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Assessment of Water Resources and Inculcation of Controlled Water Consumption System

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***Abstract*—**Deficiency of fresh water is a vital global problem today. It must be taken into consideration that in the nearest future fresh water crisis will become even more acute owing to the global climate warming and fast desertification processes in the world. Georgia has signed the association agreement with Euro Union last year where the priority spheres of cooperation are the management of water resources, development of trans-boundary approach to the problem and active participation in the "Euro Union water initiative" component of "the East Europe, Caucasus and the Central Asia". Fresh water resources are the main natural wealth of Georgia. According to the average water layer height, Georgia is behind such European countries only as Norway, Switzerland and Austria. The annual average water provision of Georgia is 4-8 times higher than in its neighbor countries Armenia and Azerbaijan. Despite abundant water resources in Georgia, there is considerable discrepancy between their volume and use in some regions because of the uneven territorial distribution. In the East Georgia, water supply of the territory and population is four times less than in the West Georgia.

***Keywords*—**GIS, sociological survey, water consumption, water resources.

I. Introduction

THE water crisis is the #1 global risk based on impact to society (as a measure of devastation), as announced by the World Economic Forum in January 2015 [1]. "Food security is also impacted by the decline in water resources. Due to land degradation there is less water and snow being stored in the ground. In 10 years, two out of every three people in the world could be living under stressed water conditions.

"Climate change and unsustainable land use, particularly by agriculture, are contributing to the decline of freshwater resources in all regions of the world. As a consequence, global food production is projected to fall by 2 per cent every decade. A world where all rights to food, water and human security are guaranteed is possible. But we need to change course and start securing every hectare of land that can provide food or freshwater" [2].

There have been 265-recorded incidences of water conflicts from 3000 BC to 2012 [3]. It is now commonly said that future wars in the Middle East are more likely to be fought over water than over oil [4]. Solution of relations regarding water use and water consumption within Georgia and beyond its borders is one of the important guarantees of the regions' stability. The mentioned problem is the urgent one for Georgia as well as the territory of the country comprises of transboundary water bodies and the transit flow consists of 12% of the total flow. It should be taken into account that, due to the global warming and progression of the process of desertification, it is probable that the fresh water crisis will become more and more pressing issue in the near future.

Fresh water resources represent the core natural wealth of Georgia. According to the average height of water layer (760 mm) Georgia lags behind Norway (1190 mm), Sweden (1040 mm) and Austria (800 mm) only. The average annual water provision is 760X10³ m³ while the same indicator for the neighboring countries such as Armenia and Azerbaijan is 190X10³ m³ and 90X10³ m³ respectively (Figs. 1 and 2). Water resources of Georgia are located within the basins of two – Black and Caspian seas. According to the average height of water layer Georgia (760 mm) follows Norway (1190 mm), Switzerland (1040 mm) and Austria (800 mm) among the European countries.

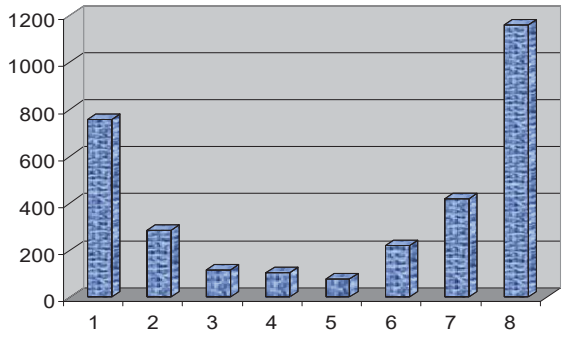

Fig. 1 Water provision by the territory 1-Georgia, 2-Armenia, 3-Azerbaijan, 4-Iran, 5-Irak, 6-Turkey, 7-France, 8-Norway

Georgia strives for deeper cooperation with Euro Union. Among the priority spheres of that cooperation, one of the most important ones is sustainable development of water resources. Water management requires a good understanding of the geographical space and related spatial information such as water sources, terrain surface, watershed, land cover, land use, rainfall, temperature, humidity, soil condition and composition, geology, conditions on the atmosphere, human activities, environmental data, etc. [5]. Inculcation of controlled water consumption system will create better conditions for the rational and more efficient use of the budget expenditures that will have positive effect on economics and social sphere of the country [6].

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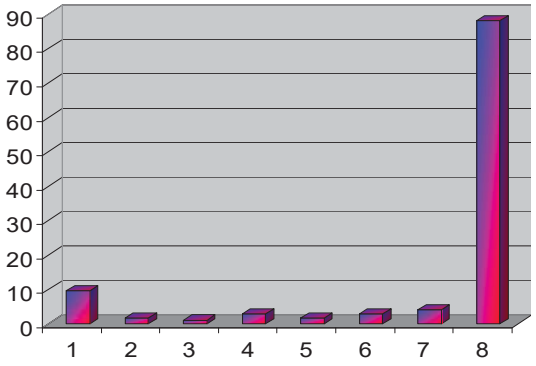

Fig. 2 Water provision by the population 1-Georgia, 2-Armenia, 3-Azerbaijan, 4-Iran, 5-Irak, 6-Turkey, 7-France, 8-Norway

According to the national action plans of Georgia [10], [11] the study region attributed to desertification sensitive territory. The fresh water problem there will become even more acute against a background of the current climatic changes and expected desertification of territories that most probably will cause migration of local population from the region.

II. Study Area and Method

Kvemo Kartli has been taken as the region under study because of the above reasons (Fig. 4). Its area is 6.5 thousand of square km (that is 9.3% of the country territory). There are 347 settlements – 7 cities, 6 towns and 334 villages.

The hydrography network of Kvemo Kartli is represented with trans-boundary river Mtkvari and its tributaries; 15 lakes are used for recreation, irrigation and fishing purposes; 6 reservoirs are used for fresh water supply, power and irrigation purposes. There are mineral, sulphur and thermal springs [12], [13].

Tbilisi -the capital of country is located next to Kvemo Kartli region. The nearby Azerbaijan and Armenia republics, Tbilisi international airport, high level of urbanization, transport and power corridors, etc., favor development of the region. Its natural conditions are most favorable for agricultural purposes with 2-3 harvests per year that stipulate for high competitiveness of the region in comparison with other ones. Different branches of industry such as mining, metallurgy, chemical production of cement and construction materials, ceramics, glass, etc., along with power generation plants are the most active water consumers in the region.

The main problem of nearly all municipalities in the region are irrigation schemes which are depreciated or in poor state today. The existing problems of water supply hinder development of agricultural branches considerably.

Against the current background of global, warming one of the best remedial measures of the said process will be drawing up the water economy balance of river basins and municipalities, assessment of the territory water supply and inculcation of controlled water consumption system in the region [7]-[9].

The GIS for creation of Kvemo Kartli water resources management system will use for the first time instead of the bulky and versatile data available.

The goal of study is to integrate the recent mechanisms compatible with European standards into Georgian water resources management system based on GIS. Moreover, to draw up water economy balance for the purpose of proper determination of water consumption priorities that will be an exchange ratio of water resources and water consumption of the concrete territory.

With that end, in view the region under study subdivided into four units. For all four units held the following activities:

1. **Collected of data and information.** At the initial stage, all available data on water resources and water consumption existing in different institutions of the country gathered.
2. **Created of GIS basis of Kvemo Kartli water resources.** The basis created according to the topographic map of Georgia, scale 1:200 000. Detail lose sheets (scale 1:100 000 and 1:50 000) were issued when required.
3. **Field-expedition works.** The said works arranged in all municipalities with a view to specify data. So, the most recent and real information on the state of water objects, irrigation schemes, etc. obtained.
4. **Sociological inquiries.** The questionnaire worked out with a view to find out the opinion of local population on water consumption issues in the course of field works.
5. **Formed of the bases structure and data loaded into GIS.** The final structure of databases determined after collection, initial processing and analysis of data. The basis transformed according to the design problems and all types of data and information loaded. The obtained information converted to digital format.
6. **Drew up water economy balance of many years for river basins and the separate municipalities.** The data of 2016 on population, irrigation schemes and land use specified by field works used in water economy balance.
7. **Evaluated of the territory provision with water and determine of sensitive territories according to water resources.** Water provision of territory estimated and corresponding map drawn up.
8. **Calculated and mapped of the maximum possible population number calculated per head for different water consumption standards.**
9. **Calculated of water resources and water consumption exchange ratio.**
10. **Exchanged of information on trans-boundary water objects with representatives of organizations dealing with water resources from neighbor countries (Armenia, Azerbaijan, Turkey).**
11. **Prepared of Kvemo Kartli water resources GIS and the program multi-media packet.**
12. **Worked out virtual scenarios of water resources management for training purposes.**

According to the activity 4, sociological survey was implemented in order to assess the water consumption issues that local population face in Tetritskaro (Fig. 3). The main

objectives of the survey were following: 1) Identification of main water maintenance types; 2) Assessing the locals' accessibility to drinking and irrigation water; 3) Evaluating people's general satisfaction with the water supply, it's quality and quantity; 4) Identifying the main issues associated with water consumption.

Considering the goal and the objectives of the study, qualitative research method was used. Survey was conducted using focus group (group discussion) method. Group discussions were organized prior to the survey by key personnel of the project in collaboration with local municipalities. Each focus group consisted of 6-8 locals who were intensively engaged in agricultural activities. A guideline for the group discussions was designed by the key personnel (sociologist) of the project in collaboration the experts from the relevant area of the study. The semi-structured guideline included approximately 15 questions. The focus groups were led by a moderator. In total 4 focus groups will be conducted in Tetritskaro municipality: One focus group was conducted in municipality center and 3 focus groups were conducted in different villages of the municipality. The lengths of the discussions were around 1.5 hours. The focus group discussions were recorded on an audio tape. Recorded group discussions were transcribed. Obtained data was analyzed in the framework of code categories developed based on transcripts. Survey followed all ethical standards of the social research. The study shows that only some of the settlements of the municipality have integrated water supply system.

Fig. 3 Sociological Survey in Tetritskaro Municipality

The rest of the locals usually use the underground water as drinking water and the rainwater for agricultural reasons.Tetritskharo water is consumed for irrigation needs by the other municipalities as well, however, the locals emphasize that the received water is not usually enough for irrigation. Locals presume that brurst mains and leaks do happen and this can result in properties suffering from no water or low pressure. They presume that irrigation system is outdated and damaged and needs renovation. Focus group participants also mentioned that the quality of the water is quite low, especially during rainy days.

They also argued the hygiene issues caused by the limited accessibility with integrated sewerage system.

Fig. 4 Study Area

One of the basic conditions for preservation and smooth development of the unique ecological systems in Georgia is elaboration of the united and efficient management system of water resources. The strategy of water resources management means their protection, restoration and rational use first of all.

According to the directives of Euro Union water management/regulation is quite complicated system that must be followed by proper monitoring and executive system. According to Euro Union notion water management is a dynamic process directed to the positive result. Updating of analysis and estimates envisaged in the frame directive on water by Euro Union are made periodically. There are no institutions in Georgia for sustainable management of water resources today. The integrated management of water resources can be initiated with slow steps before creation of corresponding legislation and institutions.

The scientific value and practical realization of the project results are directed to the receipt of real estimate of water resources quantitative characteristics existing in Kvemo Kartli region. The data bases of GIS will be created and subject maps will be drawn up that will help administration bodies to work out plans of regional economic development.

The results of project will help water users to develop tight bonds between industry branches, transparent management of water resources, rational use of water resources and methods against water losses. Moreover, it is important that by means of GIS it will be possible to update data bases along with their analysis.

For proper planning/development of country economics it is necessary to introduce the virtual water as an independent component into water economy balance expression. Virtual water is comparatively new notion. It is a volume of water contained in any product that is necessary for its manufacture. In the outgoing (spending) part of the balance made up by the said method the volume of water needed for manufacture of any product in the region will be envisaged. Thus, realization of the project will create more perfect, realistic and perspective picture of water economy balance and the part played by virtual water there.

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