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STUDY OF ALAZANI RIVER AND SURFACE WATER COMPOSITION IN SOME VILLAGES OF KAKHETI REGION OF GEORGIA

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ABSTRACT

The article reviews the chemical composition of borehole and surface waters in three villages of one of the regions of Georgia - Kakheti, Gurjaani Municipality. The study was specifically focused on iodine content in waters. It turned out that certain amount of iodine really existed in borehole waters, which means that by everyday drinking of water, the human body gets maybe not the complete required amount of iodine, but at least some part of it. It was also discovered, that according to certain parameters, waters are clean, do not contain heavy metals and can be freely used for drinking and cooking. The chemical composition of the Alazani River was also examined according to all four seasons. This river is interesting because of being used for irrigation of vineyards and fruit gardens.

Keywords: *Georgia waters, environmental chemistry; river pollutants, drinking water.*

1. INTRODUCTION

Water cleanliness is of particular importance nowadays. This is conditioned by the fact that pollutants from water directly penetrate into the human body. Through underground waters they flow into the ground, ultimately getting into surface waters. From there, they might be found in the atmosphere through deodorants

The purpose of our job was to study surface and borehole waters in some villages of Gurjaani region [1].

Gurjaani is a municipality of Kakheti region in east Georgia. The territory of Gurjaani municipality belongs to moderate humid subtropical climate zone. The moderately humid climate is developed on the plain in the east, with moderately cold winter and hot summer. There is a moderately humid climate on Gombori ridge, with long summers. The average annual temperature is 12,4°C, the average temperature of the coldest month – January is 0,11C, and of the hottest month – August - 35.8°C. Average annual precipitation on the major part of the territory is up to 800mm, ultimately decreasing to 500-600mm in the direction of the plateau.

Generally, water is not a problem in the villages of Gurjaani region. Water scarcity might be the case in any season. At this time, water in rural community tap is actually dependent on rainfall. Waters themselves flow down from mountains and gather in a catchment, with no treatment plant functional. Such plants might exist in some of the villages, though very outdated and needing repairs. Therefore, population avoids drinking the tap water.

There is no centralized wastewater system in villages; accordingly, affluent waters are not treated as, for instance, in neighbor countries [2]. As for rural spring waters, they are the so called borehole waters, originating from the top of the mountains. They do not gather in any catchment, but rather flowing down straight to the designated area (or to privately owned yards or village streets for common use) through the forest, being naturally filtered in the moss. The population drinks them directly (Fig.1; 2; 3). The water running to the village (running from community taps) is used for washing (including, for washing food products) and watering the house gardens.

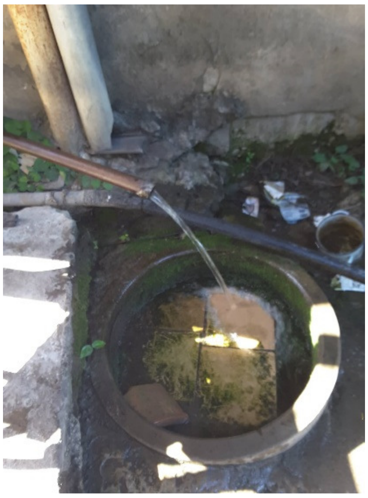

Figure 1. Borehole water in one of the village dwellers' yards (village Vazisubani)

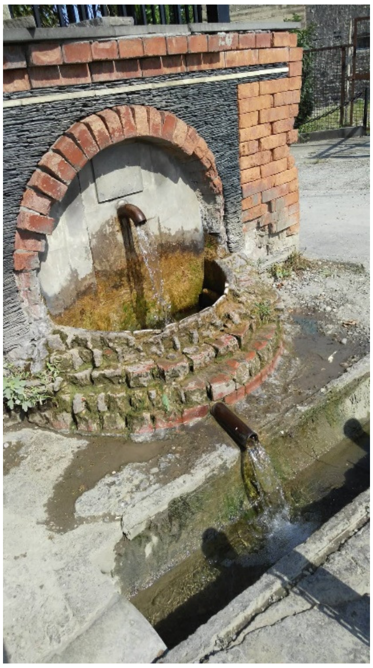

Figure 2. Borehole water in village street (Village Kalauri)

Figure 3. Borehole water on the highway (Village Chalaubani)

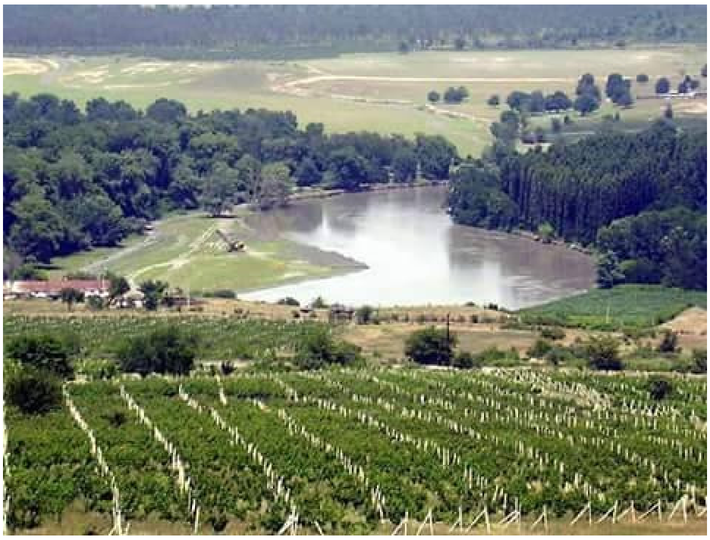

Figure 4. Alazani River

The chemical composition of the Alazani river (Figure 4) was also studied during the research process. It is one of the significant rivers of east Georgia, with a length of 390 km, catchment area – 11800 sq.km. River head is located on the Greater Caucasus mountain range, on the eastern slope of peak Great Borbalo. In the upstream it is a mountain river, flowing down to Alazani valley, developing the branches and joining the Mingechauri Reservoir (Azerbaijani). Before reservoir construction, Alazani used to stream down directly into Mtkvari River. Adjacent planes of the Alazani River belong to the vinegrowing municipality, and the river is used for irrigation. Interestingly, here, one can find different varieties of grapes (Rkatsiteli, Mtsvane, Cabernet, Saperavi, etc.). The banks of Alazani River are covered by cultivated strawberry and peach gardens. That's why we are interested in the ecological condition of Alazani, as, in case of its pollution, it can contaminate food products as well. Unfavorable ecological condition of Alazani River may be resulted by untreated affluent municipal waters, as well as by drainage runoff from agricultural lands. The river is also significantly contaminated by existing legal and illegal landfills, often located on river banks [3,4,5].

It should be noted that polluted landfill left-over waters are extremely toxic for water ecosystems, containing both organic substances, heavy metals, and other dangerous components. The river is used for irrigation of agricultural crops without any specific biological and chemical treatment. In this case, the whole polluted water body is filtered in the soil, enriching it with both heavy metals and various toxic compounds, often posing a threat of polluting the products, especially the vegetables cultivated in this zone.

2. MATERIALS AND METHODS

Samples were taken throughout the year of 2018, during all the four seasons of the year, but not in all cases. Iodine samples were taken in all four seasons.

5 samples were taken from the village Vazisubani. From there, 4- from borehole water and one from rural surface water.

Three samples were taken from the village Kalauri. Out of them, 2 were taken from borehole water and one-from rural surface water.

Two samples were taken from village Chalaubani, both of them from borehole water.Mainly the following parameters were examined: pH; Carbonate hardness; Common acidity, general acidity; Presence of Sulfate and chloride ions; the existence of some heavy metals and iodine samples. The main physiological function of iodine is to participate in the metabolism of hormones produced by the thyroid gland. Thyroid and breast glands are characterized by the ability to accumulate iodine. Its accumulation is also visible in saliva. Iodine deficiency is characterized by a number of symptoms: weakness, skin jaundice, feeling of cold, hair loss, irritability, frequent fatigue, memory loss, and finally, the most important development of feeble-mindedness [6,7,8].

Nowadays, world medicine has found the easiest and cheapest way of getting iodine, which means iodine supplementation in the salt, i.e., the use of iodized salt. However, this is also a disputable issue, because the same salt needs to be stored in a remote place away from sunlight to prevent iodine disintegration. It can be done at home, but we do not know in what conditions the salt was stored or transported before getting placed on supermarket shelves. Even if we assume that iodine really exists in salt and is not disintegrated, eating large amounts of salt creates other, not less dangerous problems to the body. Thus, we should be looking for other additional natural ways of getting iodine both from products and water [9].

It's a common knowledge that one of the reasons causing goiter disease is iodine deficiency in potable water. It is established that in the places where one liter of potable water contains 0,0001-0,001mg iodine, i.e., 0,1-1,0 mg, from 1000 people 15-30 men get diseased with goiter. Where iodine content reaches 0.001-0,01mg in a liter, from 1000, only two-three disease cases are registered [10,11,12].

Borehole water studies have shown that waters contain different quantities of iodine in different periods of the year. It depends on a number of conditions, for instance, on rocks, from which the spring is flowing down, on atmospheric conditions, on time, on soil type, etc.

Deriving from the above mentioned, we've explored iodine content in surface waters of the aforementioned villages. Iodine was defined through the following method [13,14,15,16,17]: iodides were oxidized through bromine water till getting iodates, and the segregated iodine was determined by the iodometric method:

$I^- + 3OBr^- \rightarrow IO_3^- + 3Br^-$

$IO_3^- + 6H^+ + 6I^- \rightarrow I^- + 3I_2 + 3H_2O$

$3I_2 + 6S_2O_3^- \rightarrow 3\ S_4O_6^{-2} + 6\ I^-$

Basically, we applied the methods of quantitative analysis for defining other parameters (total hardness, alkalinity, acidity). Through quantitative analysis, we also determined nitrates, nitrites, and sulfate ions. Chlorine defining method was based on chlorine-ion titration with a solution of mercury nitrate in the presence of indicator dyphynill carbasone. During titration, Mercury ions join chlorine ions and produce slightly dissociating HgCl2. And excess ions of mercury produce complex purple compounds with indicator dyphynill carbasone.

In the course of the experiment, we determined some of the metals: TS EN ISO 7294-2, TS EN ISO 11885. pH, temperature, conductivity, and suspended solids were measured on site, through methods SM 4500 H^+ B, SM 2550 B and SM 2540 D. [18,19,20]. Obtained results are given in tables #1-8. Samples from Alazani were taken in spring and summer from the points descending into the river from Village Vazisubani. See the results in Table #9

3. RESULTS AND DISCUSSIONS

Carbonate hardness of examined waters is within the norms. However, it can be said that they have hardness. Compared to borehole waters, hardness is higher in village tap waters. General alkalinity and acidity are much less compared to the norm. However, their indicator in rural village surface waters is significantly higher compared to borehole waters. The maximum indicator was observed in the summer season. It is significant that the quantity of ammonium ion, nitrates, and nitrites is minimal. This means that anthropogenic contamination should be completely excluded. As for the sulfate ions, they do not exist in borehole waters. A very little amount was observed in rural tap water. Hereby we note, that there is a very low indicator of aluminum in waters and it does not exist in the form of sulfate. Aluminum may get into surface and underground waters through affluent waters. There is no central wastewater system in villages and used rural surface water flows down to the ground. Aluminum sulfate might get into wastewater through cheap household chemistry, shower gels, shampoo, washing jellies). However, in our case, sulfate ions in rural surface waters are present in insignificant amounts, but they are completely absent in borehole waters, which means that no mixing or water contamination takes place there.

As for other metals, copper exists in rural surface water in little amounts. Presumably, water is polluted in catchments, where rural surface water is collected before running into the village. Iron is present in all types of water in little quantities, and we assume that it might be caused by pipes. Lead and manganese aren't measured anywhere.

It is notable that no metal is observed in borehole waters of village Chalaubani. These waters are channeled on the main road, where numerous passengers and tourists use to stop. Pipes, where water flows from, are made of stainless steel.

We haven't measured the hazardous heavy metals in any sample, such as mercury and cadmium (lead belongs to the group, we measured). Although we conducted the reactions to discover these metals, their existence was not revealed.

As for iodine content, it is observed in examined rural borehole waters in certain amounts. Sometimes it is absent, or present in very little quantities in rural tap waters.

According to seasons of the year, iodine is more in samples taken in summer (especially April-May), which probably is related to intensive washout of substances included in rocks due to rainfall in these months.

For a comprehensive assessment of Alazani river ecological condition, we considered it relevant to study the process of its mineralization. As the studies showed, the river is characterized by average mineralization near Vazisubani area, with the value varying between 140-160 mg/l. The following ions are found in water HCO^{-3}, Cl^-, SO_4^2, Ca^{2+} , Na^+ , Mg^{2+} etc.

There is an anthropogenic impact. For instance, the wastewater system in Gurjaani is not in good working conditions or represents an open sewage system; their ravines are used as landfills and the coastline - as a "resting place" for animals, therefore, they play a big role in polluting the Alazani River. As a result of observation, it was established that cation concentrations in the Alazani River increase streamwise and do not exceed maximum permissible concentration. As for SO_4^{2-} and Cl ions, they increase, indicating an intensification of anthropogenic impacts, fecal contamination, and eutrophication process. Compositions of biogenic elements (NO_2^-, NO_3^-), increasing streamwise, reach the maximum value in Gurjaani, where their concentrations are number of times more than 0.002 mg/l.

On the whole, pollution of the Alazani River does not go beyond the norm. In our opinion, it happens thanks to self-purification of the river. During this time, water more or less regains the original chemical and bacteriological composition.

This is facilitated by the turbulent flow of Mountain Rivers and good aeration. In addition, increased turbidity creates favorable conditions for sorption purification of water.

4. CONCLUSIONS

As a result of the research conducted, borehole waters in Gurjaani municipality villages – Chalaubani, Kalauri, Vazisubani, are of good quality and can be used for drinking. In addition, a certain amount of iodine was observed in the inspected borehole waters, which means that drinking these waters is also useful for health.

It is preferable to abstain from drinking rural surface waters. However they can be used for irrigation and washing purposes.

Alazani River studies have shown that, on the whole, its pollution is within the norms and presumably this is achieved by self-purification of the river.

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Table 1. Some parameters of borehole and surface waters in village Vazisubani

village Vazisubani	Unit	Standard	Sample1 (Borehole water)		Sample 2 (Borehole water)		Sample 3 (Borehole water)		Sample 4 (Borehole water)		Sample 5 (Vilaage Water)	
			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
pH	-	6-9	7.8	6.2	8.7	8.4	7.9	6.1	8.0	7.6	9.3	6.1
Conductivity	µS/cm	<2500	140	111	101	98	120	73	90	63	87	69
Color	Pt-Co	<10	-	-	-	-	-	-	-	-	8	5
Temperature ºC	ºC		17	6	16	8	13	5	15	8	23	5
Suspended Solid	mg/L		-	-	-	-	-	-	-	-	-	<2
Total Hardness	mg/L	<50	9.0	7.6	10.2	8.1	15.4	8.2	12.02	9.1	20,1	14,3
Sulfat (SO_4)	mg/L	<250	-	-	-	-	-	-	-	-	0,57	0.23
Alkalinity	mg/L	<200	3,85	2,01	3,5	1,97	2,18	2,02	2,0	0,34	4,18	4,2
Acidity	mg/L	<300	0,7	0,54	0,67	0,53	1,8	1,06	1,07	0,52	3,8	1,63
NH4	mg/L	0.2	0,08	0.01	0.12	0.02	0,07	0.02	0,1	0.011	0.2	0.04
Ammonia Nitrogen (NH3-N)	mg/L	0.2	0.1	0.01	0.1	0.01	0.32	0.05	0.2	0.01	0.2	0.07
Cl	mg/L	250	5.0	4.0	23.8	15.9	37.2	32.1	29.0	22.8	54.1	21.6

Table 2. Some metals of borehole and surface waters in village Vazisubani

village Vazisubani	Unit	Standard	Sample1 (Borehole water)		Sample 2 (Borehole water)		Sample 3 (Borehole water)		Sample 4 (Borehole water)		Sample 5 (Vilaage Water)	
			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Al	µg/L	1-200	1.0	0	0.5	0.2	0.3	0.01	1.2	1	13.8	9.0
Cu	µg/L	100	-	-	-	-	-	-	-	-	14	9
Fe	mg/L	0.2	0.13	0.01	0.11	0	0.11	0.1	0.09	0.02	0.21	0.11
Pb	µg/L	10	-	-	-	-	-	-	-	-	-	-
Mn	µg/L	50	-	-	-	-	-	-	-	-	-	-

Table 3. Some parameters of borehole and surface waters in village Kalauri

village Kalauri	Unit	Standard	Sample1 (Borehole water)		Sample 2 (Borehole water)		Sample 3 (Vilaage Water)	
			Max	Min	Max	Min	Max	Min
pH	-	6-9	7.2	4.1	8	7.4	7.2	5.01
Conductivity	µS/cm	<2500	120	88	131	69	120	53
Color	Pt-Co	<10	-	-	-	-	8	4
Temperature ºC	ºC		15	7	14	4	19	7
Suspended Solid	mg/L		-	-	-	-	-	<1.5
Total Hardness	mg/L	<50	8.0	6.1	12.0	9.3	18.7	6.02
Sulfat (SO_4)	mg/L	<250	-	-	-	-	1.0	0.45
Alkalinity	mg/L	<200	2.0	0.04	2,0	0,25	8,98	9,02
Acidity	mg/L	<300	1,07	1,02	1.5	0,65	0,9	0,99
NH4	mg/L	0.2	0,01	0	0,01	0.014	0.09	0.03
Ammonia Nitrogen (NH3-N)	mg/L	0.2	0.56	0.07	0.2	0.1	0.2	0.09
Cl	mg/L	250	8	7	11.8	5.7	43.7	35.2

Table 4. Some metals of borehole and surface waters in village Kalauri

village Kalauri	**Unit**	**Standard**	**Sample1 (Borehole water)**		**Sample 2 (Borehole water)**		**Sample 3 (Vilaage Water)**	
			Max	Min	Max	Min	Max	Min
Al	µg/L	1-200	1.2	0.9	1.89	1. 34	18.7	7.9
Cu	µg/L	100	-	-	-	-	12	8
Fe	mg/L	0.2	1.1	0.05	0.2	0.01	0.43	0.14
Pb	µg/L	10	-	-	-	-	-	-
Mn	µg/L	50	-	-	-	-	-	-

Table 5. Some parameters and metals of borehole and surface waters in village Chalaubani

village Chalaubani	Unit	Standard	Sample1 (Borehole water)		Sample 2 (Borehole water)	
			Max	Min	Max	Min
pH	-	6-9	6	6.7	8.01	8.05
Conductivity	µS/cm	<2500	57	34	45	23
Color	Pt-Co	<10	-	-	-	-
Temperature ºC	ºC		5	3	7	2
Suspended Solid	mg/L		-	-	-	-
Total Hardness	mg/L	<50	2.9	2.0	3.7	3.0
Sulfat (SO_4)	mg/L	<250	-	-	-	-
Alkalinity	mg/L	<200	43	12	32	16
Acidity	mg/L	<300	1.98	1.0	2.8	0.97
NH4	mg/L	0.2	-	-	-	-
Ammonia Nitrogen (NH3-N)	mg/L	0.2	-	-	-	-
Cl	mg/L	250	114.5	48.6	23.8	8.1
Al	µg/L	1-200	-	-	-	-
Cu	µg/L	100	-	-	-	-
Fe	mg/L	0.2	-	-	-	-
Pb	µg/L	10	-	-	-	-
Mn	µg/L	50	-	-	-	-

Table 6. Iodine content borehole and surface waters in village Vazisubani

village Vazisubani	Unit	Standard	Winter	Spring	Summer	Autumn	Average
	µg/L	4-18					
Sample1 (Borehole water)			2.4	19.4	18.5	3.2	10.8
Sample2 (Borehole water)			1.1	11.0	9.7	12.8	8.7
Sample3 (Borehole water)			0.8	5.3	5.0	8.6	3.4
Sample4 (Borehole water)			8.2	25.0	4.1	21.5	12.0
Sample 5 (Vilaage Water)			0.2	0.9	0.4	-	0.37

Table 7. Iodine content borehole and surface waters in village Kalauri

village Kalauri	Unit	Standard	Winter	Spring	Summer	Autumn	Average
	µg/L	4-18					
Sample1 (Borehole water)			8.9	15.0	13.2	12.8	12.4
Sample2 (Borehole water)			5.6	16.0	13.8	12.6	12.0
Sample 3 (Vilaage Water)			0.9	2.9	2.4	3.5	2.4

Table 8. Iodine content borehole waters in village Chalaubani

village Chalaubani	Unit	Standard	Winter	Spring	Summer	Autumn	Average
	µg/L	4-18					
Sample1 (Borehole water)			6.9	17.0	10.0	3.8	8.7
Sample2 (Borehole water)			13.5	7.0	3.2	4.2	4.4

Table 9. Some parameters from Alazani River

Some parameters from Alazani River	Gurjaani	
	Spring	Summer
Odor (in scores)	0	0
Color	20	20
Transparency	8.0	8.9
pH	7.9	8.3
BOD	7.2	6.5
Suspended substances	79	80