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Adaptation measures proposed in the reference basins due to the climate change impact

1. INTRODUCTION

To ensure future water requirements for the population, industry, agriculture, needs some structural and non-structural measures. The adaptation measures to climate changes are based on estimated future water resources and on the analysis concerning the vulnerability of these resources.

As it was mentioned in the previous report (D5.5), when the water resources in the conditions of climatic changes were determined and the vulnerability of water resources of Buzau and Ialomita Rivers was analyzed, the following conclusions were drawn:

From the water dependence point of view

- For the Buzau River catchment, there are 482 inhabitants for 1 million cubic meters of hydrologic resource. As this number is between 101 and 500 inhabitants per million cubic meters of water, it resulted that for this hydrographical area the main vulnerability issue is water resources management.
- For the Ialomita River basin, there are 1273 inhabitants for 1 million cubic meters of hydrologic resource. According to the same vulnerability criteria, the above-mentioned criterion being above the 1000 persons per million cubic meters value, the Ialomita River basin will be categorized as an area characterized by water scarcity.

From the water balance point of view

According to this criterion it resulted the following:

- For the Buzau River basin, the available resource per inhabitant will be 2077 cubic meters per year, and the usage ratio will be of 3.4% in 2015 and 6.2% in 2020. According to Brouwer and Fallkenmark, the water resource per inhabitant being between 2001 and 10.000 cubic meters per year, and the usage ratio under 40%, in this basin there will be a water surplus.
- For the Ialomita River Basin, the available water resource per inhabitant will be 786 cubic meters per year, and the usage ratio will be of 19.7 in 2015 and 28% in 2020. According to the same authors, when the water resource per inhabitant is under 1000 cubic meters per year and the usage ratio is under 40%, we are dealing with a marginal vulnerability.
- We must point out that the water resources of the two river basins taken into consideration were determined in the conditions of future climate changes in a year that we will call average year (normal) in conditions of climate change. It is to be assumed that in the new climatic conditions in the Buzau and Ialomita catchments, there will also occur dry years, when hydrological resources will diminish drastically. Considering that these diminishing will be (percentage) about the same dimension as the ones occurred during the last 20 years, therefore it results that in changed climatic conditions, in a dry year, the water resources of the two catchments will be:

- ***For the Buzau river basin*** - 500 mil.m^3/year;
- ***For the Ialomita river basin*** - 700 mil.m^3/year.

In these conditions the resource per inhabitant and the usage ratio in 2020 will have other values, namely:

- ***In the Buzau river basin***
  - Estimated population – 327.000 inhabitants;
  - Water Resource per inhabitant – 1529 m^3/year;
  - Water usage ratio – 9.36%;
- ***In the Ialomita river basin***
  - Estimated population – 1.280.000 inhabitants;
  - Water Resource per inhabitant – 547 m3/ year;
  - Water usage ratio – 44.71%.

Catchment	**RESOURCE** *(m^3/inhabitant year)*	**USAGE RATIO** *(%)*
BUZAU	1529	9.36
IALOMITA	547	44.71

In these conditions of dry year, according to the same vulnerability criteria – water balance, it results:

- In the Buzau river basin, the vulnerability remains marginal;
- In the Ialomita river basin, with values of the water resources under 1000 cubic meters per year per inhabitant and the usage ratio between 40 and 60%, there will be water stress

In this situation, during the dry year, in the conditions of climatic change, adaptation measures are imposed.

2. PORPOSED ADAPTATION MEASURES

The role of the adaptation measures is to achieve a new equilibrium between the available water resources and the demands of the utilities in the conditions of climatic changes.

As in every water balance, the equilibrium can be made either acting for the increase in water availability at the sources, or by reduction of the demands, either both components – water resource and water demands.

The increase in water availability at the sources

The increase in available water resources is made by:

- Use of groundwater in case of drought or by aquifer replenish;
- Reutilization of purged used waters as an alternative to the use of freshwater and its use not for drinking purposes;
- Water desalinization;
- Encouraging the use of inferior quality water for specific purposes;
- Realization of new reservoirs in the distribution systems in order to create compensation capacities;
- Realization of new interconnections between water supply systems;
- Use of water from dead volumes of reservoirs (through pumping from floating installations.

Structural measures for the increase in water availability

These measures pursue the realization of new infrastructures or the physical change of certain existent ones in view of increasing the water availability at the source and at the same time, the mitigation of the effects of discharge monthly distribution, as a result of climatic changes.

The main envisaged structural measures are:

Major structural measures:

- The realization of the Azuga dam and reservoir in view of supplying water to the population from the Sinaia – Comarnic area;
- Improvement of Bolboci, Pucioasa and Dridu dams and reservoirs performance parameters on the Ialomita River;
- Rehabilitation and aggradation of the Siriu dam on the Buzau river in view of increasing the capacity of the reservoir;
- The realization of the Surduc – Buzau with complex use;
- Realization of an inlet dam at Dramboca on the Buzau river and a derivation from the Buzau River and the Ialomita River;
- Realization of Siret-Bragan channel on the sector between Buzau and Ialomita rivers, with reversible operation, for water supply for the population and for irrigation in the Ialomita, Buzau and Mosistea catchments;

Local structural measures

Although the climatic changes affect each individual, the issue of adaptation measures is for human communities and society in general. If the major measures are the ones adapted by the society, individual persons can take their own measures in order to cover their water demands in the conditions of climatic changes. The following individual measures are recommended:

- Solutions for the collection, storing and use of precipitation water;
- The realization of reservoirs in depressions, or by excavating through small dams, with the water level under the terrain level;
- The use of certain agricultural crops with less water demands, or resistant to higher temperatures (dry farm)

Measures for the reduction of utilities' water demands

In Romania there are no studies regarding the change of water demands as a result of climatic changes. There is a single study which deals with agricultural crops. The main measures which regard the reduction of water demands are:

- Changes in water policy;
- Water allocation according to priorities;
- Change in water price;
- Changes in irrigation technology and crop type;
- Use of water conservation techniques;
- Measures for water conservation.

Water conservation

We must point out that there is no universal accepted definition for the water conservation notion, this term being often used in the sense of water saving by an efficient or wise use. The population does not always agree the notion of efficiency because there are

different degrees of efficiency. For example, the efficient water use in the urban environment could come from the reduction in the volume of the toilet water tank, car wash restrictions, etc., actions which impose a change in lifestyle.

Currently, water conservation has several meanings. It means collecting, saving, reduction or recycling. In more detail it means:

- **In land irrigation scope:**
  - Improvement of putting into practice of irrigation systems which use special valves, connection and sprinkler systems, as well as sensors for measuring soil moisture and crop water demand;
  - Use of meteorological data in order to achieve a balance in water allocation between available soil moisture and crop water demand;
  - Water proofing of intake and derivation channels in view of diminishing losses and suffusion.
  - Irrigation with recycled water.

- **In urban environment:**
  - Water metering so that the user will pay as much as he consumes;
  - Using recycled water for park and sport field irrigation;
  - Increase in water storage in aquifers and saving excess water in order to be used during summer season;
  - Encouraging subscribers to install high efficiency supplies;
  - Reduction of water demands peaks in order to avoid supplementary costs in water pumping and treatment.

- **In industry:**
  - Identifying conservative methods;
  - Use of treated waste water for the production process and for cooling.

Generally, the adaptation measures proposed by the society (or communities) are structural measures and have the purpose of achieving new infrastructure or physical modification of existing ones to increase the availability of water and also to minimize the effects of monthly distribution of flows due to climate changes.

Given that climate scenarios made in the frame of project cover almost all the country and the methodology used to analyze the hydrological regime in terms of climate changes can be applied to other river basins, this study can continue.

The increasing of knowledge level on vulnerability and climate changes impacts in Romania will support the effective adaptation of preventive policies with efficient cost.

Moreover many of the proposed adaptation measures are those that will prove beneficial even in the absence of climate changes impacts and those that can be implemented with low costs.

The research results on climate change impacts on water resources involve the developing of new criteria and technical design and construction of dams, making water management systems less sensitive to changes in hydrological regime due to the impact of variability and climate change. There is also the need to develop new procedures for the operation of water management systems that can take account of the uncertainty degree in the hydrological regime due to development, particularly climate changes.