



Sustainable Management of Water Resources on the Background of Current Climate Change

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To cite this article:

Nana Bolashvili, Tamaz Karalashvili, Vakhtang Geladze, Nino Machavariani, Ana Karalashvili, Nino Chikhradze, Geladze Giorgi, David Kartvelishvili. Sustainable Management of Water Resources on the Background of Current Climate Change. *Earth Sciences*. Vol. 6, No. 5, 2017, pp. 75-79. doi: 10.11648/j.earth.20170605.13

Received: August 4, 2017; **Accepted:** August 7, 2017; **Published:** September 6, 2017

Abstract: We are all dependent on water. We need it every day, in so many ways. We need it to stay healthy; we need it for growing food, for transportation, irrigation and industry. Under the existing trend of climatic change, serious problems will occur accompanying the intensive migratory processes of the population living in the arid regions. The main goals of the project was increasing local population's participation in decision-making process on ecological issues by raising their awareness on irrigation water pollution issues, reinforcing them to participate in investigation of the problem in frames of the project, and supporting them to impact on local water resource management policy.

Keywords: Climate Change, Water Resources, Desertification, GIS

1. Introduction

At the beginning of the twenty-first century, the Earth, with its diverse and abundant life forms, including over seven billion humans, is facing a serious water crisis. We are all dependent on water. A person can live about a month without food, but only about a week without water. Six hundred sixty six million people - 1 in 10 - lack access to safe water [1]. In recent years, the concept of virtual water trade has gained weight. The virtual water is the sum of the water use in the various steps of the production chain, to create the goods and services that we consume and use. Thinking about virtual water can make us look at our water management systems in completely different ways [2].

Water resources shortage is often artificially created as a result of not taking into consideration the water resources

amount during the population urbanization, intensive development of industry and agriculture. For sustainable development of water resources, it is necessary to move to managed water consumption and to evaluate the water deficit or excess in relation to its needs. Water management is the management of water resources under set policies and regulations. Water, once an abundant natural resource, is becoming a more valuable commodity due to droughts and overuse.

By 2030 the demand for water is projected to rise by 35 per cent. Unless we change our land-use practices, we face the prospect of diminishing and inadequate water supplies, as well as more frequent and intense droughts. Food security is also impacted by the decline in water resources. 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. 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 [3].

In the countries with scarce water resources they often become a reason of armed conflicts. It is now commonly said that future wars in the Middle East are more likely to be fought over water than over oil [4].

The peaceful settlement of relations connected with management and water consumption issues within and beyond the frontiers of the country is an important guarantee of the region stability. Study and estimation of water objects located in the vicinity of frontiers by means of hydrological, hydro-chemical and hydro-biological methods is an immediate objective of many international projects. The said problem is urgent in Georgia as well [5]. Georgia is an active participant of joint and regular monitoring, information exchange meetings with its neighbor countries (Azerbaijan and Armenia) with a view of common protection and use of trans-boundary water objects (Mtkvari /Kura/), Alazani, Iori, Khrami, Debeda, etc.). Usually, in the trans-governmental basins the available water resources and the territories corresponding to them are unequally distributed, that quite often is a reason for conflicts among the states.

In spite of possible problems and conflicts, they give place to cooperation during the joint usage of trans-governmental river flows.

Water is more likely the factor of cooperation, than the opposition, as besides the economic and market relations the categories, such as "transparency", "validity" and "ethics" play an important role in the mechanism of water resources management.

2. Materials and Methods

Water resource management strategy firstly means water protection, restoration and its rational use.

Against the background of climate change, one of the most real and effective measures and priorities for the suspension of the mentioned process and adaptation to climate change is the rehabilitation of irrigation systems. As a result of climate global warming the expected changes in natural zones require correction of types of irrigation systems and technologies. It should be also taken into account the trend of increase in areas of irrigated areas.

Fresh water resources are the major natural resources of Georgia. The largest water consuming region of the country is its eastern part, where water supply for population and the territory is four times less than in Western.

With the purpose of sustainable development of water resources in eastern Georgia there is a direct evidence of necessity of transition to a system of managed water consumption [6; 7]. Therefore, the management system of water resources should be proceeded from the situation, that the lack or surplus of water should be estimated according to

the demand for it. There are outlined two approaches in management of water resources: territorial redistribution of the water resources and planning of economy and population occupancy with the water factor in view.

Information about water (river, lake, reservoir, irrigation schemes, run-off, discharge, etc.) water demand and demographic data (population, its density, urban and rural population, etc.) are existed in various departments and published in the literary sources (monograph, article, atlases, statistical handbooks and other); all of the above mentioned materials are freely available [8; 9; 10; 11; 12; 13]. The purpose of the project was collection and analysis all above mentioned data and creation geographical information system (GIS) of water resources in eastern Georgia.

The main goal of the sociological study was the assessment of local people's attitudes towards the irrigation water pollution issues and investigation of their civil engagement experience. Based on the information gained from the sociological study, main themes/subjects for information meeting have been determined.

The main objectives of the sociological study were as follows:

- (1) Determining key problems associated with irrigation water pollution that local people face in different municipalities;
- (2) Studying local people's motivation and previous activities towards dealing with the water pollution issues and their accessibility to impact on local policy of water management;
- (3) Assessing local people's awareness of the main reasons and characteristics of water pollution issue;
- (4) Determining the main themes that local people are less aware about water protection and the themes that local people would be interested to gain more knowledge about.

The target group of the sociological study were local people who are the most affected by water pollution issue and own agricultural land (in a sense that they consume irrigation water).

For fulfilling the purpose of the study, qualitative research methods were used considering that there are no previous studies that would assess water pollution issue from local people's perspective. From the qualitative research methods, the Focus group (group discussion) method was used. This method was chosen for the following reasons: the subject of the study is not sensitive and could be discussed in groups; during the focus group moderator has opportunity to ask follow-up questions and gain in-depth information on people's attitudes, experience, and motivations towards water pollution; group dynamics might bring out important aspects of the water pollution issues that may not have been anticipated by the researcher before the study; for the following project, focus group method was enough flexible in time and price.

The exact number of the focus groups determined based on the desk research which provided the information on the target geographical areas that are the most affected by

irrigation water pollution problem. Approximately 4-6 focus groups conducted. The focus group recruitment criteria specified based on the desk research results.

A guideline for group discussions was designed by the sociologist. The semi-structured guideline composed of approximately 15 questions.

Each focus group consisted of approximately 8 members. The length of the discussion was around 1-1.5 hours. The focus group discussions recorded on an audio tape. Recorded focus group discussions transcribed and analyzed by categorical analysis method.

Focus group results used for preparation the materials for information meeting.

3. Study Area

Kakheti and Kvemo Kartli have been taken as the regions under study, because according to the national action plans of Georgia [14; 15], they are attributed to desertification sensitive territories. The major part of the population is engaged in agricultural activities, and they are typical agricultural regions.

The area of Kakheti region is about 12 thousand km², it includes the basins of the rivers of Iori and Alazani. There are 5 hydrological regions in Kakheti (3 – in the Alazani River basin and 2 – in the Iori River basin), the runoffs of which are uniquely determined by the average height of the area. The length of most of rivers (95%) does not exceed 10 km. River network density is 0.45 km/km².

The Iori River water resources (within Georgia) – 0.80 km³

(210 mm). Middle and lower parts of the basin is poor in water resources. Runoff module ranges within 5.00-2.80 l/sec km². During the low flow periods and seasons the runoff is often lower than ecological rate. In the near future, due to the global warming and desertification processes, it is expected to face more problems of water shortage. Small insignificant brackish lakes are scattered in the Gare Kakheti upland in the Iori River basin. From reservoirs the Sioni and Dalismta reservoirs of complex importance can be noted.

Alazani River basin compared with the Iori, is rich in water resources. Water resources (within Georgia) of the Alazani River basin are 3.10 km³ (570 mm). Left tributaries of Alazani, which flow from the southern slopes of the Greater Caucasus, are characterized by high-water. Mudflows are characterized for the tributaries of the both sides of the river. The runoff module along the river flow ranges within 49.0-9.00 l/sec km².

Almost all left tributaries of the Alazani River are distinguished by a great activity of mudflow processes. Lately, the mudflow processes have significantly activated in the right tributary river basins of Alazani, where in the relatively small areas the powerful mudflows are formed. As a result of ponding of the confluence sections of the Alazani River left tributaries (Kabali, Chiauri and Svideba Rivers), the several hundreds of hectares of areas are flooded, including the unique Chiaura forest.

Kakheti occupies the leading place by agriculture in Georgia (viticulture, grain growing, livestock farming, etc.). The region's natural conditions enable the need for artificial irrigation on its largest part.

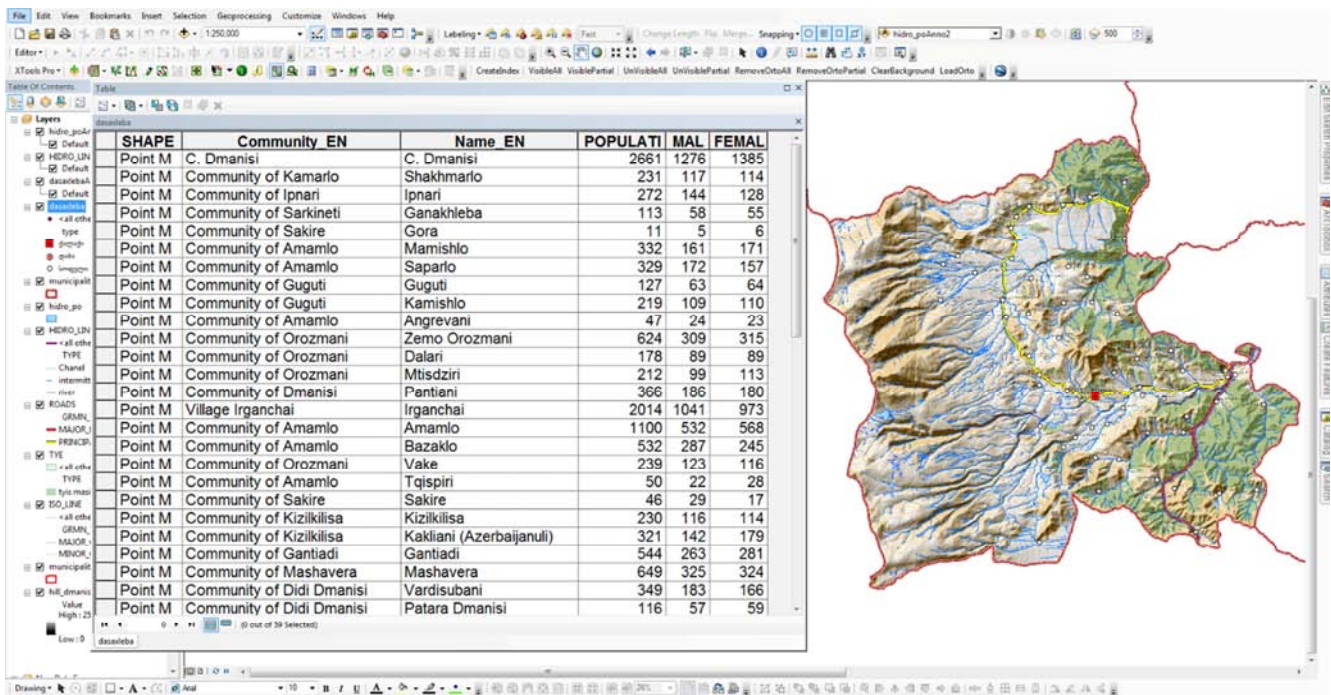


Figure 1. Digitalized surface and underground water objects (Dmanisi municipality, Kvemo Kartli region).

In Kakheti can be irrigated 150000 hectares. At present technically can be irrigated about 50000 ha.

Currently, almost all of the irrigation systems of Kakheti are more or less functional, but do not work at full capacity.

The majority of the irrigation systems do not have the regulated runoff; there is no strict control of water intake, collector-drainage network and irrigation process automation; parts of irrigation systems have to be cleaned; most of canals have the ground bed without revetment; there are abandoned the canals and wells in many places. In addition, there are no new data on detailed surveying of the relief of irrigation area, which is necessary to select the optimal configuration of canal contours. All of this leads to uneven irrigation and unnecessary expenditure of water [16].

The area of Kvemo Kartli 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 hydrographic 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. The hydrographic 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.

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 [9; 10; 11; 12].

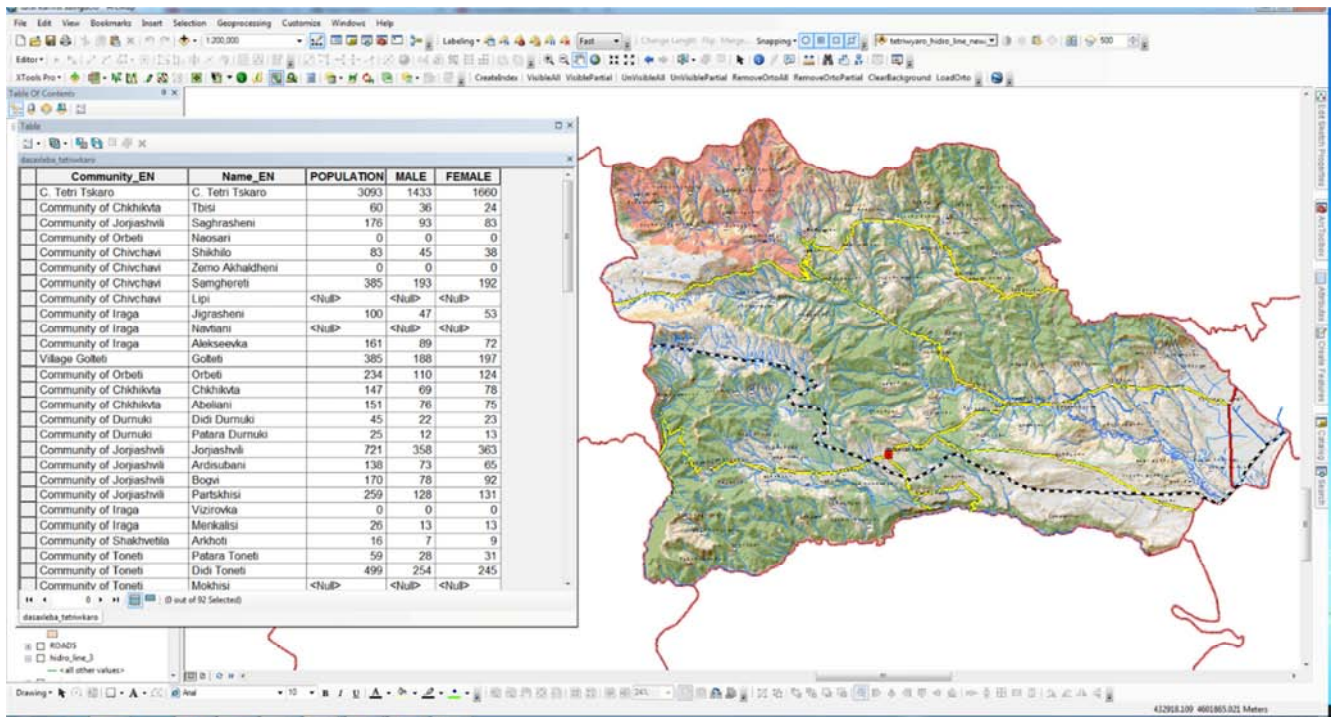


Figure 2. Digitalized surface and underground water objects (Tetrtskaro municipality, Kvemo Kartli region).

4. Results

The following tasks were completed during the implementation of the project:

- (1) Inventoried and digitalized the surface and underground water bodies (Figures 1 and 2);
- (2) Identified the different categories of territories according to the supply of water resources;
- (3) A survey was conducted in the villages in order to reveal the population's attitude to the water consumption related issues. Within the study the 20

- people were interviewed from each village;
- (4) Renowned maps showing settings of the geographical areas in municipalities affected by polluted irrigation water and databases and maps showing disposition of water pollution levels on mentioned areas; provided maps and databases was crucial for elaborating plans to improve water management policy. Moreover, provided information could be useful for educational and academic purposes;
- (5) Informed society which participated in investigation of the water pollution issues by obtaining empirical data on water pollution levels under supervision of the

project coordinators. Project included activities that will increase local population's awareness on irrigation water pollution issues and activities that encourage them to protect natural resources and their constitutional right to a healthy environment. From long term perspective, this would lead to more open, participatory society.

5. Discussion

Based on focus group results, determined those themes on ecology and water pollution issue that local people are interested to gain more knowledge in. The survey results confirm that there is a drinking water shortage and the irrigation water acute shortage in the municipalities. The overwhelming majority of the interviewed respondents in the villages of are dissatisfied with the amount of drinking and irrigation water. However, population in some districts did not have access to spring water due to the water supply system there and they have to carry the water. Discussions with the population revealed that the water pipes in the villages damaged, water is wasted and lost.

Acknowledgements

The authors are grateful to the staff of municipalities of Kakheti and Kvemo Kartli Region for supplying data. The study is funded by Shota Rustaveli National Scientific foundation (Georgia), projects: № AR/121/9-180/13 and №216916.

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