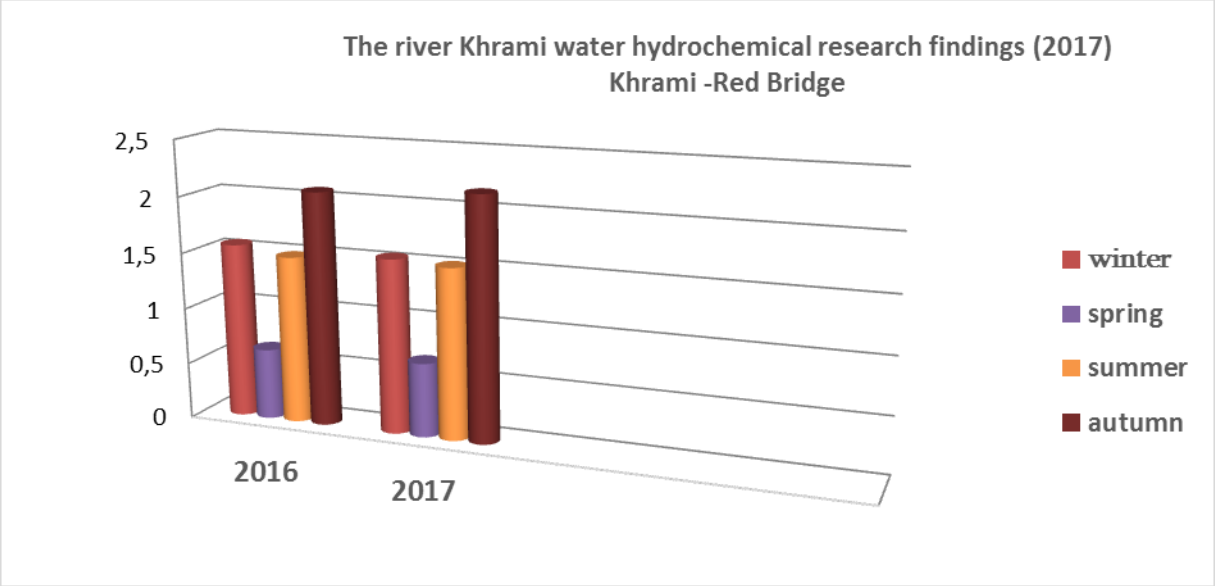

Fig. 1. Seasonal changes of BOD in the water of the river Khrami (Red Bridge)

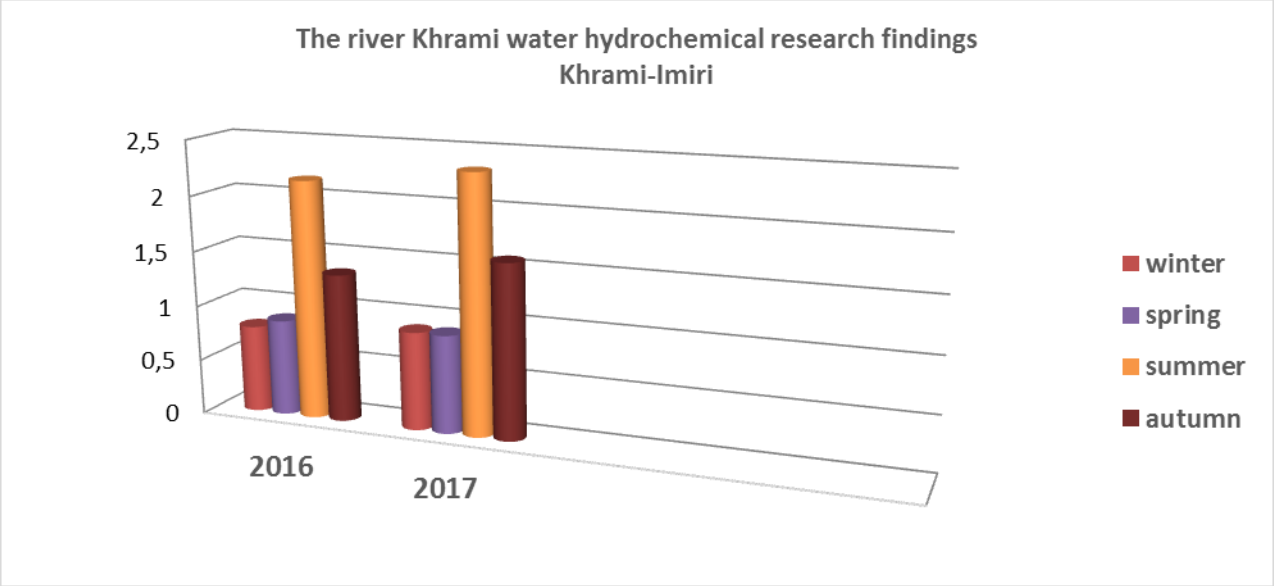

Fig. 2. Seasonal changes of BOD in the water of the river Khrami (Imiri)

The Mashaverariver, used for irrigation, joins the river Khrami at the village Nakhiduri. There are 5 irrigation systems on this river, which irrigate 7440 hectaresof Bolnisi and Marneuli cultivable land. The Kazretula river, which is very contaminated with heavy metals, joins the river Khrami as well. This river flows near the vicinity of regions with mining quarries. Heavy metals and acid water are penetrated in its water from the Sakdrisi gold mining quarry (Mchedluri, 2012).

That is why, it is important to measure the concentration of certain heavy metals in the river Khrami water. The monitoring of the river Khrami was conducted Khrami-Imiri (№1)and Khrami-Red Bridge in 2016-2017. The concentration of several heavy metals, specific for the region, was measured in the taken water samples and the findings are given in the Tables 3-4 and a Figure 3.

Table 3. Concentration of certain heavy metals in the water of the river Khrami (2016)

Description	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khrami Imiri
№	1	2	1	2	1	2	1	2
Time of taking samples	spring	spring	summer	summer	autumn	autumn	autumn	autumn3
Iron mg/l	0.2098	0.4158	0.2194	0.1096	0.0933	0.0683	0,1700	0,2073
Zinc mg/l	0.0293	0.0317	0.0417	0.0093	0.0090	0.0065	0,0108	0,0078
Coppermg/l	0.0236	0.0128	0.0240	0.0085	0.0099	0.0034	0,0073	0,0048
Leadmg/l	0.0013	0.0011	0.0054	0.0042	0.0011	0.0038	0,0027	0,0018
Manganeseml/l	0.0464	0.0422	0.0797	0.0090	0.0064	0.0050	0,0069	0,0087

Table 4. Concentration of certain heavy metals in the water of the river Khrami (2017)

Description	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khrami Imiri
№	1	2	1	2	1	2	1	2
Time of taking samples	Spring	spring	spring	spring	summer	summer	autumn	autumn
Iron mg/l	0.2228	0.3877	0.2290	0.1198	0.1732	0.0723	0,1805	0,2570
Zinc mg/l	0.0256	0.0312	0.0398	0.0089	0.0099	0.0055	0,0138	0,0070
Copper. mg/ლ	0.0211	0.0202	0.0248	0.0088	0.0091	0.0045	0,0080	0,0068
Lead. mg/l	0.0018	0.0014	0.0048	0.0044	0.0021	0.0040	0,0032	0,0020
Manganese. mg/l	0.0457	0.0445	0.0782	0.0086	0.0066	0.0058	0,0077	0,0079

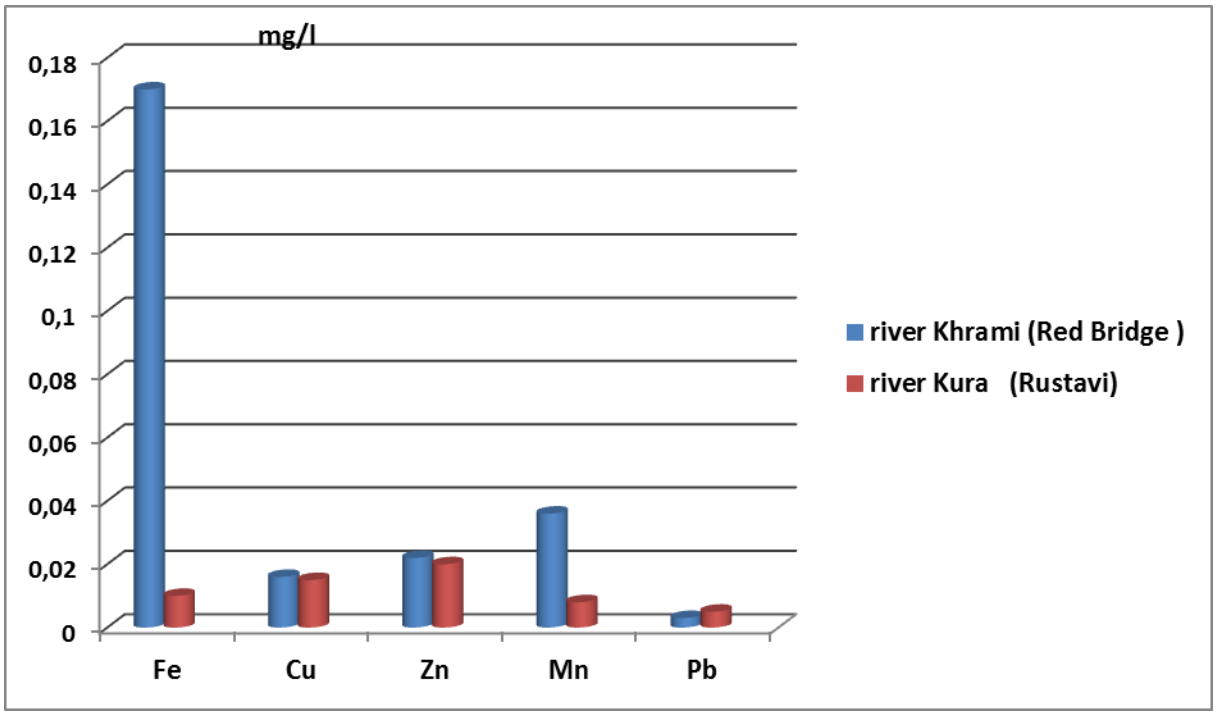

Fig. 3. Comparative study of certain heavy metals' concentration in the water of the Kura river and the river Khrami

Predictably, concentration of heavy metals in the river Khrami was higher than in the Kura river as it is given in the Figure 3. The Figure 3 shows that iron concentration in the water of the river Khrami was 15 times higher than in the Kura river, manganese concentration 4.5 times higher and so on. Although, their concentration did not exceed the maximum permissible level due to the high pH of the river water.

4. Conclusion

Based on the research findings, it can be concluded that the river Khrami water is a hydrocarbonate-type, high in calcium. The nitrogen level and biological oxygen consumption do not exceed the permissible limit.

After completing the study on the heavy metals concentration, it can be concluded that the ecological condition of the river Khrami is highly affected by one of its tributaries – the Mashaverariver.Mining quarries and Sakdrisi gold mining quarry have serious anthropogenic impact as well, due to which the concentration of certain metals in the river Khrami water is higher than in the Kura river (city Rustavi). Although, the heavy metals concentration in the river water does not exceed the permissible level.

According to the monitoring findings, the soluble forms of the heavy metals change but their concentration do not exceed the permissible limit which is conditioned due to the high pH of the river water, which hydrolyzes heavy metals and their main part precipitates on the bottom and the rest is sorbed on floating debris.The anthropogenic substances in the river Khrami, are transformed into non-toxic admixtures due to chemical, physical-chemical and biological processes. Organic and biogenic substances are oxygenated or consumed by life forms. Due to this or the process, called self-purification, the ecological condition of the river is improved.

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