IRRIGATION AND WATER SUPPLY RECOMMENDATION SCHEME IN RIONI RIVER BASIN

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IRRIGATION AND WATER SUPPLY RECOMMENDATION SCHEME IN RIONI RIVER BASIN

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ABSTRACT

Nearly 20 years have passed since the European Community implemented the European Directives on water management. Its main directions are the achievement of good water quality and the implementation of water management principles. In Georgia, this process has been underway already for 3 years. The country's territory is divided into 6 basin areas. One of them is the Rioni River basin, whose area is 13,000 km^2 with up to 700 rivers. In addition, there are reservoirs and a system of irrigation canals. In the downstream. The Rioni River flows along the wetland territory of the Colchis lowland and merges with the Black Sea near the city of Poti. Rioni is the affluent river of Georgia and taking into account this parameter, is characterized by frequent natural disasters, especially during the spring season. To this are added the tributaries, which originates from high mountains and are distinguished by fast flows. Historically fixed floods are the most ambitious than other river basins and caused the greatest losses at different times.

The functioning of the agricultural lands located here and the process of stable development of settlements depends on natural disasters caused by the hydrological regime of the Rioni River, since the riverbed in the downstream and middle flow is in close contact with these objects. Given this factor, in this area there are many vulnerable districts for which prevention and mitigation of natural risks has of great importance. In the Rioni basin, in the eastern part of the Colchis Lowland, there are two cities of cultural and economic importance - Kutaisi and Samtredia, and rural settlements adjacent to their agglomerations, whose incomes are self-employment in the agricultural sphere. Therefore, reducing the vulnerability of these areas and ensuring a stable economic environment are crucial. Since the main place in the economy of the studied area is agriculture, the major challenge is the efficient use of the water resources of the Rioni River basin and the creation of a modern scheme for this use. It is also important to effectively address the issue of drinking water supply of large urban settlements and rural areas. The increased number of flood disasters in the Rioni River basin, gives us an idea, that the basin has more than enough water resources and their proper distribution would increase the effect of the economic benefits of the region and would receive a scientifically based regulated basin management system.

To accomplish the goals, was made a stationary work and field trip to the study area. During the stationary work past topographic maps were analyzed to describe the earlier system of hydrotechnical constructions and management. New topographic maps and orthophotos performed by the National Agency of Public Registry (NAPR) of Georgia in 2007-2016 were used in conjunction with past maps to reveal the dynamics. Water users, such are the agricultural lands, were also identified on the base of cadastral information obtained from the NAPR of Georgia. The population of urban and rural

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settlements was determined according to the census data of the National Statistics Office of Georgia. To get acquainted with the current state of water supply/demand and its use, a field trip was made to the region. In the final phase of the research were used a computer programs “AQUATOOL” and “WEAP”.

Keywords: Modelling, Water, Irrigation, Management

INTRODUCTION

Water resources are the most important natural resource for any country, and especially for Georgia. Georgia occupies a prominent place on the world map with the frequency of the hydrographic network.

Most of the rivers of Georgia originate at high points and are characterized by high speeds. The Rioni River and its tributaries, which flow into the Colchis Lowlands in western Georgia, are characterized by natural disasters and flood important agricultural land and other areas. These areas are mainly part of the wetlands of Colchis, dried up for agricultural purposes in the twentieth century, as well as the wetlands themselves along the lower reaches of the Rioni River [1]. Over the past hundred years, there have been several severe floods that have caused enormous economic damage to villages and the city of Poti near wetlands - floods of houses and farms, death of domestic animals. The natural disasters of the last two decades have been characterized by an increasing trend caused by intense melting of glaciers, and dozens of major or minor floods occur every year.

As already mentioned, Georgia has large reserves of water resources. These resources are not used for supply, and there is also no established plan for their rational use and integrated management. In rural areas there is no practice of taking waters from rivers. Basically, there are reserves of groundwater, the use of which is not based on real needs and estimating of reserves, is unsystematic and cannot give a positive effect.

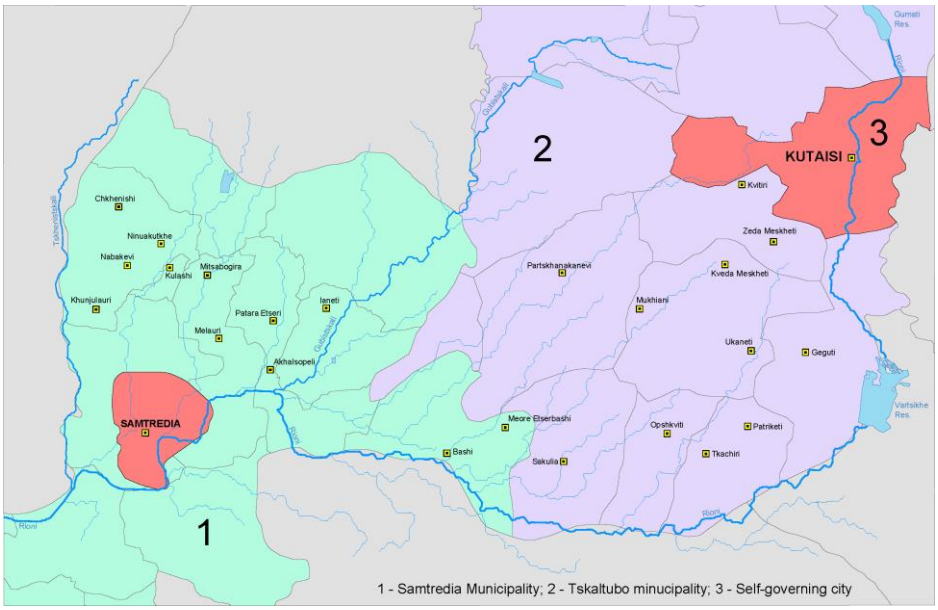


Figure 1 Project study area

In addition, this basin is characterized by swamping processes and an abundance of vulnerable areas, especially in the Colchis lowland. Here, on the midflow of the Rioni, around cities of Kutaisi and Samtredia, there are rural settlements and agricultural lands. Some of them are in exploitation and most of them abandoned.

The essence of the problem lies in the fact that from the point of view of water resources use there is no practice of quantifying this resource and a management plan based on these results. In addition, the high risk of flooding in the basin is still actual. Therefore, the topic of the study was a quantitative assessment of water resources in the immediate vicinity of the Kutaisi-Samtredia agglomeration (Figure 1) as a pilot region and the development of an alternative rational management plan.

METHODOLOGY

The research aimed to accomplish the following tasks:
1. Description of hydraulic structures on the Rioni River in dynamics, assessment and analysis of the current and earlier management systems;
2. Selection of water bodies in the study area and collection/processing of their hydrological parameters. Modelling of the Rioni river basin;
3. Collecting data on water users in the study area, assessing their estimated annual consumption;
4. Assess the state of water consumption. Identify and classify water supply by areas;
5. Modelling in the AQUATOOL program and an alternative model of the pilot area management plan in WEAP;

To accomplish the goals, was made a stationary work and field trip to the study area. During the stationary work past topographic maps were analyzed to describe the earlier system of hydrotechnical constructions and management. New topographic maps and orthophotos performed by the National Agency of Public Registry (NAPR) of Georgia in 2007-2016 were used in conjunction with past maps to reveal the dynamics. Water users, such are the agricultural lands, were also identified on the base of cadastral information obtained from the NAPR of Georgia. The population of urban and rural settlements was determined according to the census data of the National Statistics Office of Georgia. To get acquainted with the current state of water supply/demand and its use, a field trip was made to the region. In the final phase of the research were used a computer programs “AQUATOOL” and “WEAP”.

RESULTS

The main purpose of the analysis of topographic maps and orthophotos was to identify past structure of the irrigation system and to compare the existing situation on this basis. Irrigation system maps was built in ArcGIS. As the old maps show, the region was quite busy with a network of canals. In the last century, two main systems were set up here: 1. Sabchota-Mashveli canals - supplied the area of Tskaltubo municipality (to the west and south-west of Kutaisi) and 2. Tskhenistskali canals, which included villages north of Samtredia, along Tskhenistskali River [2].

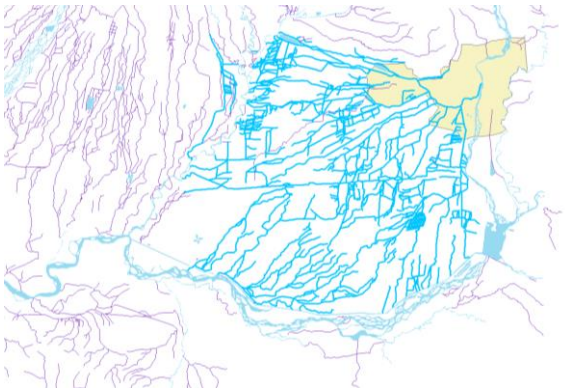


Figure 2 Past irrigation systems network

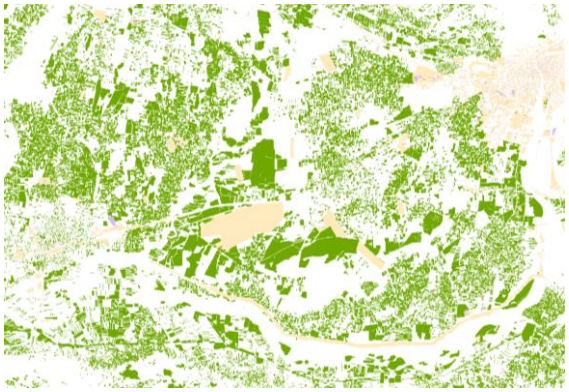


Figure 3 Land structure in study area

The systems shown in the Figure 2 provided almost complete irrigation of agricultural land, but in recent decades they have lost their function and today only three of their branches are working, providing water supply only to those lands that are directly adjacent to them, and can only take water with help of the water pumps. We can say that water resources in area is almost never used.

The total area of land is 34,226.8 ha, of which 4889.4 ha are non-agricultural, and the remaining 29326.9 ha are agricultural (Figure 3). As you can see, agricultural land plays an important weight. Today, almost 80-90% of these areas remain without irrigation water. The map below shows the entire land structure included of the study area. Agricultural land is highlighted in green, and non-agricultural land including the urban settlements of Kutaisi and Samtredia are highlighted in yellow.

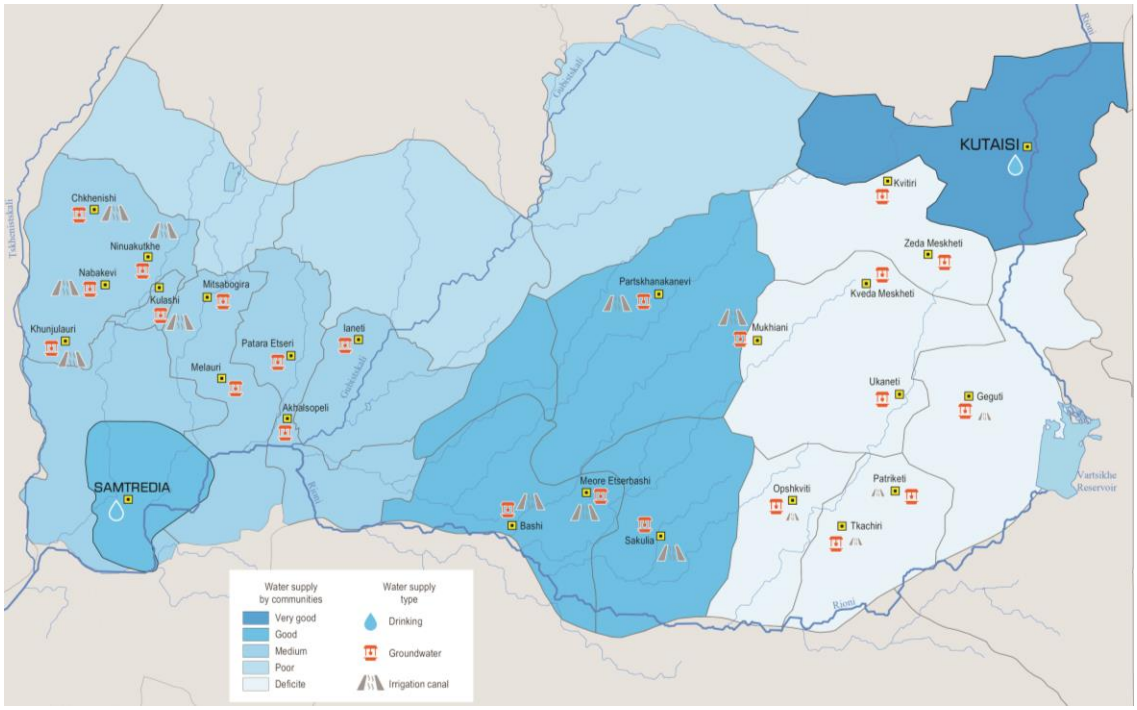


Figure 4 Water supply map of study area

During the field work, the state of water supply and water consumption on the indicated lands was revealed (Figure 4). As it turned out in the course of population surveys and field observations, drinking water is supplied only from underground resources, while irrigation supply is carried out only by three branches, preserved or restored from old irrigation systems. Two of them are located in the research area of the project. This is a branch of the Partskhanakanevi-Kutaisi and Vartsikhe reservoirs along the river Rioni. The first one mainly serves the water supply of the city of Kutaisi, although the villages of the Partskhanakanevi community also have access to it. The second branch serves the Vartsikhe HPP cascade and is used only to generate electricity to supply the Zestaponi Ferroalloy Plant. The color of the areas shown on the map shows the quantitative differences in water resources. Symbols shown separately indicate the supply of drinking water from groundwater.

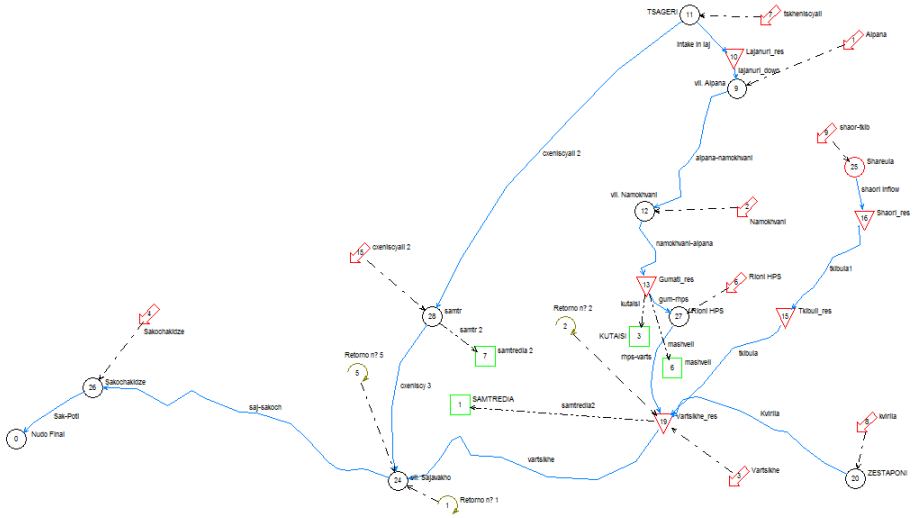


Figure 5 Rioni River basin model "AQUATOOL"

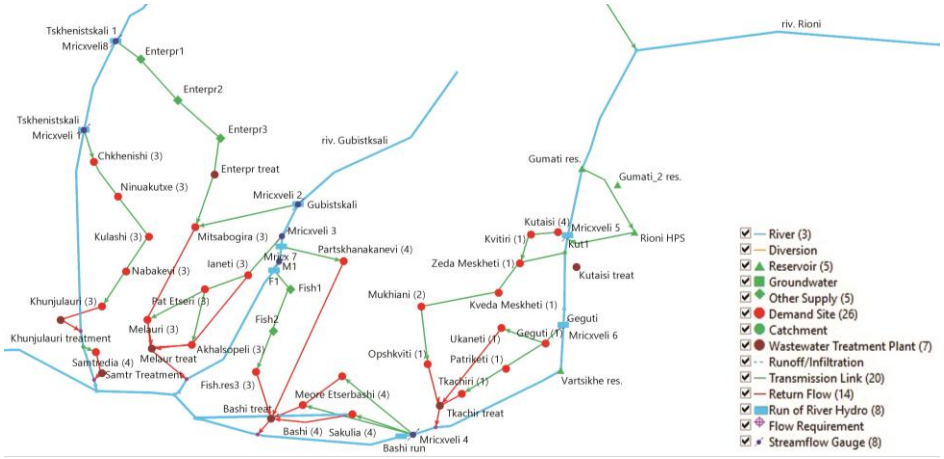


Figure 6 Rioni River basin model "AQUATOOL"

One of the objectives of the project was to model the basin using the AQUATOOL software. The model shows a complete picture of the Rioni River from the upper

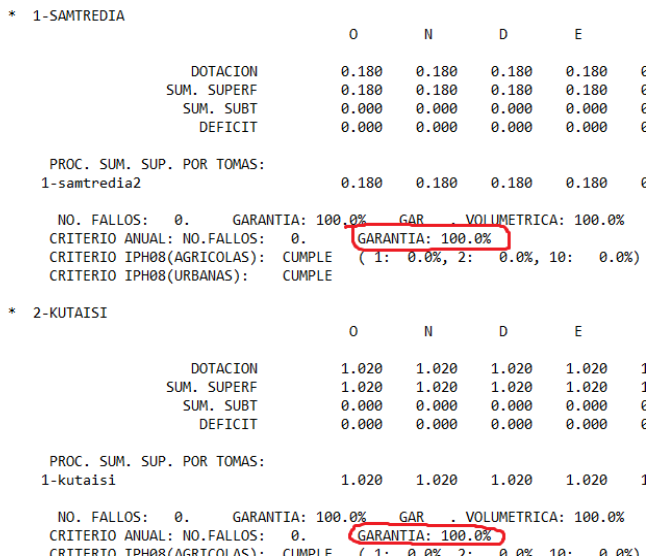
reaches to the city of Poti, where it joins the Black Sea (Figure 5). The study area covers the section from Kutaisi to Samtredia, but full modelling provides a better understanding of the state of the available resources. The model also includes the resources of the Tskhenistskali River and the Kvirila River, as well as reservoirs operating in the basin and the main key points and intersections. Modelling includes data on flow rates or volumes of water for each facility for the year. Different regimes were reflected in different bodies of water, respectively. Based on the results obtained, an approximate initial scheme was constructed, which can be used to organize additional supply systems, treatment facilities, metering systems or potential new facilities.

CONCLUSION

As can be seen from the results, at present, the canals in the villages mainly perform the function of discharging excess water in the Rioni Basin, rather than irrigation. All these resources eventually flow into the lower back, and here disasters become inevitable, which has been active in the last century or in recent years. In rural areas, canals run along roads, most of which need to be restored for its old targets. In communities where the resources are more or less good, access to water is available only to the owners of the land adjacent to the canal. Their number is less compared to the total. Therefore, in almost all regions it is necessary to organize a new system of the initial stage at a minimum level with further planning and improvement.

Due to the use of groundwater by landowners, agricultural production process is not fully loaded. This is not the potential that the region may have.

Regarding the basin model in AQUATOOL, we have obtained an absolutely complete resource reserve as a result of modeling, which means that Rioni water is practically not used in the region. The red square in the table indicates the provision of 96-100% of the resources near Samtredia, Kutaisi and rural areas, which means that water is abundant and must be distributed in an orderly manner (Figure 7).



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*  1-SAMTREDIA
                                        O       N       D       E

                     DOTACION          0.180   0.180   0.180   0.180   0
                   SUM. SUPERF         0.180   0.180   0.180   0.180   0
                     SUM. SUBT         0.000   0.000   0.000   0.000   0
                       DEFICIT         0.000   0.000   0.000   0.000   0

    PROC. SUM. SUP. POR TOMAS:
   1-samtredia2                      0.180   0.180   0.180   0.180   0

     NO. FALLOS:   0.     GARANTIA: 100.0%    GAR   . VOLUMETRICA: 100.0%
    CRITERIO ANUAL: NO.FALLOS:   0.      GARANTIA: 100.0%
    CRITERIO IPH08(AGRICOLAS):  CUMPLE   ( 1:  0.0%, 2:   0.0%, 10:   0.0%)
    CRITERIO IPH08(URBANAS):    CUMPLE

*  2-KUTAISI
                                        O       N       D       E

                     DOTACION          1.020   1.020   1.020   1.020   1
                   SUM. SUPERF         1.020   1.020   1.020   1.020   1
                     SUM. SUBT         0.000   0.000   0.000   0.000   0
                       DEFICIT         0.000   0.000   0.000   0.000   0

    PROC. SUM. SUP. POR TOMAS:
   1-kutaisi                         1.020   1.020   1.020   1.020   1

     NO. FALLOS:   0.     GARANTIA: 100.0%    GAR   . VOLUMETRICA: 100.0%
    CRITERIO ANUAL: NO.FALLOS:   0.      GARANTIA: 100.0%
    CRITERIO IPH08(AGRICOLAS):  CUMPLE   ( 1:  0.0%, 2:   0.0%, 10:   0.0%)
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Figure 7 Water resources in basin, which can be used in future

Another problem with taking water from gravity canals is that their chemical composition is not checked and therefore there is no guarantee that they do not contain contaminants [3]. For example, the Rioni River originates in the Racha Highlands, where arsenic deposits are found. It is quite reasonable to assume that arsenic from the deposit enters the bed of the Rioni River and continues to flow to the Colchis Lowland, and untested water will lead to undesirable consequences if water would be consumed for agricultural or other purposes [4].

However, the population has a desire to pay a certain tax if there is a proper supply-discharge system. If we look at this section of the Colchis Lowland, the characteristic winds here cause the soil to dry out [5]. a creating the need for additional water supply. In this case, the middle reaches of the Rioni River in the Kolkheti Lowland with the tributaries Tskhenistskali and Gubistskali have great potential.

The smooth functioning of a unified network without monitoring points would be unimaginable. The recommendation is to install remote water chemical analysis stations on rivers at the administrative boundaries of all municipalities (for first stage), and municipal or basin councils will monitor the information and respond accordingly. There will be a municipal registry at the community level about entrepreneurs and water users, what kind of activities they are doing and what content and amount of water they are likely to return to the riverbeds.

According to the assumed scenario, if today 96% of the surface resource and in some places 100% remain unused, we can assume that the supply of this resource can increase the economic effect by 100% or more.

Kutaisi and Samtredia, with a total population of 172,953 people, are included in the study area of the project. The current daily consumption of these cities is 103 million liters water, and the demand of the population of rural settlements is - 18 million liters (meaning drinking water). Arable land requires much less, depending on the crop grown. The table below clearly shows the runoff volumes of the main rivers in the Rioni Basin study area and the potential to meet demand:

Table 1 Annual Runoff in Rioni River basin

River	**Runoff, mln. l.**
Rioni at Kutaisi	3 714 000
Kvirila	3 687 000
Tskhenistskali	8 121 600
Gubistskali	1 408 320
Khanistskali	1 969 920
Total	**18 900 840 mln. l.**

The table shows that water resources in the study area exceed demand by a factor of thousands. This already shows that effective planning and distribution of this resource will have a significant economic impact on both the region and the country.

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