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Chemical Composition of Artificial Reservoirs and Saline Soils in Kakheti Region

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Research Article

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ABSTRACT

The purpose of our researches is to integrate surveys of the soils of the Alazani valley, as it is one of the urgent actions to mitigate and or prevent anthropogenic undesirable actions. As well as the study of the chemical and microbiological composition of artificial reservoirs placed on these soils for production of ecologically clean products is essential. The paper deals with the Alazani valley soils (v. Old Anaga) in order to establish the quality of their fertility and salinization of soils in the artificial reservoirs. To determine the chemical and microbiological contamination, at their surrounding areas as well as to assess the adverse effects of anthropogenic activities to promote mitigation measures and Recommendations which will be developed on the basis of our results to the farmers of the studied reservoirs to take effective measures that will facilitate the production of ecologically clean products and avoid any other negative actions

INTRODUCTION

In the modern world, the problem of limited resources, namely, the reduction of food resources is increasing. First of all, it concerns the land and especially the agricultural lands, because the latter is decreasing due to anthropogenic impact and this happens on the background of rapid growth of the planet's population. The same situation is in Georgia, in the Kakheti region, the Alazani valley. Artificial reservoirs are located on the degraded soils. Despite the positive effect of the population (fish breeding, which leads to the improvement of socio-economic conditions of the population), artificial reservoirs gives a negative effect. Such effects include the destruction of arable lands, their swamp and etc. Under the operation of artificial reservoirs it is expected to increase the process of waves, hydrological processes, Especially on the soils of Alazani valley, which is characterized by heavy mechanical composition. The bed waters of these soils and the proximity of groundwater (1.5-3 m) leads to soil moisture which is why the soils are transformed into silks and marshes [1]. Even after the disposal of artificial reservoirs (cancellation), it will be difficult to conduct meliorative measures. Thus, the agricultural lands of the country will be reduced even more in Georgia [2].

MATERIALS AND METHODS

Study Report

The purpose of our researches is to integrated surveys of the soils of the Alazani valley, as it is one of the urgent actions to mitigate and/or prevent anthropogenic undesirable actions. As well as the study of the chemical and microbiological composition of artificial reservoirs placed on these soils for production of ecologically clean products is essential. Water samples were taken once in a quarter in 2016. The chemical and microbiological components were measured, in soil samples once in every 6 months [3]. The sampling continued in 2017 as well in the laboratory Soil samples were treated for chemical analysis Depending the method EPA 3051: drying, grinding, etc. [2,4]. In the soil samples were determined: main ions and dry balance at 0-20, 20-40, 40-60, 60-80 and 80-100 cm depth; forms (N, P, K) humus at 0-20, 20-40, 40-60 cm depth; heavy metals (Cu, Pb, Ag) at 0-10 and 10-20 cm depth depending the ISO 11885:2007. The results of the formation of humus and food items (N, P, K) are obtained in the samples of the soil of 0-1, 20-40, 40-60 cm [5].

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Table 1. Results of determining of the elements.

Name of the Soil	Depth, cm	Humus %	mg/100 g Dry wt		Hydrolyzed N mg/100 g
			P_2O_5	K_2O	
Village old Anaga	0-20	2.36	2.2	50.0	4.6
	20-40	1.46	1.8	43.0	4.0
	40-60	1.11	1.2	30.0	3.8

As it is shown in **Table 1** the humus content in the village old Anaga soils upper layers is 2.36% and in the depth its decreases and is 1.11%, reported at 40-60 cm, in fact this soil is humus-less secured. The soils are rich with compatible potassium (50.0 mg /100 g dry wt in the soil, but the amount of phosphorus is small enough). In the depth, potassium content decreases and is 30.0 mg/100 g in soil. The number of hydrolyzed nitrogen changes according to the humus content, maximum in the upper humus layer and is 4.6 mg/100 g in soil. In the depth, its number decreases. This indicates that the samples are low in hydrolysis, or the nitrogen content that is less suitable. The soil is considered to be the most productive soil. Determination of heavy metals in soil samples was carried out (Cu, Pb, Ag) at 0-10 and 10-20 cm depth. **Figure 1** provides results of analysis.

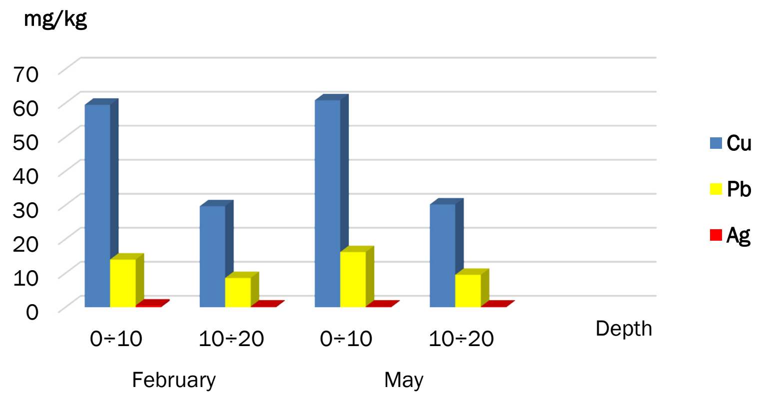

Figure 1. Heavy metals content in soil samples in Sighnaghi municipality village old Anaga (February, May -2016).

As seen on the summer (August), there is an increase in dry residue (0.610-1.956%) in old Anagasoils. In August, the salts maximum number was 1.956% at 60-80 cm depth. During this period the movement of salts is observed in the upper layers of soil, which is due to the combination of factors such as soil moisture, air temperature rise, soil drying, intensive evaporation of sediments from soil surface etc. The copper content in the top 0-10 cm layer is 59.53 mg/kg, and the lower 10-20 cm layer is 29.72 mg/kg. The copper content in Clarke is 47, while its average content in the soil is 20 mg/kg **(Figure 1)**. As seen from the results, copper content exceeds the average content of clarks in soil. The lead content in the top 0-10 cm layer exceeds its mean value in the soil. Silver content is within the norm. **Figure 2** shows the results of the salinity (dry residue) in village of old Anaga under the grass 2016, which is located in the vicinity of artificial reservoirs in 20 m. Observations were conducted during the winter and summer seasons. As shown from the figure, in the village of Sighnaghi municipality old Anaga the soils, in February, the dry residue ranges from 1.130-1.580%. In its depth of 40-60 cm minimal is (1.130%) and reaches maximum 60-80 cm depth (1.580%). This soil belongs to the strongest and most powerful saline soils [6,7].

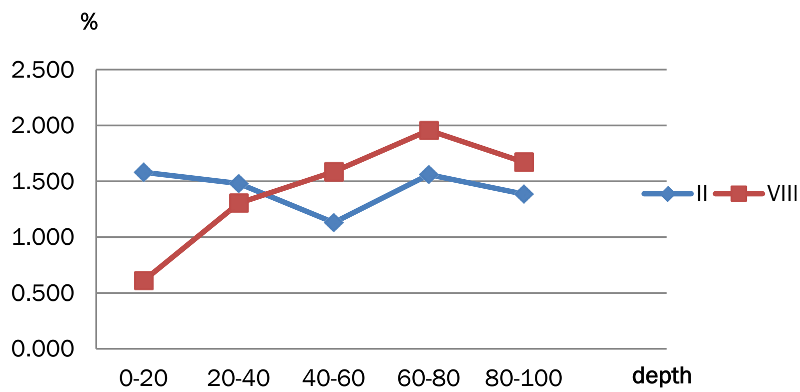

Figure 2. Dry residue content, (Old Anaga, Grass), II, VIII.

To those factors are added also ground water bodies, which are located close to the surface, resulting in a capillary-moisture. Due to this, immediate evaporation of ground water is accompanied by accumulation of salts in the upper layers of soil and strengthening the salinization process [2]. Based on the analysis, we can conclude that the natural grass soil is characterized by the movement and distribution of salts in the soil. Under conditions of climatic and hydro-geological factors, different parts of the profile are saline and desalinized. At the same time, the composition of the salts mainly changes in the layer of 40-80 cm. Salinization in these types of soil is caused by climatic factors, especially with sediments and evaporation, because salinization of these soils is not subject to economic impacts (cultivation, irrigation, etc.). **Figure 2** describes the content of the anions (CL^-, $SO4^{-2}$) and cations (Na^+, Ca^{+2}, Mg^{+2}) depending on the depth (0-100 cm) of the soil for February 2016. As seen from the figure, from the anions dominate the $SO4^{-2}$ ions, then followed by Na^+ ions and then Ca^{+2}, Cl^- and Mg^{+2} ions. The ratio of chloride ions to the sulfates is much less and the natural grass is salted by sulfate type salinity **(Figure 2)**.

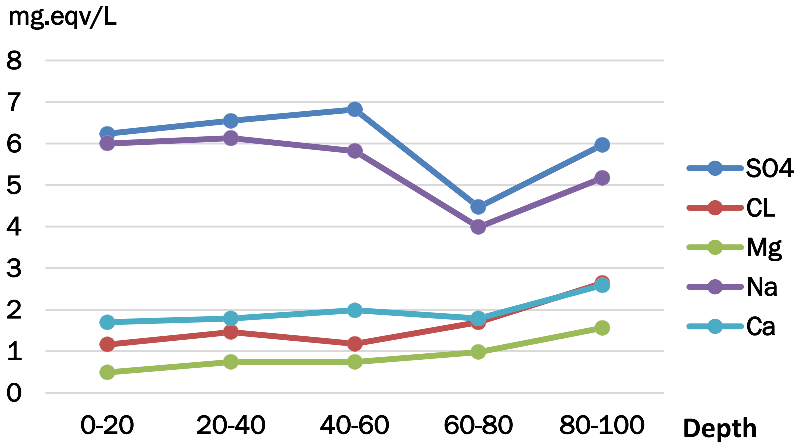

Figure 3. Ionic content (Old Anaga -Gass).

According to cations, the degree of salinity can be defined as alkaline-sodium, where sodium and calcium ions exceed magnesium ion. Distribution of sodium and calcium ions is different in profile: at the first meters exceeds sodium cations, and in the depth profiles the calcium cations **(Figure 3)**. The sodium sulfate-Na_2SO_4, which is formed, is a very easily soluble group of salts and is progressing in the upper horizons. Calcium sulfate ($CaSO_4$) is average soluble salts group. Consequently, the rapidly soluble salts are rising. While the NaCl and $MgSO_4$ are replaced by each other. Thus, during the process of salinization and desalinization processes in saline soils, the salinization process prevails because the natural washing of the soil does not occur, because the natural draining process is not in place.

RESULTS

Thus, according to the results of the study the soils in the mentioned village Anaga to its fertility belongs to low fertile soils, highly saline soils category, where the artificial reservoirs are located and where the fish breeding for sale is actively realized.

The results of conducted analysis show that the pH of water reservoirs varies within 8.21-8.22. There is a reaction to the alkaline direction. The water pH determines the oxidation-restorative potential and the ability to self-purify of the water. From the cations dominates Ca^{++} and the Mg^{++} Ions ($Na^+ > Ca^{++} > Mg^{++}$), which concentrations varies in the following ranges Na^+-11.5-280.0, Ca^{++} - 31.10-65.16, and Mg^{++} -11.22-21.75 mg/l. It should be noted that the content of these cations is high in winter months (February), which is due to our view that in the cold period of the year the water of the lower Alazani channel is closed and the number of water is significantly reduced in the reservoirs **(Table 2)**. Comparable levels of hydrocarbonates are 124.400 to 17.16 mg/l. The content of chlorine ions varies between 5.82-53.31 mg/l. Sulfate content is high (75.18-606.59 mg/l). Therefore, mineralization is high and 284.72-1051.2 mg/l.

Table 2. The results of the physical-chemical and hydrochemical analysis of Alazani valley reservoirs.

	Measured parameters	**Sighnaghi, Old Anaga**					
		New water reservoir	**old water reservoir**	**New water reservoir**	**old water reservoir**	**New water reservoir**	**old water reservoir**
		February		**May**		**October**	
1	Temperature , °C	6.2	6.3	12.4	12.3	11.8	11.5
2	Smell	0	0	0	0	0	0

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3	Transparency, cm	11	10	9	7	9	10
4	pH	8.22	8.21	7.64	7.41	7,84	7,97
5	Carbonate, mg/l	3.0	3.3	-	-	-	-
6	Carbon dioxide, mg/l	-	-	2.0	2.7	1,58	1,23
7	Hydrocarbonate, mg/l	217.16	146.40	124.44	170.8	146,44	183,0
8	Hardness, w/l	3.92	4.22	2.47	4.20	3,77	5,04
9	Ammonium, mg N/l	0.562	0.684	0,569	0,685	0,342	0,677
10	Calcium, mg/l	55.78	55.40	31.10	54.02	46,53	65,16
11	Magnesium, mg/l	13.78	17.69	11.22	18.27	17,57	21,75
12	Electrodynamics, μsms/cm	999	887	289	486	315	548
13	Dissolved oxygen mg/l	6.95	6.01				
14	BOD_5, mg/l	4.25	5.75				
15	Nitrate, mg/l	<0.001	<0.001	0.715	0.003	0,169	0,147
16	Nitrite, mg/l	0.003	0.006	0.424	0.006	0,008	0,329
17	Phosphate, mg/l	0.063	0.020	0.160	0.022	0,485	0,194
18	Color, mg/l	0.107	0.133	0.138	0.192	0,140	0,155
19	Sulfates, mg/l	396.26	606.59	75.18	237.40	80,62	153,47
20	Chlorides, mg/l	41.95	40.83	5.82	37.33	7,14	53,31
21	Sodium, mg/l	64.0	280.0	11.5	42.5	14,5	65,5
22	Potassium, mg/l	2.6	4.5	0.9	2.2	1,0	2,0
23	Mineralization, mg/l	791.55	1051.2	284.72	502.36	315,39	546,13
24	Copper, mg/l	0.0058	0.0044	0.0043	0.0048	0,0029	0,0031
25	Bullet, mg/l	0.0016	0.0036	0.0016	0.0012	0,0009	0,0019
26	Silver, mg/l	0.0006	0.0006	0.0002	0.0002	0,0004	0,0018

The artificial reservoir water belongs to moderate mineralization (500-1000 mg/l) [7,8] which the Kvemo Alazani irrigation channel is supplied with water and is filled artificial reservoirs. Results of the obtained analysis indicate that ammonium ions (0.342-0.685 mg N/L) are particularly distinguished from nitrogen mineral forms (NO_2-, NO_3-, NH_4^+) in the artificial reservoir waters that exceed the permissible concentrations in February and May. The concentrations of nitrates, nitrates and phosphates do not exceed the appropriate permissible concentrations Maximum permissible concentrations (MPC). The content of heavy metals (Cu, Pb, Ag) is within the norms [9]. As it is known, saline soils have a large amount of toxic salts, both in soil and in groundwater [10,11]. These are: hydrochloric and carbonic acid sodium salts - NaCl, $MgCl_2$, $CaCl_2$, Na_2CO_3, $NaHCO_3$, Na_2SO_4 and $MgSO_4$, among which the highest toxicity is characterized by soda and the lowest by sulphates. Among them are chlorides. Naturally, these toxic salts are easily found in soils and groundwaters in artificial reservoirs and cause pollution, which is a more important factor for the production of ecologically pure products as well as from economic point of view. In **Table 3** are presented the results of microbiological analysis of artificial reservoirs.

Table 3. Results of the microbiological analyses in Alazani valley artificial reservoirs.

Measured Ingredients	Unit	Signaghi vill. Old Anaga	
		New reservoir	Old reservoir
Total coliforms	In 1 dm^3	8 000	9 000
E-coli	In 1 dm^3	5 000	7 000
streptococcus fecalis	In 1 dm^3	600	750

As a result of water contamination, its physical properties (color, odor, turbidity), and chemical composition (organic, biogenic substances, heavy metals, etc.) and micro flora is changing. Water bacteriological cleanliness is assessed by E-coli content in a 1L of water. The high value of the Escherichia coli is water fecal pollution indicator which is clearly visible from the results of our analysis (maximum permissible amount of 5000 1dm3).

CONCLUSION

The paper deals with the Alazani valley soils (v. Old Anaga) in order to establish the quality of their fertility and salinization of soils in the artificial reservoirs. To determine the chemical and microbiological contamination, at their surrounding areas as well as to assess the adverse effects of anthropogenic activities to promote mitigation measures and Recommendations which will facilitate the production of ecologically pure products, and avoid any other negative actions.

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