CHEMICAL COMPOSITION OF IRRIGATION, COLLECTOR-AND-DRAINAGE AND GROUND WATERS OF THE LOWER ALAZANI VALLEY

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ABSTRACT. – Chemical composition of irrigation, collector-and-drainage and ground waters of the Lower Alazani Valley. Kakheti region is one of the important regions for agriculture development in Georgia. Salinized soils (54 thou. hectares) are extended in the area of Alazani valley, in Sighnaghi region of Kakheti. Sighnaghi region is poor with water resources and atmospheric precipitations. Air temperature in summer months reaches here 35-40°C that along with extended period without precipitations often becomes the reason of droughts. Chemical composition of irrigation channel, collector-and-drainage and ground waters of the Lower Alazani Valley in Sighnaghi region of Kakheti is considered in the work. It is established that the water of Lower Alazani irrigation channel is suitable for irrigation; collector-and-drainage waters in case of low mineralization may be used as the additional source of irrigation; ground waters belong to the category of ground waters of high salinity and at the same time mineralization have a tendency to change according to seasons, in particular, mineralization increases in summer and autumn.

Keywords: irrigation channel, collector-and-drainage and ground waters

1. INTRODUCTION

Kakheti region is one of the most important regions of Georgia for development of agriculture. Salinized soils (54 thou. he) are spread in Sighnaghi region, at Alazani valley, and exactly this region is the subject of our research. Sighnaghi region is poor with water resources and atmospheric precipitations. In summer months the air temperature reaches here 35-40°C that along with long-term period without precipitations often causes droughts.

Under conditions of Alazani valley ameliorated lands the characterization of chemical composition of ground and drainage water is of great practical importance for elaboration of correct effective washing-out mode or irrigation

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regime and for proper land management of ameliorated massifs. At the same time it is important to assess irrigation water quality and its fitness for irrigation in order to get rid of secondary salinization of soils.

Collector-drainage waters may be used as additional irrigation source if they are of high ecological quality. In case of high mineralization they may become the source of pollution of natural waters. Based on this fact, a study of formation process of chemical composition of collector-drainage waters is of great applied importance. Lower Alazani irrigation system is situated on the right bank of Alazani valley, where the subject of our study is. In 1970's the irrigation of 35 thousand hectares of territory of Alazani valley was conducted by means of Lower Alazani main channel, water discharge of which at headworks was equal to 18 m^3/sec, while it was only 3 m^3/sec at the mouth of the Alazani river (Chantladze and Shavliashvili , 1982; Chantladze and Chikvaidze, 1976)

Water was delivered from main channel to the fields by means of 46 distributors, while waste waters were collected by 50 small and large collectors. Returned waters move from small collectors into more large ones and afterwards into Alazani River. Collector network allow roughly 4-7 m^3/sec of waste waters to ingress into Alazani River.

Besides, in Sighnaghi region, at the territory of former Tsnori stock breeding complex in the beginning of 1980's was constructed closed collector-drainage network for 10000 hectares. Construction of collector-drainage network for 5000 hectares, in total 15000 hectares was conducted at areas adjacent to Tsnori in Vakiri, Tibaani, Jugaani and Zveli Anaga villages. Soil salinization maps were composed and substantial wash-offs were conducted at highly and averagely salinized soils at rates of 8-12 m^3/he.

According to recommendations made on the basis of statistical data of trial plot existing at former Tsnori stock breeding complex and adjacent areas the distance between drainages is 215 meters, with 3-3,5 meters thickness. Ground waters are located at 1-5 meters depth at this territory.

It should be noted that during last 20 years some of existing collector-drainage systems came out of action, the inner economic network was destroyed and as a result the washing-out and carry-over of salts from agricultural lands was stopped that caused significant deterioration of soil quality.

Irrigation system available at this moment doesn't correspond to modern technical requirements. Efficiency coefficient of most of them doesn't exceed 0,4-0,6. After 90's of the past century due to ongoing economic and political processes in the country was significantly reduced/eliminated the irrigation system network and, as a consequence, irrigation areas. Despite system rehabilitation started on a national scale today the Upper Alazani irrigation system includes only 22464 he of area, while in 90's of last century 44300 hectares were irrigated (Geladze at al. 2013).

Formation of chemical composition of collector-drainage and ground waters occurs under influence of wide range of factors, such as: land (topography)

relief, climate conditions (first of all atmospheric precipitations, air temperature, evaporation from soil surface). Two mutually related and mutually acting factors have special influence on this process, namely irrigation water's mineralization and chemical composition of soil of irrigated territory. Should be noted the fact that ground water level must move down below the critical depth (1-5 meters) and along with irrigation water by means of drainage must go out of the field. Otherwise this saline water will move up by capillaries and will make the soil salinized again, i.e. secondary soil salinization will take place (Gedevanishvili and Talakhadze, 1981).

Evaporation has important influence on chemical composition of collector-drainage waters and soils. Salt concentration takes place in them as a result of evaporation process.

2. RESULTS AND DISCUSSION

By means of mobile ionometer were determined physical-chemical indices (pH, temperature and mineralization) of collector-drainage and ground waters of the Lower Alazani irrigation channel.

Based on analysis of obtained results it was established that mineralization in the Lower Alazani irrigation channel was changed in May 2012 from 0,240 to 0,247 g/l near Dzveli Anaga and Tsnori. At both objects these indices increase in September and are equal to 0,287 and 0,278 g/l, respectively, while according to results of 2013 mineralization increases at both objects and equals: 0,246-0,306 in June and 0,231-0,350 g/l in September. Maximum permissible salt content in water, which is used for irrigation of agriculture plants is equal to 1 g/l, that's why the water of Lower Alazani irrigation channel may be considered as suitable for irrigation.

Collector-drainage waters mainly represent filtrates of salinized soils. They have relatively high mineralization compared with surface water runoffs. Mineralization of collector-drainage waters in May-September-December of 2012 varies within the limits of 0,761-7,526 g/l, while in March-June-September-December of 2013 mineralization fluctuates within the limits of 0,536-3,750 g/l. In summer and autumn months is observed high mineralization of collector-drainage waters in comparison with winter months.

Observations over chemical composition and mineralization of collector-drainage waters, which come out of soil layers of ameliorated massifs generate significant interest not only when assessing the degree of salt extraction, but also for opportunity of its reuse. In case of high mineralization of collector-drainage waters is necessary to elaborate the measures for its lowering, through direct descent of clean irrigation waters from Alazani main channel to these collectors by means of distributors. It is also should be noted the impact of collector-drainage waters on quality of Alazani river waters, since collector-drainage waters originated as a result of

irrigative amelioration flow into the Alazani River, that's why study of formation processes of chemical composition is of applied importance.

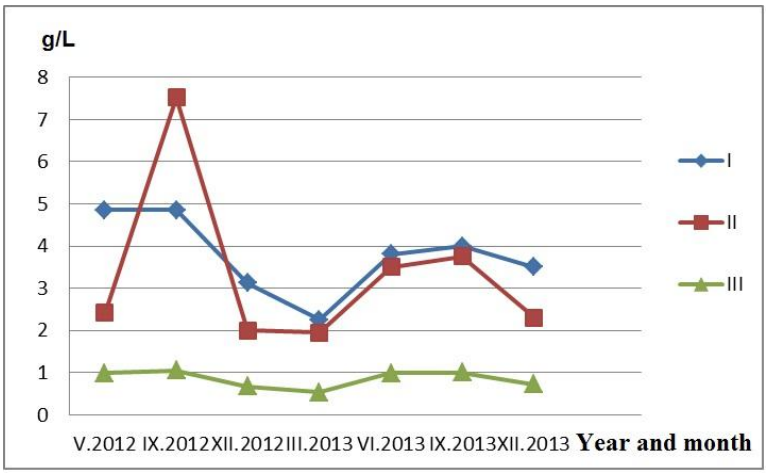

Fig. 1. ***Mineralization of collector-drainage waters, 2012-2013***

I - collector-drainage waters - Dzveli Anaga, below the plot #3
II – Dzveli Anaga, Collector K-36 prior to drain to Kumbati collector
III - collector-drainage water, K-29 near Tsnori

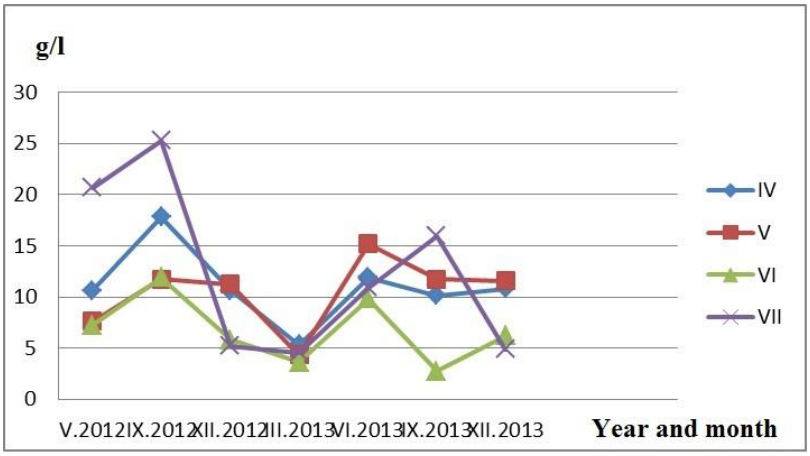

Fig. 2. ***Ground water mineralization, 2012-2013***

IV – ground water #1 Dzveli Anaga
V - ground water #2 Dzveli Anaga
VI – ground water #1 Tsnori
VII - ground water #2 Tsnori

Mineralization degree of ground waters is of great importance. Alazani valley ground waters are quite mineralized, salinized, and their level varies in different limits (Kharebava at al. 1985).

According to calculations in May-September-December of 2012 mineralization of ground waters changes within 5,800-25,253 g/l, while according to March-June-September-December of 2013 mineralization fluctuates within 3,630-15,951 g/l. In general, mineralization has a trend toward change according seasons. In particular, mineralization increases in summer and autumn. Based on the results of measurements carried out by us, data of December and March are lesser than May-September data (Fig. 2). As we can see, mineralization increase is caused by penetration of filtration waters in these wells from drainage network, it is even more true if drainage network passes through salinized soils.

As is seen from analysis results, ground waters at the territory of both objects belong to category of saline ground waters (Table 1).

Table 1. ***V. Chkhikvishvili's gradation scale (Chkhikvishvili –1960).***

1	Drinking water, amount of water soluble salts	0,25 g/l;
2	Light salted	1-10 g/l;
3	Salted	10-35 g/l;
4	High-salinity water	> 35 g/l

Thus, as is seen from obtained results, mineralization of collector-drainage and ground waters obtained in June and September is much more than results obtained in December-March. First, in summer months takes place water evaporation from wells, due to which mineralization increases in them, in addition, in summer months in irrigation zone occurs penetration of filtration waters into collector-drainage and ground waters, which take out (remove) highly soluble salts from soils (Chkhikvishvili 1960; Shavliashvili at al. 2013).

Except physical-chemical indices in September 2013 was conducted chemical analysis of the Lower Alazani irrigation channel and ground waters for determination of content of different ingredients. It was established that all ingredients are within normal limits. Sequence of cations and anions concentrations are of following nature: $Ca^{++}>Mg^{++}>Na^{+}$ and $HCO_3^{-}>SO_4^{--}>CL$. According to its composition irrigation water is hydrocarbonate-calcic, while in ground waters are observed high contents of sulfates, sodium, calcium, and magnesium, compared with maximum permissible concentrations (MPC). It is a characteristic feature, since ground water intake well is located at Tsnori salinized soils, from where occurs even more saturation of ground waters with drainage waters containing mentioned ingredients. In the ground waters $Na^{+}>Ca^{++}>Mg^{++}$ and $SO_4^{--}>CL^{-}>HCO_3^{-}$. Content of biogenic elements (NO_2^{-}, NO_3^{-}, PO_4^{---}) is lower than MPC (Shavliashvili at al. 2014).

3. CONCLUSIONS

Proceeding from obtained results we can make the following conclusions:

1. Water of Lower Alazani irrigation channel fits for irrigation.

2. Collector-drainage waters in case of lower mineralization may be used as the source of additional irrigation.

3. Ground waters belong to the category of ground waters of high salinity and at the same time, mineralization has a tendency towards the change according to seasons, in particular, mineralization increases in summer and autumn.

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