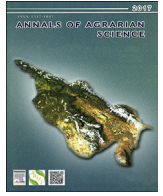


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Water resources of Kakheti and ecological problems

Zurab Lomsadze*, Ketevan Makharadze, Marat Tsitskishvili, Rusudan Pirtskhalava

The Technical University of Georgia, The Centre for Studying Productive Forces and Natural Resources of Georgia, 69, M. Kostava Str., Tbilisi, 0175, Georgia

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ABSTRACT

Water is an essential life-sustaining resource whose existence and availability for human being can not be overestimated. Rapid socio-economic development over the past several decades in the world, adverse effects of human activities on natural ecosystems, seriously threaten fragile landscape ecology and water resources. All these problems that are observed in today's world didn't pass round Georgia too. The article provides an overview of the present-day condition of Kakheti water resources, one of the important regions of Georgia, and highlights all related negative aspects and issues.

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Introduction

Water resources are important to both society and ecosystems. We depend on a reliable, clean supply of drinking water to sustain our health. We also need water for agriculture, energy production, recreation and manufacturing. Many of these uses put pressure on water resources.

Freshwater is the most important resource for mankind, cross-cutting all social, economic and environmental activities. It is a condition for life on our planet, an enabling or limiting factor for any social and technological development, a possible source of welfare or misery, cooperation or conflict [1,2].

According to the United Nations agencies one-third of the world's population live in the countries that are experiencing moderate to high water stress [3,4]. By 2013 figures from the world health organization some 780 million people (11% of the world's population) don't have access to safe drinking water, while 2.5 billion (40% of the world's population) don't have proper sanitation (hygienic toilet facilities). Annual death from water-borne diseases is estimated at more than three million. Such illnesses as diarrhea, causing from sewage disposal kills 760 thousand children under five each year [5].

Climate change will have also an important role in the hydrological cycle and in the quantity and quality of water. These alterations can promote countless changes in the availability of water

and the health of the human population [6,7]. The present-day water crisis with its many components of an environmental, economic and social origin, overuses of water, pollution, changes in availability and water mismanagement are some of the current problems. To cope with these problems we need new strategies for long term management [8–10].

Georgia with its inner waters (rivers, lakes, reservoirs, glaciers, underground waters, wetlands) was one of the first among former Soviet republics. Though, water resources in the country are spread uneven. In the west part of the country, water flow (with transit flow) is 49.8 km³, while in the east part it is only 16.5 km³ [11,12].

From main adverse factors influencing on water resources of Georgia are: the increasing pollution of hydrosphere and environment (atmosphere, lithosphere). The causes of qualitative deterioration of water resources are: irrigation, land-reclamation of salinized lands, run-off waters, malorganization of reservoirs' foundation pits, et cetera. The importance of the problem is proved by the fact that even purified, recycled waters need dilution 15 times with clean water to regain natural water quality.

The annual amount of all kind of runoff waters contaminate 12–15 times more natural water. The quality of water in rivers and reservoirs of Georgia is extremely disturbing. As long as in 1986 river pollution 1.7-times exceeded average world level [12,13]. Decrease of industrial activities, after breaking of the Soviet Union some 25 years ago, had one positive effect-lessening of air and water pollution. In spite of important administrative and legislative efforts, priority in future must be given to economically grounded scientific-technical measures such as: rational territorial distribution of industrial enterprises according to water resources

* Corresponding author.

E-mail address: zlomsadze@mail.ru (Z. Lomsadze).

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availability and quality; working out new technologies enabling production with minimal expenditure of natural resources and minimization of waste products.

Results and analysis

Water resources of Kakheti

Kakheti is one of the most important regions of Georgia. It is located in eastern part of the country and borders upon Russia from north and Azerbaijan from east and south. The total area of the region is 11310 km² and population 320 thousand (9% of the country). There are 8 administrative regions in Kakheti with 9 towns and 276 villages. The centre of the region is Telavi.

Kakheti is characterized by mono-economy and low level of urbanization, –80% of the population live in villages and they are occupied mainly in governmental infrastructural projects, that are very important for the region [13].

The annual precipitations in Kakheti is 10070 ml m³ (907 mm), from that amount 5698 ml m³ are evaporated and 4372 ml m³ (394 mm) flow into rivers. The underground flow-the regulated part, is- 44% of total river flow. The total water resources of the region is- 5.27 km³.

The **Table 1** represents the water resources of Kakheti. For characteristic of annual regulated river flow there are some coefficients, one of them is coefficient of natural river flow regulation- ϕ , which is the part in the basic annual flow. Besides, there are criterions proposed by L.Vladimirov [14], coefficients of maximum (k_{max}) and minimum (k_{min}) expenditure and the relative data of underground flow that also characterizes the natural flow regulation.

When using rivers for maintenance of their normal ecological condition, it is necessary to determine sanitary expenditure of them. Their average minimal monthly expenditure is 75% in case of 95% securing. The expenditure that exceeds sanitary minimum in the river is a potential water resource that can be used for economy [15–17].

In **Tables 2 and 3** and **Figs. 1 and 2** are presented the distribution of Kakheti water resources according to the municipalities and per capita [17].

Among Kakheti municipalities Akhmeta is distinguished by water resources formed at the place (0.9 km³). The least amount of water resources is in Signaghi municipality(0.07 km³). As to the water resources per capita, Akhmeta is leading again with 28606 thousand m³ an year, or 78.3 m³ in twenty-four hours. In the poorest by water resources municipality-Signaghi, water resources per capita is 2337thousand m³ in an year i.e. 6402 m³ in twenty-four hours. It is 12.23 times less than in Akhmeta municipality. Especially must be underlined Dedoflistskaro municipality, where water resources formed at the place are 51 mm. Water resources per capita here is 6126 thousand m³ in twenty-four hours. It is 2.6 times more than in Signaghi. Such difference is determined by population number in these municipalities. The water flow coming from outside, according to the municipalities is: Akhmeta-1.36 km³; Sagarejo-0.30 km³; Signaghi-0.28 km³; Dadoflistskaro-0.16 km³ [18–20].

Water and sewerage sector

Kakheti is rich by water resources. Alazani is the basin of artesian wells, where there are substantial supplies of fresh water. Besides, the output of Alazani tributaries allows full supply of Kakheti population with drinking water. The water quality control in all Kakheti municipalities is made according to the general parameters. In most part of municipalities the drinking water is

chlorinated, though because of headwater constructions malfunction, the water frequently get turbid in rains.

The sewerage system in Kakheti is developed least of all. This system is working well only in towns, mostly in Televi and Signaghi. The problem is the absence or amortized purifying constructions. The most part of villages in Kakheti is supplied from self flow and artesian wells. There is the program of village development financed by the government. In 2012, 39% from all finances were spent on creation and restoration of water supplying systems and only 2% on sewerage systems [20,21].

The weak sides of the problem

- Low quality of drinking water increases risk of infective diseases. Because of absence or malfunction of purifying construction, unpurified sewerage waters inflow into Alazali and contaminate it chemically, as well as, biologically. These polluted waters then are used for irrigation.
- Malfunction of sewerage water systems provoke in rainy days, filling the sewerage wells with rain water and this water outflows on the surface and is a source of insanitary.
- Malfunction of municipal water system provokes: water losses, irrational use of water resources, pollution of drinking water in rains and their dilution with sewerage waters.

Purposeless use of water lessens the water reserves. Control of water quality is complicated and it adversely influences on drinking water quality.

The strong sides of the problem

- Considerable amount of water resources in the region.
- At a slow pace, but still, the rehabilitation of drinking and sewerage water systems.

Treats

The global warming, the process of desertion and secondary marshiness are the main threats; changing of water output; changing of river conditions; changing of chemical characteristics of water causing from fluctuation of precipitations.

Possibilities

The modern technologies of water resources exploitation allow to supply population with quality water. The increasing demand on ecologically clean drinking water in the world enables Georgia to become an exporter of drinking water.

Priorities

It is necessary to estimate the fresh water resources of Kakheti, as well as, underground waters and outputs of the rivers. It is also necessary to organize modern laboratories to control water quality.

For provision of local population with quality water and sewerage service, it is necessary to rehabilitate the infrastructure of these systems. The local municipalities should pay more attention to organization of proper sewerage systems and cleaning constructions to promote ecological balance and living conditions of the people.

The ecological condition of water resources in Kakheti

We have analyzed the facts of journalistic investigation concerning ecological condition of water resources of Kakheti [22]. As it was found out unlawful dust-holes, polluted surface waters, cemeteries, located near headwaters and malfunction of sewerage

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