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ASSESSMENT OF WATER QUALITY AND IRRIGATION SUITABILITY OF THE HRAZDAN RIVER AND SEVERAL CANALS FED FROM IT

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The chemical composition of waters of the Arzni-Shamiram and Lower Hrazdan canals fed by the Hrazdan River, as well as Hrazdan River water in that area, was studied, and their suitability for irrigation was assessed. Water samples were collected from 7 sampling points and the total amount of salts, electrical conductivity (EC), pH, bicarbonates as well as some toxic microelements (Al, As, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Zn, Ni, Pb, Se, V) were determined. It has been shown that waters of the Arzni-Shamiram canal are suitable for irrigation. The water pollution processes in the Lower Hrazdan Canal is observed. Despite the fact that the concentrations of some heavy metals and hydrocarbonates don't exceed the MPC for irrigation, depending on amount and composition of wastewater discharging this system, there is a high probability that their concentrations in the canal exceeds the permissible limit in the near future.

Hrazdan River – Arzni-Shamiram and Lower Hrazdan Canals – irrigation – water chemical composition – assessment

Ուսումնասիրվել է Հրազդան գետից սնվող Արզնի-Շամիրամ և Ստորին Հրազդան ջրանցքների, ինչպես նաև այդ հատվածում Հրազդան գետի ջրերի քիմիական կազմը, գնահատվել է ոռոգման համար դրանց պիտանելիությունը: Ջրի նմուշները վերցվել են 7 դիտակետերից: Լաբորատոր պայմաններում որոշվել են ջրում լուծված աղերի ընդհանուր քանակը, էլեկտրահաղորդականությունը (EC), pH-ը, հիդրոկարբոնատները, ինչպես նաև որոշ թունավոր միկրոէլեմենտների (Al, As, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Zn, Ni, Pb, Se, V) պարունակությունները: Ցույց է տրված, որ Արզնի–Շամիրամ ջրանցքի ջրերը լիովին պիտանի են ոռոգման համար: Ստորին Հրազդանի ջրանցքում դիտվում է ջրերի աղտոտում: Չնայած որոշ ծանր միկրոէլեմենտների, հիդրոկարբոնատների կոնցենտրացիաները չեն գերազանցում ոռոգման համար թույլատրելի սահմանները, սակայն առանձին դեպքերում, կախված այդ համակարգ մուտք գործող կեղտաջրերի քանակից և դրանց բաղադրությունից, մեծ է հավանականությունը, որ մոտակա ժամանակաշրջանում ջրանցքում դրանց կոնցենտրացիաները կգերազանցեն թույլատրելի սահմանը:

Հրազդան գետ – Արզնի-Շամիրամ և Ստորին-Հրազդան ջրանցքներ – ոռոգում – ջրի քիմիական կազմ – գնահատում

Исследован химический состав каналов Арзни-Шамирам и Нижний Раздан, питаемых рекой Раздан, а также вод реки Раздан в этом районе, и оценена их пригодность для орошения. Образцы воды были отобраны с 7 точек отбора проб. Были определены общее ко-

личество растворенных в воде солей, электропроводность (EC), pH, гидрокарбонаты, а также некоторые токсичные микроэлементы (Al, As, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Zn). в лаборатории, Ni, Pb, Se, V). Показано, что воды канала Арзни-Шамирам полностью пригодны для орошения. Загрязнение воды наблюдается в канале Нижний Раздан. Несмотря на то, что концентрации некоторых тяжелых микроэлементов и гидрокарбонатов не превышают максимально допустимых концентраций для орошения, в некоторых случаях, в зависимости от количества сточных вод, поступающих в систему и их состава, вполне вероятно, что их концентрации в канале в ближайшее время превысят допустимый предел.

Река Раздан – каналы Арзни-Шамирам и Нижний Раздан – орошение – химический состав воды– оценка

For the sustainable development of agriculture in arid regions, expansion of arable farming and modernization of its infrastructures are important. It is known that the expansion of irrigated areas fundamentally changes the nature of water regime in the region formed over the centuries [3, 11]. As a result in a number of developing countries of the world, on the one hand, a significant increase in agricultural production has been observed, and on the other hand, negative phenomena have been detected, in particular, soil salinization, alkalinization, anthropogenic pollution and waterlogging [4, 6].

In general, soil salinization process is mainly due to the lack or insufficient work of drainage systems, however, in some cases, it is also the result of irrigation with low-quality water, during which lands are being enriched with anthropogenic pollutants, contributing to the acceleration of soil contamination processes [8-0]. According to the observations of international organizations, 2-3 million hectares of agricultural land are destroyed worldwide by soil salinization every year [1, 8]. The intensity of soil pollution and salinization is determined by the climatic peculiarities, the depth of groundwater from the Earth's surface and its chemical composition, as well as the anthropogenic impact on irrigation systems [2].

The Republic of Armenia is distinguished by mountainous terrain, semi-desert climate, poor vegetation, wind intensity, lack of systematic management of agriculture, which contributed to the desertification and degradation of lands [7]. Consequently, fight against land desertification in Armenia has acquired strategic importance as a precondition for the sustainable development of the country. Land degradation is also caused by the penetration of various compounds of technogenic origin into irrigation waters [5].

Observations of the Ministry of Nature Protection of the Republic of Armenia have shown that the main source of water pollution is untreated or insufficiently treated wastewater, which is discharged into surface water and appears in irrigation systems. Under these conditions, it is important to study the qualitative composition of river waters and irrigation systems in soil-water-plant system, which will help to identify negative phenomena on the land and ensure high quality indicators of crops and a rich harvest.

In some works, chemical composition of Hrazdan River water and its impact on ameliorative state of irrigated lands have been studied [12]. It is shown that the main source of river pollution is the untreated or insufficiently treated domestic and industrial wastewater discharged into them. The benefits of wastewater treatment and reuse are highlighted, especially in agriculture.

SNCO "Center for Hydrometeorology and Monitoring" has a rather dense monitoring network in the rivers of the Republic of Armenia, through which monitoring studies of the qualitative composition of river waters are carried out. However, irrigation

systems that pass through different settlements and are exposed to anthropogenic impacts are not sufficiently studied.

The aim of the work is to study the quality indicators of water in a number of canals of the Ararat Valley and assess their suitability for irrigation.

Materials and methods. The studies were carried out at the parts, where the Hrazdan River flows from Arzni to Yerevan. Changes in water quality, as well as water quality indicators in Arzni-Shamiram and Lower Hrazdan canals fed by the river were studied.

The Arzni-Shamiram canal is an irrigation system fed by the waters of Lake Sevan and the Hrazdan River, through which about 30 thousand hectares of land in the Armavir, Aragatsotn and Kotayk regions are irrigated. The main canal (about 92 km long) originates from the pressure basin that feeds the Arzni hydroelectric power station and at the beginning has a capacity of 25 m^3/sec.

The Lower Hrazdan Canal is diverted from the left bank of the Hrazdan River near Yerevan and passes through the closed canal to the right bank. The length is 51 km. It irrigates about 11 thousand hectares of land in the city of Etchmiadzin, and simultaneously fills the waters of the Kasakh River. At the beginning of the canal, the water output is 14 m^3/sec.

Water samples from Arzni-Shamiram canal were taken at Nor-Hachn-Yeghvard intersection (7), Byurakan community (6), Kosh community (5). Water samples from the Lower Hrazdan canal were taken at Hrazdan Gorge (1), Monte Melkonyan street (2), Merdzavan community (3), Dasht community (4). Microelement analyses of the samples were performed in the laboratory of Armenian National Agrarian University, Soil Science, Melioration and Agrochemistry Scientific center after H. Petrosyan and microelement analyzes were carried out in the laboratory of "Center for Hydrometeorology and Monitoring" SNCO. This section should clearly indicate the research methodology.

Results and Discussion. Table 1 presents water chemical composition in different parts of the Arzni-Shamiram canal fed by the Hrazdan River.

Table 1. Water chemical composition in Arzni Shamiram and Lower Hrazdan Canal***s***

№	PPm, g/l	EC, mSm/cm	pH	Salts, g/l	Ions, mg/eq/l					
					HCO_3	Cl	SO_4	Ca	Mg	Na
Arzni-Shamiram Canal										
7	0.393	0.47	8.5	0.379	3.56	1.61	0.31	1.20	2.48	1.8
6	0.381	0.50	8.4	0.390	3.64	1.75	0.29	1.00	2.88	1.8
5	0.400	0.52	8.2	0.424	3.64	2.00	0.44	1.60	2.48	2.0
Lower Hrazdan Canal										
1	0.595	0.85	7.8	0.616	4.77	4.12	0.30	2.50	2.64	3.8
2	0.596	0.88	7.9	0.613	4.67	4.26	0.11	2.60	2.64	3.9
3	0.590	0.87	8.0	0.619	4.56	4.12	0.52	2.60	2.80	3.8
4	0.623	0.90	8.0	0.611	4.56	4.48	0.08	2.00	3.12	4.0

Considering the results of the analysis shown in the tab. 1, it can be stated that these waters are of a hydrocarbon nature, where magnesium and sodium hydrocarbonates predominate. As a result, especially at the beginning of the canal, water has an alkaline reaction (pH is 8.5). Along the length of the canal, due to a number of processes, the alkaline reaction decreases to some extent and at the end of the canal - in Kosh community, the pH is 8.2. Water mineralization is low - 0.379-0.424 g/l. The value of electrical conductivity (EC) is 0.47-0.52 mSm/cm, which can not cause any salinity problem in case of irrigation. In general, it can be stated that the change in the chemical composition of water along the length of the canal, from the intersection of Nor Hachn-Egvard to the Kosh community, is poorly expressed, which can be explained by the fact that the canal passes through the higher point of settlements, and is less exposed

to anthropogenic impact. This is confirmed by the chemical composition of microelements contained in the water in different parts of the canal (tab. 2).

Considering the Indicators shown in the table, we came to the conclusion that the concentration of microelements along the entire length of the canal remains unchanged or in some cases a slight decrease is observed.

Discussing the indicators of the chemical composition of water in the Lower Hrazdan Canal, we come to the conclusion that the waters of the Hrazdan River, from the Arzni hydropower plant to the inlet part of the Lower Hrazdan Canal, are subject to significant anthropogenic impact (tab.1). Thus, for example, the total mineralization increases almost 2 times and is 0.616 g/l, and the EC value is 0.85 mSm/cm, which, although permissible, but it should be taken into account s that higher anthropogenic pressures during the year can cause certain problems in the soil-plant system. In the chemical composition of salts, there is a significant increase in hydrocarbonates, especially chlorine and sodium ions, which are the result of exposure to domestic water (tab. 1). These ions have a toxic effect on crops. High concentrations of sodium in crop stems and leaves can cause a number of osmotic and metabolic problems.

Table 2. The content of microelements in the waters of Arzni-Shamiram, Lower Hrazdan canals and the Hrazdan River and their maximum permissible concentration (MPC) for irrigation

Elements	MPC, mg/l	Arzni-Shamiram canal		Lower Hrazdan Canal	
		Nor Hachn-Yeghvard intersection	Kosh community	Hrazdan Gorge	Dasht community
Al (Aluminum)	5.0	0.0482	0.0243	0.115	0.0180
As (Arsenic)	0.1	0.00856	0.0119	0.003	0.00922
Be (Beryllium)	0.1	0.0001	0.0001	0.0001	0.0001
Cd (Cadmium)	0.01	0.0001	0.0001	0.0001	0.0001
Co (Cobalt)	0.05	0.00017	0.00015	0.00020	0.00028
Cr (Chromium)	0.1	0.0022	0.00258	0.0100	0.00518
Cu (Copper)	0.2	0.00130	0.00117	0.0022	0.00221
Fe (Iron)	5.0	0.141	0.163	0.321	0.227
Li (Lithium)	2.5	0.0443	0.0404	0.0456	0.0318
Mn (Manganese)	0.2	0.0167	0.00992	0.0165	0.00989
Mo (Molybdenum)	0.01	0.00318	0.00289	0.0020	0.00637
Ni (Nickel)	0.2	0.00085	0.00082	0.0040	0.00142
Pb (Lead)	5.0	0.00012	0.00011	0.0040	0.000206
Se (Selenium)	0.02	0.00117	0.00168	0.0010	0.00219
V (Vanadium)	0.1	0.0130	0.0129	0.019	0.0215
Zn (Zinc)	2.0	0.00243	0.00245	0.016	0.0229

The accumulation of toxic ions in these organs is usually greater than in the roots. Such accumulations in the leaves are usually expressed by gray burns along the length of the leaves, causing leaf fall. Nuts and fruits are the most sensitive to sodium. It is proved that in the system of soil absorption, even 5-10% sodium content can contribute to the occurrence of burns on the leaves of these crops.

At the same time, a significant increase in a number of toxic microelements is observed in waters of Hrazdan River and Lower Hrazdan Canal especially near the Dasht community in Hrazdan Gorge, Arzni (fig.1).

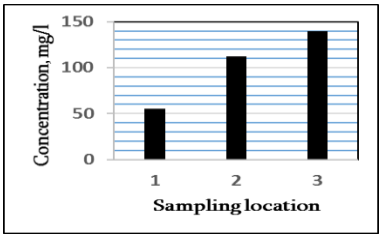

Fig. 1. The concentration of sodium in the Hrazdan River and the Lower Hrazdan Water Canal. 1-the part near Arzni, 2 - Hrazdan Gorge, 3 – Lower Hrazdan Canal near Dasht community

It is shown that the concentrations of toxic microelements such as vanadium, chromium, copper, zinc, selenium, molybdenum and lead, although do not exceed the MPC for irrigation, nevertheless, as compared to Arzni part of the river, the concentrations of these elements in the Lower Hrazdan canal increase by 2-10 times.

Fig. 2 shows the concentrations of a number of toxic microelements in this area.

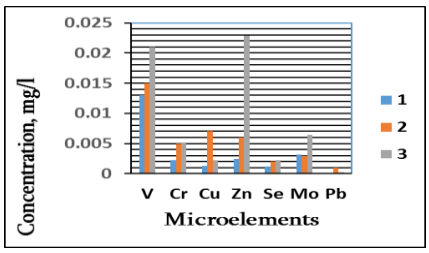

Fig. 2. Concentrations of toxic microelements in the Hradan River and Lower Hrazdan canal 1- Hrazdan river-near Arzni, 2- Hrazdan gorge, 3- Dasht community.

In fig. 3, a pipe built on a canal is clearly visible, from which wastewater periodically discharged into the canal, resulting in contamination of water.

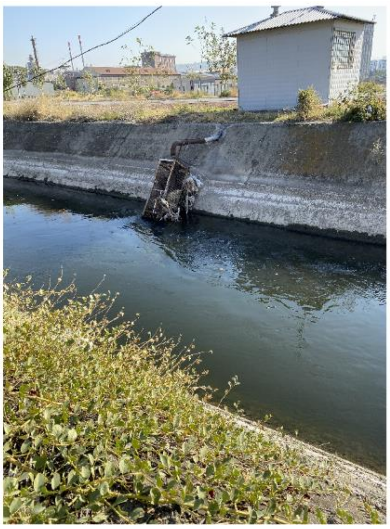

Fig. 3. Lower Hrazdan canal and wastewater discharge pipe located on it

Conclusion Studies have shown that the waters of the Arzni-Shamiram canal are ideally suited for irrigation. There is no significant change in water chemical composition along the entire length of the canal, which can be explained by the fact that it passes through the settlements at high points and has low anthropogenic effects.

Water pollution was observed on the area of the Hrazdan River from Arzni to Yerevan, as well as along the entire length of the Lower Hrazdan canal, as a result of which water mineralization doubled due to high concentrations of sodium and chloride ions, as well as some heavy microelements that are extremely toxic to crop.

Taking into account the exceptional importance of quality of canal waters in food safety, as well as the increasing anthropogenic pressures on these waters, it is proposed to set hydrochemical networks also on the main canals by the Ministry of Nature Protection, which will allow monitoring of chemical composition of irrigation water during irrigation and establish control over the objects, that may contaminate the canals. It is recommended to apply the standards for irrigation water recommended by FAO for water quality assessment.

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