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CONTENTS

ABBREVIATIONS AND ACRONYMS

ABA	River Basin Water Agency
ANAR	“Romanian Waters” National Administration
BCM	Billion Cubic Meters
CMIP5	Coupled Model Intercomparison Project Phase 5
EEA	European Environment Agency
EU	European Union
ESIF	European Structural and Investment Funds
GHG	Greenhouse Gas Emissions
GIS	Geographic Information Systems
IPCC	Intergovernmental Panel on Climate Change
KM	Kilometer
MW	Megawatt
OP	Operational Program
RBMP	River Basin Management Plan
SOP E	Sectorial Operational Program on Environment
TWh	Terawatt-hours
WSS	Water Supply and Sanitation

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EXECUTIVE SUMMARY

Rapid Assessment Report on Climate Change Impacts on Water Resources in Romania

(Romania Climate Change RAS)

Objective

1. The purpose of this report is to assess the climate change impacts on water resources in Romania from an integrated, multi-sectoral perspective, and to recommend priority actions for addressing the identified risks and opportunities. The analysis is presented from an integrated water resources perspective, thereby including all pertinent water-related sectors, viz. municipal water supply and sanitation, industrial water supply, agriculture, energy generation, environment, and disaster management. More details on specific water-related aspects can be found in the companion rapid assessment reports for the energy, urban, and agricultural and rural development sectors. The recommended priority actions are presented in the context of consideration for possible financing under the Operational Programs funded by the European Structural and Investment Funds (ESIF) in 2014-2020 planning horizon. This analysis is based on the available information on the current status of water resources sector in Romania, along with the existing knowledge on the anticipated impacts of climate change in this sector.

Water Resources Availability and Demands

2. The total surface water potential of Romania amounts to 127 Billion Cubic Meters (BCM)/year, with the internal river basins contributing 40 BCM and 87 BCM available from the Danube basin. The groundwater potential is estimated at 10 BCM/year. The utilizable fraction of the total (surface and ground) water resources, as defined by the existing capacity to extract and use water, is 40 BCM/year. In contrast the total water demand stands at 8 BCM/year.

3. With a current population of 20.2 million, the average water availability in Romania amounts to approx. 2000 cubic meters per capita per year. While this value is above the threshold generally defined for water stress (1700 cubic meter per capita per year), it is lower than the average value for Europe (approx. 4500 cubic meters per capita per year), and underscores the need for good management to ensure resource conservation and sustainability.

4. There is a significant inter-annual variation in water resources availability. In the driest years the water availability has fallen to 20 BCM. There is also a significant variation

within Romania, with the basins of Jiu, Arges-Vedea, Buzua-Ialomita, Siret, Prut-Barlad, and Dobrogea-Littoral facing the most serious water scarcity.

5. The current water demand comprises of industry (67%), agriculture (18%), and municipal (15%). The water demand has steadily decreased since the 1990s, because of structural changes in economy, including reduction in industrial activity, shut-down of economically unviable irrigation schemes, introduction of metering and tariffs in domestic water supply, and reducing system losses. The total demand, in terms of volume of water made available to users, has decreased from approx. 20 BCM/year in the early 1990s to approx. 8 BCM/year now. As a result there is currently a degree of over-capacity in the system at the national level. The actual water consumption in 2012 was 6.5 BCM.

6. Irrigated area in Romania has decreased from 2 million ha in the late 1908s/early 1990s to approx. 0.8 million ha (considered irrigable with functional infrastructure), as economically unviable schemes were closed down In fact, the land under irrigation has remained below 300,000 ha for the past 5 years. The corresponding water demand has reduced from about 8 BCM to 1 BCM per year. While the overall situation appears good because of over-capacity, there are areas of water scarcity in many basins where summer droughts are a significant concern.

7. About 70% of the water supply for domestic use is sourced from surface waters, compared to 95% dependence on surface waters for industrial supply. From a quantitative perspective, a majority of the basins have no serious problems in ensuring sufficient volume for water for meeting the domestic and industrial demands. However, the basins with lower endowment of water (Jiu, Arges-Vedea, Buzau-Ialomita, Siret, Prut-Barlad, and Dobrogea-Litoral) face supply reliability challenges during the summer months, especially in dry years. The Dobrogea-Litoral basin is the most severely affected in this regard.

8. Romania's hydropower potential is estimated at 36 TWh/year, and currently the total installed hydropower capacity amounts to 6,400MW. Hydropower generation accounts for 32% of Romania's total electricity generation, and 16% of the total energy use. The Government intends to decommission/modernize some of the high-emission and obsolete thermal power plants, and therefore plans on a modest increase in hydropower generation capacity. While hydropower is not a consumptive user of water, operations rules for hydropower facilities constrain and are constrained by water uses in other sectors. Therefore the proposed new hydropower facilities would need to be planned taking into account the existing and anticipated future water uses in all sectors. In the basins where scarcity already arises in summers of dry years, hydropower production will be adversely affected for a short duration, as it was in the dry year of 1990. These constraints can be alleviated to a large extent by careful systems planning and operations optimization, and by accounting for the anticipated climate change impacts in the operations planning for these as well as existing facilities.

9. Almost 60% of the water bodies in Romania meet the EU Framework Directive's water quality designation of good ecological status/potential, which is based on multiple elements of quality (biological, physio-chemical, and specific pollutants).

Projected Impacts of Climate Change

10. Precipitation has decreased at a rate of about 30 mm per decade in Romania, between 1961 and 2006. Continental-scale studies for Europe project that annual mean precipitation is likely to decrease by 5-20% in southern Europe and the Mediterranean in the period 2071-2100, compared to the period 1961-1990. In line with the precipitation changes, annual river flows are increasing in the north and decreasing in the south, and this trend is projected to increase in the future. Large changes in seasonality are also projected, with lower flows in summer and higher flows in winter for Romania. As a consequence, droughts and water stress are expected to increase, particularly in summer. Flood events are projected to occur more frequently in many river basins, particularly in winter and spring, although estimates of changes in flood frequency and magnitude remain uncertain. In general, the range of climate change impacts across Romania includes a likely increase in cold spells, heat waves, heavy floods, landslides, formation of ice-dams on watercourses, damaging frost, and avalanches.

11. Four river basins of Romania- Buzau, Ialomita, Arges, and Mures – have been studied with the objective of quantifying climate change impacts. The results for Buzau and Ialomita basins indicate a likely reduction of mean annual flow, of 15-20 % for the period 2021-2050, and of 30- 40 % for the period 2070-2100. Also predicted are earlier occurrence of floods produced by snow-melt, and amplification of extreme phenomena. An analysis of changes in demands shows that the demand-supply gap will be manageable for the next 15-20 years, but significant measures will be needed to address vulnerability in the time period after that. The results for Arges and Mures basins indicate a reduction of mean annual flow in these basins of 10-15 % for the period 2021-2050. More frequent winter floods are expected, and while torrential flood events will occur more frequently, the frequency of floods with long duration and large volume is expected to decrease.

12. The following are some of the key vulnerabilities to climate change that are identified in various water-related sectors:
    a. Water supply will be adversely affected because the warmer and shorter winters will lead to the decrease of the seasonal snow volume and to the early and fast snow melting, leading to shortages in summer months.
    b. Hotter and drier summers will also cause a qualitative deterioration of the water resources, thereby effectively reducing the supply.
    c. Supply will also suffer from a lowering of groundwater table in summer months, due to reductions in the surface flow regime.
    d. Higher summer temperatures will lead to increased evapo-transpiration and therefore higher water demands in agriculture, during the same period when

supplies will suffer a shortfall. The domestic water demands and supply will experience the same (but less pronounced) effect.

e. Wastewater treatment will be more frequently impaired by floods, due to storm-water infiltration in sewer systems, and also due to direct inundation of treatment facilities.
f. The flora and fauna in the aquatic ecosystems (rivers and lakes) as well as in those dependent on precipitation and river flows (such as wetlands) will suffer from a quantitative reduction in summer water flows, and from increased frequency of floods and droughts.
g. Higher summer temperatures leading to water quality degradation (through decreases in dissolved oxygen, eutrophication and algal blooms) will also adversely affect the environment.
h. Changes in aquifer levels will also adversely affect the water balance in wetlands, which are sustained by groundwater in the low flow season.
i. The summer generation from hydropower plants will be adversely affected in dry years. The hydropower facilities will also face increasing threat of intensive floods, and operations will also need to provide sufficient flood cushion in the storage reservoirs.

13. The Sectorial Operational Programme on Environment (SOP E) has been implemented by Romania with financing support from European Union. While SOP E has implemented a sizable quantum of water sector investments (especially in water supply and wastewater), there remain a number of priority actions which can bring significant benefits to Romania in terms of addressing the climate change issues in water-related sectors. This report presents these recommended actions in the following table, for possible financing under the two Operational Programs (OPs) financed by the European Structural and Investment Funds (ESIF) in the 2014-2020 time period. The two main OPs relevant for water sector investments in this context are:
    a. Large Infrastructure OP, with the key water-related areas being public utilities services (water and wastewater), risk prevention and climate (structural measures such as dams, flood control embankments, etc.), coastal areas and non-structural measures for risk reduction.
    b. Rural Development OP, with the key water-related areas being investments in agriculture and rural development (e.g. irrigation), and public infrastructure in rural areas.

14. The analysis presented in this report is significantly limited by the extent of the available information. The most significant shortcomings of this analysis pertain to the following:
    a. There is a need for developing quantitative estimates of climate change impacts on water-related sectors, especially since water is the one of the primary modalities through which the climate change effects are manifested. This analysis needs to be conducted on priority for the water-scarce basins, because a comprehensive list of actions for building climate resilience cannot be developed until the River Basin

Management Plans are updated with the quantitative estimates of climate change impacts on supply and demands.

b. The actions suggested in this report have not been validated through an economic analysis. Since the needs are high compared to the available resources in the short-term, it would be important to undertake a multi-sectoral techno-economic assessment, preferably through modeling, in order to prioritize the recommended actions for investment. Nonetheless, some of the obvious "no-regret" actions have been presented separately, with the recommendation that these be initiated at the earliest, given the strong need and significant benefits. It should also be noted that while some of the recommended investments (such as those in rural water supply and flood management) do not directly seem to be related to climate change, these can be validly considered to be a part of the adaptation response and hence may be eligible for climate change-related funding

15. The tables below summarize the recommended actions for improving climate resilience in water-related sectors, for proposed financing and support under the ESIF (2014-2020) OPs. The estimated time-frame for these actions is also indicated.

Table 3: Recommended "No-Regret" Actions

Action	Type of Action	Time frame
1. Conducting Quantitative Assessments of Climate Change Impacts on Hydrology, for estimating future water availability and demands under climate change scenarios. This exercise needs to be completed for all basins of Romania (4 are already covered)	Research & Analysis/ Technical Assistance	Short term
2. Establish requirements that River Basin Management Plans (RBMPs) in each basin must be updated with the results of quantitative climate change assessments described in #1 above.	Policy Training/ education	Short term
3. Ensure that RBMPs currently being prepared for 2015 are updated with quantitative climate change assessments	Technical Assistance	Short term
4. Conduct analysis to assess the specific levels and types of irrigated agriculture that can be sustained in each of the river basins, accounting for climate change impacts. This should feed into RBMP process.	Research & Analysis/ Technical Assistance	Medium term
5. Conduct analysis of the technical options and economic returns of converting pumped-irrigation to gravity-based schemes, in areas with confirmed and steady demand for irrigation services	Research & Analysis/ Technical Assistance	Medium term
6. Conduct quantitative assessments of water demands and supply reliability for all the main WSS utilities of Romania, taking into account the expected impacts of various climate change scenarios. This should feed into RBMP process	Research & Analysis/ Technical Assistance	Medium term
7. Establish regulations to ensure that large industrial	Policy/Regulation	Short term

water users are provided through utility supplies, instead of private groundwater wells (The issue is being considered by the Ministry of Environment and Climate Change)		
8. Conduct quantitative assessments for water needs of various ecosystems. These environmental uses should feed into the RBMP process.	Research & Analysis/ Technical Assistance	Medium term
9. Update flood hazard and risk analysis by using a higher resolution GIS-based approach; upgraded nationally to 1% (1 in 100 years flood) level for inhabited area; and take into account expected climate change impacts.	Technical Assistance	Medium term
10. Establish regulations to formally introduce flood risk assessments into the regional development and general city planning processes.	Policy/ Regulation	Medium term
11. Assess feasibility of regulation for monitoring and managing construction activities in the high flood-risk areas.	Policy/ Regulation	Medium term
12. Strengthen local-level planning capacity for episodic events such as heat waves.	Capacity-building	Medium term

Table 4: Recommended Actions for Prioritization and Financing ESIF (2014-2020)

Sectoral Focus	Action	Type of Action	Time frame	Applicable OP
Irrigation	1. Implement pilots to test different models of efficient irrigation systems coupled with climate-smart agriculture practices.	Pilot Investments	Medium term	Rural Development OP
	2. Establish regulations to limit the use of groundwater for domestic water supplies, in the areas where groundwater over-abstraction is leading to serious depletion of aquifers.	Policy/ Regulation	Medium term	Rural Development OP
	3. Wastewater reuse in irrigation should be encouraged, especially in water-scarce basins	Policy/ Pilot Investments	Medium term	Rural Development OP
Water Supply and Sanitation	4. Investments in infrastructure to ensure water supply and wastewater provisions for 263 municipalities having more than 10,000 inhabitants, by 2015 (and by 2018 for 2,346 smaller townships with 2,000 - 10,000 inhabitants)	Direct Investment	Long term	Large Infrastructure OP / Rural Development OP
	5. Assess scope and scale of methane capture and flaring, as well as high efficiency pumps, to reduce the GHG emissions from the water and wastewater supply investments, and to hence qualify these investments as climate actions.	Technical Assistance/ Direct Investments	Medium term	Large Infrastructure OP / Rural Development OP
	6. Support utility investments aimed at reducing system losses in water distribution networks (currently estimated	Direct Investment	Long term	Large Infrastructure OP

	at approx. 50%).			
	7. Wastewater reuse in industrial sectors should be encouraged.	Policy/Pilot Investments	Medium term	Large Infrastructure OP
	8. Assess feasibility of using aquifers coupled with artificial recharge for inter-annual water storage should be explored in water-scarce basins.	Technical Assistance/Pilot Investments	Medium term	Large Infrastructure OP
	9. Establish requirements for protection of critical water supply sources (reservoirs or aquifers) in water-scarce locations, through land use zoning measures.	Policy/ Regulation/ Pilot Investments	Medium term	Large Infrastructure OP/ Rural Development OP/ Regional OP
	10. Assess feasibility of desalinization for provision of drinking water supplies in water-scarce coastal basins	Technical Assistance	Medium term	Large Infrastructure OP
	11. Afforestation and other catchment improvement activities should be encouraged in flood- and erosion-prone uplands	Direct Investments	Medium term	Rural Development OP
	12. Implement pilots on suitable co-benefit models of natural resource management, in forest catchments and in wetland fisheries, whereby the ecosystems sustain local livelihoods while providing valuable environmental service	Technical Assistance/ Pilot Investments	Medium term	Rural Development OP/ Regional OP
Disaster Risk Reduction and Management	13. Undertake construction of flood management infrastructure. Since the potential investments pipeline is huge (estimated at 17 billion €), investments should be prioritized on the basis of updated flood hazard/risk mapping and accounting for the climate change impacts.	Direct Investments	Long term	Large Infrastructure OP
	14. Upgrade to digital the existing radar network for measuring precipitation intensity, and installing a new radar station in Galati.	Direct Investment	Medium term	Large Infrastructure OP

1. INTRODUCTION

1. The purpose of this report is to assess the climate change impacts on water resources in Romania from an integrated, multi-sectoral perspective, and to recommend priority actions for addressing the identified risks and opportunities. The analysis is presented from an integrated water resources perspective, thereby including all pertinent water-related sectors, viz. municipal water supply and sanitation, industrial water supply, agriculture, energy generation, environment, and disaster management. More details on specific water-related aspects can be found in the companion rapid assessment reports for the energy, urban, and agricultural and rural development sectors. The recommended priority actions are presented in the context of consideration for possible financing under the Operational Programs funded by the European Structural and Investment Funds (ESIF) in 2014-2020 planning horizon. This analysis is based on the available information on the current status of water resources sector in Romania, along with the existing knowledge on the anticipated impacts of climate change in this sector.

2. WATER RESOURCES AVAILABILITY AND USE IN ROMANIA

2. Romania's surface water endowment consists of internal river basins as well as the Danube, which is a trans-boundary river basin shared by 19 countries. The natural surface water potential of Romania amounts to 127 Billion Cubic Meters (BCM)/year, with the internal river basins contributing 40 BCM and the Danube contributing 87 BCM per year. The groundwater endowment is estimated at 10 BCM/year. The utilizable fraction of the total (surface and ground) water resources, as defined by the existing capacity to extract and use water, is 40 BCM/year. In contrast the total water demand stands at approx. 8 BCM. The details are provided in Table 1.

Table 1: The potential and utilizable water resources for Romania, 2010

(Source: National Report on the State of Environment, National Environmental Protection Agency, 2010)

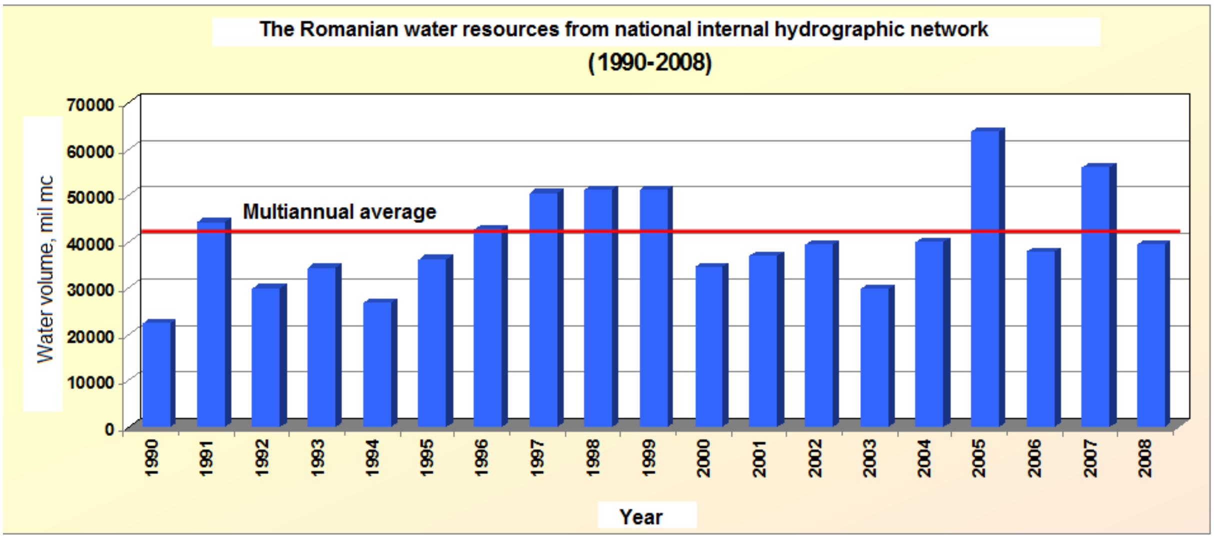
Category	Volume (BCM)
A. Interior River Basins	
Potential natural resource	40.0
Utilizable resource	13.8
Demand	3.2
B. ***Danube***	
Potential natural resource	87.0
Utilizable resource	20.0
Demand	3.7
C. ***Groundwater***	
Potential natural resource	9.6
Utilizable resource	5.4
Demand	0.8
Total	
Potential resource	**136.6**
Utilizable resource	**39.3**
Demand	**7.7**

3. The Danube is the second longest river in Europe, with a length of 2,850 km, out of which 1,075 km is in Romania's territory. The average flow of Danube at the point of entry is 175 BCM/year, and Romania is entitled to use half of this quantum under the existing agreements. The Danube supports different water uses including irrigation, fisheries, and hydropower generation. The Danube delta has a number of environmental conservation areas covered by the EU Habitats Directive.

4. There are 27 major inland rivers in Romania, belonging to 11 inland river basins. Mures is the longest river in Romania (761 km) and Viseu is the shortest (81 km). The Siret forms the largest river basin, with a surface area of 42,890 km^2. Although the Danube theoretically contributes more than the internal rivers to the water resources potential of Romania, the constraints of spatial access and availability mean that the inner rivers are actually the more important water resource provider for Romania.
5. Romania has developed significant storage on the rivers. There are currently 1232 storage reservoirs, for the purpose of hydropower generation, irrigation and flood control, with a total storage capacity of 10 BCM (FAO, Aquastat 2012). The total untapped storage potential is estimated in the range of 50-78 BCM, out of which 25 BCM is considered feasible for development, if needed.
6. With a current population of 20.2 million, the average water availability in Romania amounts to 2000 cubic meters per capita per year. While this value is above the thresholds generally defined for water stress (1700 cubic meter per capita per year) (Falkenmark, 1989), it is lower than the average value for Europe (approx. 4500 cubic meters per capita per year), and underscores the need for good management to ensure resource conservation and sustainability.
7. There is a significant natural inter-annual variation in water resources availability (See Figure 1). In the driest years the water availability has fallen as low as 20 BCM.

Figure 1: Natural Variability of Utilizable Water Resources of Romania

(Source: National Water Resources and their Evolution in the Context of Climate Change. National Institute of Hydrology and Water Management, 2011)



8. The average national-level value of 40 BCM/year also hides the significant range of variation within Romania, depending on the river basin. Table 2 presents the utilizable water resources corresponding to each of the 11 internal river basins.

Table 2: Water Resources of Internal Basins of Romania

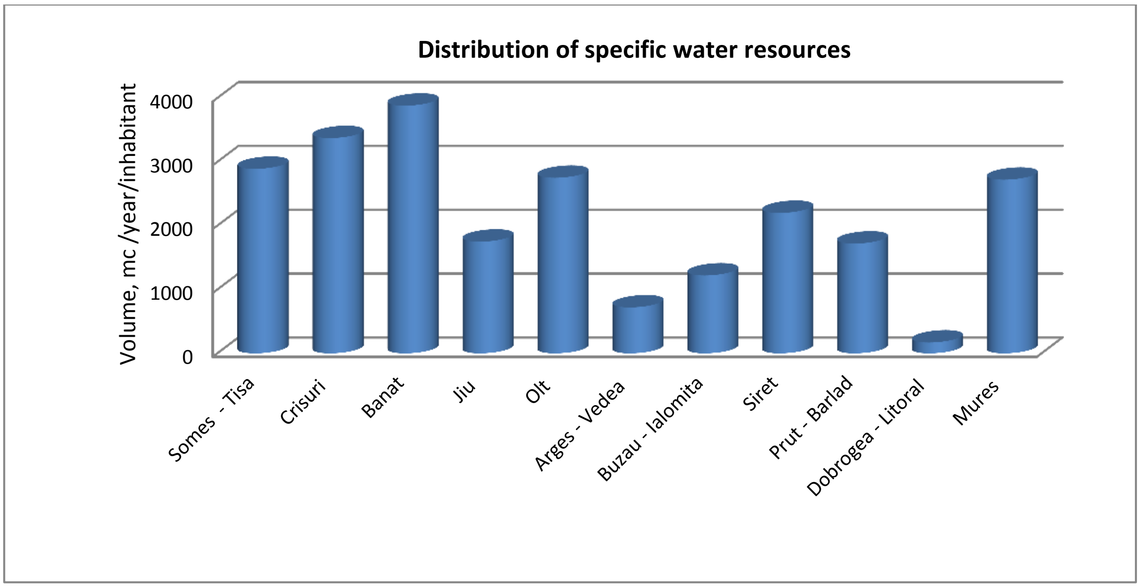
(Source: Technical Report- Water Balance, National Administration of Romanian Water, 2011)

River Basin	Utilizable Water Resources (BCM/year)
Someş – Tisa	6.24
Crişuri	2.87
Mureş	5.77
Banat	3.56
Jiu	3.47
Olt	5.30
Argeş - Vedea	2.39
Buzău - Ialomiţa	1.39
Siret	7.54
Prut	1.76
Dobrogea-Litoral	0.11
Total	**40.41**

9. The per-capita water availability for the internal basins is shown in Figure 2. It can be seen that the basins of Jiu, Arges-Vedea, Buzau-Ialomita, Siret, Prut-Barlad, and Dobrogea-Litoral face significant scarcity, with the last one being the most water-scarce basin in Romania.

Figure 2: Per capita Utilizable Water Resources in Romania's Internal basins

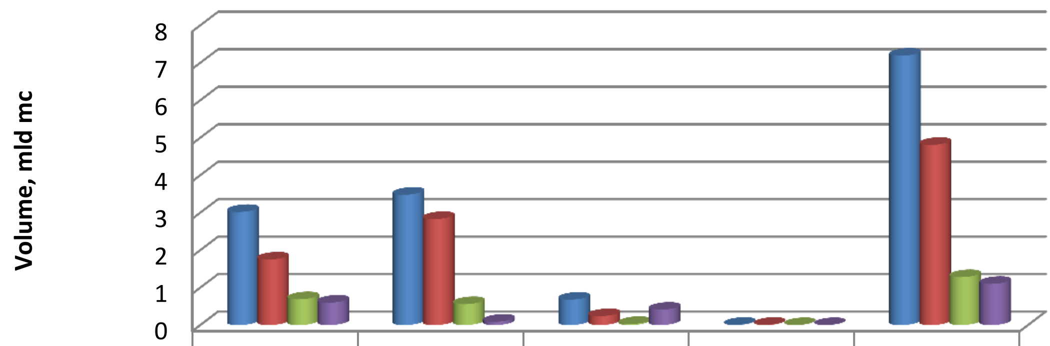
(Source: National Water Resources and their Evolution in the Context of Climate Change. National Institute of Hydrology and Water Management, 2011)



10. The total water demand in Romania, as measured by the volume of water made available to users, stood at 7.2 BCM in 2012, which was met by abstractions of 3 BCM from inland rivers, 3.5 BCM from the Danube, 0.7 BCM from groundwater, and a small volume (0.01 BCM) from the Black Sea. The sector-wise break-up shows that the largest water demand comes from industry (67%), followed by agriculture (18%), and municipal (15%). The sources of demand and supply are shown in Figure 3. The actual water consumption in 2012 amounted to 6.5 BCM.

Figure 3: Water Demand and Supply Sources, 2012

(Source: Technical Report- Water Balance, National Administration of Romanian Water, 2012)



	Internal rivers	Danube	Groundwater	Blak Sea	Total
Total	3.02	3.48	0.68	0.008	7.19
Industry	1.75	2.83	0.24	0.008	4.81
Agriculture	0.69	0.56	0.03	0	1.28
Population	0.6	0.09	0.41	0	1.1

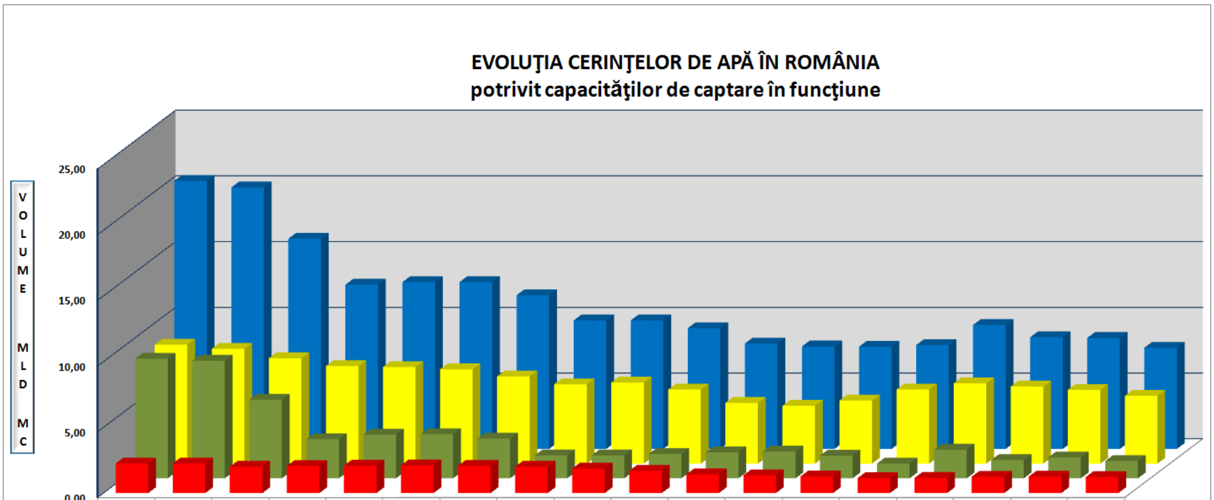
11. The water demands have steadily decreased in Romania since the 1990s, mainly due to structural changes in the economy:
    a. Economically unviable irrigation schemes have closed.
    b. Industrial production has reduced, and the remaining industries have significantly reduced water consumption in production processes.
    c. Utilities have reduced losses and introduced tariffs, which have helped reduced water consumption in the domestic sector, even though the provision of water supply and sanitation services has expanded to an increasing fraction of the population.

12. As a result, total water demand has decreased from approx. 20 BCM in early 1990s to approx. 8 BCM now (See Figure 4, which shows the volumes of water made available to users in each sector. The respective sector consumptions follow the same trend). Therefore, on an average there is a significant degree of over-capacity in the systems, which were built to meet demand levels of 20 BCM, compared to the current demands that are less than half the capacity. However, the situation varies from basin to basin, and also many of the unused water extraction and conveyance facilities are now in disrepair. Another concern, on which data are not fully available, pertains to loss of storage capacity

due to sedimentation in reservoirs (for example the effective storage of Bascov-Pitesti reservoirs is now estimated to have reduced by 90%).

Figure 4: Evolution of Total Water Demand in Romania, 1990-2011

(Source: Technical Report- Water Balance, National Administration of Romanian Water, 2012)



	1990	1993	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Populaţie	2,25	2,25	2,00	2,05	2,08	2,11	2,07	2,00	1,86	1,69	1,42	1,35	1,26	1,13	1,15	1,24	1,25	1,22
Agricultura	9,10	8,95	5,98	2,98	3,33	3,36	3,03	1,74	1,75	1,86	1,98	2,05	1,72	1,13	2,18	1,39	1,59	1,32
Industrie	9,06	8,74	8,02	7,43	7,35	7,18	6,64	6,04	6,17	5,64	4,62	4,40	4,80	5,64	6,11	5,87	5,61	5,16
TOTAL	20,40	19,90	16,00	12,50	12,70	12,70	11,70	9,78	9,78	9,19	8,02	7,80	7,78	7,90	9,44	8,50	8,45	7,70

Sectoral Uses of Water

13. Agriculture: Irrigated area in Romania has decreased from 2 million ha in the late 1908s/early 1990s to approx. 0.8 million ha (considered irrigable with functional infrastructure), as economically unviable schemes were closed down In fact, the land under irrigation has remained below 300,000 ha for the past 5 years. The corresponding water demand has reduced from about 8 BCM to 1 BCM per year. While the overall situation appears good because of over-capacity, there are areas of water scarcity in many basins where summer droughts are a significant concern. The situation will become more serious as the impacts of climate change become more pronounced, the most salient being increase in temperatures and reduction in water availability across all of Romania. Addressing this challenge will require adoption of climate-resilient agriculture, and updation of the basin plans while taking climate change impacts into account, to re-assess the sustainable levels and modes of irrigation in the water-scarce basins.

14. Industrial Water Supply and Domestic Water Supply/Sanitation: About 70% of the water supply for domestic use is sourced from surface waters, compared to 95% dependence on surface waters for industrial supply. From a quantitative perspective, a majority of the basins have no serious problems in ensuring sufficient volume for water for meeting the domestic and industrial demands. However, the basins with lower endowment of water (Jiu, Arges-Vedea, Buzau-Ialomita, Siret, Prut-Barlad, and Dobrogea-Litoral) face supply

reliability challenges during the summer months, especially in dry years. The Dobrogea-Litoral basin is the most severely affected in this regard. For example, almost 95% of the supply for the city of Constanta is being sourced from groundwater, which is being pumped from significant depths (300-700m). A number of cities in Banat and Moldova regions also face water scarcity in summer months. These cases stand apart from most of the other urban areas in Romania (and especially from Bucharest), which have multiple sources offering significant buffer supplies and a high degree of reliability. As mentioned above, groundwater accounts for almost 30% of the domestic water supply, but the incidence of nitrate pollution in upper layers of aquifers is increasing, especially in the south of the country, which will place further stress on surface water resources.

15. Hydropower: Romania's hydropower potential is estimated at 36 TWh/year, and currently the total installed hydropower capacity amounts to 6,400MW. Hydropower generation accounts for 32% of Romania's total electricity generation, and 16% of the total energy use. While coal and other fossil fuels remain the primary source of energy and electricity generation for Romania, the share of renewable sources of energy is large, increasing and higher than EU average. The Government intends to decommission/modernize some of the high-emission and obsolete thermal power plants, and therefore plans on a modest increase in hydropower generation capacity. While hydropower is not a consumptive user of water, operations rules for hydropower facilities constrain and are constrained by water uses in other sectors. Therefore the proposed new hydropower facilities would need to be planned taking into account the existing and anticipated future water uses in all sectors. In the basins where scarcity already arises in summers of dry years, hydropower production will be adversely affected for a short duration, as it was in the dry year of 1990. These constraints can be alleviated to a large extent by careful systems planning and operations optimization, and by accounting for the anticipated climate change impacts in the operations planning for these as well as existing facilities. Furthermore, the development of new hydro infrastructure will need to ensure that the environmental and hydro-morphological impacts are managed in compliance with the requirements of the EU Water Framework Directive

Water Quality

16. Out of the 3399 surface water bodies that are monitored at the national level, 2008 (59%) met the EU Framework Directive water quality designation of good ecological status/potential in 2009, based on biological, physio-chemical and specific pollutant standards. It is proposed to increase this fraction to 65% by 2015.

Water-related Hazards

17. Floods: Flooding occurs frequently in Romania, and the flood-prone is estimated at about 1.1 million ha. Romania has made significant investments in flood protection infrastructure, which include 9920 km of embankments, 6300 km of river training works, 217 temporary flooding areas, and 1232 reservoirs with active flood control operations. However floods happen almost every year, and the incidence of severe flooding is on the

rise. The existing pipeline of infrastructure works proposed for flood management is estimated at approx.17 billion €.

18. While flood hazard mapping has been conducted for the large rivers (Category 1, 2 and 3) in all 11 river basins, smaller rivers have not yet been covered. Furthermore, ANAR recognizes the need to improve the analysis by using a high-resolution GIS-based approach, and to upgrade to 1% flood level protection for inhabited areas. It would also be important to take account of the expected climate change impacts on hydrology in updating the flood hazard mapping. The flood hazard and risk mapping for the Danube basin has been completed as a part of collaborative European exercise.

19. Flash Floods: The high-intensity and short-duration floods (flash floods) are also becoming increasingly common in the mountain areas, mainly due to increasing frequency of high-intensity precipitation events, but also exacerbated by land use changes. The National Meteorological Administration, with 160 meteorological stations, 8 radars and 7 regional centers, conducts forecasting for flash floods. The current forecasting and early warning systems are able to provide a reasonable (12-48 hours, depending on the river system) lead time for flood events, but the warning time for small mountainous catchments which are prone to flash floods is about 2 hours, leaving the communities in these areas highly vulnerable to risk. This issue is of growing concern, since the incidence and toll of flash floods is increasing in Romania. It is possible to increase the warning time from the current level of 2 hours to 3-5 hours or more, and will require investments in upgrading the radar network for estimating rainfall intensity (including a new radar station in the Galati area), and for strengthening capacity of regional centers for flash flood forecasting.

20. Drought: Due to increasing temperature and decreasing river flows (see the following section on climate change) the frequency of droughts is increasing in Romania. The National Meteorological Administration maintains 55 agronomic monitoring stations throughout the country, and prepares 1 week and 1-3 month soil moisture forecasts based on integration of agronomic data with hydro-met data. It is not clear how these forecasts are integrated with other agricultural services to help farmers better manage the drought conditions.

3. INSTITUTIONS AND CAPACITY FOR INTEGRATED WATER RESOURCES MANAGEMENT

21. Romania is one of the few countries that have many decades of experience in managing water resources using an integrated basin-level approach. Each of its 11 internal river basins has a functioning River Basin Water Agency (abbreviated as ABA), which is charged with water resources management planning and implementation, and operation of large facilities. All 41 counties of Romania have a dedicated water resources management unit, which reports to the ABA. The ABAs revise the basin water resources management plans every 6 years, which aim to address the emerging issues pertaining to both quantity and quality. The ABAs are institutionally federated into the "Romanian Waters" National Administration (abbreviated as ANAR), which is responsible for planning and management of water resources at the national level. The Directorate of Water Management in the Ministry of Environment and Climate Change is responsible for water sector policy making. Therefore, the separation of policy, administration, and service provision functions exists in water sector in Romania.

22. About 60 years of hydrological data is available on the main rivers of Romania; in case of Danube some records are available for the last 100 years. However not all these data have been fully digitized yet, which limits its ability for use in modeling and water resources planning.

23. Romania's hydro-met network comprises of 882 monitoring stations, out of which about 600 are automated. In addition to this network, the National Meteorological Administration operates 160 stations, 8 radars and 55 agronomic monitoring stations. While the major gaps in the hydro-met network seem to have been addressed through a series of recent projects (assisted by the EU), the meteorological network could be strengthened by up-gradation of radar stations, expanding the agronomic station network, adding a new radar station in Galati, and providing more resources for snowpack studies.

24. The operations of water resources infrastructure are reviewed and approved by the ABAs, as a part of the river basin management plan process. The operations rules for the facilities (referred to as "restriction logic") are originally based on the results of optimization analysis conducted for the specific cascades/basins, with the priority (in decreasing order) being domestic water supplies, energy production, industry and agriculture. Given the recent changes, especially in demand patterns and incidence of floods, many ABAs have recently conducted review and updating of restriction logics for the major facilities in their respective basins, to ensure that the operations respond adequately to the ground reality. However, a quantitative accounting for climate change impacts in the operations planning still has not been attempted.

4. PROJECTED IMPACTS OF CLIMATE CHANGE

25. The quantitative estimates for water-related climate change impacts in Romania broadly come from two categories of sources: (i) continental-level climate change studies of Europe; and (ii) studies aimed at assessing climate change impacts for specific selected river basins of Romania.

26. The results of the continental-scale studies include relevant findings for Romania. The observed changes in climate over Europe in the 20th century show that Southern and South-Eastern Europe has experienced decreases in annual precipitation of up to 20%. Precipitation has decreased at a rate of about 30 mm per decade in Romania, between 1961 and 2006 (See Figure 5).

27. Annual mean precipitation is projected to decrease by 5-20% in southern Europe and the Mediterranean in the period 2071-2100, compared to the period 1961-1990 (See Figure 6). In line with the precipitation changes, annual river flows are increasing in the north and decreasing in the south, and this trend is projected to increase in the future. Large changes in seasonality are also projected, with lower flows in summer and higher flows in winter for Romania. As a consequence, droughts and water stress are expected to increase, particularly in summer. Flood events are projected to occur more frequently in many river basins, particularly in winter and spring, although estimates of changes in flood frequency and magnitude remain uncertain. In general, the range of climate change impacts across Romania includes a likely increase in cold spells, heat waves, heavy floods, landslides, formation of ice-dams on watercourses, damaging frost, and avalanches.

Figure 5: Observed change in annual precipitation in Europe, 1961 – 2006

(Water resources across Europe, EEA Report No. 2/2009)

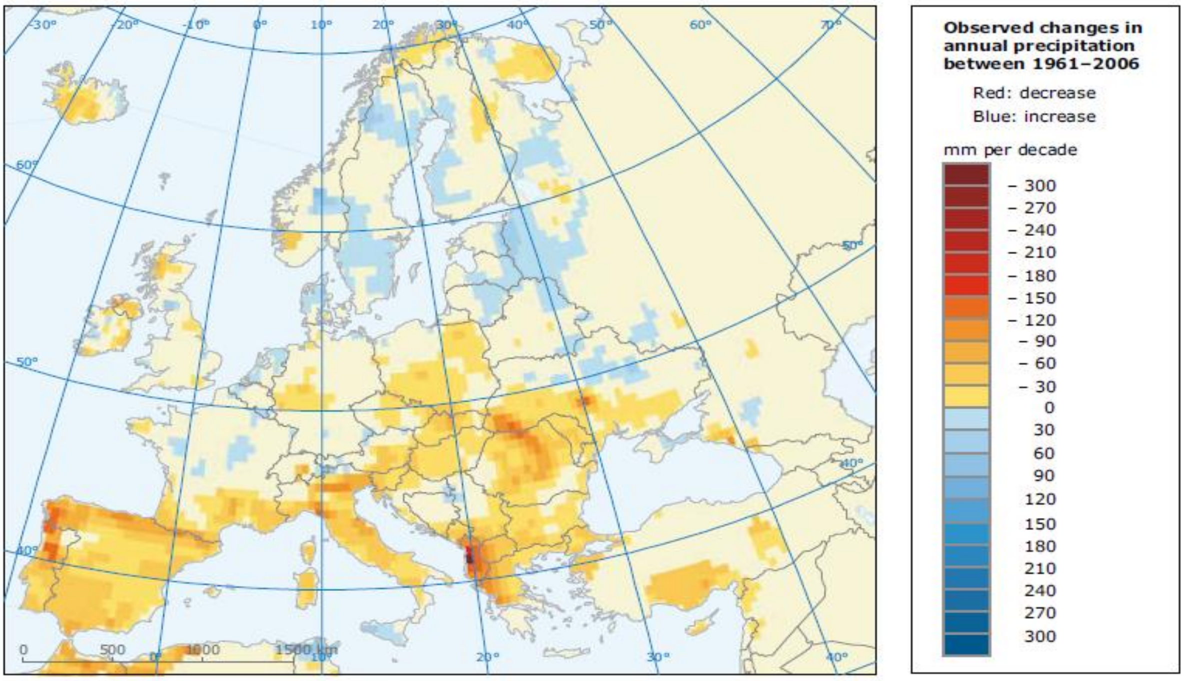
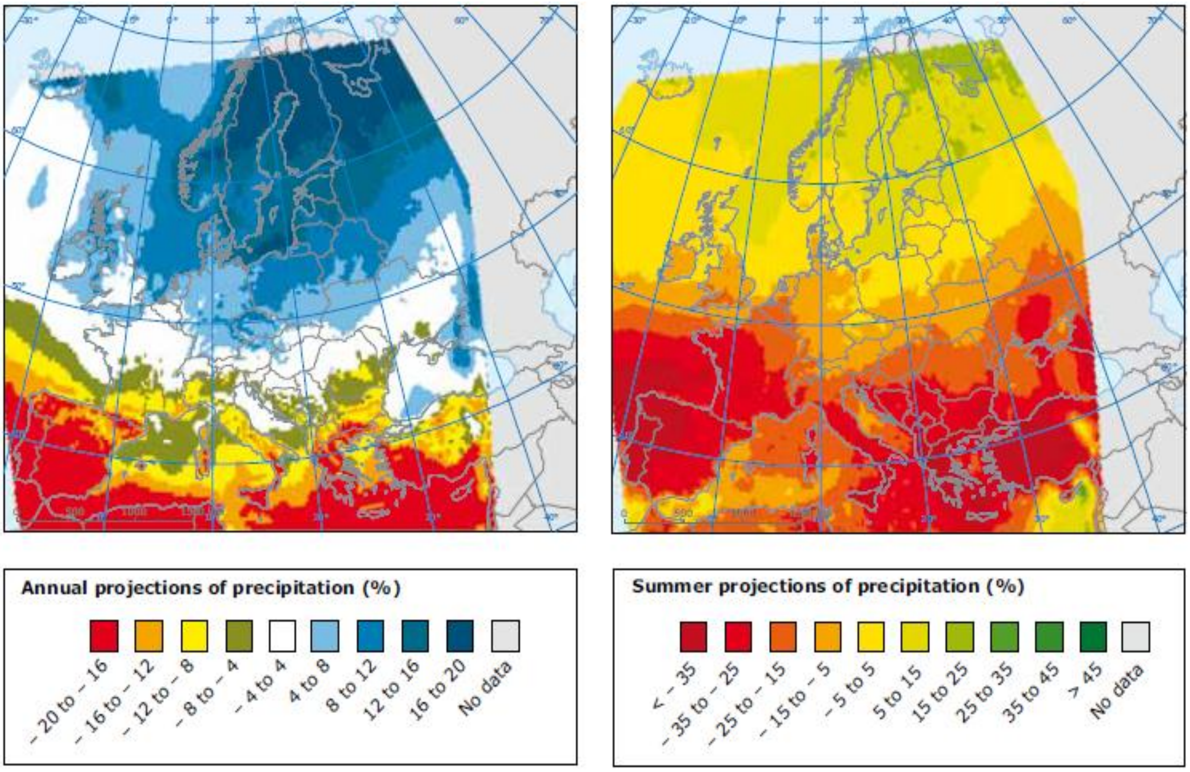


Figure 6: Projected changes in annual (left) and summer (right) precipitation between 1961–1990 and 2071–2100

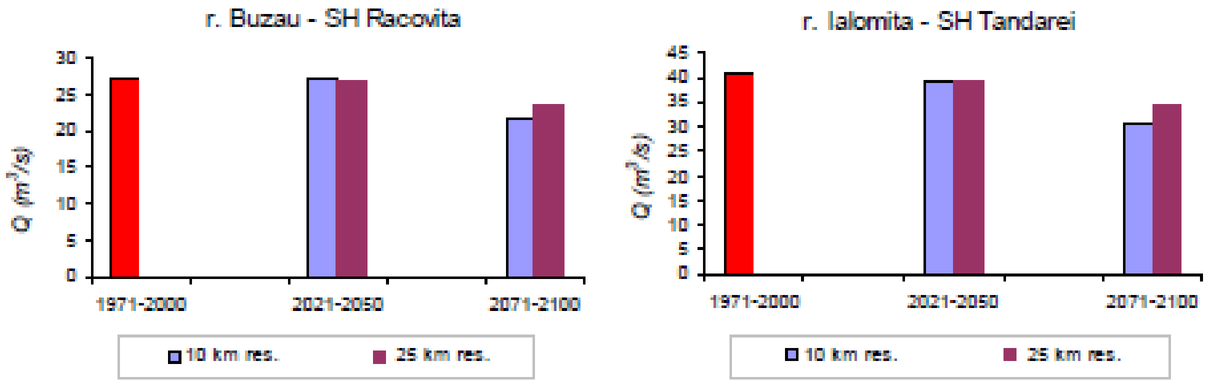
(The European environment, State and outlook - EEA, 2010)



28. Climate change studies focusing on specific basins in Romania have been completed for only four river basins - Buzau, Ialomita, Arges, and Mures. A study on Crisul Alb and Barlad basins is currently underway at the National Institute of Hydrology and Water Management.

29. The results for Buzau and Ialomita basins (from the CECILIA project, funded by the EU) indicate a likely reduction of mean annual flow in these basins, of 15-20 % for the period 2021-2050, and of 30- 40 % for the period 2070-2100 (See Figure 7). Also predicted are earlier occurrence of floods produced by snow-melt, and amplification of extreme phenomena. An analysis of changes in demands shows that the demand-supply gap will be manageable for the next 15-20 years, but significant measures will be needed to address vulnerability in the time period after that.

Figure 7: Changes to Mean Annual Flow due to Climate Change, Buzau and Ialomita



30. The results for Arges and Mures basins (from the CLAVIER project, funded by the EU) indicate a likely reduction of mean annual flow in these basins of 10-15 %, for the period 2021-2050. More frequent winter floods are expected, and while torrential flood events are likely to occur more frequently, the frequency of floods with long duration and large volume is expected to decrease. Incidence of low water levels/discharges is expected to increase by 25% which will cause water shortages, especially for big users. This will also affect users by making water intakes inoperative and hampering navigability of waterways. Figures 8 and 9 present the expected number of low water occurrences for the Mures and (lower) Danube rivers.

Figure 8: Low water occurrences, Mures – Arad

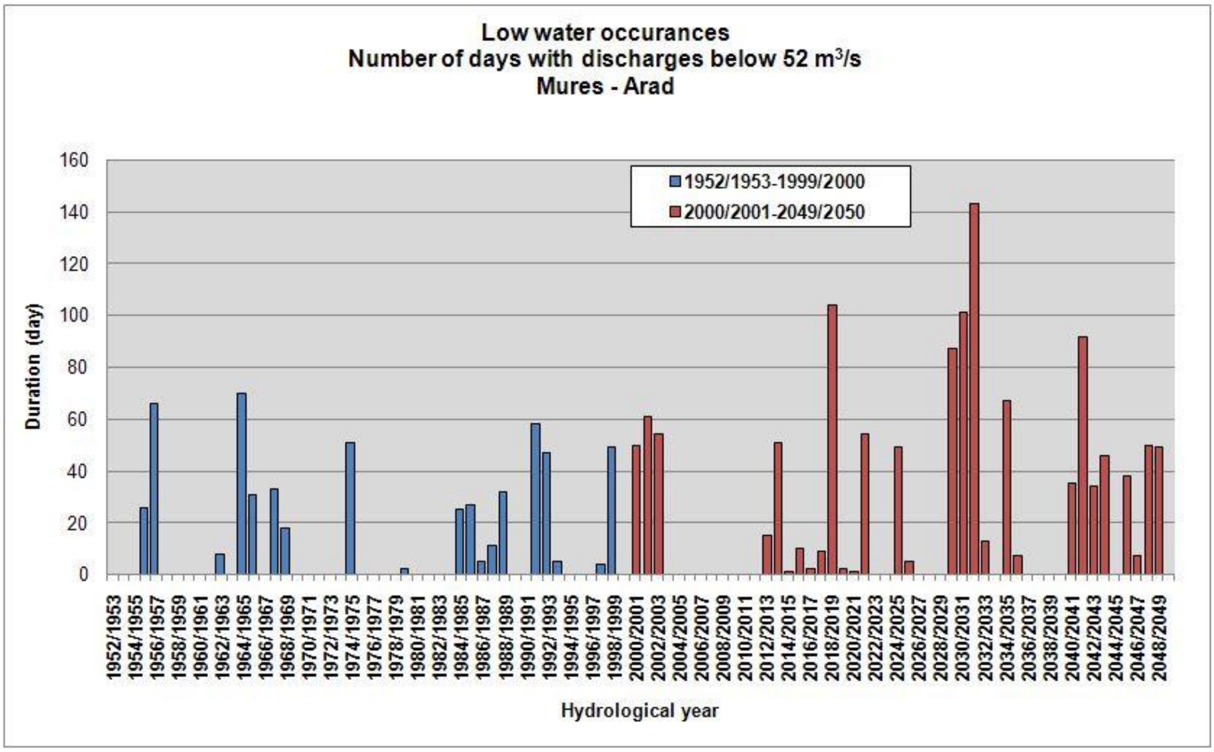
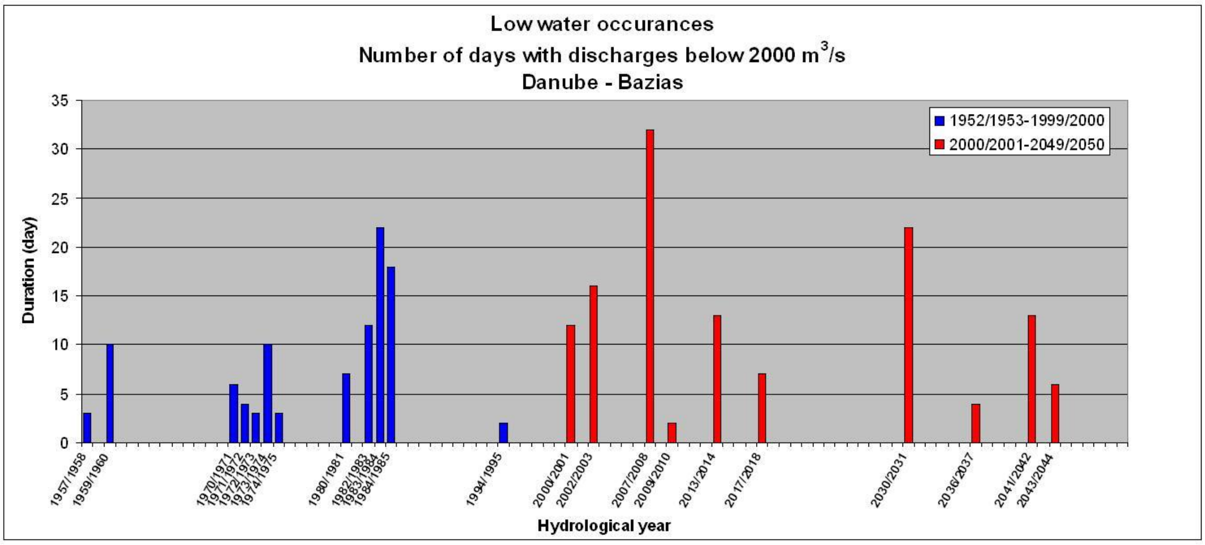


Figure 9: Low water occurrences, Danube-Bazias



Identified Vulnerabilities to Climate Change in Water-related Sectors

31. Water supply for agriculture, industrial and domestic use:
    a. Water supply will be adversely affected because the warmer and shorter winters will lead to the decrease of the seasonal snow volume and to the early and fast snow melting, leading to shortages in summer months.
    b. Hotter and drier summers will also cause a qualitative deterioration of the water resources, thereby effectively reducing the supply.
    c. Supply will also suffer from a lowering of groundwater table in summer months, due to reductions in the surface flow regime.
    d. Higher summer temperatures will lead to increased evapo-transpiration and therefore higher water demands in agriculture, during the same period when supplies will suffer a shortfall. The domestic water demands and supply will experience the same (but less pronounced) effect.

32. Sanitation: Wastewater treatment will be more frequently impaired by floods, due to storm-water infiltration in sewer systems, and also due to direct inundation of treatment facilities.

33. Environment:
    a. The flora and fauna in the aquatic ecosystems (rivers and lakes) as well as in those dependent on precipitation and river flows (such as wetlands) will suffer from a quantitative reduction in summer water flows, and from increased frequency of floods and droughts.
    b. Higher summer temperatures leading to water quality degradation (through decreases in dissolved oxygen, eutrophication and algal blooms) will also adversely affect the environment.
    c. Changes in aquifer levels will also adversely affect the water balance in wetlands, which are sustained by groundwater in the low flow season.

34. Hydropower: The summer generation from hydropower plants will be adversely affected in dry years (as they were in 1990), and therefore the operations rules will need to be reviewed and revised to ensure maximum energy production consistent with the objectives of maintaining the reliability of irrigation, industrial, and domestic water supplies. The hydropower facilities will also face increasing threat of intensive floods, and operations will also need to provide sufficient flood cushion in the storage reservoirs.

5. RELEVANT POLICIES AND PROGRAMS

35. National Climate Change Strategy for Romania The recently approved National Climate Change Strategy for Romania (2013-2020) provides guidelines and framework for developing sector-level action plans for mitigation and adaption to climate change in Romania. It also emphasizes the upcoming EU budget cycle (Multi-annual Financial Framework for 2014-2020) as the opportunity and trigger for preparation of specific investment plans aimed at meeting climate change mitigation and adaption targets for Romania.

36. National Sustainable Development Strategy The National Sustainable Development Strategy for Romania identifies the specific needs and outlines the proposed plans in all key water-related sectors. These include:
    a. Conducting more detailed analyses on the effect of climate change on water resources, given its multi-sectoral nature and high degree of vulnerability to climate change.
    b. Construction of planned hydropower stations to increase the fraction of carbon-free energy generation, and also to replace the thermal capacity about to be decommissioned.
    c. Gradual development of inland waterways on the Romanian sector of the Danube, through upgrading and expansion of port infrastructure.
    d. To improve the quality of, and access to infrastructure for water supply and wastewater treatment, by providing safe potable water and sewerage services to the majority of urban areas by 2015 and establishing efficient regional structures for water and wastewater management. This in turn entails:
        i. Municipal wastewater collection, discharge and treatment for 263 municipalities having more than 10,000 inhabitants, by 2015 (under the terms Romania obtained for the EU Accession Treaty), and by 2018 for 2,346 smaller townships with 2,000 - 10,000 inhabitants.
        ii. Compliance with the EU acquis drinking water standards by 2015
        iii. Promoting integrated water and wastewater systems through a regional approach, in order to ensure that the services can be provided at the required quality standards and affordable prices.
        iv. Completing the implementation of the program for the gradual elimination of discharges of hazardous substances in order to prevent the pollution of inland surface water resources, coastal waters, marine environment and underground aquifers; and to limit threats to aquatic ecosystems Also included are measures to prevent water pollution from nitrates originating from farming activities.
    e. It also emphasizes the need for the preparation of a medium to long-term program for the upgrading of irrigation systems, in order to assist the agriculture sector in

adapting to higher frequency and intensity of drought and expanding desertification, in parallel with increasing scarcity of available water resources.

37. In addition, the National Strategy on Drought Effects Mitigation, the Action Plan for Addressing Nitrate Pollution from Agricultural Sources, and the National Plan for Irrigation Rehabilitation and Reform are among the key plans that are relevant for addressing climate change implications in water related sectors.

38. The Sectorial Operational Programme on Environment (SOP E) has been implemented by Romania with financing support from European Regional Development Fund and Cohesion Fund. SOP E has a significant resource provision for ensuring compliance with EU Aqui, especially on coverage of water supply and wastewater investments (under Axis 1). There are also some funding provisions for investments in flood risk reduction (under Axis 5). According to the latest (2012) country evaluation report on Cohesion Funds for Romania, SOP E's achievements in water-related sectors include:
    a. 1 new water treatment plant,
    b. 548 km of new water networks, and
    c. 388 km of sewerage networks

    Although a considerable amount of funding has been allocated, there are no physical indicators reported on pollution and climate change effects reduction. There is one approved project for floods risk reduction.

39. Operational Programs under ESIF Programming (2014-2020) It is planned to invest approx. €43 billion, allocated from European Structural and Investment Funds (ESIF) plus national co-financing, under eleven thematic objectives in Romania. The EU has set a goal of at least 20% spending of the Union budget targeted on climate change related interventions in the 2014-2020 ESIF programs. The main OPs relevant for water sector investments in this context are:
    a. Large Infrastructure OP, with the key water-related areas being public utilities services (water and wastewater), risk prevention and climate (structural measures such as dams, flood control embankments, etc.), coastal areas and non-structural measures for risk reduction.
    b. Rural Development OP, with the key water-related areas being investments in agriculture and rural development (e.g. irrigation), and public infrastructure in rural areas.

40. Given the centrality of water-related sectors in how the climate change impacts will manifest in Romania, and given the requirement of ensuring that at least 20% of the allocated funds are targeted to climate change-related investments, the priority actions for these sectors are identified and presented in the following section, as relevant to the two main OPs under the ESIF Programming (2014-2020). Please note that some of the recommended actions do not directly pertain to climate change, however in some instances a case can be made to make these investments eligible for climate change-related

funding. One example is the provision of reliable water supply service to small communities which have traditionally relied on natural supply sources - such investments are a part of adaptation to climate change because the traditional water sources cannot provide the required degree of reliability anymore.

41. It is also important to briefly address the possibilities for climate change mitigation in water-related sectors:
    a. Potential of reducing GHG emissions from wastewater treatment. The contribution of water and wastewater treatment systems is estimated to be around 2% of Romania’s GHG emissions. However, since expanding the coverage of water and sanitation services will remain a priority sector for investments to ensure compliance with EU accession requirements, there is a significant scope for incorporating climate mitigation actions by ensuring methane capture and flaring an using energy efficient pump systems.
    b. Potential of reducing GHG emissions from storage reservoirs - Depending on climate, vegetation and the methods used to remove the vegetation prior to the first filling of the storage reservoirs, there can be very significant methane emissions resulting from the decay of the organic matter at the bottom of the reservoir. Since no large storage reservoirs are currently being built in Romania, this opportunity is not relevant in the current situation.
    c. Improving energy efficiency of pumps in large water delivery systems - Given that the electricity production in Romania is primarily fossil fuel-based, improving energy efficiency in large-scale pumped-irrigation systems can lead to substantial carbon savings. However, most large lift irrigation schemes in Romania are now closed down, as irrigation sector has shed the economically unviable operations. Therefore this does not seem to offer a significant potential for climate change mitigation.

6. CLIMATE CHANGE ADAPTATION ACTIONS IN WATER-RELATED SECTORS

The main opportunities of climate change adaptation that are emerging from this analysis of the water-related sectors are as follows:

40. Strengthening the Knowledge Base:

a. There is an urgent need to improving the existing climate scenarios and conduct a quantitative assessment of impacts on water-related sectors. As mentioned earlier, only four basins of Romania - Buzau, Ialomita, Arges, and Mures - have the quantitative analyses available for estimating future water availability and demands under climate change scenarios. This exercise needs to be conducted for the remaining seven basins of Romania, with priority on the drought-prone basins of Jiu, Siret, Prut-Barlad, and Dobrogea-Littoral.
b. A newer generation of global climate models (CMIP5 – which also forms the basis of the IPCC 5th Report) is now available, and in conjunction with regional climate models and statistical methods, it can be used to estimate climate change impacts at higher spatial and temporal scales, for the critical river basins of Romania.
c. The results of the climate change studies need to be incorporated in the sector planning activities of all water-related sectors separately, and also in an integrated manner in the development of River Basin Master Plans, which are currently being prepared for 2015. These should therefore constitute a necessary input for national flood hazard/risk mapping, design of flood control infrastructure, operations rules for storage reservoirs, and for the planning processes in irrigation, domestic water supply/sanitation, hydropower, industrial development, disaster management and environmental sectors. Through the process of preparation of the River Basin management Plans, the water resources and demands should be re-evaluating at the level of hydrographical basins and sub-basins under climate changes conditions.

41. Irrigation:

a. In view of the plans to expand irrigation in Romania, it is important to assess the specific levels and types of irrigated agriculture that can be sustained in each of the river basins. This exercise would entail quantitative assessments of water availability and crop water needs under different climate scenarios, and is best conducted in a Decision Support System framework, so that the tradeoffs between different choices can be explicitly analyzed and discussed with the stakeholders.
b. It is recommended that Romania start piloting on a systematic basis the different models of efficient irrigation systems coupled with climate-smart agriculture practices.

c. Analysis of the technical options and economic returns should be conducted for converting pumped-irrigation to gravity-based schemes, in areas with confirmed and steady demand for irrigation services.
d. In the areas where groundwater over-abstraction is leading to serious depletion of aquifers, the use of groundwater should be reserved for domestic water supplies.
e. Wastewater reuse in irrigation should be encouraged, especially in water-scarce basins. A new directive on water reuse, considered as a no-regret measure for droughts, should be proposed by 2015.

42. <u>Water Supply and Sanitation</u>:

a. Quantitative assessments of water demands and supply reliability should be conducted for all the main utilities of Romania, taking into account the expected impacts of various climate change scenarios. This should cover all demand sectors, including industries and environment. This analysis should form the basis for providing inputs to the River Basin Management Plans, and review/updation of operations rules.
b. The efforts aimed at reducing system losses in water distribution networks (currently estimated at approx. 50%) should be strengthened. Similarly, water demand management initiatives should be promoted in domestic and industrial sectors.
c. While Romania is striving (in phases) to provide water supply and sanitation provisions to all habitations with more than 2000 inhabitants, it would also be important to assess the needs of the areas which will not be covered by these initiatives.
d. Wastewater reuse for irrigation and industrial sectors should be encouraged.
e. The feasibility of using aquifers coupled with artificial recharge for inter-annual water storage should be explored in suitable basins.
f. Critical water supply sources (reservoirs or aquifers) in water-scarce locations should be actively protected through land use zoning measures. It is recommended that Romania should pilot different drinking water source protection models, to assess feasibility and efficacy of this approach.
g. The national policy on groundwater use allows large abstractors situated in utility service area to abstract groundwater in large volumes (after due diligence of the permitting process), instead of using the utility supply. This has led to significant lowering of the groundwater table in vulnerable areas (e.g in the Dobrogea-Littoral basin), and it also adversely affects the viability of the water utilities due to loss of revenue and increased cost of pumping water from greater depths. The issue is being considered by the Ministry of Environment, and policy action on addressing it will be critical for ensuring the viability of groundwater as a buffer resource.
h. Desalinization should be considered for provision of drinking water supplies in water-scarce coastal basins

i. Feasibility of implementing new infrastructure for storage and inter-basin water transfers should be examined, if needed, to address the future challenges.

43. Environment and Natural Resources Management:

a. Quantitative assessments for water needs of various ecosystems should be conducted and the results should be used as input for the preparation of the River Basin Management Plans in each basin, in order to ensure water allocation for environmental uses.
b. Afforestation and other catchment improvement activities should be encouraged in flood- and erosion-prone uplands
c. It is recommended to pilot suitable co-benefit models of natural resource management, in forest catchments and in wetland fisheries, whereby the ecosystems sustain local livelihoods while providing valuable environmental services.

44. Disaster Management:

a. There is a need to improve the flood hazard and risk analysis by using a higher resolution GIS-based approach, so that the hazard/risk maps can be particularized at the level of localities/habitations.
b. The analysis also needs to be upgraded to 1% (1 in 100 years flood) level for inhabited areas, and should take into account the expected impacts of climate change on local hydrological systems.
c. Risk maps need to be formally introduced into the regional development and general city planning processes.
d. A formal regulation could be considered for monitoring and managing construction activities in the high flood-risk areas.
e. Local-level planning capacity for episodic events such as heat waves needs to be strengthened.
f. The current pipeline of infrastructure investments proposed for flood protection is estimated at 17 billion €. These investments should be re-prioritized after the flood hazard maps are updated to reflect the climate change impacts and the required higher degree of flood protection, so that the investments at any given level of funding can ensure the maximum possible benefits.

7. CONCLUSIONS – NEXT STEPS AND RECOMMENDED PRIORITY ACTIONS FOR ESIF (2014-2020) OPs

The analysis presented in this report is significantly limited by the extent of the available information. The most significant shortcomings of this analysis pertain to the following:

(i) There is a need for developing quantitative estimates of climate change impacts on water-related sectors, especially since water is the one of the primary modalities through which the climate change effects are manifested. This analysis needs to be conducted on priority for the water-scarce basins, because a comprehensive list of actions for building climate resilience cannot be developed until the River Basin Management Plans are updated with the quantitative estimates of climate change impacts on supply and demands.

(ii) The actions suggested in this report have not been validated through an economic analysis. Since the needs are high compared to the available resources in the short-term, it would be important to undertake a multi-sectoral techno-economic assessment, preferably through modeling, in order to prioritize the recommended actions for investment. Nonetheless, some of the obvious "no-regret" actions have been presented separately, with the recommendation that these be initiated at the earliest, given the strong need and significant benefits.

It should also be noted that while some of the recommended investments (such as those in rural water supply and flood management) do not directly seem to be related to climate change, these can be validly considered to be a part of the adaptation response and hence may be eligible for climate change-related funding

The tables below summarize the recommended actions for improving climate resilience in water-related sectors, for proposed financing and support under the ESIF (2014-2020) OPs. The estimated time-frame for these actions is also indicated.

Table 3: Recommended "No-Regret" Actions

Action	Type of Action	Time frame
1. Conducting Quantitative Assessments of Climate Change Impacts on Hydrology, for estimating future water availability and demands under climate change scenarios. This exercise needs to be completed for all basins of Romania (4 are already covered)	Research & Analysis/ Technical Assistance	Short term
2. Establish requirements that River Basin Management Plans (RBMPs) in each basin must be updated with the results of quantitative climate change assessments described in #1 above.	Policy Training/ education	Short term
3. Ensure that RBMPs currently being prepared for 2015 are updated with quantitative climate change assessments	Technical Assistance	Short term
4. Conduct analysis to assess the specific levels and	Research &	Medium term

	types of irrigated agriculture that can be sustained in each of the river basins, accounting for climate change impacts. This should feed into RBMP process.	Analysis/ Technical Assistance	
5.	Conduct analysis of the technical options and economic returns of converting pumped-irrigation to gravity-based schemes, in areas with confirmed and steady demand for irrigation services	Research & Analysis/ Technical Assistance	Medium term
6.	Conduct quantitative assessments of water demands and supply reliability for all the main WSS utilities of Romania, taking into account the expected impacts of various climate change scenarios. This should feed into RBMP process	Research & Analysis/ Technical Assistance	Medium term
7.	Establish regulations to ensure that large industrial water users are provided through utility supplies, instead of private groundwater wells (The issue is being considered by the Ministry of Environment and Climate Change)	Policy/Regulation	Short term
8.	Conduct quantitative assessments for water needs of various ecosystems. These environmental uses should feed into the RBMP process.	Research & Analysis/ Technical Assistance	Medium term
9.	Update flood hazard and risk analysis by using a higher resolution GIS-based approach; upgraded nationally to 1% (1 in 100 years flood) level for inhabited area; and take into account expected climate change impacts.	Technical Assistance	Medium term
10.	Establish regulations to formally introduce flood risk assessments into the regional development and general city planning processes.	Policy/ Regulation	Medium term
11.	Assess feasibility of regulation for monitoring and managing construction activities in the high flood-risk areas.	Policy/ Regulation	Medium term
12.	Strengthen local-level planning capacity for episodic events such as heat waves.	Capacity-building	Medium term

Table 4: Recommended Actions for Prioritization and Financing under ESIF (2014-2020) OPs

Sectoral Focus	Action	Type of Action	Time frame	Applicable OP
Irrigation	1. Implement pilots to test different models of efficient irrigation systems coupled with climate-smart agriculture practices.	Pilot Investments	Medium term	Rural Development OP
	2. Establish regulations to limit the use of groundwater for domestic water supplies, in the areas where groundwater over-abstraction is leading to serious depletion of aquifers.	Policy/ Regulation	Medium term	Rural Development OP
	3. Wastewater reuse in irrigation should be encouraged, especially in water-scarce basins	Policy/ Pilot Investments	Medium term	Rural Development OP
Water Supply and Sanitation	4. Investments in infrastructure to ensure water supply and wastewater provisions for 263 municipalities having more than 10,000 inhabitants, by 2015 (and by 2018 for 2,346 smaller townships with 2,000 - 10,000 inhabitants)	Direct Investment	Long term	Large Infrastructure OP / Rural Development OP
	5. Assess scope and scale of methane capture and flaring, as well as high efficiency pumps, to reduce the GHG emissions from the water and wastewater supply investments, and to hence qualify these investments as climate actions.	Technical Assistance/ Direct Investments	Medium term	Large Infrastructure OP / Rural Development OP
	6. Support utility investments aimed at reducing system losses in water distribution networks (currently estimated at approx. 50%).	Direct Investment	Long term	Large Infrastructure OP
	7. Wastewater reuse in industrial sectors should be encouraged.	Policy/Pilot Investments	Medium term	Large Infrastructure OP
	8. Assess feasibility of using aquifers coupled with artificial recharge for inter-annual water storage should be explored in water-scarce basins.	Technical Assistance/Pilot Investments	Medium term	Large Infrastructure OP
	9. Establish requirements for protection of critical water supply sources (reservoirs or aquifers) in water-scarce locations, through land use zoning measures.	Policy/ Regulation/ Pilot Investments	Medium term	Large Infrastructure OP/ Rural Development OP/ Regional OP
	10. Assess feasibility of desalinization for provision of drinking water supplies in water-scarce coastal basins	Technical Assistance	Medium term	Large Infrastructure OP
	11. Afforestation and other catchment improvement activities should be encouraged in flood- and erosion-prone uplands	Direct Investments	Medium term	Rural Development OP
	12. Implement pilots on suitable co-benefit	Technical	Medium term	Rural

	models of natural resource management, in forest catchments and in wetland fisheries, whereby the ecosystems sustain local livelihoods while providing valuable environmental service	Assistance/ Pilot Investments		Development OP/ Regional OP
Disaster Risk Reduction and Management	13. Undertake construction of flood management infrastructure. Since the potential investments pipeline is huge (estimated at 17 billion €), investments should be prioritized on the basis of updated flood hazard/risk mapping and accounting for the climate change impacts.	Direct Investments	Long term	Large Infrastructure OP
	14. Upgrade to digital the existing radar network for measuring precipitation intensity, and installing a new radar station in Galati.	Direct Investment	Medium term	Large Infrastructure OP

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8. REFERENCES

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