MANAGEMENT AND PERSPECTIVES OF USING OF UNDERGROUND FRESHWATERS FROM TRANSBOUNDARY AQUIFERS IN ARMENIA

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Abstract

Investigation of transboundary aquifers is a relatively new direction of regional hydroecology. Academic research has begun to focus on this issue. Over recent years the problem of water utilization has got a special urgency for countries of South Caucasus. For example, as a result of anthropogenic activity, Ararat ground artesian basins (transboundary with Turkey) in Armenia have serious changes. Most of the artesian water is used for drinking purposes. There are many wells in this area. These wells were mainly for irrigation. However, they were not equipped respectively and could not be operated. Water has been leaking out of the wells very easily for years, causing damage and creating marshes in the valley. Observed processes are also associated with changes in the seasonal dynamics of the groundwater basin. On the other hand climate change impacts on the underground water in this region is not studied.
For sustainable development of groundwater in the region it is necessary to improve the management system. This requires solving a number of tasks designed to assess the quantity and quality of groundwater within the border as well as in transboundary aquifers.

Keywords: groundwater, management, monitoring

Introduction

Research of formation and perspectives of using fresh underground water of transboundary water-bearing layers is a relatively new section of the regional hydrogeology. The "Convention on the Protection and Use of Transboundary Watercourses and International Lakes", adopted in Helsinki in 1992 has an important role with respect to this issue. It emphasized the need to develop common principles for the protection of the interstate and use of transboundary water objects, including surface water and groundwater on the basis of special agreements between the countries. Problems of the use and protection of transboundary rivers are solved a little easier than those of using the transboundary groundwater horizons. This is due to the fact that most countries have a rather developed observation networks for discharge and quality of river water. Much more complicated is dealing with the study and use of transboundary water-bearing layers.
Today the experience of regional assessment of resource and quality of transboundary aquifers is very limited, despite the fact that such horizons exist almost in all countries. Given the importance of the issue to UNESCO organized a special working group whose purpose is to review and analyze the situation established with the study and use of transboundary groundwater.
Our academic research has begun to focus on this issue. Over recent years the problem of water utilization has got a special urgency for countries of South Caucasus. For example, as a result of anthropogenic activity, Ararat ground artesian basins, which include the Ararat valley in Armenia has undergone serious changes.

Description of the study area.

The Republic of Armenia is located in the northeast of the Armenian Highlands, at the border of Caucasus and Western Asia. Armenia borders Georgia from the north, Azerbaijan from the east, Turkey from the west and southwest, Iran from the south (Fig.1).

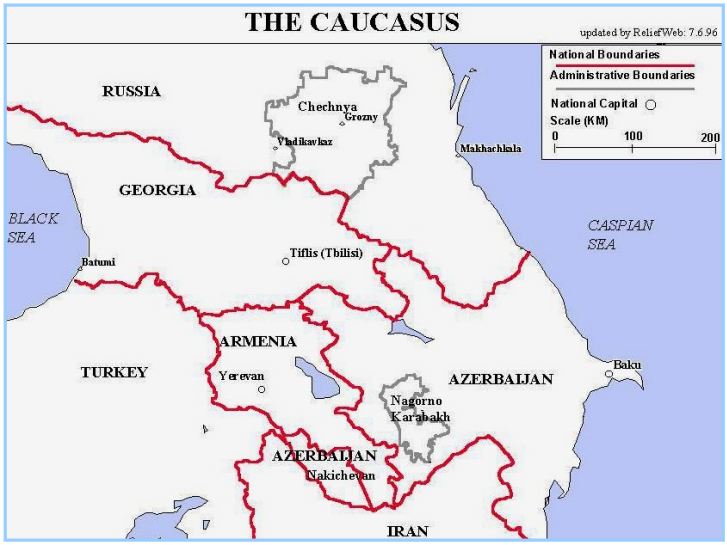

Figure 1. A Map of South Caucasus

One of the most arid zone of Armenia is the Ararat valley. The annual precipitation here is around 200-250 mm. Maximum precipitation is recorded in high mountainous areas at around 1000 mm per year. In Ararat valley, the average precipitation in summer months does not exceed 32-36 mm. The average annual wind velocity in Armenia is distributed unevenly in the range of 1.0-8.0 meters per second. In some regions, particularly in Ararat valley, mountain valley winds are quite common. In summer, their velocity reaches 20 m/s and over. The summer is temperate, at the end of July the temperature in Ararat valley varies between 24-26°C.

Ararat basin after the formation in result of depressions and the eruption of the Upper and Lower Quaternary basaltic lavas exposed to intense erosion, which continues today. The geological structure of the Ararat Valley involves lymno-fluvial and effusive water bearing formations which thickness reaches 500m. Beneath those formations, a folded water resistant formation is found which is represented by Paleozoic and Mezocainosoic sandstone, clayey and carbonate rocks (*Amroyan et al*., 1974).

Aquifers are the lava (porous and fractured basalt, slagged basalts, andesite-basalts), tuffs, lake-water-bearing fluvial deposits.80% of springs there are originated from the lavas. The water balance of the Ararat bowl involves ground waters which differ by conditions of formation, chemical composition and bedding conditions. The basic feeding source to aquifers is atmospheric precipitation and infiltration of surface waters. Water accumulation and flow mostly occurs through andesite-basalts and loose fragmented materials of under-bed Quaternary sediments (Fig.2). Data from numerous wells and geophysical surveys prove that the basin feeding ways mostly coincide with the modern river network.

The underground water in the valley lies at the depth up to 25 meters. These water-bearing layers are confined as young Alluvial diluvial deposits. Aquitard for these waters are sandy clay layers. By hydrogeological and hydrogeochemical properties groundwaters of the first pressure water-bearing subhorizons comply with the requirements laid for the quality of drinking water and are exploited. Waters of the second layer are confined to cracks and pores of slagged andesite-basaltic lavas. Waters are distinguished with high piezometric pressure. The subhorizon is intensively exploited (*Shaginyan et al.*, 2004).

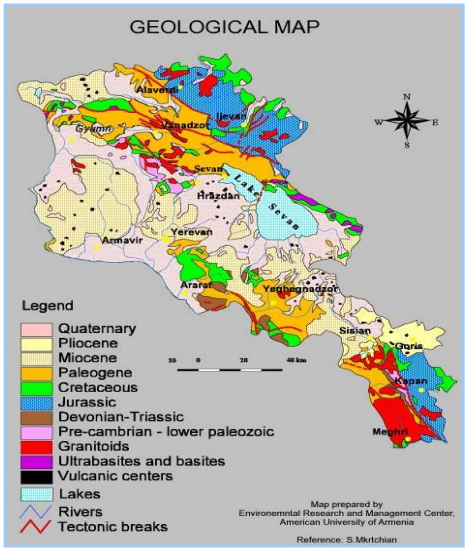

Figure 2. Geological Map of Armenia

The landscape of the flat portion of the Ararat Valley is desert-semi-desert, with typical grey-brownish soils (Fig.3). In some areas sandy hills, salt-marshes, saline soils as well as wetland coexist. A major part of the plain is cultivated and covered with crops - orchards and wine yards- and irrigation requiring soils. The uncultivated part of the territory is covered with xerophyte, halophyte and wormwood.

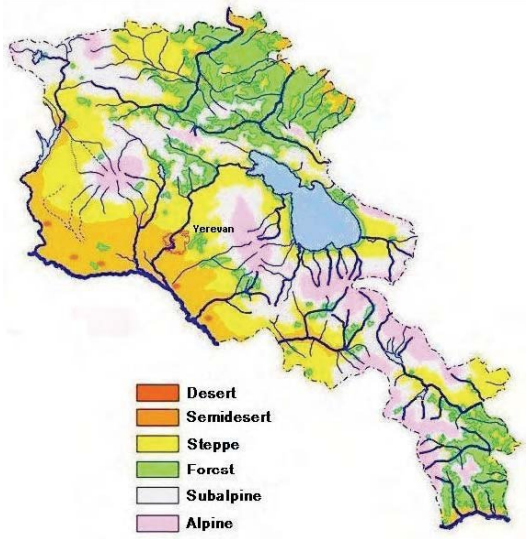

Figure 3. Main ecosystems of Armenia

In Armenia, irrigation has been always representing 70 % of the total surface and ground water use. The irrigation water demand grows in the end of April with the peak in July and the decline in October. The average annual water withdrawal per hectare is 8,000 cu m. The 40% of the irrigated areas are highly dependent upon mountain pumping stations, which pump the water to the height of above 100m.

The 300,000 hectares of irrigated lands in 1985 have been reduced to current 135,000 hectares area. Major factors to contribute this decline are large-scale breakdown of infrastructure, high operation costs of pumping station, fragmentation of former collective farms (1000-3000 hectares to numerous

small farms of 1 to 2 hectares in size), as well as drainage related problems, particularly in the Ararat Valley where the ground water is shallow.

Problems and perspectives of ground water management.

Over past 20-25 years in the consequence of lack of financial means monitoring of underground waters has been conducted not regularly. Currently with respect of need to recommence the observations and control of underground water a methodology of staged restoring of the monitoring system was developed (*UNDP Report, 2005*).

Monitoring and evaluation will be managed by the Ministry of Nature Protection and National Water Council.

Program to re-establish ground water resources monitoring in Armenia is based on following methodology:

- make inventory of available groundwater (GW) data and maps in RFG's archive,
- scan GW maps and geo-reference them to the base map,
- build GW spatial and tabular database,
- design GW monitoring network and program,
- prepare implementation plan,
- rehabilitate the still usable milestone wells and construct and test the additionally required observation wells,
- provide training in support of these activities,
- monitor continuous data collection.

Implementation of monitoring observations and investigations will allow to fill gaps, such as:

- continued lack of needed data for ground water management and protection,
- lack of the data for development of IWRM plans for basin management areas and for decision-making.

On the other hand there exist serious problems related with using highly mineralized underground water for irrigation, as well as with seasonal changes of the level of groundwater.

The main reason for soil salinization is high level of underground waters. The communities in Armavir Region (mostly Ararat valley) with salt-affected land areas are located in sub-Araks zone where water is high. When water evaporates, salt remains in the soil. Besides, after melting the spring snow water raises thus forming more and more swamps in the village. Approximately 5000 ha land in the region is salt-affected, while some territories undergo double salinization processes.

Ararat valley is very rapidly losing its supply of fresh water in artesian waters. Abandoned wells remained from Soviet times. Among them there are those that are partially conserved. As it turned out, it is much more dangerous and can lead to environmental disaster. The danger of such a partial conservation is that water under ground leaks into the lower soil resulting not only in loss of water but also arable lands.

Thus to provide sustainable development and utilization of underground water in the valley it is necessary to solve the issue of control of water utilization.

The present strategy for sustainable agricultural development stems from the state policy for the agricultural sector. The strategy is consistent with the Government "Poverty Reduction Strategy" programme and ensures continuation of the agrarian reforms in the Republic.

Over past 25 years the level of participation of the Government in the agricultural sector was greatly reduced by the liberalization of the economy, privatization of land and other productive means, servicing infrastructures, sales and processing organizations. Based on the peculiarities of the country and taking into consideration the problems of food security an important role is given to the state assistance to the agricultural sector during the transition period. The implementation of the strategy will be supported by the Government in the following areas: formation of the regulatory framework in agro-food sector, provision of agricultural entities with favorable conditions for smooth operation and investments, development of infrastructures and promotion of food safety, etc.

As the valley is a major granary of the country, is necessary to harmonize strategies of rural development and rational use of groundwater resources in accordance with IWRM plans, as well as exploring the possible risks and their prevention. Since watershed basins of many rivers are situated in the Ararat valley, an integrated approach to the study and management of water and underground accumulation pools is required.

Climate change impacts.

As a mountainous country with arid climatic conditions, Armenia, with its entire territory, is vulnerable to the global climate change. According to the World Bank assessment, Armenia is among the most sensitive countries in the Europe and Central Asia region in regard to climate change. Increased temperatures and reduced precipitation accelerate the desertification processes and will have a negative impact on public health and sectors, which depend on the climate. Declining water resources will have a direct impact on agriculture (reduced possibilities for irrigation, worsened conditions for dry farming, reduced crop yields), and will result in reduction of electricity production from HPPs and scarcity of technical water.

Table 1. Changes in seasonal and annual temperatures (°C) compared to the average for 1961-1990, according to PRECIS model under A2 scenario of IPCC

Region	Winter	Spring	Summer	Automn	Annual
2030					
Ararat valley	1	2	0	1	1
2070					
Ararat valley	3	4	1	2	2
2100					
Ararat valley	2-6	4-7	1-3	2-4	3-5

According to investigations of the climate change impact o the meteorological conditions in Ararat valley a continuous increase in temperature will be observed, and the increase will reach its maximum value in spring-summer months at 4-7 ^{0}C (Table 1). In Ararat valley, higher temperature rises are expected compared to other parts of the country. The forecasted climate change will result in less precipitation (Table 2). More evaporation from the land surface and the saline swamplands of Ararat valley will turn into salt marshes (*Second National Communication on Climate Change, 2010*).

Table 2. Deviations of seasonal and annual precipitation (%) compared to the average for 1961-1990, according to PRECIS model under A2 scenario of IPCC

Region	Winter	Spring	Summer	Automn	Annual
2030					
Ararat valley	**-13**	**-9**	**-13**	**-9**	**-11**
2070					
Ararat valley	-25	-18	-25	-18	-22
2100					
Ararat valley	-35	-25	-35	-25	-30

It is impossible that the consequences of global climate change did not reflect on the balance of underground and surface waters, this makes ground why it is necessary to conduct studies directed to synchronous assessment of the climate change impact on the resources of ground and surface waters in the region.

Conclusion

In the current situation, paramount actions for sustainable management and use of water in transboundary basin should be measures aimed at achieving the following objectives:

- Evaluation of resource stores in boundary and transboundary aquifers
- Determination of physico-chemical, biological, and radionuclide composition of the groundwater
- Vulnerability assessment of fresh groundwater transboundary aquifers to anthropogenic pollution from the surface land
- Development of joint monitoring and protection of transboundary groundwater aquifers.

In the face of the dynamic process of global climate change the studies acquire more urgency and significance.

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