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Preliminary result of stable isotopes monitoring in the Alazani-Iori catchment

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Abstract

In order to static stable isotopes variation has selected please and organized GNIP and GNIR station on the territory Alazani-Iori catchment. In order to investigate underground water systems in Alazani-Iori catchment, for the first time have been conducted studies based on the hydrochemical and environmental isotope methods. The first step was to organize the monitoring of air temperature, humidity and precipitation on the recharge and discharge areas of aquifer. Also have been organized monitoring of water level and discharge on Alazan and Iori rivers as well as monitoring of underground water level in Lagodekhi and Dedoplitskaro.The results of isotope data analyze clearly shows the seasonal variations. Their composition changes according to the elevation and geographical location of observation stations, which is fully consistent with the regularities of isotope distribution all over the world.

Introduction

Global warming will have negative effect on natural conditions of Georgia. These negative effects could be the most serious in Eastern Georgia, especially in the basin area of the Iori river, which is famous for clearly depicted characteristics of arid-zone and semi-desert. Geomorphologically this is Uplands of Kakheti, which includes: Big and Small Shiraki, Eldari, Taribani, Natbeuri, Naomari, Ole, Jeiran-Choli valleys and their watersheds, as well as majority of Southern slope of Kakheti mountain range, i.e. 3000 km2 area of Dedoplistskaro and partially Sagarejo and Gurjaani administrative regions. Preliminary meteological data show that precipitation has significantly decreased in this region, which caused significant decrease and in some places even drying of surface water flows and depletion of underground water natural springs. Significant decrease of groundwater tables resulted in aeration and exhaustion of soil crust, activation of wind erosion and reduction of areas covered by vegetation (including pastures). Hence, there is a distinct tendency of processes actively leading to desert formation. All these

negative ecological events led to deterioration of population's social-economic conditions. It can be expected that the situation will become even worse since the population is already experiencing deficit of potable and irrigation water. As the negative ecological processes become stronger, desert formation can easily turn into irreversible form. Thus, the most promising region for agricultural products, such as crops, cattle-breading and vine-growing and for developing oil and gas extraction can be left without population.

Understanding the groundwater regime, interactions with surface waters and factors which influence groundwater quantity and quality is therefore of utmost importance to secure water supply for the economy and population.

Besides the traditional methods of hydrogeological survey such as pumping tests, geophysics, geochemistry and groundwater flow modeling, environmental isotopes as water tracers provide useful complementary information on water origin (where does the water come from) and history (which pathways did the water move until it arrived to an aquifer). Chemical and isotopic composition of surface waters and groundwater is determined by the composition of rainfall and modified by the processes in the vadose zone, snow cover, tributaries and aquifers. These modifications are different in various climatic settings and result in different pathways of water from rainfall to runoff and groundwater recharge.

In order to study isotope distribution on the some territory at first is necessary to know its background value in precipitation and surface water. International Atomic Energy Agency IAEA organized regular sampling and analysis of oxygen and hydrogen (18O, 2H,) isotopes in surface water-Global Network Isotope in River (GNIR) and precipitation Global Network Isotope in Precipitation (GNIP). This network is becoming common in many countries of World as part of national meteorological, geological and hydrological services. Independent network was organizing in Switzerland or in the USA. This kind of investigation is new and startin the Georgia only now.

In order to definition of hydrogeological, hydrogeochemical and isotope regimes has been planned the organization of multi-disciplinary monitoring in Alazanis-Iori catchment basinsin the framework of Rustaveli National Science Foundation Grant.

Field observations

According project goal has selected please and organized GNIP and GNIR station on the territory of Kakhetia. On the first stage, the regime observation of air temperature, humidity, atmospheric pressure and precipitation at the meteorological stations since 2013 had been organizedin the recharge areas of aquifers, which are located evenly throughout of all territory of area and characterize the following regions: Tianeti – recharge area of river Iori, Telavmdinare – the upper part of Alazani river, Lagodekhi – the recharge area of left tributaries of Alazani river and Dedoplitskaro – River Iori and the lower part of Alazani river (1).

The parameters were measured daily at the mentioned meteorological stations. Air temperature and humidity were measured by the specialized equipment (HOBO). In addition, the atmospheric precipitation is measured daily and also, in order to determine the stable isotope composition, the sampling takes place once per month. Their Station has been included in network GNIP of IAEA.

In order to determine the water level variations in rivers, the observations has been organizedat the groundwater discharge areas, namely on the river Iori in Tianeti and in Alazani river at village Shaqriani (Telavi discrit). Also, the water sampling has been started for stable isotope analyzes from the mentioned rivers. The stations have been joined to the global network GNIR of IAEA.

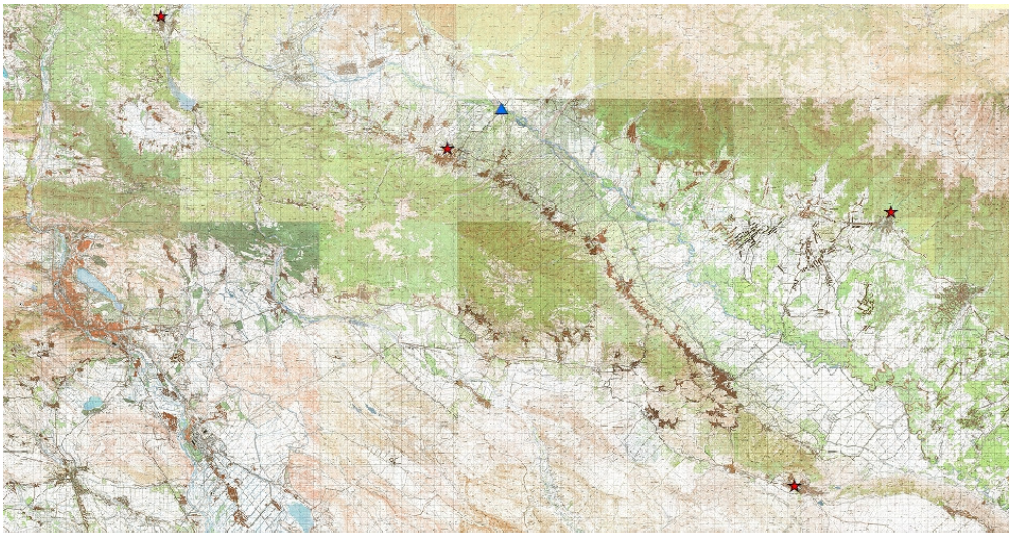


Fig 1. The location of GNIP and GNIR stations

The Isotope and hydrochemical analyze of Water samples have been done with the equipment laser spectrometer “Picarro”, purchased by Agency at the laboratory of Geophysics and Geothermal research Center, Institute of Geophysics.

In order to determine the underground water regime in the main aquifers of Alazani and Iori catchments, the hydrodynamic observations have been organized. The monitoring was started on the borehole, located in Lagodekhi discreet. The equipment, (produced in the USA) provides the data logging and transfer to the center in Tbilisi by GSM system. Water level in borehole, air temperature and atmospheric pressure is measured in a minute regime.

The observations have also been organized at “Dedoplitskaro” – the "Diver was installed in the wall. Water level and temperature is measured hourly. Data transfer occurs once per month or two via laptop. It is planned to increase the number of observed parameters in future.

The data is collected at the center by the required frequency. Also, data processing occurs at the center and the influence of seasonal and other factors are analyzed.

Database creation and analysis

In order to fulfill the objectives of the Project, the database was created, which is consistently updated by the meteorological, hydrogeological and hydrological data. Only the primary analysis of Isotope data showed the seasonal variations. In the monthly Precipitation isotope variations are observed from "Telavi" meteorological station. In particular, the Spring fraction is light (-10 ‰ -18O; -80 ‰ -2H), which becomes heavier in summer (--4 ‰ 18O; -20 ‰ -2H) and in winter period it is reduced again (-15 ‰ -18O; -80 ‰; -120H Before).The peak of the "weighting" is marked on almost perfect curve, which is related to the autumn rainy season (fig. 2).

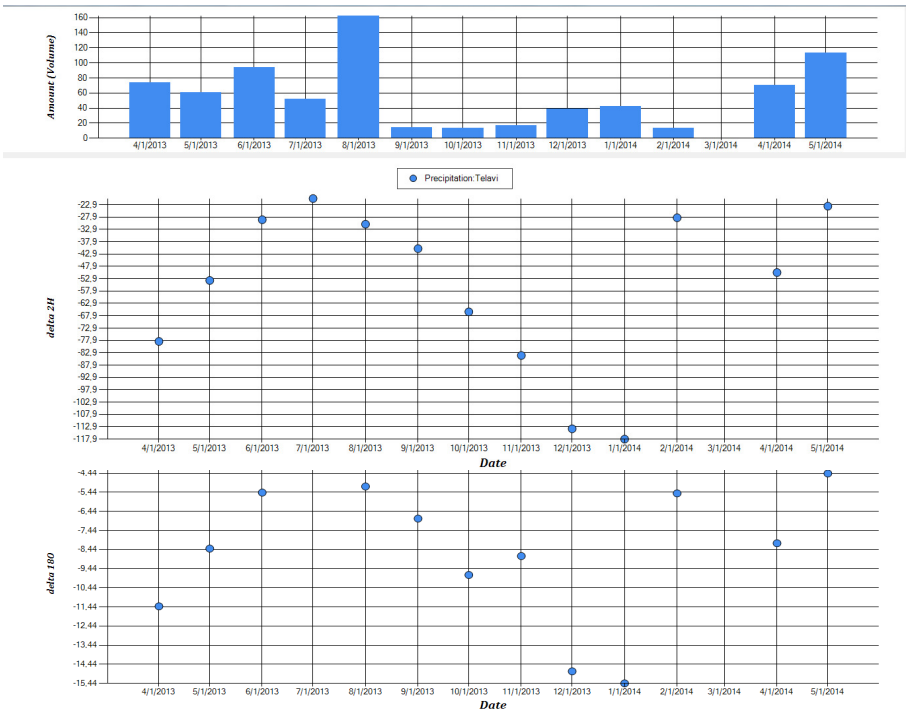


Fig.2 Stable isotope variations in precipitation, "Telavi" station

We get a different picture of the nearby located "Shakriani" Station on the River Alazani" samples (Fig. # 3). The isotopes "Winter" values (-9.2 ‰ - 18O; -60 ‰ -2H) are getting "lighter" in May, which is caused by the mixing of mountain snow melt water into the river (-10 ‰ - 18O; -68 ‰ -2H), in June-August, the isotopic composition becomes again "heavier", however, it does not fully repeat the Isotope values of atmospheric precipitation curve of nearby located "Telavi" station, because in this case the isotopic composition of river water characterizes the more area from the beginning of Alazani river down to its middle part. The "heavy" peak of rainy season in October and also in January 2014, the peak of getting "lighter" caused by snowfall (10.5 - ‰ - 18O; -72 ‰ - 2H) is observed on the curve.

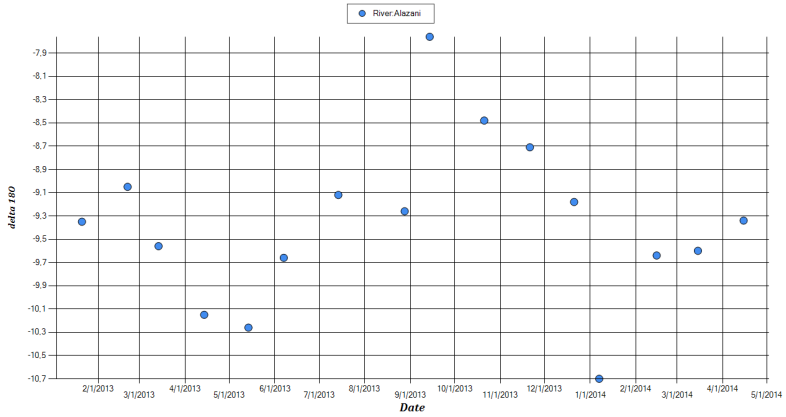


Fig. 3 Stable isotope variation in river Alazani; "Alazani-Shaqriani" station

We have different picture of Isotopic composition in precipitations in samples collected at "Tianeti" meteorological station. Sharply expressed "lightness" of isotope composition (10 - ‰ - 18O; -68 ‰ -2H) in March-April 2013, during the snow melting period (Fig.#4).

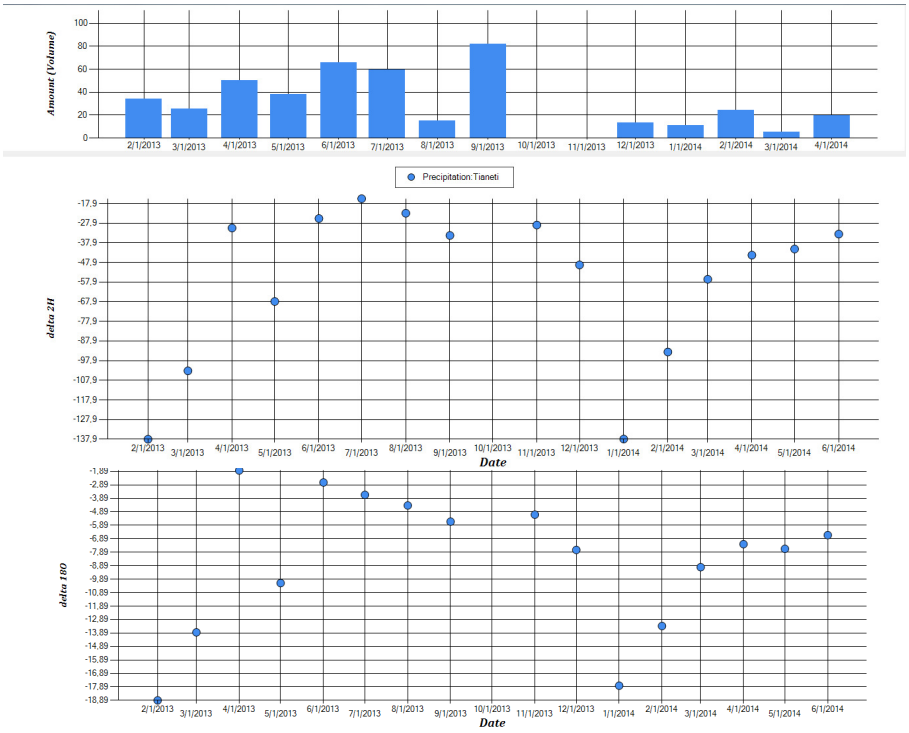
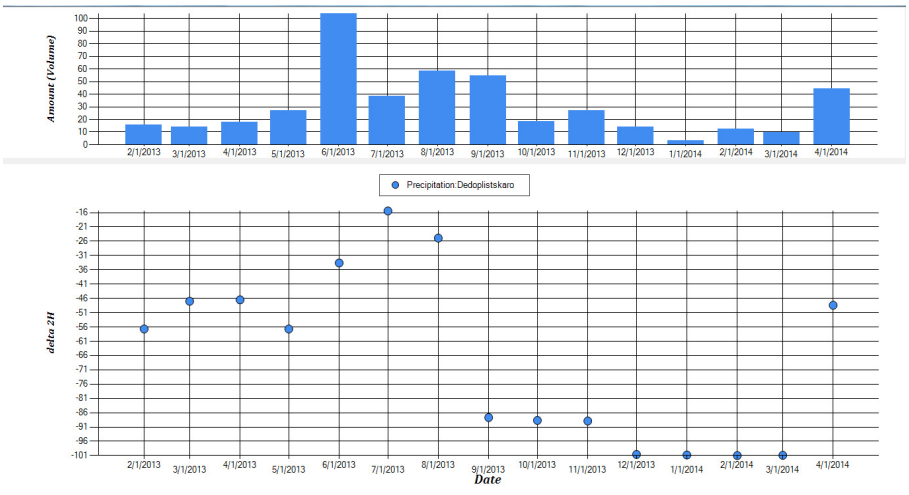


Fig. 4 Stable isotopes Changes in atmospheric precipitation curve; "Tianeti" station

Like previous case, in the precipitation samples from "Dedoplitskaro" station, we observe that isotopes become "lighter" in spring (Figure 5).



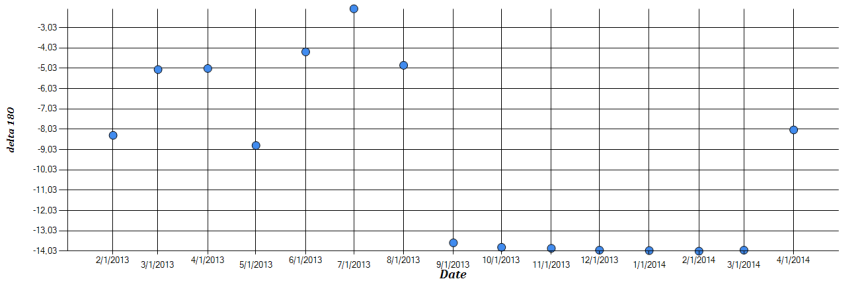


Fig. 5 Stable isotope variation in precipitation curve; "Dedoplistskaro" station

Comparing the Values of isotope composition and character of their variation, the differences between of geographical location and altitude of observation stations should be taken into account. Overall, on "Tianeti" station, the isotope composition variation in "lighter"- less range (-14 - (- 18) ‰ - 18O; -100 - (- 140) ‰ - 2H) has been observed during one year. On the "Telavi" station, which is located southwest and at lower elevation, accordingly we observed "heavier" changes: -11 - (- 16) ‰ - 18O; -80 - (- 120) ‰ - 2H).There are much "heavier" isotope values on "Dedoplistskaro" meteorological station, which is actually located on the semi-desert zone: -5 - (-8.8) ‰ - 18O; -55 - (- 85) ‰ - 2H)

The isotope composition of river waters is "heavier" then in precipitations. In accordance to the changes of geographical location of observation station, the isotope values of the rivers also changes. In particular, the samples taken from the river "Iori" at "Tianeti" station, isotope composition variation is is -10 - (- 11) ‰ - 18O; -66 - (- 68) ‰ - 2H, which is much "heavier" then values in precipitation at "Tianeti" meteorological station (-14 - (- 18) ‰ - 18O; -100 - (- 140) ‰ - 2H) and at the same time slightly "lighter" than values from "Alazani-Shaqriani" station (-9 - (- 11) ‰ - 18O; -60 - (-70) ‰ - 2H). The Alazani river samples, at "Shaqriani" station, the measured isotope composition is much "heavier" than observed values in precipitation samples at "Telavi" station values (-11 - (- 16) ‰ - 18O; -80 - (- 120) ‰ - 2H).

Conclusions

For the first time on territory of Kakheti have been organized GNIP and GNIR stations in order to study the Stable isotope variations. Fixed up to date revealed regularities, which fully agree with the general regularities of Stable isotope distribution on the World. The continuing of mentioned studies will give us possibility to determine the background value of isotope distribution for this area (global meteoric waterline -GMW L), which is necessary condition for the Hydrological and hydrogeological investigation.

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Первичные результаты мониторинга стабильных изотопов в Алазани-Иорском водном бассейне

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РЕЗЮМЕ

Для изучения стабильных изотопов были выбраны и организованы GNIPи GNIR станции на территории водосбора Алазани-Иори. Для изучения подземных водных систем водосбора Алазани-Иори были предварительно проведены исследования, основанные на гидрохимических и изотопных методах изучения окружающей среды. Первым шагом стала организация мониторинга температуры воздуха, влажности и осадков в областях питания и разгрузки водоносных горизонтов. Было организовано также наблюдение за уровнем воды и водной разгрузкой на реках Алазани и Иори, а также мониторинг за уровнем подземными вод в Лагодехи и Дедоплисцкаро. Результаты изотопного анализа ясно показали наличие сезонных колебаний. Их состав меняется в зависимости от высоты и географического расположения наблюдательных станций, которые полностью соответствует закономерностям распределения изотопов во всем мире.

ალაზანი-იორის წყალშემკრებ აუზებში სტაბილური იზოტოპების მონიტორინგის პირველადი შედეგები

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2საქართველოს გარემოსა და ბუნებრივი რესურსების დაცვის სამინისტრო, გარემოს ეროვნული სააგენტო

რეზიუმე

ალაზანი-იორის წყალშემკრებ აუზებში, მიწისქვეშა წყლებში სტაბილური იზოტოპების ვარიაციების შესწავლის მიზნით შეიქმნა გნიპ და გნირ სარეჟიმო სადგურები და ორგანიზება გაუკეთდა რეჟიმულ დაკვირვებებს. პირველ ეტაპზე, წყალშემცველი ჰორიზონტების კვების და განტვირთვის არეალებში, ორგანიზება გაუკეთდა რეჟიმულ დაკვირვებებს ჰაერის ტემპერატურასა, ტენიანობასა და ატმოსფერულ ნალექებზე. მდინარე ალაზანსა და იორზე დაიწყო რეჟიმული დაკვირვებები მდინარის დონესა და ხარჯზე და ასევე მიწისქვეშა წყლების დონეებზე ლაგოდეხსა და დედოფლისწყაროში. იზოტოპური მასალის ანალიზმა დააფიქსირა სეზონური ვარიაციები მათ ცვლილებაში და განსხვავებები მათ მნიშვნელობებში, სადგურების გეოგრაფიულ მდებარეობისა და სიმაღლის მიხედვით, რაც სრულად ეთანხმება მსოფლიოში იზოტოპების გავრცელების ზოგად კანონზომიერებებს.