WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

Interreg
Greece-Bulgaria
WATER RESCUE
European Regional Development Fund

EUROPEAN UNION

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.5.1 Climate change impacts assessment report** *Joint Deliverable*
Sub-Deliverables integrated	**D.3.1.1, D.3.2.1, D.3.3.1, D.3.4.1, D.3.5.1, D.3.6.1**
Project Beneficiary No	**PB5**
Beneficiary Institution	**Municipality of Gotse Delchev**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Chapter 1. Introduction: The WATER RESCUE project in brief

1.1 The Project in brief

WATER RESCUE project's concept is based on the common cross-border (CB) water management problems in the two international river basin districts (RBDs) shared between Greece & Bulgaria (Struma-Strymonas; Maritsa-Evros). The common CB problems include water resources quality & quantity being at risk due to natural and human activities and climate change conditions. The consequence is that water bodies fail to meet the good ecological status (GES) (recorded in the river basin management plans-RBMP). In particular, drinking water faces significant risks due to the deteriorated water resources quality while at the same time significant water volume is lost in the water distribution networks (WDNs). The project aims at the sustainable and efficient management of drinking water supply by increasing drinking water use efficiency in WDNs and improving water quality in the whole water supply cycle (from the source and back to the environment). Good Ecological Status can be achieved by improving water quality and reducing water abstraction and can be maintained by taking climate change adaptation measures. The project focuses in drinking water supply management suffering from high Non-Revenue Water (NRW) levels and deteriorated water quality jeopardizing the drinking water consumers' safety and health and their quality of life. Urban water volumes end up to the sewerage networks while wastewater treatment plants are a pressure to water resources quality. Surface water bodies are both used for drinking water abstraction and are the final recipient of treated effluents. Thus, their ecological status is affected by both water quantities abstracted and water quality in the whole water supply cycle (from the resource to the water supply and the wastewater treatment plant and back to the environment).

1.2 Theme of the Project

WATER RESCUE project is expected to achieve Non-Revenue Water/water losses reduction by upgrading and adapting already developed methodologies, technologies and tools including Water Balance assessment and Performance Indicators, hydraulic simulation models, decision support systems and GIS tools. Additionally, WATER RESCUE is expected to achieve water quality improvement across the entire water supply chain (from the water intake point and the raw water treatment plant, back to the environment after the waste water treatment plant) through constant monitoring of water quality parameters in real time, water quality simulation models (including water age) and automatic chlorination systems on line and in line. Climate change impacts will be assessed to finally propose and adopt measures for climate change adaptation. WATER RESCUE has a clear innovative character since the methodologies and tools are integrated and do not tackle individual problems. It is the first time that integrated methodologies will be adapted to include the entire drinking water supply cycle. These methodologies/tools will serve as Early - Warning Systems both for water quantity and quality. WATER RESCUE results will improve drinking water management. At the same time as drinking water is involved, the consumers' safety and health are safeguarded and their quality of life is improved. Non-Revenue Water reduction will increase water resources efficiency, since less water will be abstracted from surface and groundwater bodies and reduce energy consumption as water and energy are interconnected in water supply systems (water-energy nexus). Drinking water quality will be improved through real time monitoring of water quality parameters across the entire water supply chain, from the water intake points, to the water treatment plant and the water distribution network, back to the environment through the wastewater treatment plant. Thus, drinking water quality will be safeguarded from its source up to the consumer's tap. As wastewater effluents return to water resources, their quality monitoring prevents water resources degradation due to this pressure. Water and energy resources efficiency will be promoted and the ability of the cross-border area to adapt to climate change conditions will be improved as all possible natural and man-made pressures will be evaluated, including climate change conditions. Water saving will be accomplished through water losses reduction and increase of the environmental awareness of the public. The quality of life is expected to be upgraded with special emphasis to the protection of the natural environment. Joint policy recommendation guidelines and papers will be developed. Good governance, transparency and participation of all stakeholders in the design, implementation and monitoring of these policies is expected. Know-how and technology transfer will take place not only among the beneficiaries but also in the stakeholders' network that will be developed.

1.3 Project Beneficiaries

Lead Beneficiary is the Municipal Water and Sewerage Company of Komotini (Greece); Beneficiary 2 is the Municipal Water and Sewerage Company of Thermi (Greece); Beneficiary 3 is the University of Thessaly-Special Account Funds for Research-Department of Civil Engineering (Greece); Beneficiary 4 is the Municipality of Kardzhali (Bulgaria); Beneficiary 5 is the Municipality of Gotse Delchev (Bulgaria); and Beneficiary 6 is the Municipal Water and Sewerage Company of Thermaikos (Greece).

1.4 The present deliverable

1.4.1 The subject of the present deliverable

The present deliverable refers to WP3.1. This deliverable includes the climate characteristics and climate change scenarios, the impacts of climate change on water quality and quantity. Specifically, the deliverable presents the analysis of the climate characteristics in the cross-border area and their future trends based on climate change scenarios. Water availability is assessed referring to the cross-border water resources. Water quality of these water resources is evaluated, identifying pollution sources. Land uses are also taken into consideration. Finally, the DPSIR (driver – pressure – state – impact – response) methodology is used.

1.4.2 The approach applied developing the present deliverable

As the topics the WATER RESCUE project is dealing with, need precise knowledge of the way water supply and distribution systems operate, it was made clear, even during the kick-off meeting of the project, held in Komotini in January 2018 that WATER RESCUE beneficiaries, beyond their common agreement to work closely together, should be guided by the scientific beneficiary, University of Thessaly, to ensure the prompt delivery of what was expected by the WATER RESCUE project. Thus, the University of Thessaly, prepared the methodology and the questionnaires for this task. Municipality of Gotse Delchev (PB5) as the WP Leader took over the responsibility to prepare the joint deliverable of Phase 3.1.

Regarding the implementation of Phase 3.1., the beneficiaries reported on climate change impacts on cross-border water resources. University of Thessaly (PB3) provided a questionnaire consisting of the following chapters: (a) Climate characteristics and climate change; (b) Water Availability – Climate Change impacts on water resources; (c) Water Quality and Land Uses; and (d)Summary Table. All beneficiaries provided their deliverables to the WP leader, who properly elaborated the data in order to prepare the joint deliverable. The WP leader prepared the respective deliverable D3.1.

Chapter 2. Climate Change Impacts Assessment – Results & Discussion

The analysis is based on two levels: National Level and Regional / Local level. As there are project beneficiaries who are National organizations (PB3) this beneficiary submitted the deliverables referring to the National level, focusing on the cross-border area. All other beneficiaries, who are water utilities, submitted their deliverable referring to regional / local level.

2.1. PB1 – Municipal Water Supply and Sewerage Company of Komotini, Greece

2.1.1. General presentation

The region of Thrace is located in the eastern part of Northern Greece. The region covers an area of 8,578 km2 and its population is 361,208. The Water District of Thrace (EL12) (area 11,243Km2) consists of five river basins: the river basin of Nestos (area 2,975.5 km2); the river basin of Xanthi – Xirorema streams (area 1,662.6Km2); the river basin of Komotini – Loutro Evrou stream (area 1,958.3Km2); the river basin of Evros (area 4,080.8Km2); and the river basin of Thasos – Samothraki (area 562,8km2) (RBMP, 2017) and is divided in three areas: the island part and a narrow coastal zone with continental Mediterranean climate; the inner part and the low lands with mid-european climate; and the mountainous area with mountain climate (RBMP, 2017). The water district's altitude ranges from 0 to 2,200m and the average annual temperature ranges from 14.5 to 16.5o C, while the annual temperature range exceeds 20oC. The annual precipitation levels range in the coastal and island part between 500 and 600mm, in the inner part between 600 and 1,000mm, while at the northern maintains it exceeds 1000mm (RBMP, 2017). According to the National Programme of Management and Protection of Water Resources (2008), the mean annual precipitation is estimated to 778mm.

The Water District of Thrace includes 199 surface water systems (RBMP, 2017): 176 rivers, 5 reservoirs, 1 lake, 5 transitional systems and 12 coastal systems.

The Municipal Water Supply and Sewerage Company of Komotini supplies with water the Municipality of Komotini. The water resources used are Vosvozis river (EL1209R0000010085N) and the groundwater system of Rodopi (EL1200120). Their characteristics are:

- Vosvozis river: (EL1209R0000010085N – length: 7.70Km; river basin area: 74.91Km^2; average annual runoff: 42.52hm^3)
- Rodopi system: (EL1200120 - area 755.58Km^2)

2.1.2. Climate characteristics and Climate change

2.1.2.1. Temperature

There are showed graphs from the nearest meteorological station (located in Alexandroupoli) about average, minimum and maximum monthly and average annual air temperature. Based on that data, the monthly average temperature ranged from 4.7oC (January) to 25.7oC (July) at the period 1971-2000. The average minimum temperature ranged from 0.9 (January) to 17.6oC (July) in 1971-2000. The average maximum temperature ranged from 8.6 (January) to 30.3oC (July and August) in 1971-2000. It is shown that the average annual air temperature is with increasing trend from 1971 to 2000.

2.1.2.2. Precipitation

According to monthly precipitation values at the station in Alexandroupoli is show that the driest months are from July to September and the most wet months are November and December. Mean precipitation values ranged from 12.4mm (August) to 81.0mm (November) in 1971-2000. Analyzed meteorological data showed that mean precipitation values are decreasing with slight trend from 1971 to 2000.

2.1.2.3. Existing hydrological monitoring

It was established a national monitoring network in 2011. Its purpose is the monitoring of ecological and chemical status of the surface water bodies. There are 57 stations for monitoring of surface bodies in the water district of Thrace, 48 of them for surveillance and 9 for operational monitoring (RBMP, 2017).

There is given information about the number of the monitoring stations per type of water body in Thrace WD (source: RBMP, 2017):

Type of station	Surveillance	Operational
Rivers	36	4
Lakes	1	4
Coastal	3	1
Transitional	8	
TOTAL	**48**	**9**

2.1.2.4. Climate change

There is presented a study by Bank of Greece, made in 2011. It examined climate change and climatic characteristics based on four emission scenarios. The results showed that at national level, temperature is projected to increase in all regions throughout the year. The temperature increase is expected to be greater in the summer and smaller in winter. The study revealed that under all four scenarios the warming trend increases throughout the 21st century. According to the study annual precipitation levels are projected to decline at national level.

There is presented a table with mean annual values of air temperature based on two scenarios (A2 and B2), temperature differences (ΔT) and changes as % (reference period 1961-1990) for 2071-2080, 2081-2090, 2091-2100 (source: Bank of Greece, 2011)

Periods	A2 T(°C)	B2 T(°C)	A2 ΔT	B2 ΔT	A2 (%)	B2 (%)
2071-2080	16.29±1.74	15.42±1.15	4.05±1.06	3.05±0.41	33.5±9.8	24.8±4.0
2081-2090	16.84±1.80	15.63±1.29	4.60±1.11	3.27±0.56	38.0±10.3	26.5±4.7
2091-2100	17.52±1.81	15.79±1.26	5.28±1.08	3.42±0.62	43.6±10.1	27.8±5.6
1961-1990	12.24±1.39	12.36±1.06				

There is presented a table with mean annual values of rainfall based on two scenarios (A2 and B2), rainfall differences (ΔR) and changes as % (reference period 1961-1990) for 2071-2080, 2081-2090, 2091-2100 (source: Bank of Greece, 2011)

Periods	A2 R(mm)	B2 R(mm)	A2 ΔR	B2 ΔR	A2 (%)	B2 (%)
2071-2080	526.8±131.1	625.6±137.2	-81.5±56.6	-38.0±92.3	-13.4±8.6	-5.3±14.4
2081-2090	465.1±102.8	599.9±116.7	-143.2±64.0	-63.7±64.7	-23.3±8.5	-9.3±9.9
2091-2100	487.6±126.1	652.1±159.1	-120.7±57.5	-11.5±93.8	-20.1±8.6	-1.8±14.6
1961-1990	608.3±132.4	663.6±115.4				

It is projected that the maximum consecutive 3-day precipitation period during 2021-2050 will remain the same as the reference period in Thrace. The number of frost days per year is projected to decrease gradually during the years.

2.1.3. Water Availability – Climate Change Impacts on Water Resources

2.1.3.1. Water Demand

Thrace water district covers six regional units: Drama (47.3 % of its area), Kavala (36.2% of its area), Thasos (100%), Xanthi (100%), Rodopi (100%) and Evros (100%). The total population of the WD is 408,186 inhabitants (2011 census). The total number of available beds in touristic units is 17,541 (RBMP, 2017) while only in Rodopi (where Komotini is located) is 1,607.

According the RBMP of Thrace annual water demand is in the territory is presented as follows:

Water Demand	WD of Thrace		RB of Komotini-Loutro Evrou streams	
	hm³	%	hm³	%
Agriculture	941.4	58.8	160.44	85.6
Domestic	60.5	3.8	14.66	7.8
Livestock	3.9	0.2	0.7	0.4
Industry	14.1	0.9	11.55	6.2
Hydroelectrical production	582.0	36.3		
Total	**1,602.0**		**187.35**	

There is given information about the river basin of Komotini - Loutra Evrou streams which consists of 28 river surface water systems and 4 groundwater systems. The data is about 18 surface water systems at good ecological status; 4 at moderate ecological status; 2 at poor ecological status; and 4 in unknown ecological status; 1 surface water system in bad chemical status; 1 out of 4 groundwater systems are found to be in bad chemical status. The groundwater systems are with good quantitative status. The river Vosvozis supplying is in poor ecological status and good chemical status (generally poor qualitative status).

DEYA Komotinis (the WS company) is supplying Komotini municipality with water from the river of Vosvozis and the groundwater system of Rodopi.

Based on data from the RBMP (2017) water availability and average annual abstraction of the groundwater system of Rodopi is:

Groundwater system	Water availability (10^6 m³)	Av. Annual abstraction (10^6 m³)	Agriculture (10^6 m³)	Domestic (10^6 m³)	Livestock (10^6 m³)	Q-tive status
Rodopi	50.4	14.7 (or 29,1%)	12.0	2.5	0.2	Good

2.1.3.2. Climate change impacts on Water Resources Availability

It is predicted that the climate change (higher temperature and less rainfalls) will affect water resources at the territory.

2.1.3.3. Water Resources Availability

The water resources availability is analyzed using Water Exploitation index (WEI). It is giving the rate of Water Demand (WD) to the renewable Water Resources (WR). The study was focused on the groundwater systems used by WS company and the estimations considered both WEI for total water demand and for drinking water demand. There were made a study with 5 different scenarios for the water demand – present WD, present WD increased by 25%, decreased by 25%, present renewable WR increased by 25% and respectively decreased by 25%.

The authority explained that for analyzing WEI variations were developed numerous scenarios by changing WD and water supply by 5% for three of ground systems.

There were estimated six WEI indexes for the demands acc. the study:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Option, WEI	EL1200120	
	Total use (WEI values)	Drinking water (WEI values)
WEI1= WD0/WR present	0.292	0.050
WEI2= WD0/WR future1	0.233	0.040
WEI3= WD1/WR future1	0.292	0.050
WEI4= WD2/WR future1	0.175	0.030
WEI5= WD1/WR future2	0.486	0.083
WEI6= WD2/WR future2	0.292	0.050

Compared with WEI thresholds calculated WEI values are showing that the groundwater system of Rodopi is at low risk both under the present conditions and if the circumstances change - water demand increases and water availability decrease. The same ascertainment is done for drinking water usage.

2.1.4. Water Quality and Land Uses

2.1.4.1. Water Resources Quality Characteristics

It is given summarized information about the annual BOD, N and P loads due to different pollution sources in RB Komotinis - Loutrou Evrou streams (source: RBMP, 2017):

Sources	Annual BOD (tons/year)	Annual N (tons/year)	Annual P (tons per year)
Point sources			
Industrial units	27.9	26.1	25.9
Leakages from uncontrolled disposal points of and Landfills	0.0	0.0	0.0
Wastewater treatment plants	70.1	43.0	2.8
Sewerage networks discharge to physical receivers	72.4	14.5	3.0
Large hotels	0.0	0.0	0.0
Aquaculture – fish farming	0.0	0.0	0.0
Large Livestock farming units	3.1	1.8	0.4
TOTAL	**173.6**	**85.3**	**32.1**
Diffuse pollution sources			
Urban	186.7	53.2	1.3
Agricultural	0.0	196.7	11.9
Livestock farming	2,038.2	538.5	19.5
Other sources	0.0	118.0	0.9
TOTAL	**2,224.8**	**906.4**	**33.6**
Point + diffuse pollution	**2,398.4**	**991.7**	**65.6**

The groundwater system is assessed for its chemical and quantitative status and there are not any problems identified.

2.1.4.2. Land use

It is given information about all different land uses identified in the WD of Thrace:

Land Uses	WD of Thrace		RB of Komotini – Loutro Evrou streams	
	Area (acres)	%	Area (acres)	%
Urban	79,380	0.76	17,847	0.92
Pasture	1,446,499	13.81	385,557	19.83

Agriculture	3,407,066	32.54	767,828	39.49
Forest	5,016,819	47.91	696,009	35.79
Roads / water	270,925	2.59	37,521	1.93
Other	250,667	2.39	39,734	2.04
TOTAL	**10,471,357**		**1,944,497**	**100.00**

2.1.5. Summary Table – SWOT Analysis

S	W
▪ measures included in the RBMP include the reduction of water losses in water utilities; ▪ the elaboration of Master Plans; ▪ low pollution loads; ▪ good quantitative status; ▪ good chemical status.	▪ high water demand mainly for irrigation purposes; ▪ temperature increase; ▪ precipitation decrease.
O	**T**
▪ new technologies for irrigation; ▪ financial instruments for the construction of new works (irrigation distribution networks).	▪ temperature increase; ▪ precipitation decrease; ▪ high water demand; ▪ low efficiency irrigation practices.

2.1.5. Conclusions

Municipal Water Supply and Sewerage Company of Komotini (PB1) has prepared detailed report. It is provided information about expected climate change based on study. The data about water demand and present availability is complete.
Strengths, weaknesses, opportunities and threats are named.

2.2. PB2 – Municipal Water Supply and Sewerage Company of Thermi, Greece

2.2.1. General presentation

The region of Central Macedonia is located in Northern Greece. The region covers an area of 18,811 km^2 and its population is 1,874,590 (according to the 2011 census). Thessaloniki is the capital city. Most of the area of Central Macedonia region is part of the Water District of Central Macedonia (EL10) (area 10,163.38Km^2). The latter consists of four river basins: the river basin of Axios (area 3,327.85 km^2); the river basin of Gallikos (area 1,050.23Km^2); the river basin of Chalkidiki (area 5,545.86Km^2); and the river basin of Athos (area 239.44km^2) (RBMP, 2017). The water district is characterized by a variety of climates, as Mediterranean climate in the area of Chalkidiki and the coastal areas; continental in the inner part of the district; and mountainous in the areas with high altitude (RBMP, 2017). The average annual rainfall ranges from 400 to 800mm, while in the mountains it exceeds 1,000mm. Snowfalls are common during September to April. The mean annual temperature ranges from 14.5^{o}C to 17^{o}C. The coldest month is January and the warmest one is July (RBMP, 2017).

The Water District of Central Macedonia includes 124 surface water systems (RBMP, 2017): 104 rivers, 6 lakes, 3 transitional systems and 11 coastal systems.

The water for Thermi city is supplying from three groundwater systems. Their characteristics are:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Subsystem of down flow of Anthemountas: (EL1000081 – area:92.03Km^2)
- Subsystem of Thermi – N. Risio: (EL1000083 - area 177.00Km^2)
- Subsystem of Cholomontas - Oreokastro: (EL1000193 - area 1597.41 Km^2)

2.2.2. Climate characteristics and Climate change

2.2.2.1. Temperature

There are showed graphs from the nearest meteorological station (located in Mikra) about average, minimum and maximum monthly and average annual air temperature. Based on that data, the monthly average temperature ranged from 5.4ºC (January) to 26.8ºC (July) at the period 1971-2000. The average minimum temperature ranged from 1.8 (January) to 19.3ºC (July) in 1971-2000. The average maximum temperature ranged from 9.3 (January) to 31.6ºC (July) in 1971-2000. It is shown that the average annual air temperature is with increasing trend from 1971 to 2000.

2.2.2.2. Precipitation

According to monthly precipitation values at the station in Mikra is show that the driest months are from July to August and the most wet months are November and December. Mean precipitation values ranged from 22.3mm (July) to 60.2mm (November) in 1971-2000. Analyzed meteorological data showed that mean precipitation values are decreasing with slight trend from 1971 to 2000.

2.2.2.3. Existing hydrological monitoring

It was established a national monitoring network in 2011. Its purpose is the monitoring of ecological and chemical status of the surface water bodies. There are 37 stations for monitoring of surface bodies in the water district of Central Macedonia, 26 of them for surveillance and 11 for operational monitoring (RBMP, 2017).

There is presented information about 5 operational monitoring stations in the groundwater system with their coordinates and monitoring parameters – 3 stations for quantity, nitrates and heavy metals, 1 for quantity and 1 for quantitative, nitrates, pesticides and heavy metals.

2.2.2.4. Climate change

There is presented a study by Bank of Greece, made in 2011. It examined climate change and climatic characteristics based on four emission scenarios. The results showed that at national level, temperature is projected to increase in all regions throughout the year. The temperature increase is expected to be greater in the summer and smaller in winter. The study revealed that under all four scenarios the warming trend increases throughout the 21st century. According the study annual precipitation levels are projected to decline at national level.

There is presented a table with mean annual values of air temperature based on two scenarios (A2 and B2), temperature differences (ΔT) and changes as % (reference period 1961-1990) for three future decades (source: Bank of Greece, 2011):

Periods	A2 T(ºC)	B2 T(ºC)	A2 ΔT	B2 ΔT	A2 (%)	B2 (%)
2071-2080	15.85±1.50	14.89±1.14	4.00±1.05	2.98±0.41	34.1±10.0	25.1±3.4
2081-2090	16.40±1.54	15.11±1.23	4.56±1.07	3.20±0.51	38.8±10.3	26.9±4.0
2091-2100	17.08±1.56	15.31±1.26	5.24±1.02	3.40±0.58	44.6±9.8	28.6±4.7
1961-1990	11.85±1.13	11.91±0.95				

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

There is presented a table with mean annual values of rainfall based on two scenarios (A2 and B2), rainfall differences (ΔR) and changes as % (reference period 1961-1990) for three future decades (source: Bank of Greece, 2011):

Periods	A2 R(mm)	B2 R(mm)	A2 ΔR	B2 ΔR	A2 (%)	B2 (%)
2071-2080	475.3±130.8	531.6±124.5	-57.3±51.2	-30.7±67.8	-11.4±10.2	-5.4±12.4
2081-2090	422.9±103.0	521.4±110.3	-109.6±39.7	-39.9±50.7	-20.9±7.2	-7.1±9.8
2091-2100	444.0±116.5	555.8±144.8	-88.5±53.5	-5.5±72.6	-17.1±10.1	-1.5±13.0
1961-1990	532.6±108.7	561.3±101.3				

It is projected that up to 20 additional very warm days are expected per year in 2021-2050 and up to 40 in 2071-2100 compared with the reference period.

2.2.3. Water Availability – Climate Change Impacts on Water Resources

2.2.3.1. Water demand

Central Macedonia water district covers the whole regional units of Thessaloniki and Chalkidiki, the major part of the regional unit of Kilkis, and a significant part of the regional units of Imathia and Pella, while also Agio Orios is included in the water district. The total population of the WD is 1,420,321 inhabitants (2011 census).

According the RBMP of Central Macedonia the annual water demand for agriculture is the dominant water user with almost (81%) while domestic water use is 15%. The average annual water supply in the WD is 5.3 $*10^9$ m^3, of which 32% are from own sources and 68% come from the water inflow from Axios river.

Water availability and average annual abstraction of the three groundwater systems (used for supplying water for Thermi) in Chalkidiki River Basin are presented as follows:

Groundwater subsystem	Water availability (10^6 m^3)	Average annual abstraction (10^6 m^3)	Agriculture (10^6 m^3)	Domestic (10^6 m^3)	Industry (10^6 m^3)	Quantitative status
Down flow of Anthemountas	33.6*	37.02*	25.32*	9.71*	1.77*	Bad
Thermi – N. Risio						Good
Cholomontas - Oreokastro	99.0**	81.64	64.60	9.51	0.35	Good

* It includes also the water supply and use of the subsystem of Galarino-Galatista (EL1000082)
** Includes also the water supply and use of the subsystems of Skouries (EL1000191) and Olympiada (EL1000192).
It is evident that the subsystem of down flow of Anthemountas and Thermi – N. Risio is overexploited since 37.02 hm^3 are abstracted while only 33.6 hm^3 is the annual water availability.

The Municipal Water Supply and Sewerage Company of Thermi supplies water to several settlements: Thermi, Mikra, N. Redestos, Tagarades, N. Risio, Vasilika, Souroti, Agia Paraskevi, Agios Antonios, Lakkia, Peristera and Livadi. 97.8% (7,187,700 m^3/y) of total water quantity comes from the subsystems of Anthemountas down flow and Thermi – N. Risio. The first subsystem is assessed in bad quantitative and chemical status, while the second is assessed in good quantitative and chemical status. Only 2.1% (158,500 m^3/y) of water volume comes from the Cholomontas - Oreokastro subsystem which is found to be in good chemical and quantitative status.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.2.3.2. Climate change impacts on Water Resources Availability

It is predicted that the climate change (higher temperature and less rainfalls) will affect water resources at the territory.

2.2.3.3. Water Resources Availability

The water resources availability is analyzed using Water Exploitation index (WEI). It is giving the rate of Water Demand (WD) to the renewable Water Resources (WR). The study was focused on the groundwater systems used by WS company and the estimations considered both WEI for total water demand and for drinking water demand. There were made a study with 5 different scenarios for the water demand – present WD, present WD increased by 25%, decreased by 25%, present renewable WR increased by 25% and respectively decreased by 25%.

The authority explained that for analyzing WEI variations were developed numerous scenarios by changing WD and water supply by 5% for three of ground systems.

There were estimated six WEI indexes for the demands acc. the study:

Option, WEI	EL1000081 & EL1000083		EL1000193	
	Total use	Drinking water	Total use	Drinking water
WEI1= WD0/WR present	1.102	0.289	0.825	0.096
WEI2= WD0/WR future1	0.881	0.231	0.660	0.077
WEI3= WD1/WR future1	1.102	0.289	0.825	0.096
WEI4= WD2/WR future1	0.661	0.173	0.495	0.058
WEI5= WD1/WR future2	1.836	0.482	1.374	0.160
WEI6= WD2/WR future2	1.102	0.289	0.825	0.096

Compared with WEI thresholds calculated WEI values for the subsystems of Anthemountas down flow and Thermi – N. Risio (EL1000081 & EL1000083) showed that they are not sustainable at their present state and all of the scenarios are unfavorable more or less. Regarding drinking water demand the risk is low, regardless of the increase or decrease of water demand and renewable water resources.

Compared with WEI thresholds calculated WEI values for the subsystem Cholomontas - Oreokastro (EL1000193) showed that there is a strong risk at its present state and all of the scenarios are unfavorable more or less. Regarding drinking water demand, there is a low risk regardless of the increase or decrease of water demand and renewable water resources.

2.2.4. Water Quality and Land Uses

2.2.4.1. Water Resources Quality Characteristics

It is given summarized information about the annual BOD, N and P loads due to different pollution sources in in Chalkidiki RB (source: RBMP, 2017):

Sources	Annual BOD (tons/year)	Annual N (tons/year)	Annual P (tons per year)
Point sources			
Wastewater treatment plants	802.4	501.5	102.5
Industrial units	2,398.4	1,006.54	93.57
Livestock farming units	60.1	33.4	1.5
TOTAL	**3,260.9**	**1,541.44**	**197.57**
Diffuse pollution sources			
Agricultural activities		796.4	551.2

Sources	Annual BOD (tons/year)	Annual N (tons/year)	Annual P (tons per year)
Urban wastewater not discharged to WWTP	873.49	249.58	51.99
Livestock farming	1021.29	450.38	54.53
Urban / roads		98.31	13.12
Agricultural activities		796.4	551.2
TOTAL	**1,894.78**	**1,594.67**	**670.84**
Point + diffuse pollution	**5,155.68**	**3,136.11**	**868.41**

It is given summarized information about water resources quality assessment of the three groundwater systems used from WS company (source: RBMP, 2017)

Groundwater system	Chemical status	Increased values due to physical background	Increased values due to human pressures	Main pressures	Salt water intrusion
Down flow of Anthemountas	Bad	Fe, Mn, B, Cr, As, Cl, E.C.	NO_3, Cl	Agriculture, livestock farming, urban wastewater, salt water intrusion, over-abstraction	Yes
Thermi – N. Risio	Good	Fe, Mn, B, As, Cl, Na, H_2S	-	-	No
Cholomontas - Oreokastro	Good	-	-	-	No

2.2.4.2. Land use

It is given information about all different land uses identified in the WD of Central Macedonia:

Land Uses	%
Agriculture	56.74
Forest	37.89
Artificial surface	3.31
Transport networks	0.12
Water & wetlands	2.12
TOTAL	

2.2.5. Summary Table – SWOT Analysis

S	W
▪ measures included in the RBMP include the reduction of water losses in water utilities; ▪ the elaboration of Master Plans; ▪ low pollution loads.	▪ overexploitation of groundwater bodies; ▪ bad qualitative status in water bodies; ▪ excessive agricultural activity; ▪ high water demand mainly for irrigation purposes; water abstraction from surface water bodies; temperature increase; ▪ precipitation decrease; ▪ high population increase in Thermi.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

O	T
▪ new technologies for irrigation; ▪ financial instruments for the construction of new works (irrigation distribution networks).	▪ temperature increase; ▪ precipitation decrease; ▪ high water demand; ▪ low efficiency irrigation practices; ▪ hydro-morphological alterations of surface water bodies.

2.2.6. Conclusions

Municipal Water Supply and Sewerage Company of Thermi (PB2) has prepared detailed report. It is provided information about expected climate change based on study. The data about water demand and present availability is complete.

Strengths, weaknesses, opportunities and threats are named.

2.3. PB3 – University of Thessaly – Special Account Funds for Research – Department of Civil Engineering, Greece

2.3.1. General presentation

The University of Thessaly (PB3) focused its report on the impacts of climate change on the cross-border water resources.

There is information about all shared transnational water resources between Greece and Bulgaria:

- the River Basin (RB) of Evros is a transnational RB, shared among Greece, Bulgaria and Turkey. The river's total length is 528Km of which 310 Km belong to Bulgaria while 208 Km are the natural borders of Greece with Bulgaria and Turkey.
- the RB of Nestos shared between Greece (EL12) and Bulgaria (BG4);
- the RB of Strimonas shared between Greece (EL11) and Bulgaria (BG4).

For the transnational cooperation for the cross-border water resources shared between Greece and Bulgaria, there are in place the following cross-border agreements: (a) the agreement Greece – Bulgaria of 1963 for the cooperation in using the water from the rivers flowing the two countries; and (b) the agreement of Greece – Bulgaria for the water from Nestos (1995), foreseeing that Greece obtains annually the 29% of the river's runoff, as it is measured at the borders of the two counties.

2.3.2. Climate characteristics and Climate change

The PB provided detailed information about climate and weather specifics in Greece and relevant territory.

2.3.2.1. Temperature

Acc. the Hellenic National Meteorological Service:

- The coldest months are January and February with mean minimum temperature ranging between 5 -10^{o} C near the coasts and 0 – 5^{o}C over mainland areas, with lower values (generally below freezing) over the northern part of the country;
- The warmest period is the last ten-day period of July and the first one of August, when the mean maximum temperature lies in the range of 29.0 and 35.0^{o}C. In July and August, the daily maximum air temperature ranges between 32^{o}C and 36^{o}C;
- Mean temperature during summer (April to September) is approximately 24°C in Athens and southern Greece, while lower in the north. Temperatures are higher in the southern part of the country.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.3.2.2. Precipitation

Mean annual precipitation for Greece is estimated at 800 mm, for the different parts of the country it varies in ranges from 1,600mm (Peloponnese mountains) to 2,200mm (Pindos mountain), 1,000-1,400 mm in the Ionian Islands and 1,000-1,200 mm on the western coast of Epirus.

2.3.2.3. Climate change

The PB presented detailed study of Bank of Greece. It analyses the climate change and its parameters. In addition, several scenarios were considered based on present data, future changes and estimations for different future periods. The conclusions showed that the annual temperatures would be with increasing trend and precipitation with negative trend (up to 20%). Except of the that, climate change impacts will also include extreme events such as maximum summer and minimum winter temperatures, warm days and warm nights, days with precipitation, frost days, energy demand for heating and cooling, forest fires and days with increased thermal discomfort. Based on the climate scenarios the future variation of flood and landslide risk regimes presents an increasing trend.

2.3.3. Water Availability – Climate Change Impacts on Water Resources

2.3.3.1. Water demand

There is detailed information about all districts in Greece including data for water demand in four different categories – agriculture, industry, domestic and livestock. It is showed that the biggest water consumer is agriculture (81.5%), followed by domestic water use (15.25%), industry (2.42%) and livestock farming (0.8%).

2.3.3.2. Climate change impacts on Water Resources Availability

The PB presented summary of study about climate change expectations for the possible impacts on water resources. They are:

- Decreased rainfall will decrease aquifer infiltration and recharge;
- Increased temperature will impact on water resources evapotranspiration increase and increased water demand;
- Salinization phenomena will intensify at coastal aquifers;
- Pollutant load concentrations in coastal water bodies and the sea will increase;
- Faster degradation of deltaic regions, in cases where degradation has already begun as a result of transversal dam construction upstream;
- Water deficits will intensify desertification phenomena;
- Droughts determined by social factors such as population changes, population shifts, demographic characteristics, technology, government policies, environmental awareness, water use trends, social behavior, level of water development and/or exploitation, and water availability.

2.3.3.3. Water Resources Availability

It is done an estimation of groundwater supply and water abstracted for all WDs in Greece. The results are showing that stressed groundwater bodies exist in Central Macedonia (EL10) where 80% of the available water from groundwater bodies is abstracted, and in Thessaly (EL08) with 49% abstraction.

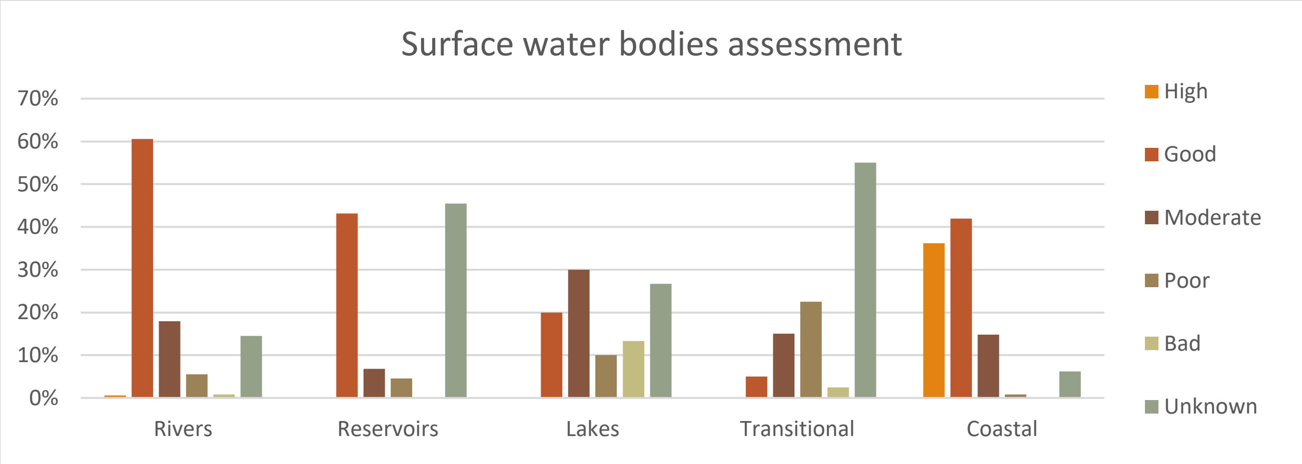
The ground water resources availability is analyzed using Water Exploitation index (WEI). It is giving the rate of Water Demand (WD) to the renewable Water Resources (WR). The study was focused on the groundwater systems used by WS company and the estimations considered both WEI for total water demand and for drinking water demand. There were made a study with 5 different scenarios for the water demand – present WD, present WD increased by 25%, decreased by 25%, present renewable WR increased by 25% and respectively decreased by 25%.

The results show that groundwater bodies are assessed at low risk regarding their availability. Exceptions include the groundwater bodies of Central Macedonia (EL10) being at strong risk at their present condition and are not sustainable when water demand increases, or available water resources decrease. Thessaly groundwater bodies are at possible difficulties when water demand increases, and available water resources remain the same or when water demand remains, and available water resources decrease. When water demand increases, and available water resources decrease, then groundwater bodies are at strong risk. Possible difficulties exist for the groundwater bodies of Western Macedonia when water demand increases, and available water resources decrease.

2.3.4. Water Quality and Land Uses

2.3.4.1. Water Resources Quality Characteristic

All water bodies are assessed for their qualitative status in the RBMPs. In particular, surface water bodies are assessed for their ecological and chemical status while groundwater bodies are assessed for their quantitative and chemical status. The results are presented at the following graph:



It is showed that transitional water bodies have unknown qualitative status (55%) while 22.5% of them are found to be in poor status. That is a field for additional work of the parties, water bodies pollution prevention and constant monitoring.

The assessment criteria for groundwater bodies are defined in the guidance documents provided by the European Commission. Based on the results from the RBMPs, groundwater bodies in Greece are found to be in good chemical status (84.75%) and good quantitative status (84.04%).

2.3.4.2. Land use

The dominant land use in the country is forests (27.68%) followed by semi-natural vegetation (26.22%) and arable land (23.12%). The biggest differences between 2000 and 2006 in land uses are met in open spaces (increased by 30%) and semi-natural vegetation (decreased by 22%). Forests are decreased by 15%, artificial areas are increased by 15% and pastures is reduced by 9% between 2006 and 2012.

2.3.5. Summary Table – SWOT Analysis

S	W
▪ good qualitative status of water bodies; ▪ good quantitative status of groundwater bodies; ▪ institutional framework in place; ▪ RBMPs.	▪ decreased precipitation; ▪ increased temperature; ▪ high water demand for irrigation; ▪ salinization phenomena; ▪ artificial land uses increase.
O	**T**
▪ implementation of WFD; ▪ adaptation measures for climate change.	▪ climate change.

2.3.6. Conclusions

The University of Thessaly (PB3) has prepared completed report answering all topics. The PB and the people working there could be really helpful to other authorities (as municipalities, water supply companies, agricultural organizations, etc.) with their knowledge in order new opportunities for more efficient water use to be found and implemented.
Strengths, weaknesses, opportunities and threats are named.

2.4. PB4 – Municipality of Kardzhali, Bulgaria

2.4.1. General presentation

The municipality of Kardzhali gave basic information about water resources at the territory:

Rivers:
- Arda river – 241 km length and 5201 km^2 catchment area;

Water dams:
- Kardjali dam – 532,9 10^6 m3 total volume;
- Studen cladenets dam – 489,10 10^6 m3 total volume.

2.4.2. Climate characteristics and Climate change

2.4.2.1. Temperature

The municipality presented a study about weather change. It compares the present weather conditions to future periods. Presented results are showing that in 2030 it is expected average annual temperatures increase of 1.6°C. From June to September can be expected the highest increase - from 1.5 to 2.2°C.

2.4.2.2. Precipitation

The study includes analysis about precipitation change as it is compared again the present level with predicted future level. The results are showing that the average annual precipitation in the territory a is assumed to be 613 mm, against 573 mm in 2030, equivalent to a decrease of 6.6 %.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.4.2.3. Climate change

The municipality of Kardzhali expressed an opinion based on different sources that the climate change is fact and the trends are for warming and intensification of the hydrological cycles, which means dryer dry seasons and wetter rainy seasons, more extreme events - frequent floods and drought.

2.4.3. Water Availability – Climate Change Impacts on Water Resources

The PB did not provide information about present and future water demand and water availability.

2.4.4. Water Quality and Land Uses

2.4.4.1. Water Resources Quality Characteristics

There are 7 points of operational monitoring (microbiological, physical and chemical monitoring) controlled by the government authority in the territory of Kardzhali. The points are:

- Arda River upstream of Kardzhali Dam;
- Arda River downstream of the town of Kardzhali;
- Arda River downstream of Studen Kladenets Dam;
- Varbitsa River upstream of Studen Kladenets Dam;
- Byala River before the border;
- Studen Kladenets Dam – middle part;
- Studen Kladenets Dam.

The main pollution of the water bodies at the territory is due to discharge of wastewater (both treated and row):

River Basin	Source of pollution	Quantity (million m^3/year)	Pollution load (kg BOD/year)	Treatment
Arda River	The town of Kardzhali – urban collector	3.53	1,641,613	Treated - Kardzhali UWWTP
	Industry	1.11	No data	Kardzhali Lead and Zinc Works, Gorubso, Bentonit, etc. LWWTP
Varbitsa River	The town of Momchilgrad	0.528	247,005	Treated - Momchilgrad WWTP
	The village of Benkovski	0.114	43,817	not treated, no WWTP
Ardinska River	The town of Ardino	0.246	109,390	not treated, no WWTP
Krumovitsa River	The town of Krumovgrad	0.377	160,577	not treated, no WWTP
Dzhebelska River	The town of Dzhebel	0.180	94,831	not treated, no WWTP
Ground water	Domestic solid waste landfill	No data	No data	No studies about the quality and quantity of infiltrated water. The existing landfills are subject to closure
	Agriculture	No data	No data	No data

2.4.4.2. Land use

No exact data.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.4.5. Summary Table – SWOT Analysis

S	W
Kardzhali region water demand is covered from different types of water sources – four rivers, two dam, and many underground sources. This ensures that, following the scenarios for climate change in the future, there is no option for lack of water.	Due to climate change scenario for dry year with low quantity of precipitations all the surface water sources capacity in the region could decrease seriously. This would lead Kardzhali city to use a nearly located underground source for covering its water consumption needs. The water quality itself is highly related to the use of pesticides and nitrates, as the surrounding land is agricultural.
O	**T**

2.4.6. Conclusions

For more efficient exploitation of water resources at the territory it would be helpful if it will be made a study about all water resources present condition (surface and ground), their qualitative and quantitative characteristics. In addition, a statistic about different water users (by types) with data about their water demand and pollution is needed.

Strengths and weaknesses are named. The PB could make an analysis in order to define new opportunities, to find new technologies and to set measures for sustainable water resources use according climate change trends.

2.5. PB5 – Municipality of Gotse Delchev, Bulgaria

2.5.1. General presentation

The municipality provided information about the available water sources at the territory:

Rivers:
- Struma river – 290 km length and 10 797 m^2 catchment area;
- Mesta river – 126 km length and 2767 m^2 catchment area;

Water dams:
- Bersin dam – 4,600 million m^3 total volume;
- Bagrentsi dam – 2,2 million m^3 total volume;
- Stoykovtsi dam – 13,22 million m^3 total volume;
- Kara-gyol dam – 2,252 million m^3 total volume.

2.5.2. Climate characteristics and Climate change

There is presented a climate model with two scenarios for future precipitation change:

Period/ year	Anual precipitation, mm	Summer precipitation, mm
1961-1990	707	163
2038 (realistic scenario)	668	139
2038 (pessimistic scenario)	620	102

2.5.3. Water Availability – Climate Change Impacts on Water Resources

The municipality provided detailed information about all water supply systems at Blagoevgrad region. About the PB territory the details are:

Water Supply System_	Water supply resource	Source type	Alternative	Future precipitation difference (%)	Present capacity [l/s]	Future capacity [l/s]
WSS_Gotse Delchev	Barakata	GW_3	1	-13	3,17	3,00516
WSS_Gotse Delchev	Chuchura	GW_1	1	4	0,8	0,8
WSS_Gotse Delchev	Papaz chair	GW_3	1	-21	4,44	4,12032
WSS_Gotse Delchev	Papaz chair	GW_3	1	-18	4,44	4,12032
WSS_Gotse Delchev	Papaz chair	GW_3	1	-24	4,44	4,12032
WSS_Gotse Delchev	PS Dubnitsa	GW_1	1	6	1,05	1,05
WSS_Gotse Delchev	Sofiyata	GW_3	1	-13	3,18	3,01464
WSS_Gotse Delchev	Tufcha	SW_2	1	-12	53,6	49,7408
WSS_Gotse Delchev	Barakata	GW_3	2	-13	3,17	3,00516
WSS_Gotse Delchev	Chuchura	GW_1	2	4	0,8	0,8
WSS_Gotse Delchev	Papaz chair	GW_3	2	-21	4,44	4,12032
WSS_Gotse Delchev	Papaz chair	GW_3	2	-18	4,44	4,12032
WSS_Gotse Delchev	Papaz chair	GW_3	2	-24	4,44	4,12032
WSS_Gotse Delchev	PS Dubnitsa	GW_1	2	6	1,05	1,05
WSS_Gotse Delchev	Sofiyata	GW_3	2	-13	3,18	3,01464
WSS_Gotse Delchev	Tufcha	SW_2	2	-12	53,6	49,7408
WSS_Gotse Delchev	WSS_Gotse Delchev_IP	GW_1	2	-12	143,9	143,9

It is calculated water exploitation index (WEI) for total water demand and for drinking water demand for following scenarios:

WEI1=WD0/WR present		WEI2=WD0/WR future		WEI3=WD1/WR future		WEI4=WD2/WR future	
Total use	Drinking water	Total use	Drinking water	Total use	Drinking water	Total use	Drinking water
0,28	0,22	0,29	0,23	0,36	0,23	0,22	0,15

Compared with WEI thresholds calculated WEI values for the territory showed that there is low risk at its present state and future options.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.5.4. Water Quality and Land Uses

2.5.4.1. Water Resources Quality Characteristics

In this item, the PB exposed information about two rivers water quality monitoring and ground systems quality characteristics.

Struma river – there are two monitoring points. The most often analyzed parameter is oxygen content. The other parameter and their characteristics lead to organic pollution.

Mesta river - there are four monitoring points. The main observed parameters are oxygen content and dissolved oxygen.

In assessing for quality of the groundwater bodies in the territory, according to monitoring program data, there is no groundwater body in poor condition. A Water Quality Report from 2010 listed 210 underground water sources in Blagoevgrad. All of them have good water quality - fresh, medium hardness, calcium, hydrogen carbonate, which comply with Bulgarian legislation for water quality used for domestic and drinking water demand and for the exploration, use and protection of groundwater.

2.5.4.2. Land use

As main land use is identified the agriculture - 13,2% of the total area, including 74,1% fields, 11,4% natural meadows, 1,6% artificial meadows and 12,9% fruit plantations, etc.

2.5.5. Summary Table – SWOT Analysis

S	W
Blagoevgrad region water demand is covered from different types of water sources – two rivers, four dams, many underground sources. This ensures that, following the scenarios for climate change in the future, there is no option for lack of water.	Due to climate change scenario for dry year with low quantity of precipitations all the surface water sources capacity in the region could decrease seriously. This would lead Blagoevgrad city to use a nearly located underground source for covering its water consumption needs. The water quality itself is highly related to the use of pesticides and nitrates as the surrounding land is commonly used for agriculture.
O	**T**

2.5.6. Conclusions

For more efficient exploitation of water resources at the territory it would be helpful if it will be made a study about all water resources present condition (surface and ground), their qualitative and quantitative characteristics. In addition, a statistic about different water users (by types) with data about their water demand and pollution is needed.

Strengths and weaknesses are named. The PB could make an analysis in order to define new opportunities, to find new technologies and to set measures for sustainable water resources use according climate change trends.

2.6. PB6 – Municipal Water Supply and Sewerage Company of Thermaikos, Greece

2.6.1. General presentation

The Municipal Water Supply and Sewerage Company of Thermaikos is located in the River Basin of Central Macedonia (EL10). To the east, it borders with the River Basin of Eastern Macedonia (EL11) and to the west with the River Basin of Western Macedonia (EL09).

There is presented information about all water bodies at the territory:

Type of WB	Number	Characteristic size	Minimum Area (km^2)	Average Area (km^2)	Maximum Area (km^2)	Total Area (km^2)
Rivers	104	Length (km)	0.9	10.7	41.9	1,108.6
Lakes	6	Surface (km^2)	1.1	27.7	72.1	141.7
Transitional waters	3	Surface (km^2)	0.6	23.5	67.6	70.7
Coastal waters	11	Surface (km^2)	0.06	350	1,328.5	10,307.4
GWBs	34	ground water	1.40	280.08	1,598.56	10,082.79

2.6.2. Climate characteristics and Climate change

2.6.2.1. Climate

The River Basin is characterized by a variety of climates, including Mediterranean in the area of Halkidiki and the coastal areas, continental in the inland and mountainous in the areas of high altitude. The average annual rainfall varies from 400 to 800 mm, while in the mountains parts it exceeds the 1000 mm. Snowfall is quite common between September and April. The average annual temperature varies between 14.5 ° C and 17 ° C, with coldest month in January and warmer in July. So, the present climate characteristics are described, only the climate change trends are not.

2.6.2.2. Existing hydrological monitoring

Regarding the hydrological data for the district, the average annual total water supply is 5.3 x 10^9 m^3, of which 32% (1.7x109 m3) comes from the same resources of the District, while the remaining 68% (3.6x10^9 m^3) comes from the water inflow of Axios River. 356x10^6 m^3 is transported by Aliakmonas River from the neighboring district, via the Aliakmonas-Axios Canal, for the irrigation needs of the Thessaloniki-Lagadas plain and the water supply needs of Thessaloniki.

According to established monitoring programme in the district both the quantitative and qualitative characteristics of the water bodies are under regular monitoring:

- River Bodies - 27 monitoring stations of which 5 operational and 22 monitoring.
- Lake Bodies - 5 monitoring stations, including 4 operational and 1 monitoring.
- Transient Bodies - 1 operational monitoring station in the Axios Delta, in Axios Basin.
- Coastal Bodies - 3 monitoring and 2 operational stations are located in Chalkidiki Basin and Athos Basin.
- Regarding the Groundwater Bodies:
  - Axios Basin - 3 monitoring stations and 41 operational stations;
  - Galikos Basin - 8 operational stations;
  - Chalkidiki Basin - 1 monitoring stations and 57 operational stations are located;
  - Athos Basin - 1 monitoring station.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.6.3. Water Availability – Climate Change Impacts on Water Resources

The PB presented information about the total water demand for years 2015, 2016 and 2017. There is a trend of decrease in water consumption (based only on this data the reason for decreasing cannot be evaluated).

There is a graph for WEI index change for the period from 1965 to 2010. The WEI index levels during the years show that the water systems at the territory work at low risk.

2.6.4. Water Quality and Land Uses

2.7.4.1. Water Resources Quality Characteristics

It is presented information about the different water resources but it is only in Greek and cannot be assessed.

2.7.4.2. Land use

The main land use is for agriculture - 56.74% of the total land area. Constant irrigation is taking place in 9.72% of the total and 17.5% of all agricultural land. Forest areas covers almost 37.89% of the total area. 4.26% of the total area is covered by natural pastures and grasslands and sparse vegetation forests. The artificial surfaces (Residential Areas - Industrial and Commercial Zones – Networks Transport, etc.) covers a small percentage of the territory. The larger areas covered by the settlements are located in the Thessaloniki area and to the coastal areas of the Halkidiki Peninsula. 0.12% of the area is for transport networks. The remaining area (2.1%) of the District is occupied by water areas and wetlands, including mainly land-based waters (rivers, lakes, marshes, etc.).

2.6.5. Summary Table – SWOT Analysis

S	W
O	**T**

2.6.6. Conclusions

The SWOT analysis were not completed. It would be helpful for the PB and future exploitation of water district to compare an estimated future condition of water resources (both qualitative and quantitate parameters) with an estimated future demand by type of consumer. Defining opportunities for efficient water management must be a task under climate change expectation.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Chapter 3. Discussion & Conclusions

The climate change already is a fact worldwide. As all participants in the program have exposed at local level expectations are for increase of annual temperatures and decrease of annual precipitation. The weather is going to become hotter, the rains will happen less frequently, but most probably with heavy intensity. The change in intensity, duration and abnormal climate conditions and phenomena could bring about unpredictable floods and droughts at close future.

Measures for water rescue are required – more effective systems, smarter use, constant monitoring, pollution prevention and ecological treatment for environment protection.

Annex I: Beneficiaries' reports

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.1.1 Climate change impacts assessment report** *Questionnaire*
Project Beneficiary No	**LB/PB1**
Beneficiary Institution	**Municipal Water Supply and Sewerage Company of Komotini**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Name of the organization/institution: Municipal Water Supply and Sewerage Company of Komotini
Beneficiary number: LB/PB1

1 Introduction

The region of Thrace is located in the eastern part of Northern Greece (Figure 1). The region covers an area of 8,578 km^2 and its population is 361,208 (according to the 2011 census). Most of the area of Thrace region is part of the Water District of Thrace (EL12) (area 11,243Km^2). The latter consists of five river basins: the river basin of Nestos (area 2,975.5 km^2); the river basin of Xanthi – Xirorema streams (area 1,662.6Km^2); the river basin of Komotini – Loutro Evrou stream (area 1,958.3Km^2); the river basin of Evros (area 4,080.8Km^2); and the river basin of Thasos – Samothraki (area 562,8km^2) (RBMP, 2017). The water district is divided in three areas: the island part and a narrow coastal zone with continental Mediterranean climate; the inner part and the low lands with mid-european climate; and the mountainous area with mountain climate (RBMP, 2017). The water district's altitude ranges from 0 to 2,200m. Based on the Strategic Environmental Impacts Assessment (SEIA 2013) the average annual temperature ranges from 14.5 to 16.5° C, while the annual temperature range exceeds 20°C. The annual precipitation levels range in the coastal and island part between 500 and 600mm, in the inner part between 600 and 1,000mm, while at the northern maintains it exceeds 1000mm (RBMP, 2017). According to the National Programme of Management and Protection of Water Resources (2008), the mean annual precipitation is estimated to 778mm.

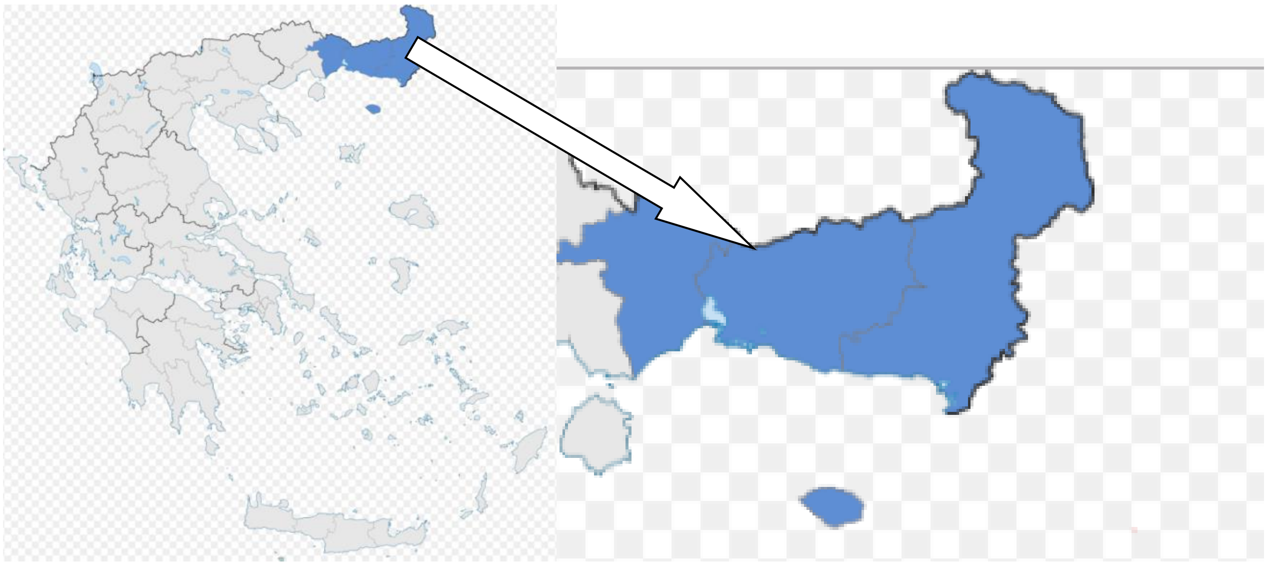


Figure 1. The map of Greece, showing Thrace region (blue colour) (source: Wikipedia https://el.wikipedia.org/wiki/map_of_Thrace_(Greece).svg)

The Water District of Thrace includes 199 surface water systems (RBMP, 2017): 176 rivers, 5 reservoirs, 1 lake, 5 transitional systems and 12 coastal systems. Table 1 shows the surface water systems of each river basin.

Table 1. Surface water systems in each river basin (RBMP, 2017).

Type of system	RB of Nestos	RB of Xanthi-Xirorema streams	RB of Komotini-Loutro Evrou streams	RB of Evros	RB of Thasos - Samothraki	TOTAL
Rivers	50	28	28	63	7	**176**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Reservoirs	2		2	1		**5**
Lakes			1			**1**
Transitional	3	1		1		**5**
Coastal	3	2		4	3	**12**
TOTAL	**58**	**31**	**31**	**69**	**10**	**199**

Eighteen groundwater systems have been identified in the RBMP (2017). The Municipal Water Supply and Sewerage Company of Komotini supplies with water the Municipality of Komotini. The water resources used are Vosvozis river (EL1209R0000010085N) and the groundwater system of Rodopi (EL1200120). Their characteristics are:

- Vosvozis river: (EL1209R0000010085N – length: 7.70Km; river basin area: 74.91Km^2; average annual runoff: 42.52hm^3)
- Rodopi system: (EL1200120 - area 755.58Km^2)

2 Climate characteristics and Climate change

2.1 Temperature

The nearest meteorological station is located in Alexandroupoli (longitude 25.95, latitude: 40.86 and altitude: 5m. Figure 2 shows the mean monthly (MT), the 90th percentile (P90) and the 10th percentile (P10) temperature in Alexandroupoli meteorological station. The average minimum and maximum temperatures are shown in Figures 4 and 5 respectively. All data are gathered from the Hellenic National Meteorological Service.

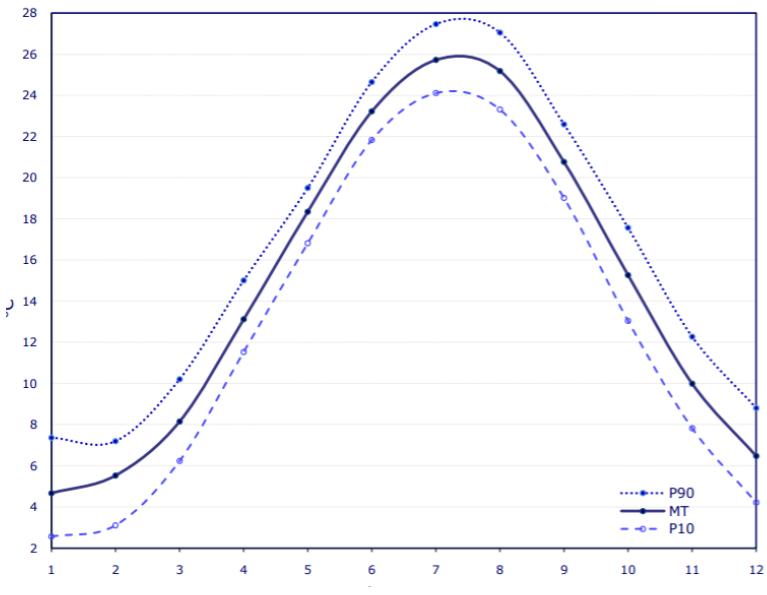


Figure 2. Average monthly air temperature in Alexandroupoli (1971-2000) (Source: http://climatlas.hnms.gr/sdi/)
[MT: mean monthly; P90 90th percentile; P10 10th percentile]

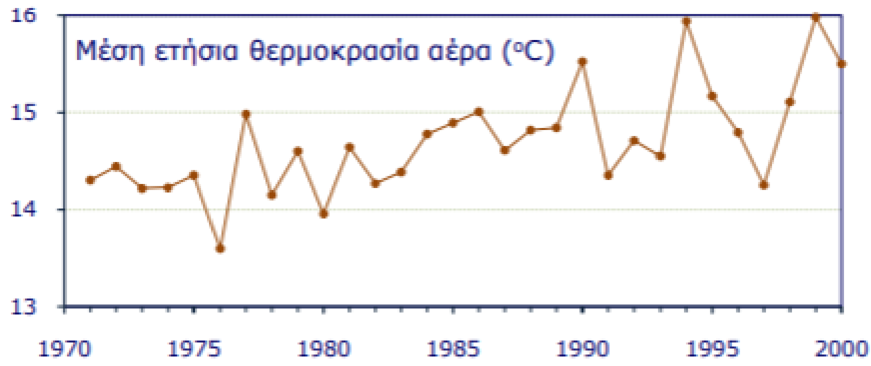
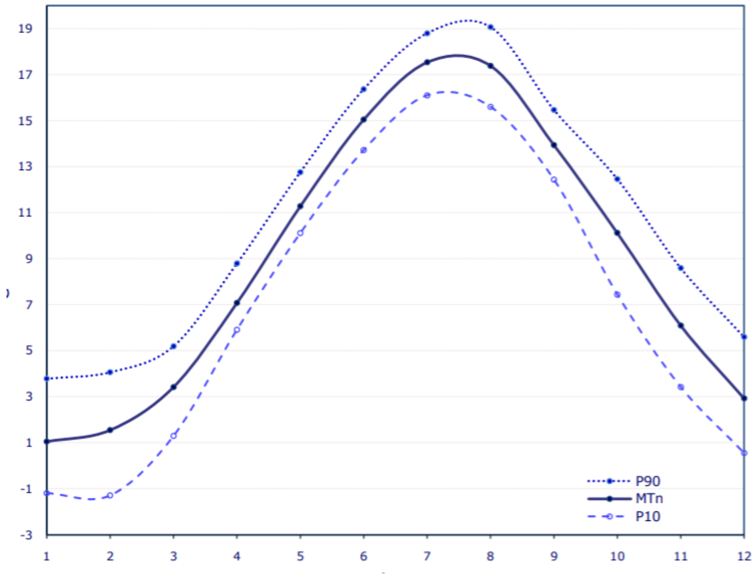


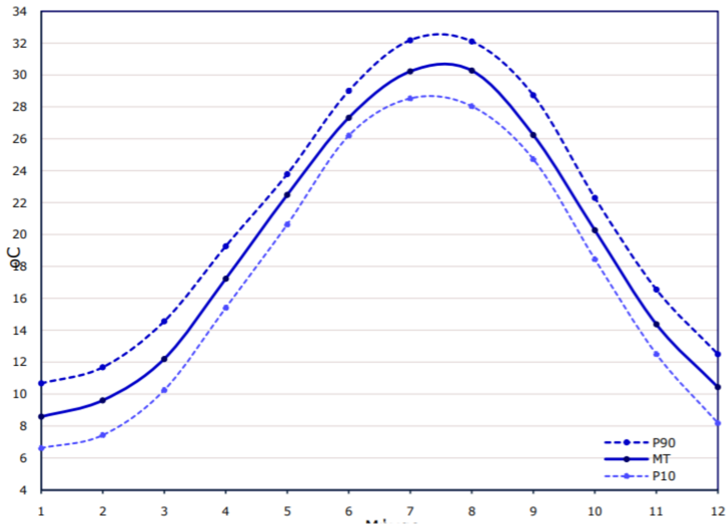
Figure 3. Average annual air temperature from 1971 to 2000 (Source: HMS http://climatlas.hnms.gr/sdi/)



Month

Figure 4. Minimum monthly air temperature in Alexandroupoli (1971-2000) (Source: http://climatlas.hnms.gr/sdi/)

[MTn: average minimum monthly; P90 90th percentile; P10 10th percentile]



Month

Figure 5. Maximum monthly air temperature in Alexandroupoli (1971-2000) (Source: http://climatlas.hnms.gr/sdi/)

[MTx: average maximum monthly; P90 90th percentile; P10 10th percentile]

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

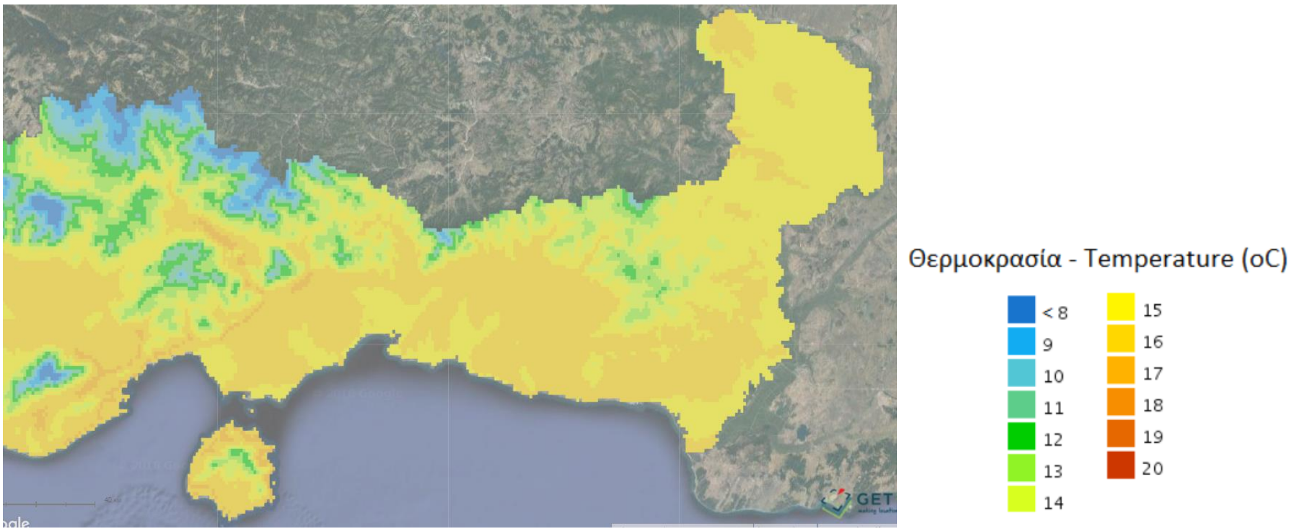


Figure 6. Average air temperature in Thrace (Source: http://climatlas.hnms.gr/sdi/)

Based on the above graphs and data, the monthly average temperature ranged from 4.7°C (January) to 25.7°C (July) at the period 1971-2000. The average minimum temperature ranged from 0.9 (January) to 17.6°C (July) in 1971-2000. The average maximum temperature ranged from 8.6 (January) to 30.3°C (July and August) in 1971-2000. It is evident (Figure 3) that the average annual air temperature shows an increasing trend from 1971 to 2000.

2.2 Precipitation

Monthly precipitation values (Figure 7) at the station in Alexandroupoli show that the driest months are July to September and the most wet months are November and December. Mean precipitation values ranged from 12.4mm (August) to 81.0mm (November) in 1971-2000. The data (Figure 8) show that mean precipitation values show a slight decreasing trend from 1971 to 2000.

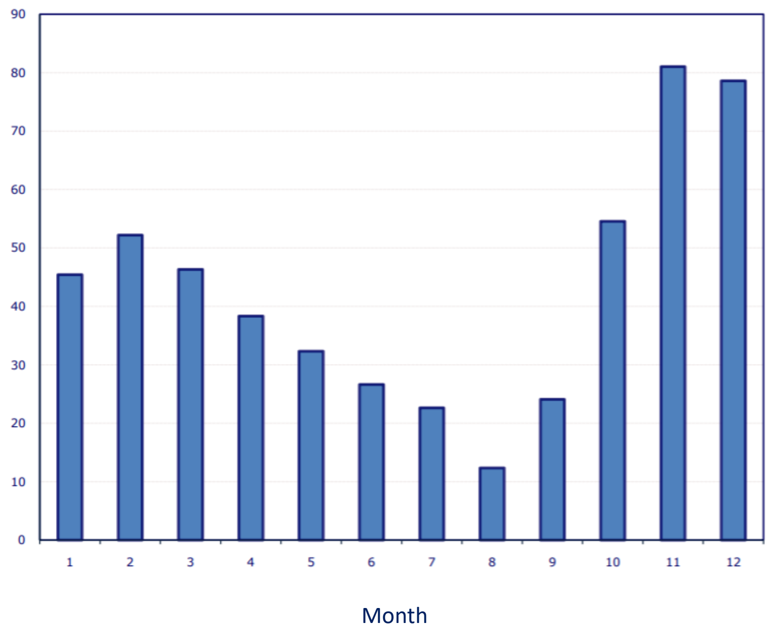


Figure 7. Average monthly precipitation (mm) in Alexandroupoli (1971-2000) (Source: http://climatlas.hnms.gr/sdi/)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

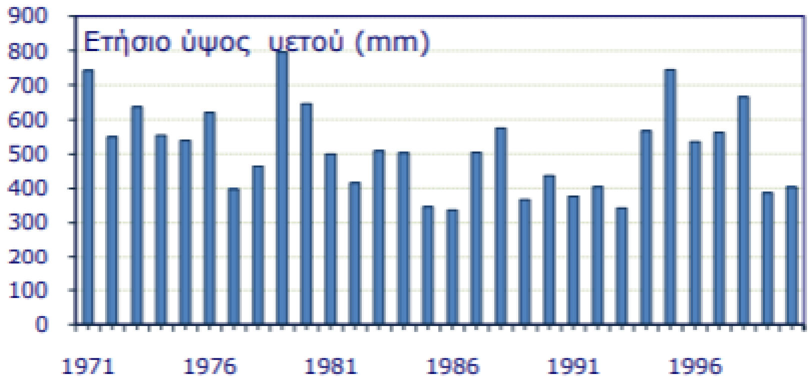


Figure 8. Average annual precipitation (mm) from 1971 to 2000 (Source: http://climatlas.hnms.gr/sdi/)

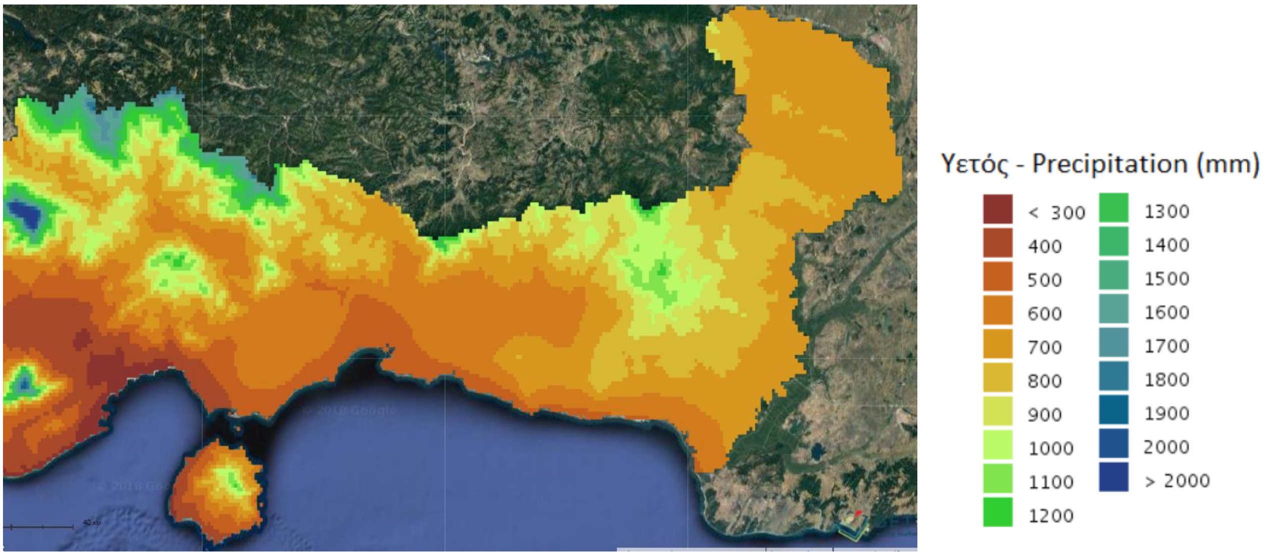


Figure 9. Precipitation (mm) in Thrace (Source: http://climatlas.hnms.gr/sdi/)

2.3 Existing hydrological monitoring

There is a national monitoring network (established with the JMD 140384/9.9.2011), monitoring the ecological and chemical status of the surface water bodies. During the implementation of the national monitoring network, 57 stations operated for the monitoring of surface bodies in the water district of Thrace, 48 of them for surveillance and 9 for operational monitoring (RBMP, 2017). The monitoring programme provides totally 75 monitoring stations in groundwater bodies, 26 of them for surveillance monitoring and 49 for operational one (RBMP, 2017). Table 2 shows the number of the monitoring stations per type of water body.

Table 2. Types and number of monitoring stations in Thrace WD (source: RBMP, 2017)

Type of station	Surveillance	Operational
Rivers	36	4
Lakes	1	4
Coastal	3	1
Transitional	8	
TOTAL	**48**	**9**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2.4 Climate change

Water resources are vulnerable to climate change as the latter affects both their availability and their quality. A study (Bank of Greece, 2011) examined climate change and climatic characteristics based on four emission scenarios: A2, A1B, B2, B1. The results showed that at national level, temperature is projected to increase in all regions throughout the year. The temperature increase is expected to be greater in the summer and smaller in winter. Based on the milder scenario A1B temperature is expected to increase by 1.5°C in the country in 2021-2050. The study (Bank of Greece, 2011) revealed that under all four scenarios (A2, A1B, B2, B1) the warming trend increases throughout the 21st century. During the period 2071-2100, this trend is stronger under Scenarios A2 (0.5°C/decade) and A1B (0.4°C/decade), milder under Scenario B2 (0.25°C/decade) and milder yet under Scenario B1 (0.1°C/decade). Annual precipitation levels are projected to decline at national level. Based on this study the decrease is important under scenarios A2 and A1B. Under scenario A1B precipitation levels countrywide will decrease relative to the reference period by about 5% in 2021-2050.

This study (Bank of Greece, 2011) used A2 and B2 emission scenarios and projected the temperature and precipitation values in Thrace for 2071-2080, 2081-2090 and 2091-2100 compared to 1961-1990. Air temperature values (at 2m above ground) estimated for 2071-2080, 2081-2090 and 2091-2100 are given to table 3. Table 4 shows the mean values of rainfall estimated for 2071-2080, 2081-2090 and 2091-2100 and also the differences in projections and the reference period for scenarios A2 and B2 (Bank of Greece, 2011).

Table 3. Mean annual values of air temperature based on A2 and B2 scenarios, temperature differences (ΔT) and changes as % (reference period 1961-1990) for 2071-2080, 2081-2090, 2091-2100 (source: Bank of Greece, 2011)

Periods	A2 T(°C)	B2 T(°C)	A2 ΔT	B2 ΔT	A2 (%)	B2 (%)
2071-2080	16.29±1.74	15.42±1.15	4.05±1.06	3.05±0.41	33.5±9.8	24.8±4.0
2081-2090	16.84±1.80	15.63±1.29	4.60±1.11	3.27±0.56	38.0±10.3	26.5±4.7
2091-2100	17.52±1.81	15.79±1.26	5.28±1.08	3.42±0.62	43.6±10.1	27.8±5.6
1961-1990	12.24±1.39	12.36±1.06				

Table 4. Mean annual values of rainfall based on A2 and B2 scenarios, rainfall differences (ΔR) and changes as % (reference period 1961-1990) for 2071-2080, 2081-2090, 2091-2100 (source: Bank of Greece, 2011)

Periods	A2 R(mm)	B2 R(mm)	A2 ΔR	B2 ΔR	A2 (%)	B2 (%)
2071-2080	526.8±131.1	625.6±137.2	-81.5±56.6	-38.0±92.3	-13.4±8.6	-5.3±14.4
2081-2090	465.1±102.8	599.9±116.7	-143.2±64.0	-63.7±64.7	-23.3±8.5	-9.3±9.9
2091-2100	487.6±126.1	652.1±159.1	-120.7±57.5	-11.5±93.8	-20.1±8.6	-1.8±14.6
1961-1990	608.3±132.4	663.6±115.4				

Regarding extreme weather phenomena, it is projected that the maximum consecutive 3-day precipitation period during 2021-2050 will remain the same as the reference period in Eastern Macedonia and Thrace. Also, the number of frost days per year is projected to decrease in Macedonia and Thrace by 15 in 2021-2050 and by 40 in 2071-2100 (Bank of Greece, 2011).

3 Water Availability - Climate Change Impacts on Water Resources

3.1 Water Demand

Thrace water district covers six regional units: Drama (47.3 % of its area), Kavala (36.2% of its area), Thasos (100%), Xanthi (100%), Rodopi (100%) and Evros (100%). The total population of the WD is 408,186 inhabitants (2011 census). In the whole WD the total number of available beds (in touristic units) is 17,541 (RBMP, 2017) while only in Rodopi (where Komotini is located) is 1,607.

Based on the RBMP of Thrace annual water demand is (Table 5):

Table 5. Annual water demand per water use in the WD of Thrace and the RB of Komotini - Loutro Evrou treams (source: RBMP, 2017)

Water Demand	**WD of Thrace**		**RB of Lomotini-Loutro Evrou streams**	
	hm^3	**%**	**hm^3**	**%**
Agriculture	941.4	58.8	160.44	85.6
Domestic	60.5	3.8	14.66	7.8
Livestock	3.9	0.2	0.7	0.4
Industry	14.1	0.9	11.55	6.2
Hydroelectrical production	582.0	36.3		
Total	**1,602.0**		**187.35**	

The water volume used for hydroelectrical production can be considered as water use.

The river basin of Komotini-Loutra Evrou streams consists of 28 river surface water systems (Table 1) and 4 groundwater systems. 18 surface water systems are found to be at good ecological status; 4 at moderate ecological status; 2 at poor ecological status; and 4 in unknown ecological status. Only one surface water system is found to be in bad chemical status. One out of 4 groundwater systems are found to be in bad chemical status. All groundwater systems are found to be in good quantitative status. The river Vosvozis supplying DEYAK with water is found to be in poor ecological status and good chemical status (generally poor qualitative status).

DEYA Komotinis is supplying Komotini municipality with water from the river of Vosvozis and the groundwater system of Rodopi. Based on data from the RBMP (2017) water availability, average annual abstraction (total and per water use) is shown in Table 6. The system of Rodopi is used at a rate of 29.1%.

Table 6. Water availability and average annual abstraction of the groundwater system of Rodopi (source: RBMP, 2017)

Groundwater system	**Water availability (10^6 m^3)**	**Average annual abstraction (10^6 m^3)**	**Agriculture (10^6 m^3)**	**Domestic (10^6 m^3)**	**Livestock (10^6 m^3)**	**Quantitative status**
Rodopi	50.4	14.7	12.0	2.5	0.2	Good

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

3.2 Climate change impacts on Water Resources Availability

The temperature increase and the reduction of rainfall projected for the future will definitely affect water resources availability.

The current quantitative status of the groundwater systems supplying DEYAK with water is good, while in Table 6 water demand per water use is shown.

3.3 Water Resources Availability

To assess water resources availability, WEI (Water Exploitation Index) index is used. WEI index is the rate of Water Demand (WD) to the renewable Water Resources (WR). Focusing on the groundwater systems used by DEYAK, the estimation of WEI index took place. We estimated both WEI for total water demand and for drinking water demand. Also, we studied 5 scenarios for water demand:

- Scenario 0: WD0 is the present water demand;
- Scenario 1: WD1 is the present water demand increased by 25%;
- Scenario 2: WD2 is the present water demand decreased by 25%;
- Scenario 3: WR future1 is the present renewable WR increased by 25%
- Scenario 4: WR future2 is the present renewable WR decreased by 25%

To assess WEI fluctuations, we developed 121 scenarios for each of the three groundwater systems and for each total demand and drinking water demand. These scenarios were developed by changing water demand and water supply by 5%.

We also estimated six WEI indexes for each demand: total WD and drinking WD.

- WEI1= WD0/WR present
- WEI2= WD0/WR future1
- WEI3= WD1/WR future1
- WEI4= WD2/WR future1
- WEI5= WD1/WR future2
- WEI6= WD2/WR future2

The results are presented in Table 7 (for scenarios 0, 1, 2, 3 and 4) and Figures 10 & 11 for all scenarios.

Table 7. WEI values (1;2;3;4;5;6) for the groundwater system of Rodopi

	EL1200120	
	Total use	**Drinking water**
WEI1	0.292	0.050
WEI2	0.233	0.040
WEI3	0.292	0.050
WEI4	0.175	0.030
WEI5	0.486	0.083
WEI6	0.292	0.050

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

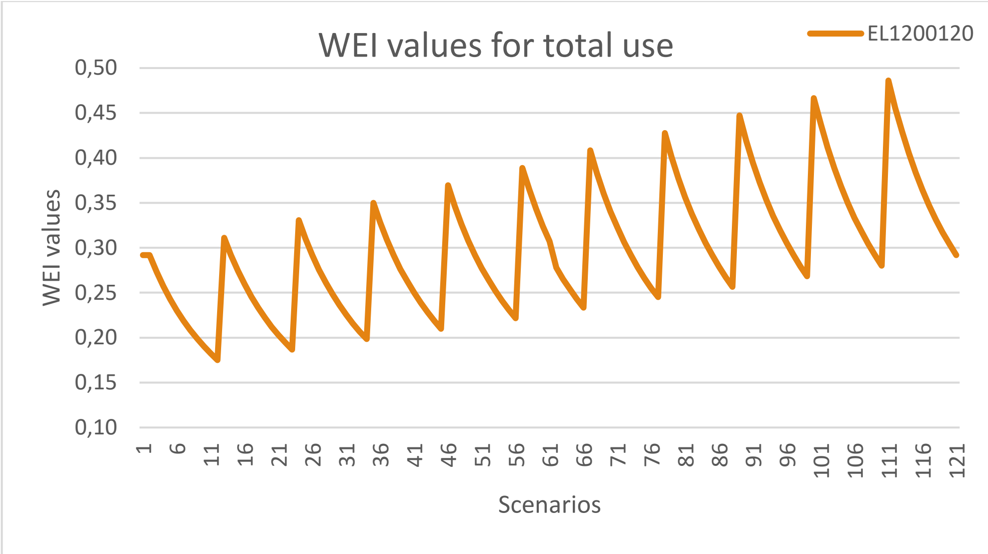


Figure 10. WEI values for all scenarios for total water use

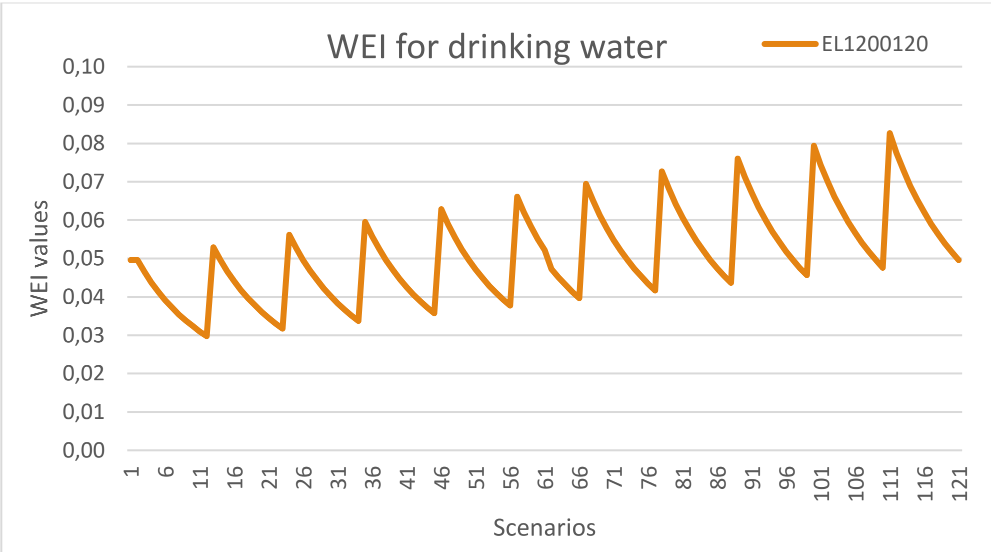


Figure 11. WEI values for all scenarios for drinking water use

The WEI Index values calculated for the aquifer are assessed based on the thresholds adopted in CCWaters project (Table 8). Up to 0.49 the system faces a low risk regarding its water availability. For values ranging from 0.5 to 0.69 there are possible difficulties, while for values ranging from 0.7 to 0.99 there is a strong risk. Systems with WEI values greater than 1, are not sustainable.

Table 8. WEI thresholds

WEI from - to		Comment
0	0.49	low risk
0.5	0.69	possible difficulties
0.7	0.99	strong risk
1		not sustainable

The results show that the groundwater system of Rodopi is at low risk at its current state. Even when water demand increases and water availability decrease, the system is still at low risk (WEI values below 0.49). The same stands when drinking water use is examined (Table 7; Figures 10 & 11).

4 Water Quality & Land Uses

4.1 Water Resources Quality Characteristics

Based on the RBMP (2017) there are point pollution sources and diffuse pollution sources met in the River Basin of Komotini – Loutro Evrou streams. Point pollution sources examined are industrial units, wastewater treatment plants, sewerage networks discharging to physical receivers, large hotels, livestocks and aquaculture and fishfarming. The annual loads of BOD, Nitrogen (N) and Phosphorus (P) due to these point pollution sources are presented in Table 9. The most polluting activity is sewerage networks discharging to physical receivers and wastewater treatment plants followed by industries for BOD and nitrogen, while for phosphorus industries contribute the most.

Table 9. Annual BOD, N and P loads due to point pollution sources in RB Komotinis - Loutrou Evrou streams (source: RBMP, 2017)

Point sources	**Annual BOD (tons/year)**	**Annual N (tons/year)**	**Annual P (tons per year)**
Industrial units	27.9	26.1	25.9
Leakages from uncontrolled disposal points of and Landfills	0.0	0.0	0.0
Wastewater treatment plants	70.1	43.0	2.8
Sewerage networks discharge to physical receivers	72.4	14.5	3.0
Large hotels	0.0	0.0	0.0
Aquaculture – fishfarming	0.0	0.0	0.0
Large Livestock farming units	3.1	1.8	0.4
TOTAL	**173.6**	**85.3**	**32.1**

Diffuse pollution sources include urban, agricultural, livestocks and other sources. Table 10 shows the BOD, N and P annual loads due to diffuse pollution sources to Komotini – Loutro Evrou streams RB. The most polluting activity is livestock, followed by agriculture regarding nitrogen loads.

Table 10. Annual BOD, N and P loads due to diffuse pollution sources in RB Komotinis - Loutrou Evrou streams (source: RBMP, 2017)

Point sources	**Annual BOD (tons/year)**	**Annual N (tons/year)**	**Annual P (tons per year)**
Urban	186.7	53.2	1.3
Agricultural	0.0	196.7	11.9
Livestock farming	2,038.2	538.5	19.5
Other sources	0.0	118.0	0.9
TOTAL	**2,224.8**	**906.4**	**33.6**

Total pollution loads in Komotini – Loutro Evrou streams RB account for 2,398.4 ton/year of BOD, 991.7 tons/year of N and 65.6 tons/year of P. Point sources contribute more to the total pollution loads.

As mentioned before, the groundwater system supplying DEYAK with water is assessed for its chemical and quantitative status (RBMP, 2017) which is found to be good. There are no problems identified in this groundwater system.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table 11. Water resources quality assessment of the groundwater system of Rodopi (source: RBMP, 2017)

Groundwater system	Chemical status	Quantitative status	Increased values due to physical background	Increased values due to human pressures	Main pressures	Salt water intrusion	Quality problems
Rodopi	Good	Good	-	-	-	No	No

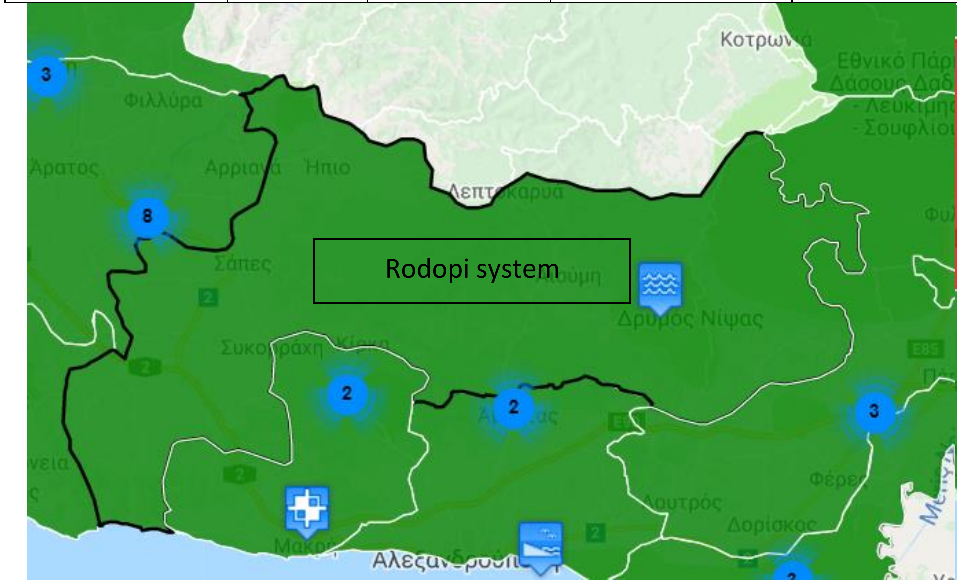


Figure 12. Quantitative status (source: http://nmwn.ypeka.gr/map)

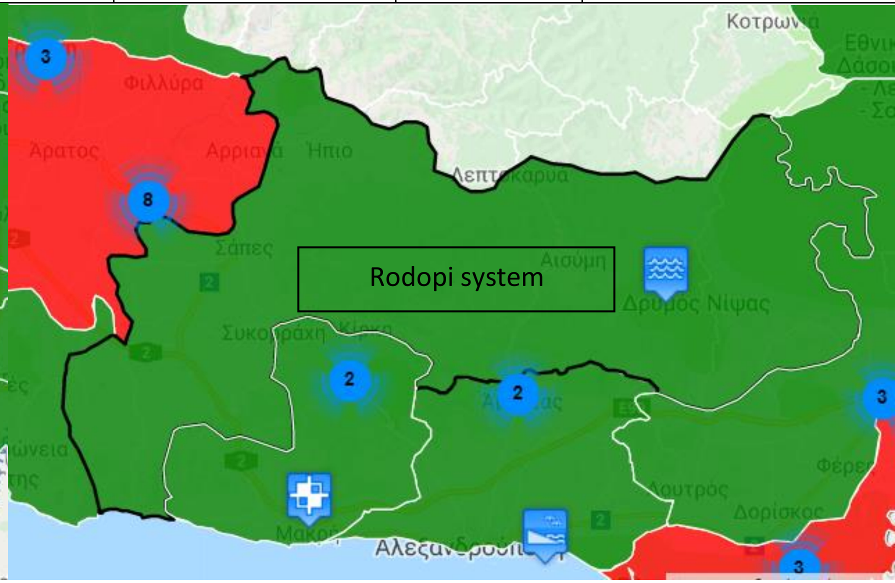


Figure 13. Chemical status (source: http://nmwn.ypeka.gr/map)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

4.2 Water Protection Zones

The Programme of measures of the RBMPs include the designation of protection drinking water supply zones. The RBMP of Thrace specifically includes the following measures:

- M12B0401 to "determine and limit zones and/or measures for the protection of drinking water abstraction points from groundwater systems";
- M12B0402 to "protect groundwater bodies included in the drinking water protection sites registry and determination of institutional framework;
- M12B0403 for the protection of water supply works from surface waters for drinking water supply

The measure M12B0401 refers to areas for the protection of water supply points or areas serving water supply networks operated by Municipal Water Supply and Sewerage Companies, Municipalities, etc. For the water intake points from groundwater systems (springs, wells, drillings) where water is abstracted to produce water for human consumption more than $10m^3$ per day (average per year) or serve more than 50 people, measures and protection zones are established.

Until the completion of the specific hydrogeological studies, temporary protection zones of water abstraction points are defined as follows (RBMP, 2017):

- <u>Zone of absolute protection I:</u> 10-20 m around the abstraction site.
- <u>Zone of controlled protection II:</u> defined depending on the type of aquifer as follows:
    - Karstic systems: 600 m upstream and both sides (recharge area) and 300m downstream of water abstraction site.
    - Fractured systems: 400 m upstream and on both sides (recharge area) and 200m downstream of water abstraction site.
    - Granular unconfined systems: perimeter with radius of 400m
    - Granular confined or semi-confined aquifers: perimeter with radius of 300m

  For the karstic and fractured systems in case no data is available regarding the piezometric level or the recharge area, a protection zone with radius equal to the abovementioned upstream distance is implemented.
- <u>Zone of protection III:</u> It refers to the recharge basin of the abstraction site and can be determined only by the aforementioned hydrogeological study.

Activities in principle prohibited by zone:

* Protection zone I (absolute protection): The zone, which protects the immediate environment of the abstraction from pollution, is characterized as zone of full ban. Within this zone, all activities are prohibited, with the exception of the necessary works for the operation and maintenance of the water abstraction works.
* Protection zone II (controlled): This zone protects the drinking water mainly from the microbiological pollution (50-day zone) and from the pollution cause by human activities or works that are dangerous due to their proximity with the abstraction site. Within this zone, all activities with high polluting risk, such as (indicatively) intensive agricultural activities using pesticides – agrochemicals, livestock facilities, industrial – handicraft facilities, facilities for treatment or transfer of wastewater or solid waste, garages, quarrying and mining activities, cemeteries, and generally any relevant activity that can be a potential pollution source equal or greater than the aforementioned, are prohibited.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

* Protection zone III (supervised): It surrounds the zones I and II and develops throughout the recharge basin that feeds the underground aquifer from which the abstraction is supplied. In Zone III the existing legislation on water protection applies. The specifications for the aforementioned hydrogeological studies will be determined by the competent authorities, under the coordination of the General Secretariat for Water.

The measure M12B0402 (RBMP, 2017) refers to the protection of the groundwater systems included in the register of drinking water protected areas and definition of the protection legislative framework. First, for the installation of new activities the prohibitions of the protection zone II of groundwater abstraction points for drinking with the exception of cemeteries, garages and parkings, and quarrying activities, are implemented. The installation of new activities may be permitted in specific locations after the submission of the hydrogeological study or report, depending on the size and category of the activity and after the positive decision issued by the competent Water Direction. Determination of the legislative protection framework, where the measures for the protection of the groundwater systems included in the register of protected areas will be adopted in detail.

4.3 Land Use

Based on the RBMP (2017) the land uses identified in the WD of Thrace are the following (Table 12):

Table 12. Land uses in the WD of Thrace (source: RBMP, 2017)

Land Uses	WD of Thrace		RB of Komotini – Loutro Evrou streams	
	Area (acres)	%	Area (acres)	%
Urban	79,380	0.76	17,847	0.92
Pasture	1,446,499	13.81	385,557	19.83
Agriculture	3,407,066	32.54	767,828	39.49
Forest	5,016,819	47.91	696,009	35.79
Roads / water	270,925	2.59	37,521	1.93
Other	250,667	2.39	39,734	2.04
TOTAL	**10,471,357**		**1,944,497**	**100.00**

Forests takes the major part of land (47.91%) followed by agriculture (32.54%) and pasture (13.81%) at the WD of Thrace. At the RB of Komotini – Loutro Evrou streams the dominant land use is agriculture (39.49%), followed by forests (35.79%) and pasture (19.83%).

4.4 DPSIR (Drivers, Pressures, Status, Impacts, Response) methodology

The DPSIR approach is followed to assess the impact of land use on water quality in the present state. Based on the land uses the predominant land use is agriculture, followed by forestry and pasture. The DPSIR approach for agricultural activities, forestry, pasture, climate change and tourism is given in Table 13 below.

The DPSIR approach is also used for the assessment of the impact of land use changes on water quality. Climate change is expected to have an impact in the water quality. Land uses are expected to change but their variations are not expected to be big.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table 13: The DPSIR approach for land uses in Komotini – present state

DRIVING FORCES	PRESSURES	STATE	IMPACT
Agriculture: use of fertilizers & pesticides	• Diffuse nitrogen contribution (runoff) • Nitrogen and phosphorus towards the aquatic environment	Groundwater and surface water quality deterioration	• Eutrophication • Contamination risks
Agriculture: irrigation	Water abstraction	Water quantity	Water shortage / drought
Urban areas: Sewage and wastewater	• Microbiological pollution • Pharmaceuticals • Heavy metals to groundwater	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Urban areas: transportation	Heavy metals and oil spills	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Industry	Pollutants in groundwater & surface water	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Forestry: loss of trees due to urbanization & temperature increase	• Climate change conditions • Higher temperatures • Drought periods • Forest fires	Deforestation	Loss of forest cover; erosion process (may affect water quality)
Climate Change	Land uses	Increased temperature; decreased precipitation	Drought conditions Water unavailability

RESPONSE

European Legislation: WFD 2000/60/EC; Drinking Water Directive 98/83/EEC; GW directive 2006/118/EC; Urban Wastewater Treatment Directive 91/271/EEC; Nitrates Directive 91/676/EEC; Environmental Impact Assessment 85/337/EEC; Special Protection Zones Directives 92/43 & 2009/147/EC

Greek Legislation: Law 3199/2003; JMD Y2/2600/2001; PD51/2007; JMD 146896/2014; Law 4117/2003; JMD 146896/2014; MD 39626/2208/E130/2009; River Basin Management Plans; MD 85178/820/2000; JMD 161690/1335/1997; JMD 5673/400/1997; JMD 191002/2013; JMD 145116/2011; MD 33318/3028/1998; 37338/1807/E.103

Measures: Water Safety Plans; Drinking Water Masterplans; Drinking Water Protection Zones

5 Table with data

The following table summarizes most of the information for the surface water and the groundwater system supplying DEYAK with water:

Table 14. Data regarding the groundwater system of Rodopi and Vosvozis river, supplying DEYAL with water

Name of region / area	Thrace	
Water Resources	Groundwater system of Rodopi (EL1200120)	Vosvozis river (EL1209R0000010085N)
Related City / Country	Komotini	Komotini
Geographical coordinates	N/A	N/A
Altitudinal range	N/A	N/A
Size	755.58Km^2	74.92Km^2
Morphology	N/A	N/A
Aquifer type	Fractural	N/A
Surface water interaction		
Geology	N/A	N/A
Mean annual precipitation	500-1000mm	
Mean annual temperature	14.5-16.5^{o}C	
Soil types	N/A	N/A
Land uses	Agriculture 39.49%; Forests 35.79%; pasture 19.83%; roads / water 1.93%; urban 0.92%	
Protection areas	No	No
Water abstraction	3,550,000 m^3/year	2,750,000 m^3/year
Qualitative status	Good	Poor
Quantitative status	Good	N/A

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

6 SWOT Analysis

The strengths and weaknesses the region faces related to climate change impact on water and energy resources include the following:

- Strengths: measures included in the RBMP include the reduction of water losses in water utilities; the elaboration of Master Plans; low pollution loads; good quantitative status; good chemical status.

- Weaknesses: high water demand mainly for irrigation purposes; temperature increase; precipitation decrease.

The opportunities and threats the region faces related to climate change impact on water and energy resources are:

- Opportunities: new technologies for irrigation; financial instruments for the construction of new works (irrigation distribution networks).

- Threats: temperature increase; precipitation decrease; high water demand; low efficiency irrigation practices.

References

River Basin Management Plan (RBMP) 1st Revision, 2017. Available at: http://wfdver.ypeka.gr/wp-content/uploads/2017/12/EL12_SDLAP_APPROVED.pdf (in Greek)

Strategic Environmental Impacts Assessment, 2013. Available at: http://wfdver.ypeka.gr/wp-content/uploads/2017/04/files/GR12/GR12_P25_SMPE.pdf (in Greek)

https://el.wikipedia.org/wiki/map_of_Thrace_(Greece).svg

http://climatlas.hnms.gr/sdi/

http://nmwn.ypeka.gr/

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WATER RESCUE

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.2.1 Climate change impacts assessment report** *Questionnaire*
Project Beneficiary No	**PB2**
Beneficiary Institution	**Municipal Water Supply and Sewerage Company of Thermi**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

Name of the organization/institution: Municipal Water Supply and Sewerage Company of Thermi
Beneficiary number: PB2

1 Introduction

The region of Central Macedonia is located in Northern Greece (Figure 1). The region covers an area of 18,811 km^2 and its population is 1,874,590 (according to the 2011 census). Thessaloniki is the capital city. Most of the area of Central Macedonia region is part of the Water District of Central Macedonia (EL10) (area 10,163.38Km^2). The latter consists of four river basins: the river basin of Axios (area 3,327.85 km^2); the river basin of Gallikos (area 1,050.23Km^2); the river basin of Chalkidiki (area 5,545.86Km^2); and the river basin of Athos (area 239.44km^2) (RBMP, 2017). The water district is characterized by a variety of climates, as Mediterranean climate in the area of Chalkidiki and the coastal areas; continental in the inner part of the district; and mountainous in the areas with high altitude (RBMP, 2017). The average annual rainfall ranges from 400 to 800mm, while in the mountains it exceeds 1,000mm. Snowfalls are common during September to April. The mean annual temperature ranges from 14.5°C to 17°C. The coldest month is January and the warmest one is July (RBMP, 2017).

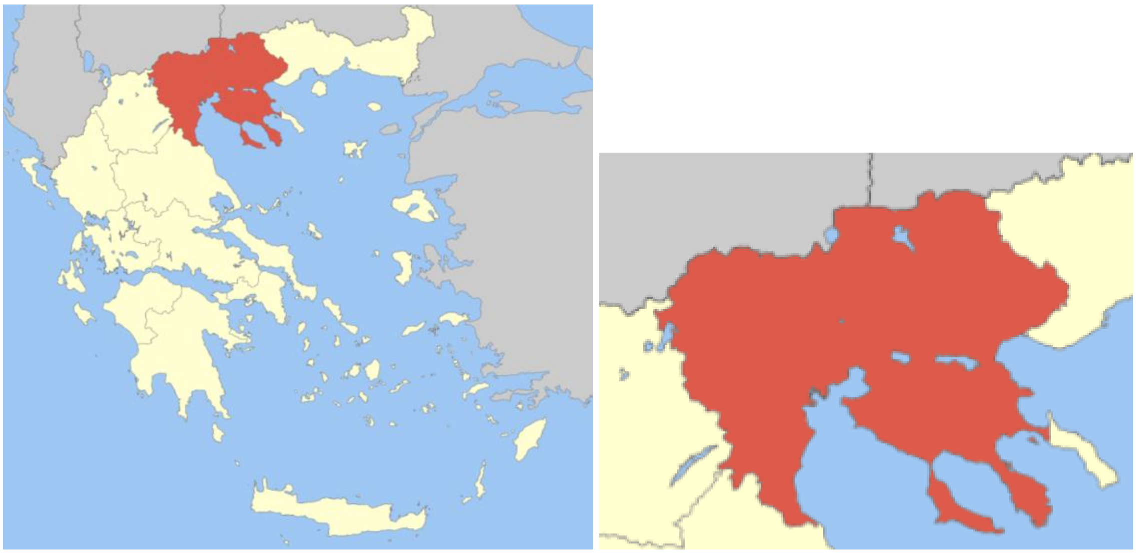


Figure 1. The map of Greece, showing Central Macedonia region (red colour) (source: Wikipedia https://el.wikipedia.org/wiki/Periferia_Kendrikis_Makedonias.png)

The Water District of Central Macedonia includes 124 surface water systems (RBMP, 2017): 104 rivers, 6 lakes, 3 transitional systems and 11 coastal systems. Table 1 shows the surface water systems of each river basin.

Table 1. Surface water systems in each river basin (RBMP, 2017).

Type of system	Axios RB	Gallikos RB	Chalkidiki RB	Athos RB	TOTAL
Rivers	35	16	53	-	**104**
Lakes	2	1	3	-	**6**
Transitional	1	-	2	-	**3**
Coastal	-	-	9	2	**11**
TOTAL	**38**	**17**	**67**	**2**	**124**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Thirty-seven (37) groundwater systems have been identified in the RBMP (2017). Three of them supply the city of Thermi with water. They are:

- Subsystem of down flow of Anthemountas: (EL1000081 – area:92.03Km^2)
- Subsystem of Thermi – N. Risio: (EL1000083 - area 177.00Km^2)
- Subsystem of Cholomontas - Oreokastro: (EL1000193 - area 1597.41 Km^2)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2 Climate characteristics and Climate change

2.1 Temperature

The nearest meteorological station is located in Mikra (longitude 22.98, latitude: 40.53 and altitude: 8m. Figure 2 shows the mean monthly (MT), the 90th percentile (P90) and the 10th percentile (P10) temperature in Mikra meteorological station. The average minimum and maximum temperatures are shown in Figures 4 and 5 respectively. All data are gathered from the Hellenic National Meteorological Service.

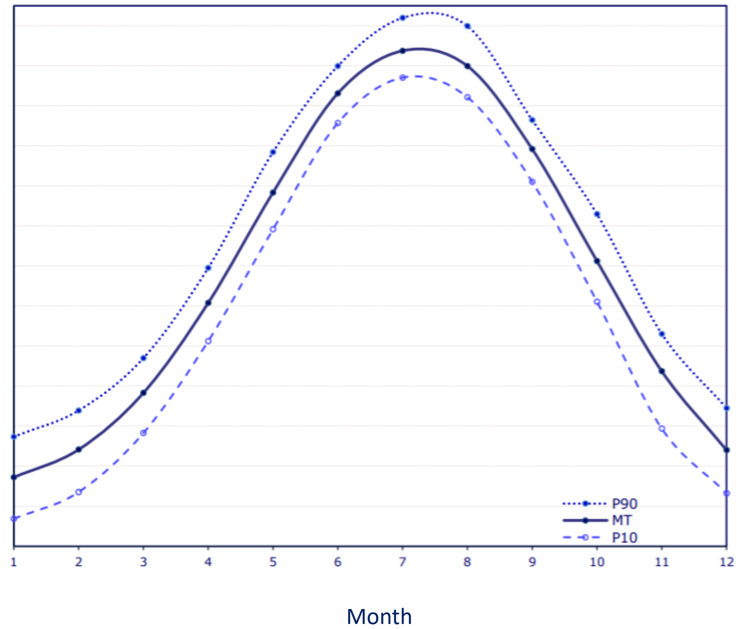


Figure 2. Average monthly air temperature in Thermi (1971-2000) (Source: http://climatlas.hnms.gr/sdi/)
[MT: mean monthly; P90 90th percentile; P10 10th percentile]

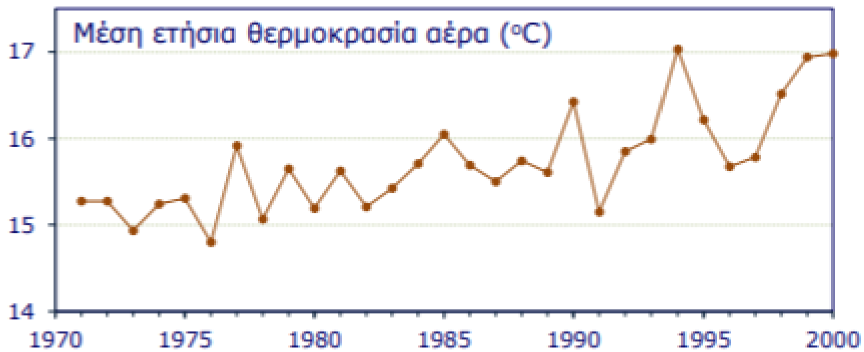


Figure 3. Average annual air temperature from 1971 to 2000 (Source: HMS http://climatlas.hnms.gr/sdi/)

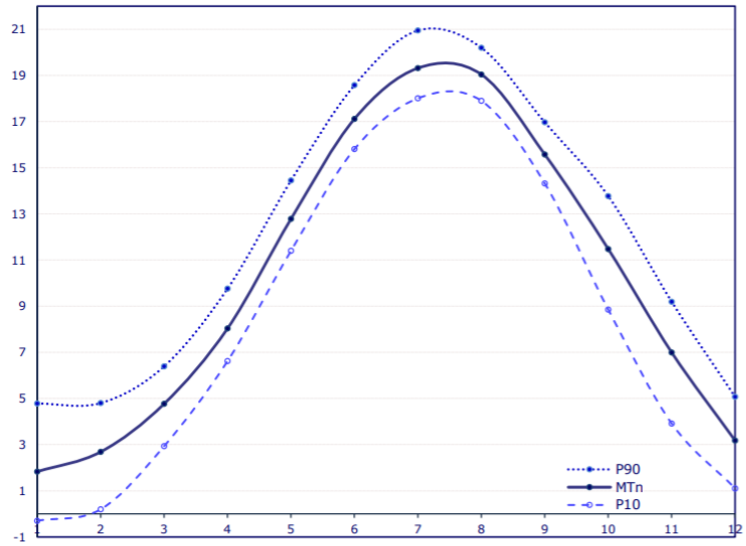


Figure 4. Minimum monthly air temperature in Thermi (1971-2000) (Source: http://climatlas.hnms.gr/sdi/) [MTn: average minimum monthly; P90 90th percentile; P10 10th percentile]

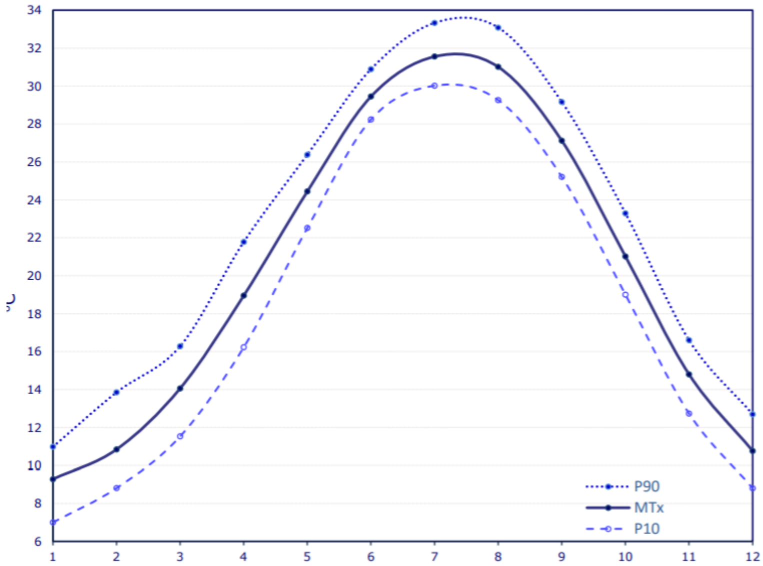


Figure 5. Maximum monthly air temperature in Thermi (1971-2000) (Source: http://climatlas.hnms.gr/sdi/) [MTx: average maximum monthly; P90 90th percentile; P10 10th percentile]

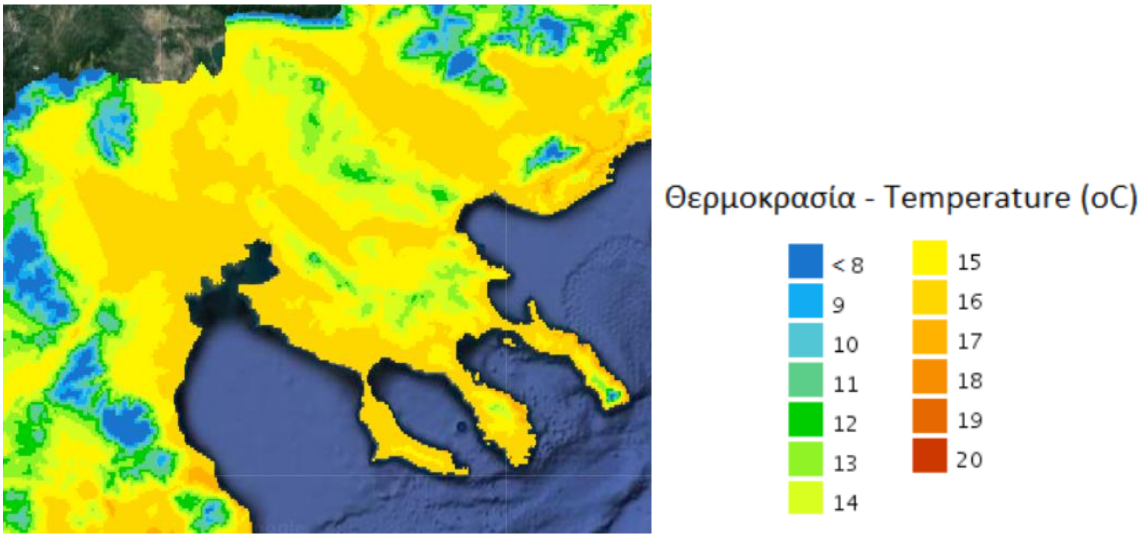


Figure 6. Average air temperature in Central Macedonia (Source: http://climatlas.hnms.gr/sdi/)

Based on the above graphs and data (HNMS), the monthly average temperature ranged from 5.4°C (January) to 26.8°C (July) at the period 1971-2000. The average minimum temperature ranged from 1.8 (January) to 19.3°C (July) in 1971-2000. The average maximum temperature ranged from 9.3 (January) to 31.6°C (July) in 1971-2000. It is evident (Figure 3) that the average annual air temperature shows an increasing trend from 1971 to 2000.

2.2 Precipitation

Monthly precipitation values (Figure 7) at the station in Mikra show that the driest months are July and August and the most wet months are November and December (HNMS). Mean precipitation values ranged from 22.3mm (July) to 60.2mm (November) in 1971-2000. The data (Figure 8) show that mean precipitation values show a decreasing trend from 1971 to 2000.

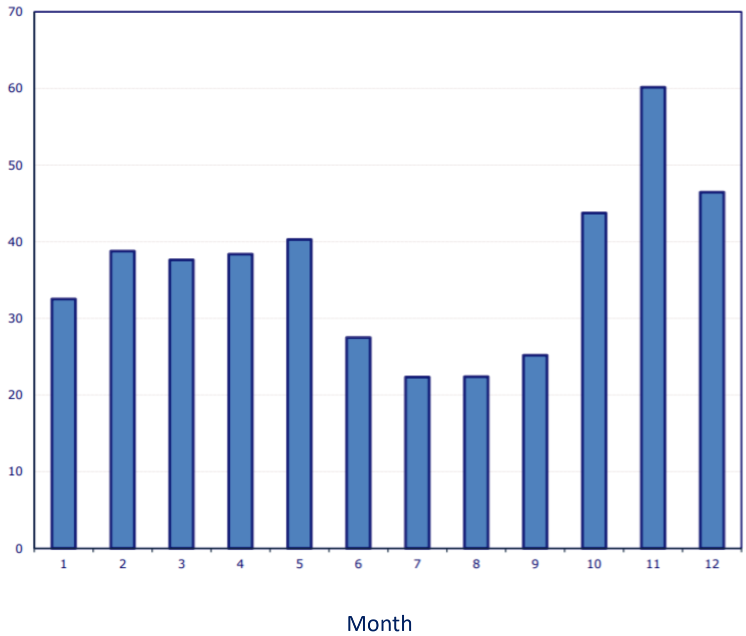


Figure 7. Average monthly precipitation (mm) in Thermi (1971-2000) (Source: http://climatlas.hnms.gr/sdi/)

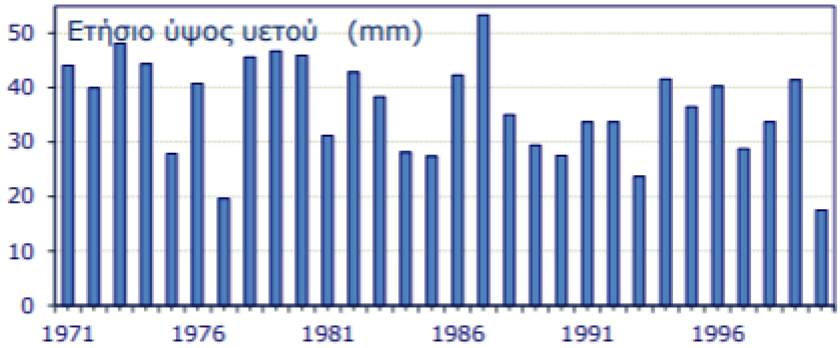


Figure 8. Average annual precipitation (mm) from 1971 to 2000 (Source: http://climatlas.hnms.gr/sdi/)

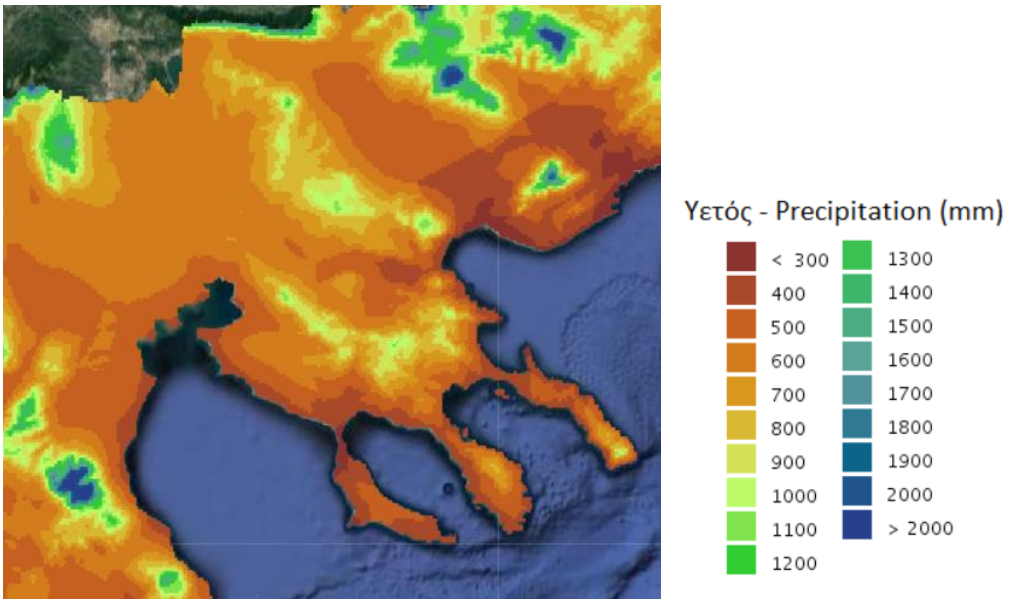


Figure 9. Precipitation (mm) in Central Macedonia (Source: http://climatlas.hnms.gr/sdi/)

2.3 Existing hydrological monitoring

There is a national monitoring network (established with the JMD 140384/9.9.2011), monitoring the ecological and chemical status of the surface water bodies. During the implementation of the national monitoring network, 37 stations operated for the monitoring of surface bodies in the water district of Central Macedonia, 26 of them for surveillance and 11 for operational monitoring (RBMP, 2017). Thirty-seven (37) of them monitored ecological parameters while 22 of them monitored chemical parameters. The monitoring programme provides totally 111 monitoring stations in groundwater bodies, 5 of them for surveillance monitoring and 106 for operational ones (RBMP, 2017). 103 stations monitored chemical parameters and 109 of them monitored quantitative parameters. Table 2 shows the monitoring stations for one of the groundwater systems from which DEYA Thermis abstracts water for drinking purposes (subsystem of down flow of Anthemountas). The data are based on the national monitoring network webpage (http://nmwn.ypeka.gr/). There are no available data for the other two groundwater systems. Table 2 shows the stations' coordinates, the monitoring parameters and the type of monitoring. All monitoring stations monitor quantitative parameters, nitrates and heavy metals (except of one), while one of them monitor additionally pesticides.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table 2. Monitoring stations in the groundwater system, coordinates, monitoring parameters and type of monitoring (source: http://nmwn.ypeka.gr/)

Groundwater system	Monitoring station code	Monitoring parameters	Coordinates	Type of monitoring
Down flow of Anthemountas	ΠΛ1 (GR10081005)	Quantitative; Nitrates; heavy metals	**Lon:**22,94323377 **Lat:** 40,50215488	Operational
	ΘΕΡ17 (GR10081009)	Quantitative	**Lon:** 22,99396218 **Lat:** 40,50972454	Operational
	ΑΝ100 (GR10081020)	Quantitative; Nitrates; heavy metals	**Lon:** 23,10800849 **Lat:** 40,49409988	Operational
	Α4 (GR10081039)	Quantitative; Nitrates; heavy metals	**Lon:** 23,01773446 **Lat:** 40,52844788	Operational
	ΘΕΡ14 (GR10081050)	Quantitative; Nitrates; heavy metals; pesticides	**Lon:** 23 **Lat:** 40,543	Operational

2.4 Climate change

Climate change affects both water resources availability and quality. A study, regarding climate change impacts in Greece (Bank of Greece, 2011), examined climate change and climatic characteristics based on four emission scenarios: A2, A1B, B2, B1. The results showed that at national level, temperature is projected to increase in all regions throughout the year. The temperature increase is expected to be greater in the summer and smaller in winter. Based on the milder scenario A1B temperature is expected to increase by 1.5°C in the country in 2021-2050. The study (Bank of Greece, 2011) revealed that under all four scenarios (A2, A1B, B2, B1) the warming trend increases throughout the 21st century. During the period 2071-2100, this trend is stronger under Scenarios A2 (0.5°C/decade) and A1B (0.4°C/decade), milder under Scenario B2 (0.25°C/decade) and milder yet under Scenario B1 (0.1°C/decade). Annual precipitation levels are projected to decline at national level. Based on this study the decrease is important under scenarios A2 and A1B. Under scenario A1B precipitation levels countrywide will decrease relative to the reference period by about 5% in 2021-2050.

This study (Bank of Greece, 2011) used A2 and B2 emission scenarios and projected the temperature and precipitation values in Central Macedonia for 2071-2080, 2081-2090 and 2091-2100 compared to 1961-1990. Air temperature values (at 2m above ground) estimated for 2071-2080, 2081-2090 and 2091-2100 are given to table 3. Table 4 shows the mean values of rainfall estimated for 2071-2080, 2081-2090 and 2091-2100 and also the differences in projections and the reference period for scenarios A2 and B2 (Bank of Greece, 2011).

Table 3. Mean annual values of air temperature based on A2 and B2 scenarios, temperature differences (ΔT) and changes as % (reference period 1961-1990) for 2071-2080, 2081-2090, 2091-2100 (source: Bank of Greece, 2011)

Periods	A2 T(°C)	B2 T(°C)	A2 ΔT	B2 ΔT	A2 (%)	B2 (%)
2071-2080	15.85±1.50	14.89±1.14	4.00±1.05	2.98±0.41	34.1±10.0	25.1±3.4
2081-2090	16.40±1.54	15.11±1.23	4.56±1.07	3.20±0.51	38.8±10.3	26.9±4.0
2091-2100	17.08±1.56	15.31±1.26	5.24±1.02	3.40±0.58	44.6±9.8	28.6±4.7
1961-1990	11.85±1.13	11.91±0.95				

Table 4. Mean annual values of rainfall based on A2 and B2 scenarios, rainfall differences (ΔR) and changes as % (reference period 1961-1990) for 2071-2080, 2081-2090, 2091-2100 (source: Bank of Greece, 2011)

Periods	A2 R(mm)	B2 R(mm)	A2 ΔR	B2 ΔR	A2 (%)	B2 (%)
2071-2080	475.3±130.8	531.6±124.5	-57.3±51.2	-30.7±67.8	-11.4±10.2	-5.4±12.4
2081-2090	422.9±103.0	521.4±110.3	-109.6±39.7	-39.9±50.7	-20.9±7.2	-7.1±9.8
2091-2100	444.0±116.5	555.8±144.8	-88.5±53.5	-5.5±72.6	-17.1±10.1	-1.5±13.0
1961-1990	532.6±108.7	561.3±101.3				

Regarding extreme weather phenomena, it is projected that up to 20 additional very warm days are expected per year in 2021-2050 and up to 40 in 2071-2100, relative to the reference period 1961-1990 (Bank of Greece, 2011).

3 Water Availability - Climate Change Impacts on Water Resources

3.1 Water Demand

Central Macedonia water district covers the whole regional units of Thessaloniki and Chalkidiki, the major part of the regional unit of Kilkis, and a significant part of the regional units of Imathia and Pella, while also Agio Orios is included in the water district. The total population of the WD is 1,420,321 inhabitants (2011 census).

Based on the RBMP of Central Macedonia, annual water demand is given in table 5. Agriculture is the dominant use (81%) while domestic water use account for 15%. The average annual water supply in the WD is 5.3 $*10^9$ m^3, of which 32% are from own sources and 68% come from the water inflow from Axios river coming from FYROM.

Table 5. Annual water demand per water use in the WD of Central Macedonia and for each River Basin (RB) (source: RBMP, 2017)

	Whole WD		**Axios RB**		**Gallikos RB**		**Chalkidiki RB**	
Water Demand	**hm^3**	**%**	**hm^3**	**%**	**hm^3**	**%**	**hm^3**	**%**
Agriculture	953.080	80.9	697.701	95.0	49.765	74.4	205.614	54.5
Domestic	177.856	15.1	20.749	2.8	3.647	5.5	153.460	40.7
Livestock	7.228	0.6	2.585	0.4	1.152	1.7	3.491	0.9
Industry	40.421	3.4	13.254	1.8	12.321	18.4	14.846	3.9
Total	**1,178.586**		**734.289**		**66.885**		**377.411**	

Chalkidiki river basin consists of 67 surface water systems (Table 1) and 21 groundwater systems. 5 of the surface water systems are found to be at a bad quantitative status and the remaining ones are found to be in good quantitative status. Four out of 21 groundwater systems are found to be in bad chemical status.

Overexploitation of groundwater systems is a fact in 5 groundwater systems in Chalkidiki RB resulting in gradual reduction of their permanent groundwater inventories. These systems face salinization phenomena as well. The groundwater subsystem of down flow of Anthemountas faces overexploitation and it is assessed to be in bad quantitative status (RBMP, 2017).

Table 6. Water availability and average annual abstraction of three groundwater systems in Chalkidiki River Basin (source: RBMP, 2017)

Groundwater subsystem	**Water availability (10^6 m^3)**	**Average annual abstraction (10^6 m^3)**	**Agriculture (10^6 m^3)**	**Domestic (10^6 m^3)**	**Industry (10^6 m^3)**	**Quantitative status**
Down flow of Anthemountas	33.6*	37.02*	25.32*	9.71*	1.77*	Bad
Thermi – N. Risio						Good
Cholomontas - Oreokastro	99.0**	81.64	64.60	9.51	0.35	Good

* It includes also the water supply and use of the subsystem of Galarino-Galatista (EL1000082)

** Includes also the water supply and use of the subsystems of Skouries (EL1000191) and Olympiada (EL1000192).

DEYA Thermis is supplying the municipal district of Thermi with water from groundwater boreholes from three groundwater subsystems: down flow of Antemountas; Thermi – N. Risio; and Cholomontas -

Oreokastro. Based on data from the RBMP (2017) water availability, average annual abstraction (total and per water use) is shown in Table 6. It is evident that the subsystem of down flow of Anthemountas and Thermi – N. Risio is overexploited since 37.02 hm^3 are abstracted while only 33.6 hm^3 is the annual water availability.

DEYA Thermis water abstraction is allocated in the groundwater systems as shown in Table 7. DEYA Thermis supplies water to the following towns: Thermi, Mikra, N. Redestos, Tagarades, N. Risio, Vasilika, Souroti, Agia Paraskevi, Agios Antonios, Lakkia, Peristera and Livadi (Table 7). The major water volume (97.8%) comes from the subsystems of Anthemountas down flow and Thermi – N. Risio. The first subsystem is assessed in bad quantitative and chemical status, while the second is assessed in good quantitative and chemical status. Only 2.1% of water volume comes from the Cholomontas - Oreokastro subsystem which is found to be in good chemical and quantitative status.

Table 7. Water availability, average annual abstraction and DEYA Thermis abstraction of three groundwater systems (source: RBMP, 2017)

<table>
<tr><th>Groundwater subsystem</th><th>Towns supplied with water</th><th>Water availability (10^6 m^3)</th><th>Average annual abstraction (10^6 m^3)</th><th>DEYA Thermis (m^3)</th><th>Chemical status</th><th>Quantitative status</th></tr>
<tr><td>Down flow of Anthemountas</td><td>Thermi, Mikra, N. Redestos, Tagarades, N. Risio, Vasilika, Souroti, Ag. Paraskevi</td><td rowspan="2">33.6</td><td rowspan="2">37.02</td><td rowspan="2">7,187,700</td><td>Bad</td><td>Bad</td></tr>
<tr><td>Thermi – N. Risio</td><td>Thermi, Mikra, N. Redestos, Ag. Antonios, Lakkia</td><td>Good</td><td>Good</td></tr>
<tr><td>Cholomontas - Oreokastro</td><td>Peristera, Livadi</td><td>99</td><td>81.64</td><td>158,500</td><td>Good</td><td>Good</td></tr>
</table>

3.2 Climate change impacts on Water Resources Availability

The temperature increase and the reduction of rainfall projected for the future will definitely affect water resources availability.

The current quantitative status of the three groundwater subsystems supplying DEYA Thermis with water is shown in Table 7, while in Table 6 water demand per water use is also shown. Overexploitation is a fact, as one out of the three systems is found in bad quantitative and chemical status.

3.3 Water Resources Availability

To assess water resources availability, WEI (Water Exploitation Index) index is used. WEI index is the rate of Water Demand (WD) to the renewable Water Resources (WR). Focusing on the three groundwater systems used by DEYA Thermis, the estimation of WEI index took place. We estimated both WEI for total water demand and for drinking water demand. Also, we studied 5 scenarios for water demand:

- Scenario 0: WD0 is the present water demand;
- Scenario 1: WD1 is the present water demand increased by 25%;
- Scenario 2: WD2 is the present water demand decreased by 25%;

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Scenario 3: WR future1 is the present renewable WR increased by 25%
- Scenario 4: WR future2 is the present renewable WR decreased by 25%

To assess WEI fluctuations, we developed 121 scenarios for each of the three groundwater systems and for each total demand and drinking water demand. These scenarios were developed by changing water demand and water supply by 5%.

We also estimated six WEI indexes for each demand: total WD and drinking WD.

- WEI1= WD0/WR present
- WEI2= WD0/WR future1
- WEI3= WD1/WR future1
- WEI4= WD2/WR future1
- WEI5= WD1/WR future2
- WEI6= WD2/WR future2

The results are presented in Table 8 (for scenarios 0, 1, 2, 3 and 4) and Figures 10 & 11 for all scenarios.

Table 8. WEI values (1;2;3;4;5;6) for the three groundwater subsystems

	EL1000081 & EL1000083		EL1000193	
	Total use	**Drinking water**	**Total use**	**Drinking water**
WEI1	1.102	0.289	0.825	0.096
WEI2	0.881	0.231	0.660	0.077
WEI3	1.102	0.289	0.825	0.096
WEI4	0.661	0.173	0.495	0.058
WEI5	1.836	0.482	1.374	0.160
WEI6	1.102	0.289	0.825	0.096

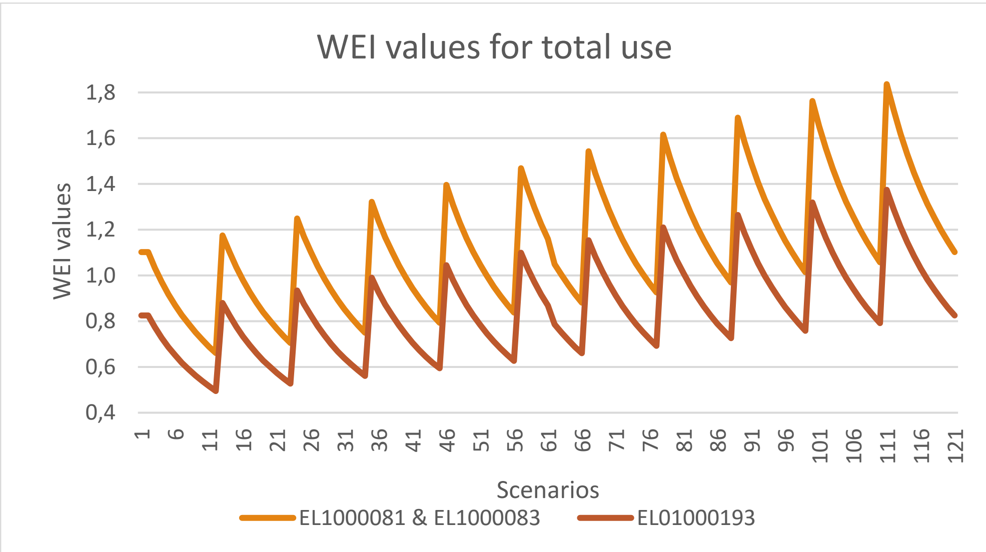


Figure 10. WEI values for all scenarios for total water use

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

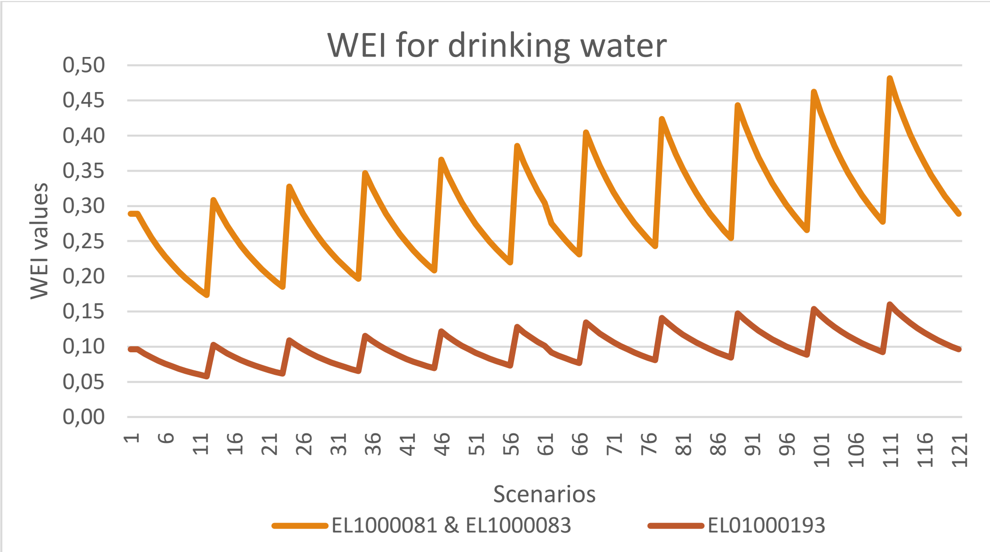


Figure 11. WEI values for all scenarios for drinking water use

The WEI Index values calculated for the three aquifers are assessed based on the thresholds adopted in CCWaters project (Table 9). Up to 0.49 the system faces a low risk regarding its water availability. For values ranging from 0.5 to 0.69 there are possible difficulties, while for values ranging from 0.7 to 0.99 there is a strong risk. Systems with WEI values greater than 1, are not sustainable.

Table 9. WEI thresholds

WEI from - to		Comment
0	0.49	low risk
0.5	0.69	possible difficulties
0.7	0.99	strong risk
1		not sustainable

The subsystems of Anthemountas down flow and Thermi – N. Risio (EL1000081 & EL1000083) are not sustainable at their present state. The results show that for these subsystems there are cases that show possible difficulties with water availability only if water demand decreases and renewable water resources increase. Strong risk exists only in the cases where water demand decrease or increase up to 10% and renewable water resources increase (Table 8 and Figure 10). In most cases the subsystem is unsustainable. Regarding drinking water demand the risk is low, regardless of the increase or decrease of water demand and renewable water resources (Table 8 and Figure 11).

The subsystem Cholomontas - Oreokastro (EL1000193) is facing a strong risk at its present state. The system becomes not sustainable when water demand remains the same or increases and at the same time renewable water resources decrease (Table 8 and Figure 10). There are possible difficulties only when water demand decreases more than 5% and renewable water resources increase by more than 5%. Regarding drinking water demand, there is a low risk regardless of the increase or decrease of water demand and renewable water resources (Table 8 and Figure 11).

4 Water Quality & Land Uses

4.1 Water Resources Quality Characteristics

Based on the RBMP (2017) there are point pollution sources and diffuse pollution sources met in the River Basin of Chalkidiki. Point pollution sources examined are wastewater treatment plants, industrial units, thermal power plant, livestock farming, mines – quarry, aquaculture and fishfarming. The annual loads of BOD, Nitrogen (N) and Phosphorus (P) due to these point pollution sources are presented in Table 10. The most polluting activity is industries and wastewater treatment plants. The thermal power plant pollution refers mainly to Cr, Zn, As, Cu, HC, PCBs, Cd, Pb, Hg, Ni. The mines and quarries pollution refers to SO_4^{-2}, Fe, Mn, Zn, Pb, Sb, As (RBMP, 2017).

Table 10. Annual BOD, N and P loads due to point pollution sources in Chalkidiki RB (source: RBMP, 2017)

Point sources	Annual BOD (tons/year)	Annual N (tons/year)	Annual P (tons per year)
Wastewater treatment plants	802.4	501.5	102.5
Industrial units	2,398.4	1,006.54	93.57
Livestock farming units	60.1	33.4	1.5
TOTAL	**3,260.9**	**1,541.44**	**197.57**

Diffuse pollution sources include urban, agricultural, livestocks and other sources. Table 11 shows the BOD, N and P annual loads due to diffuse pollution sources to Chalkidiki RB. The most polluting activity is livestock, followed by urban wastewater not discharged to WWTT for BOD loads, while agriculture is the most polluting activity followed by livestocks regarding nitrogen and phosphorous loads.

Table 11. Annual BOD, N and P loads due to diffuse pollution sources in Chalkidiki RB (source: RBMP, 2017)

Point sources	Annual BOD (tons/year)	Annual N (tons/year)	Annual P (tons per year)
Agricultural activities		796.4	551.2
Urban wastewater not discharged to WWTP	873.49	249.58	51.99
Livestock farming	1021.29	450.38	54.53
Urban / roads		98.31	13.12
TOTAL	**1,894.78**	**1,594.67**	**670.84**

As mentioned before, the three groundwater systems supplying DEYA Thermis with water are assessed for their chemical and quantitative status (RBMP, 2017). The same study provides the parameters with increased values either due to physical background or due to anthropogenic activities. The main pressures and salt water intrusion are also identified (Table 12).

Table 12. Water resources quality assessment of the three groundwater systems (source: RBMP, 2017)

Groundwater system	Chemical status	Quantitative status	Increased values due to physical background	Increased values due to human pressures	Main pressures	Salt water intrusion
Down flow of Anthemountas	Bad	Bad	Fe, Mn, B, Cr, As, Cl, E.C.	NO_3, Cl	Agriculture, livestock farming, urban wastewater, salt water intrusion, over-abstraction	Yes
Thermi – N. Risio	Good	Good	Fe, Mn, B, As, Cl, Na, H_2S	-	-	No
Cholomontas - Oreokastro	Good	Good	-	-	-	No

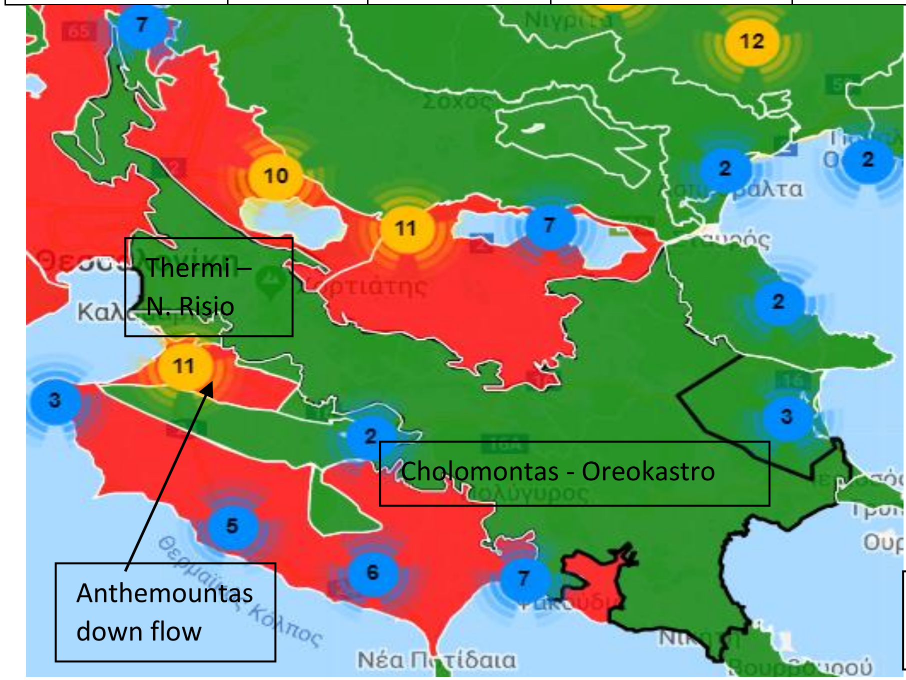


Figure 12. Quantitative status (source: http://nmwn.ypeka.gr/map)

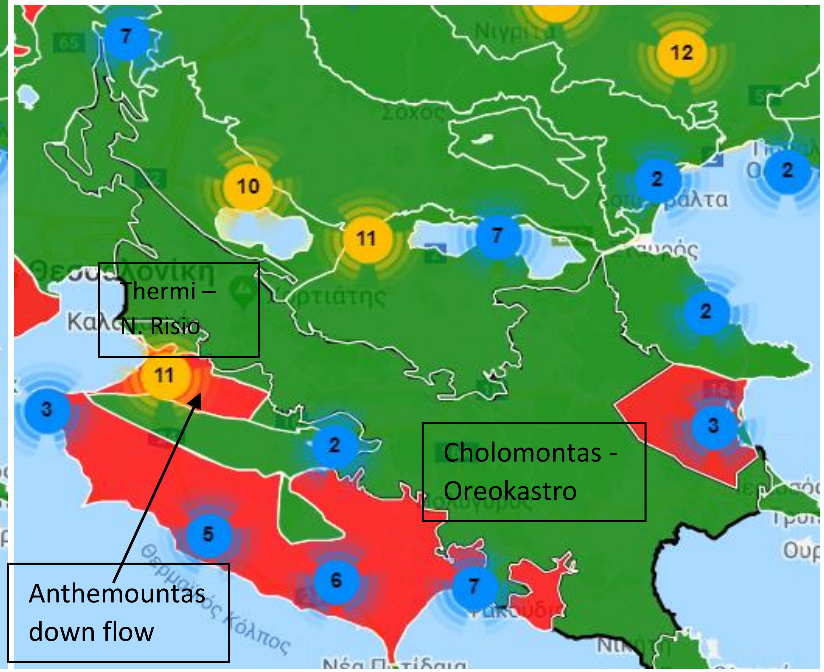


Figure 13. Chemical status (source: http://nmwn.ypeka.gr/map)

The subsystem Anthemountas down flow faces pollution problems due to agriculture, livestock farming, urban wastewater and over-abstraction. Salt water intrusion problems also exist. Increased values of Mn, Fe, B, Cr, As, Cl, are due to the physical background. Especially As values are due to geothermic fluids. The system's chemical and quantitative status is bad (Figures 12 & 13). The subsystem Thermi – N. Risio does not face pollution problems. Increased values of Fe, Mn, B, As, Cl, Na, H_2S are due to the physical background and especially the geothermic fluids and the Anthemountas crack (Figures 12 & 13). Cholomontas - Oreokastro subsystem does not face pollution problems or over-abstraction.

4.2 Water Protection Zones

Three groundwater bodies used for abstraction of water for human consumption, are protected areas for drinking water: Paikou groundwater system (EL1000020), Mavroneriou system (EL1000160) and Deve Koran system (EL1000220) (RBMP, 2017). Based on the Programme of Measures, a specific institutional framework is determined for systems included in the protected areas registry. The protection of these systems is assured with the limitations in the protection zones and the Water Directorates advise on new activities that potentially could pollute the aquifers, based on special hydrogeological studies. For the remaining groundwater systems where abstractions of water for human consumption take place, water protection is ensured with the measures and the protection zones at the level of abstraction points.

The Programme of measures of the RBMPs include the designation of protection drinking water supply zones. The RBMP of Thrace specifically includes the following measures:

- M10B0401 to "determine and limit zones and/or measures for the protection of drinking water abstraction points from groundwater systems";
- M10B0402 to "protect groundwater bodies included in the drinking water protection sites registry and determination of institutional framework;
- M10B0403 for the protection of water supply works from surface waters for drinking water supply

The measure M10B0401 refers to areas for the protection of water supply points or areas serving water supply networks operated by Municipal Water Supply and Sewerage Companies, Municipalities, etc. For the water intake points from groundwater systems (springs, wells, drillings) where water is abstracted to produce water for human consumption more than $10m^3$ per day (average per year) or serve more than 50 people, measures and protection zones are established.

Until the completion of the specific hydrogeological studies, temporary protection zones of water abstraction points are defined as follows (RBMP, 2017):

- Zone of absolute protection I: 10-20 m around the abstraction site.
- Zone of controlled protection II: defined depending on the type of aquifer as follows:
  - Karstic systems: 600 m upstream and both sides (recharge area) and 300m downstream of water abstraction site.
  - Fractured systems: 400 m upstream and on both sides (recharge area) and 200m downstream of water abstraction site.
  - Granular unconfined systems: perimeter with radius of 400m
  - Granular confined or semi-confined aquifers: perimeter with radius of 300m

  For the karstic and fractured systems in case no data is available regarding the piezometric level or the recharge area, a protection zone with radius equal to the abovementioned upstream distance is implemented.

- Zone of protection III: It refers to the recharge basin of the abstraction site and can be determined only by the aforementioned hydrogeological study.

Activities in principle prohibited by zone:

* Protection zone I (absolute protection): The zone, which protects the immediate environment of the abstraction from pollution, is characterized as zone of full ban. Within this zone, all activities are prohibited, with the exception of the necessary works for the operation and maintenance of the water abstraction works.
* Protection zone II (controlled): This zone protects the drinking water mainly from the microbiological pollution (50-day zone) and from the pollution cause by human activities or works that are dangerous due to their proximity with the abstraction site. Within this zone, all activities with high polluting risk, such as (indicatively) intensive agricultural activities using pesticides – agrochemicals, livestock facilities, industrial – handicraft facilities, facilities for treatment or transfer of wastewater or solid waste, garages, quarrying and mining activities, cemeteries, and generally any relevant activity that can be a potential pollution source equal or greater than the aforementioned, are prohibited.
* Protection zone III (supervised): It surrounds the zones I and II and develops throughout the recharge basin that feeds the underground aquifer from which the abstraction is supplied. In Zone III the existing legislation on water protection applies. The specifications for the aforementioned hydrogeological studies will be determined by the competent authorities, under the coordination of the General Secretariat for Water.

The measure M10B0402 regarding protection of GWBs included in the register of protected areas as drinking water areas and issuing/amendment of the legal framework for their protection. First, for the installation of new activities the prohibitions of the protection zone II of groundwater abstraction points for drinking with the exception of cemeteries, garages and parkings, and quarrying activities, are implemented. The installation of new activities may be permitted in specific locations after the submission of the hydrogeological study or report, depending on the size and category of the activity and after the positive decision issued by the competent Water Direction. Determination of the legislative protection framework, where the measures for the protection of the groundwater systems included in the register of protected areas will be adopted in detail.

4.3 Land Use

Based on the RBMP (2017) the land uses identified in the WD of Central Macedonia are the following (Table 13):

Table 13. Land uses in the WD of Central Macedonia (source: RBMP, 2017)

Land Uses	%
Agriculture	56.74
Forest	37.89
Artificial surface	3.31
Transport networks	0.12
Water & wetlands	2.12
TOTAL	

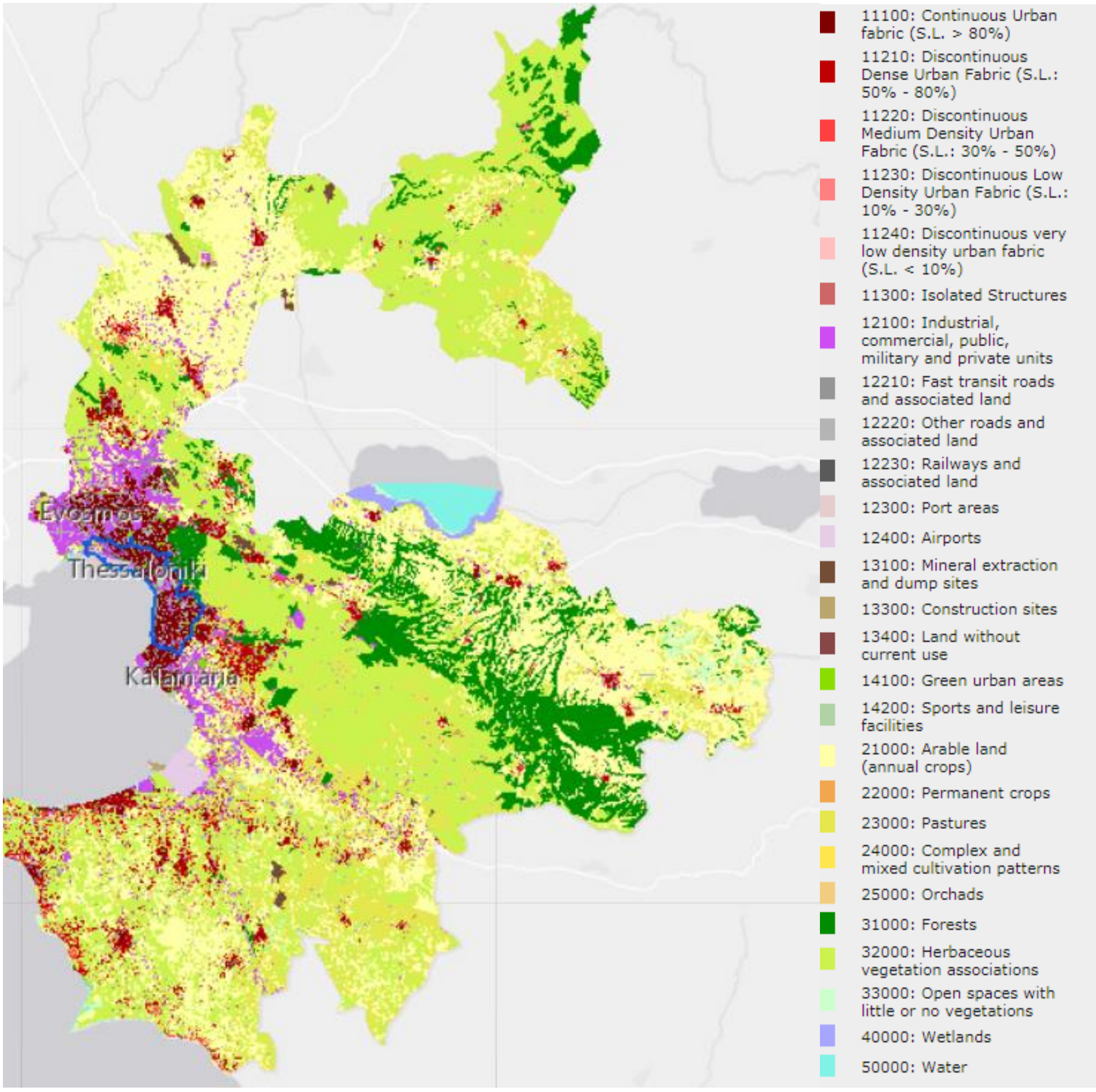


Figure 14. Land uses in Thessaloniki area (blue line: the borders of the Thessaloniki city) (source: https://land.copernicus.eu/local/urban-atlas/urban-atlas-2012?tab=mapview)

The dominant land use is agriculture (56.74%). The permanently irrigated agricultural land covers 9.72% of the total land and arable land covers 30.40% of the total land. The second largest land use is forests covering 37.98% of the total land. 4.26% of the total land is pasture. Artificial surface such as residential areas (1%), industrial and trade zones (0.54%), transport networks (0.12%), mining and mineral sites (0.13%) etc. cover a small part of the total land. Transport networks include the port of Thessaloniki, the airport "Macedonia" which are of international importance. There are also important roads such as Egnatia and the national road Patras-Athens-Thessaloniki (PATHE). Water surfaces (1.27%) and wetlands (0.86%) cover only 2.1% (rivers, lakes, and transitional waters).

4.4 DPSIR (Drivers, Pressures, Status, Impacts, Response) methodology

The DPSIR approach is followed to assess the impact of land use on water quality in the present state. Based on the land uses the predominant land use is agriculture, followed by forestry. The DPSIR approach for agricultural activities, forestry, pasture, climate change and tourism is given in Table 14 below.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table 14: The DPSIR approach for land uses in Thermi – present state

DRIVING FORCES	PRESSURES	STATE	IMPACT
Agriculture: use of fertilizers & pesticides	• Diffuse nitrogen contribution (runoff) • Nitrogen and phosphorus towards the aquatic environment	Groundwater and surface water quality deterioration	• Eutrophication • Contamination risks
Agriculture: irrigation	Water abstraction	Water quantity	Water shortage / drought
Urban areas: Sewage and wastewater	• Microbiological pollution • Pharmaceuticals • Heavy metals to groundwater	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Urban areas: transportation	Heavy metals and oil spills	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Industry	Pollutants in groundwater & surface water	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Forestry: loss of trees due to urbanization & temperature increase	• Climate change conditions • Higher temperatures • Drought periods • Forest fires	Deforestation	Loss of forest cover; erosion process (may affect water quality)
Climate Change	Land uses	Increased temperature; decreased precipitation	Drought conditions Water unavailability
Population increase	• Land uses • Construction • Wastewater and solid waste	Limited cultivated land Pollutants in groundwater and surface water	• Contamination risks • Public health risks • Climate change

RESPONSE

European Legislation: WFD 2000/60/EC; Drinking Water Directive 98/83/EEC; GW directive 2006/118/EC; Urban Wastewater Treatment Directive 91/271/EEC; Nitrates Directive 91/676/EEC; Environmental Impact Assessment 85/337/EEC; Special Protection Zones Directives 92/43 & 2009/147/EC
Greek Legislation: Law 3199/2003; JMD Y2/2600/2001; PD51/2007; JMD 146896/2014; Law 4117/2003; JMD 146896/2014; MD 39626/2208/E130/2009; River Basin Management Plans; MD 85178/820/2000; JMD 161690/1335/1997; JMD 5673/400/1997; JMD 191002/2013; JMD 145116/2011; MD 33318/3028/1998; 37338/1807/E.103
Measures: Water Safety Plans; Drinking Water Masterplans; Drinking Water Protection Zones

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

The DPSIR approach is also used for the assessment of the impact of land use changes on water quality. Climate change is expected to have an impact in the water quality. Land uses are expected to change but their variations are not expected to be big.

5 Table with data

Table 15 below summarizes the data provided earlier for the three groundwater subsystems supplying DEYA Thermis with water.

Table 15: Data for the three groundwater subsystems supplying DEYA Thermis with water (data based on the RBMP, 2017)

Name of region / area	Chalkidiki River Basin, Water District of Central Macedonia		
Water Resources	Anthemountas down flow (EL1000081)	Thermi – N. Risio (EL1000083)	Cholomontas – Oreokastro (EL1000193)
Related City / Country	Thermi municipal district	Thermi municipal district	Thermi municipal district
Geographical coordinates	N/A	N/A	N/A
Altitudinal range	N/A	N/A	N/A
Size	92,0 Km^2	177,0 Km^2	1,597.4Km^2
Morphology	N/A	N/A	N/A
Aquifer type	Granular	Granular	Granular; karstic;
Surface water interaction	Anthemountas river	-	Rivers Havrias, Vatonia streams, Petrenia, Varvara, Aspropetra
Geology	Quaternary and Neogene deposits	Quaternary	Quaternary and Neogene deposits
Mean annual precipitation	400-800mm		
Mean annual temperature	14.5 – 17°C		
Soil types	N/A	N/A	N/A
Land uses	Agricultural; forests; artificial surfaces; water surfaces and wetlands		
Protection areas	No	No	No
Water abstraction	37.2hm^3		81.64 hm^3
Qualitative status	Bad	Good	Good
Quantitative status	Bad	Good	Good

6 SWOT Analysis

The strengths and weaknesses the region faces related to climate change impact on water and energy resources include the following:

- Strengths: measures included in the RBMP include the reduction of water losses in water utilities; the elaboration of Master Plans; low pollution loads.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Weaknesses: overexploitation of groundwater bodies; bad qualitative status in water bodies; excessive agricultural activity; high water demand mainly for irrigation purposes; water abstraction from surface water bodies; temperature increase; precipitation decrease; high population increase in Thermi.

The opportunities and threats the region faces related to climate change impact on water and energy resources are:

- Opportunities: new technologies for irrigation; financial instruments for the construction of new works (irrigation distribution networks).

- Threats: temperature increase; precipitation decrease; high water demand; low efficiency irrigation practices; hydro-morphological alterations of surface water bodies.

7 Comments

No comments.

References

River Basin Management Plan (RBMP) of Central MAcedonia 1st Revision, 2007. Available at: http://wfdver.ypeka.gr/wp-content/uploads/2017/04/files/GR10/GR10_SDLAP.pdf (in Greek)

http://climatlas.hnms.gr/sdi/

http://nmwn.ypeka.gr/

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.3.1 Climate change impacts assessment report** *Questionnaire*
Project Beneficiary No	**PB3**
Beneficiary Institution	**University of Thessaly-Special Account Funds for Research-Department of Civil Engineering**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Name of the organization/institution: University of Thessaly-Special Account Funds for Research-Department of Civil Engineering

Beneficiary number: PB3

1 Introduction

This deliverable focuses on the Climate Change Impacts Assessment for water resources in Greece. As University of Thessaly (PB3) is an academic institution, the report focuses on the impacts of climate change on the cross-border water resources.

Greece is situated on the east-north Europe and on the northern part of the Balkan peninsula. At the north it borders with Albania, FYROM, Bulgaria and Turkey (at the east) (Figure 1). An its west there is the Adriatic and Ionian seas, and at its east, Aegean Sea. Greece's total population is 10,815,197 people (2011 census) and its area is 131,957Km^2. The population density is about 83 inhabitants per Km^2. The country's coast line has a length of 13,676 Km. Eighty percent (80%) of the country's area is mountainous, with Mount Olympus being the highest mountain (2,918m).

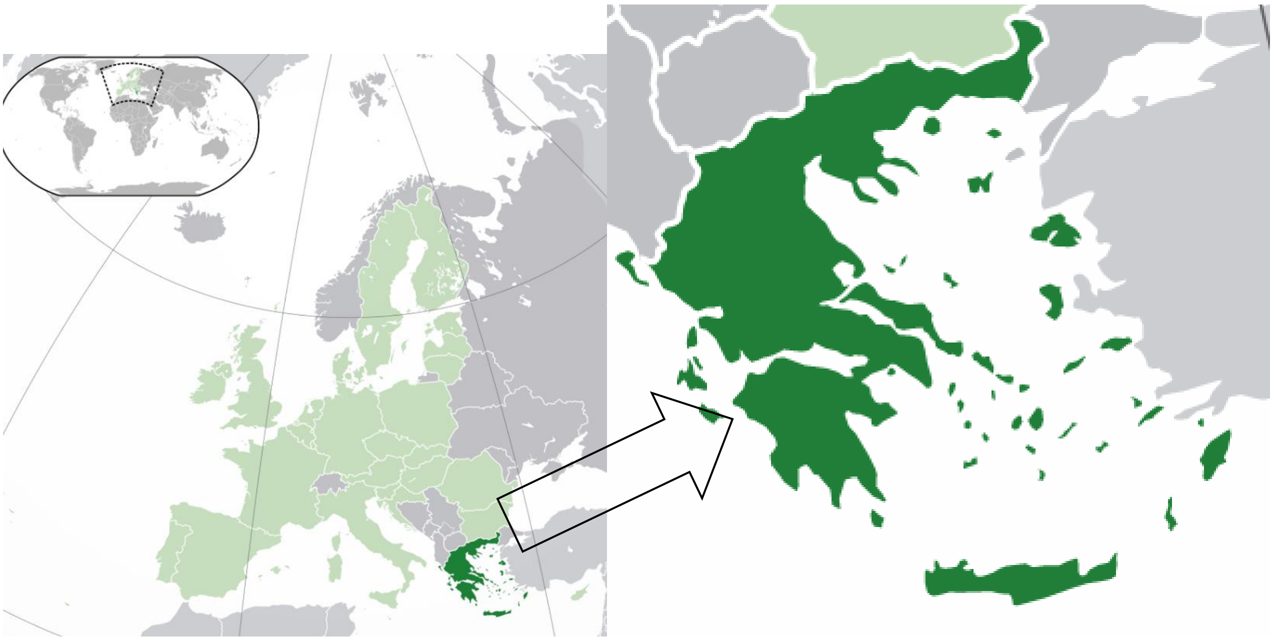


Figure 1. Location of Greece in Europe (Source: https://upload.wikimedia.org/wikipedia/commons/2/21/EU-Greece.svg)

Greece implements the Water Framework Directive (WFD) 2000/60/EC since 2003, when the country adopted the directive to its National Law. The country consists of 14 Water Districts (Figure 2 & Table 1). Based on the River Basin Management Plants already developed (1st revision has been in place since December 2017), there are 46 river basins, 1,785 surface water bodies and 565 groundwater bodies identified. The surface water bodies include 1,415 rivers, 73 lakes, 250 coastal and 47 transitional water bodies.

Table 1. The 14 WDs in Greece, their area and number of river basins (data from RBMPs)

WD	WD name	Area (Km^2)	No of RB
EL01	Western Peloponnese	7,235.00	2
EL02	Northern Peloponnese	7,397.00	3

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

EL03	Eastern Peloponnese	8,442.00	3
EL04	Western Sterea Ellada	10,199.00	4
EL05	Epirus	10,026.00	6
EL06	Attica	3,187.00	1
EL07	Eastern Sterea Ellada	12,279.00	7
EL08	Thessaly	13,377.00	2
EL09	Western Macedonia	13,615.56	2
EL10	Central Macedonia	10,163.38	4
EL11	Eastern Macedonia	7,319.00	1
EL12	Thrace	11,240.00	5
EL13	Crete	8,327.10	3
EL14	Aegean Islands	9,104.68	3

Figure 2. Water Districts in Greece (source RBMPs)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

The country shares three transnational water resources with Bulgaria (RBMP of Thrace, 2017; RBMP of Eastern Macedonia, 2017) (Figure 3).

Specifically, in the WD of Thrace, the River Basin (RB) of Evros is a transnational RB, shared among Greece, Bulgaria and Turkey. The river's total length is 528Km of which 310 Km belong to Bulgaria while 208 Km are the natural borders of Greece with Bulgaria and Turkey. The RB is shared among the three counties as follows: 35,085Km^2 (66.2%) belong to Bulgaria, 14,575Km^2 (27.5%) belong to Turkey and 3,340Km^2 (6.3%) belong to Greece (RBMP of Thrace, 2017) (Figure 4).

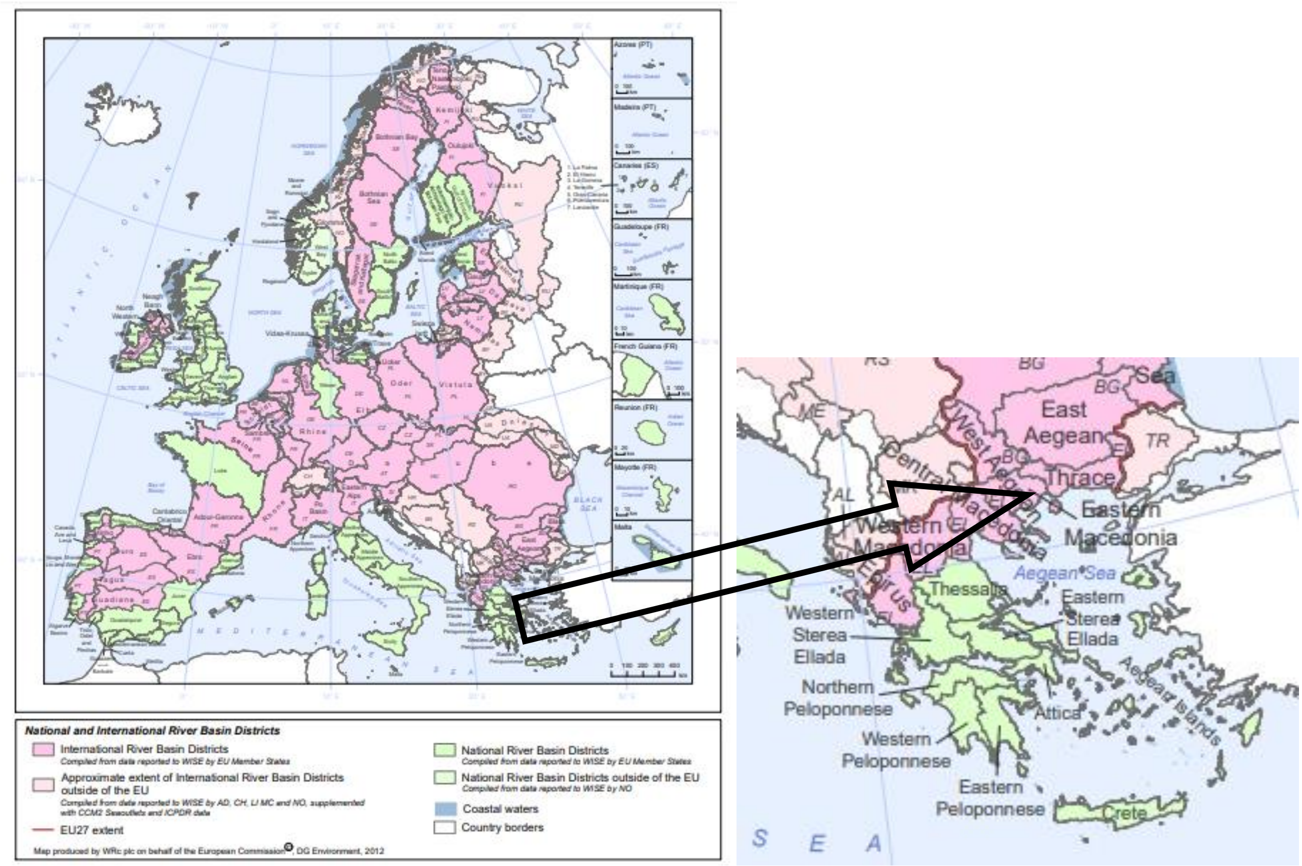


Figure 3. National and International RBs in Europe – focus on the transnational RBs shared between Greece and Bulgaria (source: http://ec.europa.eu/environment/water/water-framework/facts_figures/pdf/River%20Basin%20Districts-2012.pdf)

The second cross-border RB is the RB of Nestos shared between Greece (EL12) and Bulgaria (BG4) (Figure 5).

The last cross-border RB is the RB of Strimonas shared between Greece (EL11) and Bulgaria (BG4) (Figure 6).

For the transnational cooperation for the cross-border water resources shared between Greece and Bulgaria, there are in place the following cross-border agreements: (a) the agreement Greece – Bulgaria of 1963 for the cooperation in using the water from the rivers flowing the two countries (ΝΔ 4393/1964, ΦΕΚ 193 Α΄); and (b) the agreement of Greece – Bulgaria for the water from Nestos (1995), foreseeing that Greece obtains annually the 29% of the river's runoff, as it is measured at the borders of the two counties (Ν. 2402/1995 (ΦΕΚ Α΄ 98) (Data from the RBMPs of Thrace and Eastern Macedonia, 2017).

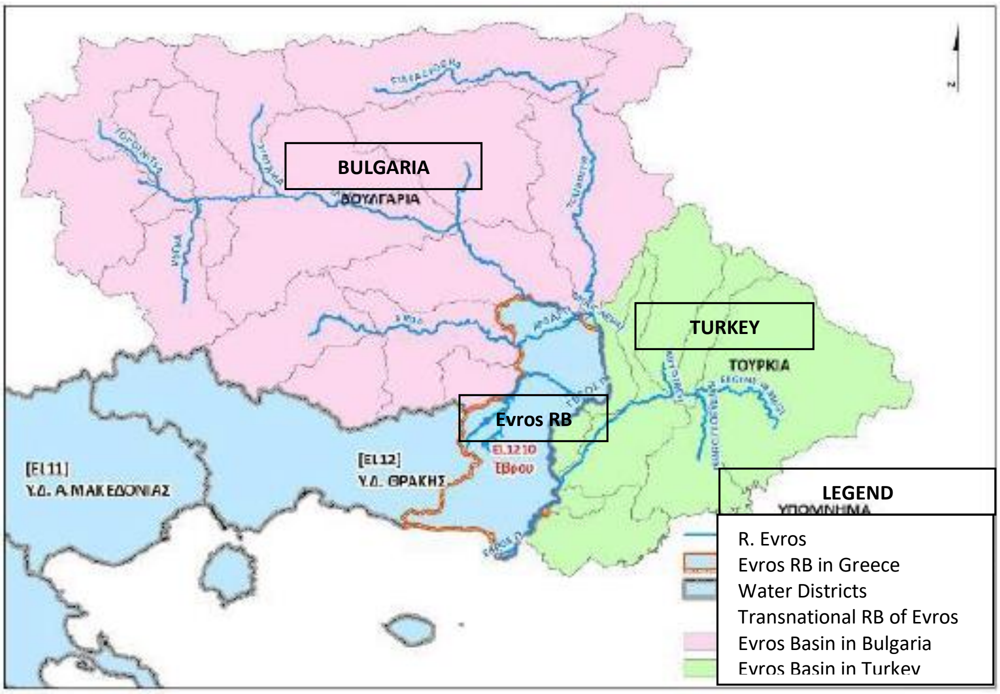


Figure 4. The transnational RB of Evros shared among Greece, Bulgaria and Turkey

Figure 5. The cross-border RB of Nestos shared between Greece & Bulgaria
Source: RBMP of Thrace, 2017

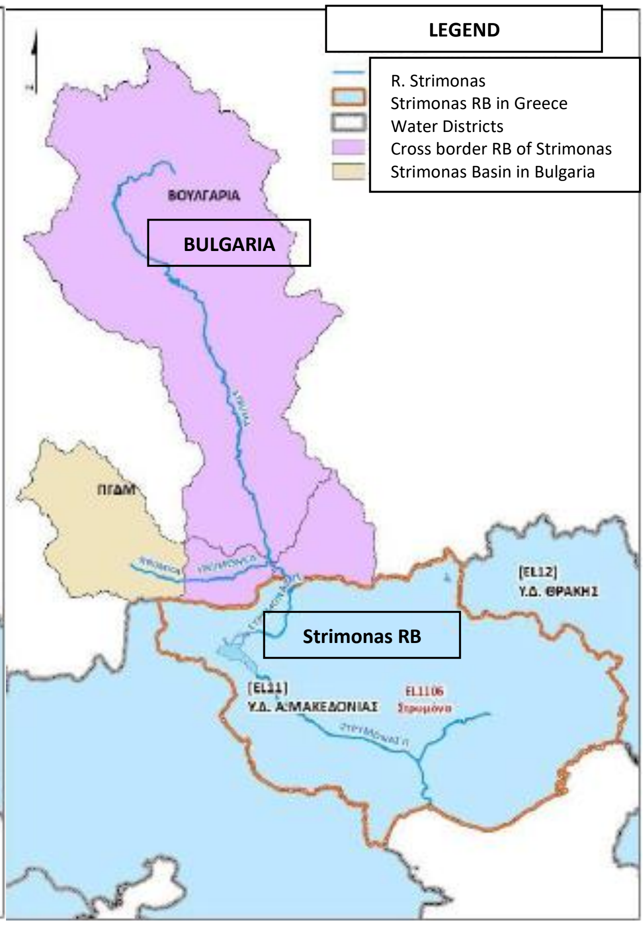


Figure 6. The cross-border RB of Strimonas shared between Greece & Bulgaria
Source: RBMP of E. Macedonia, 2017

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

2 Climate characteristics and Climate change

2.1 Climate in Greece

Greece has a Mediterranean climate, with mild and wet winters in the southern lowland and island regions, cold winters with strong snowfalls in the mountainous areas in the central and northern regions and hot, dry summers. In the Mediterranean climate frame, there are many climate subtypes in several regions of Greece. This is due to the influence of topography, with great mountain chains along the central part on the air coming from the moisture sources of the central Mediterranean Sea (Hellenic National Meteorological Service, http://www.hnms.gr/emy/el/climatology/climatology). Thus, Eastern Greece and Attica have a dry climate, while Northern and Eastern Greece have a wet one. From mid October to the end of March there is a cold and rainy period and from April until September there is a warm, non-rainny period.

Based on a study from Bank of Greece (2011), the climate of the country consists on four main sub-types:

a) a maritime Mediterranean climate, with pleasant temperate characteristics, along Greece's western coast and on the Ionian Islands;

b) a lowland Mediterranean climate, found in SE Greece, part of Eastern-Central Greece, parts of the Eastern Peloponnese, the islands and coastal areas of the Central Aegean and Crete, with drier summers and colder winters than at respective latitudes around the Ionian Sea;

c) a continental Mediterranean climate, over the larger part of Thrace, Macedonia and Epirus and part of Thessaly, with some of the continental climate characteristics typical of Balkan regions further north; and

d) a highland Mediterranean climate, in the mountain ranges running through Greece.

The islands of the Northern Aegean have a transitional type of climate (continental to lowland), whereas the climate of the Dodecanese islands has temperate maritime characteristics.

2.2 Climate characteristics in Greece

Temperature

Based on the Hellenic National Meteorological Service during the period of October to March, the coldest months are January and February, with, on average, mean minimum temperature ranging between 5 -10^{o} C near the coasts and 0 – 5^{o}C over mainland areas, with lower values (generally below freezing) over the northern part of the country. The mean annual temperature is about 10^{o}C in the mountains of the Peloponnese and about 5^{o}C in the mountains of Northern and Central Greece. The coastal areas of the Ionian and the islands of the Eastern Aegean enjoy a milder climate than regions in Eastern Greece at similar latitudes, with differences of about 0.5-1.0^{o}C in mean annual temperature, while winters on the western coast are almost 3^{o}C warmer (Bank of Greece, 2011).

The warmest period is the last ten-day period of July and the first one of August, when the mean maximum temperature lies in the range of 29.0 and 35.0^{o}C. During the warm period the high temperatures are dampened from the fresh sea breezes in the coastal areas of the country and from the north winds blowing mainly in Aegean (etesian winds) (HNMS). In July and August, the daily maximum air temperature ranges between 32^{o}C and 36^{o}C, but can climb above 40^{o}C, as daily absolute maximum temperatures of over 45^{o}C have been recorded in certain areas of Central and Southern Greece (Bank of Greece, 2011). In Northern Greece there are days with frost (temperature below 0^{o}C). Days of partial frost, when the air temperature dips below $0^{o}C$ at some point during the day, are common in winter and early spring. Figure 2 shows the mean annual temperature in the country (data 1971-2000).

Based on the 6^{th} National Communication to the UNFCCC (Hellenic Republic, MEEC 2014), mean temperature during summer (April to September) is approximately 24°C in Athens and southern Greece, while lower in the north. Temperatures are higher in the southern part of the country (Figure 7).

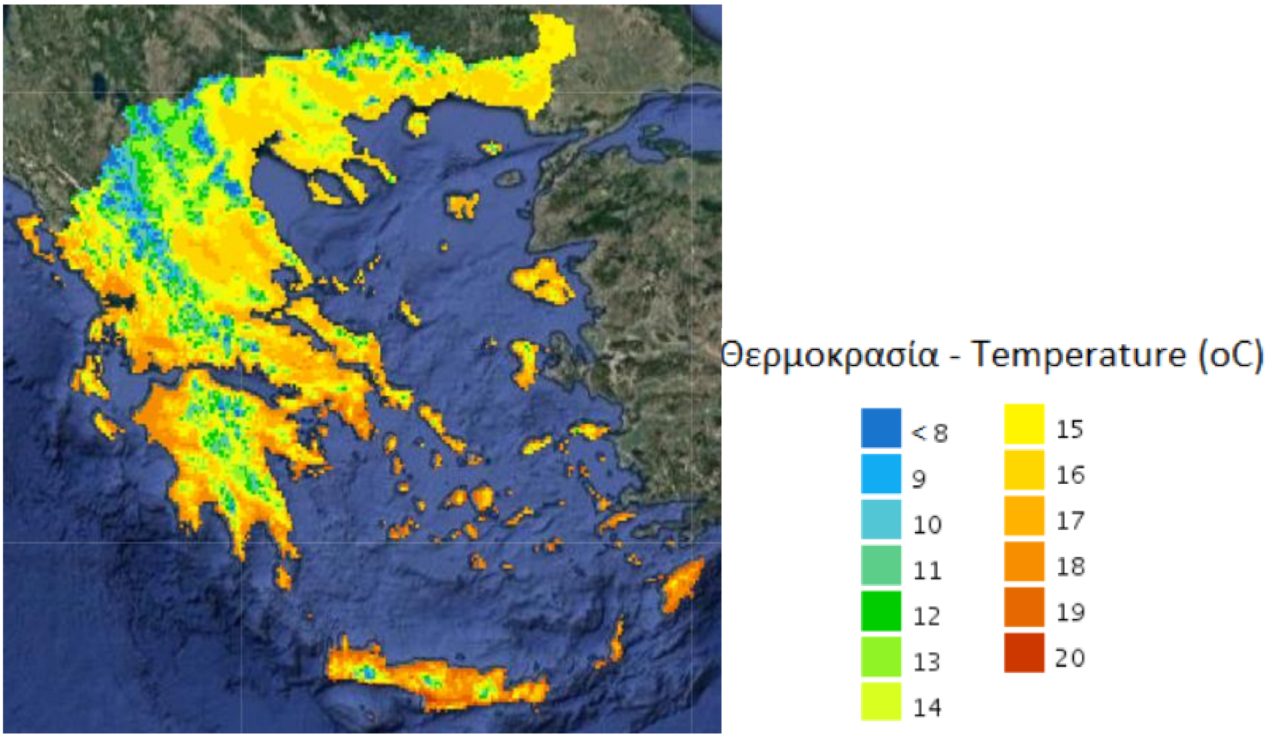


Figure 7. Mean annual temperature (1971-2000). Source: http://climatlas.hnms.gr/sdi/

Precipitation

The rainfall pattern typical of Mediterranean coastal areas is predominant, with dry spells in summer and a rainy season from mid-autumn to mid-spring (Bank of Greece, 2011). Rainfall distribution throughout the year tends to be more even in Northern Greece. Rainfall in Greece even in the winter, does not last a lot of days (HMNS). Winter bad weather days are often interrupted, during January and the first fortnight of February, with sunny days, well known as “Alkion days” in ancient times (HNMS). The winter is milder in islands of Aegean Sea and Ionian Sea than in the North and East Greece. Mean annual precipitation for Greece is roughly estimated at 800 mm, but the geographical distribution of the annual amount of precipitation and of the yearly rainy season generally follows Greece’s geomorphology (Bank of Greece, 2011). Rainfall is rare from June to August, where sunny and dry days are mainly observed.

Based on the study of Bank of Greece (2011) the mean annual precipitation received by Greece’s mountain ranges from 1,600mm (Peloponnese mountains) to 2,200mm (Pindos mountain). Mean annual precipitation reaches 1,000-1,400 mm in the Ionian Islands, 1,000-1,200 mm on the western coast of Epirus, and increases progressively with the gain in altitude up to 2,000 m, but then decreases sharply on the leeward eastern slopes of the mountains and on the Greek peninsula’s eastern side. Annual precipitation increases again somewhat, further east, in Evia and the Northern Sporades Islands, and in the mountains of Macedonia and Thessaly, but once again decreases over the Aegean coast. Figure 8 shows the mean annual precipitation in Greece for 1971-2000 (http://climatlas.hnms.gr/sdi/).

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

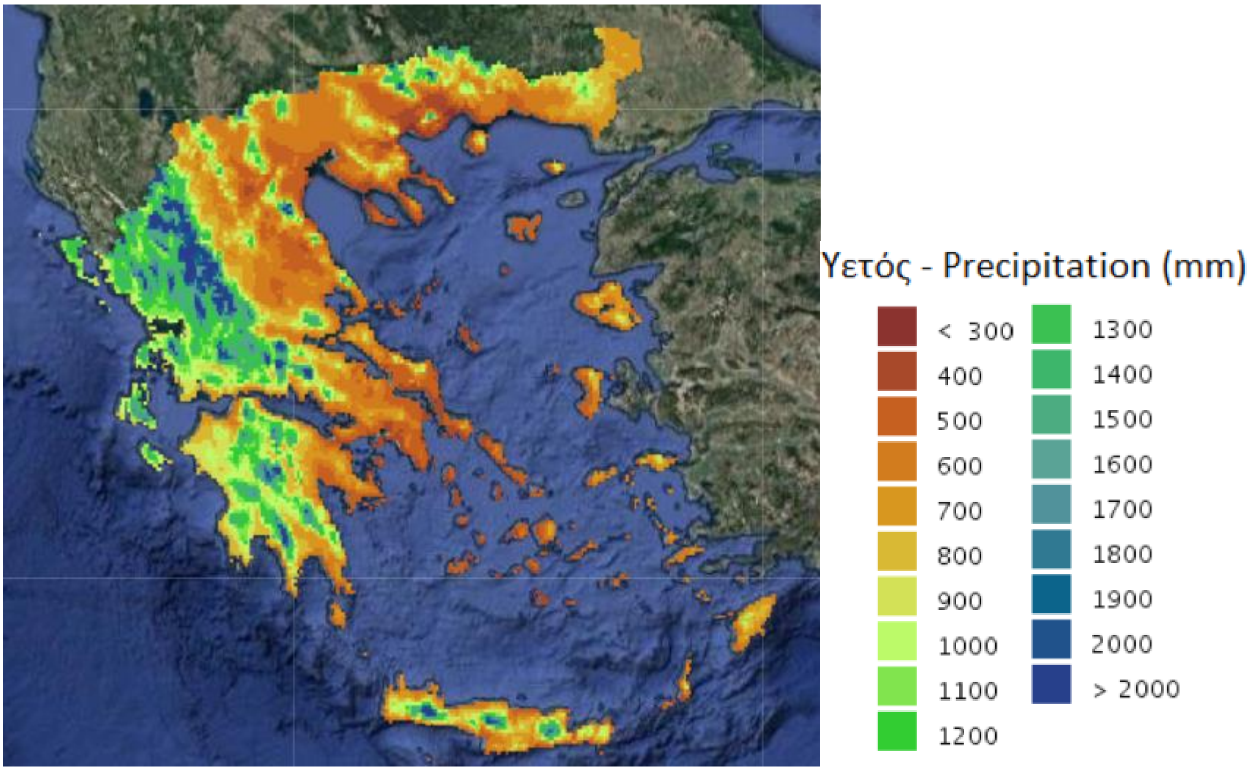


Figure 8. Mean annual precipitation (1971-2000). Source: http://climatlas.hnms.gr/sdi/

2.3 Climate change

Based on the data from the 6th National report to the UNFCCC (Hellenic Republic, MEEC 2014) temperature increased about 1°C in the last 500 years and 0.76°C in the last 100 years. It is found that mean annual temperature (2001-2013) is higher compared to the mean annual temperature of 1991-2000 in the meteorological stations in the country. It is also found that the mean annual temperature for 1991-2000 is higher than that of 1961-1990. It is estimated that the regional warming will be gradual in daytime maximum temperatures and night-time maximum temperatures. The increase is estimated to be 1 to 3°C in the near future (2010-2039), 3 to 5°C in the mid-century (2040-2069) and 3.5 to 7°C by the end of the century (2070-2099).

The study of Bank of Greece (2011) revealed that the mean annual temperature showed an increasing trend in Greece, following the increasing trend in the north hemisphere (Figure 9), up to 1970. Since 1990 and onwards the mean annual temperature shows an increasing trend in Greece too.

Regarding precipitation, a clear negative trend recorded for southern Europe and the Mediterranean (ECSN, 1995; IPCC, 1996; 2001). Rainfall in the Eastern Mediterranean decreased, with sizeable differences across regions and intense variability from year to year, depending on the topography. Regarding Greece, most regions experienced a negative trend in rainfall in the second half of the 20th century, statistically significant in some regions (Bank of Greece, 2011). In Greece, the negative trend in annual rainfall in the course of the 20th century ranges from 20% in Western Greece to 10% in Eastern Greece and can be attributed partly to the trend observed in the North Atlantic Oscillation (Bank of Greece, 2011).

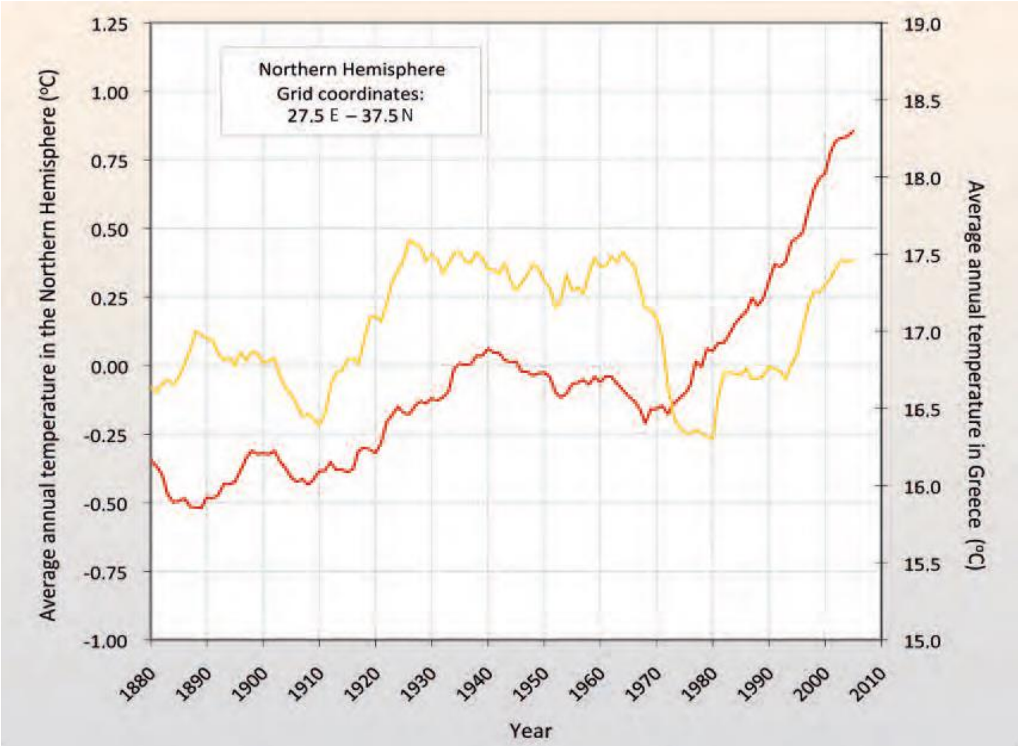


Figure 9. Mean annual temperature (yellow line: Greece, red line: north hemisphere) source: bank of Greece, 2011

Based on the study of Bank of Greece (2011), the Research Centre for Atmospheric Physics and Climatology of the Academy of Athens has developed model simulation datasets for Greenhouse Gas Emission Scenarios A2, A1B, B2 and B1. Based on these scenarios the mean annual temperature and the mean annual precipitation are estimated for 2071-2080, 2081-2090 and 2091-2100 (Tables 2&3). All climate simulation models show an overall mean warming in the country relative to the reference period 1961-1990. Scenario A2 provides higher temperature increase while scenario B1 provides the lowest temperature increase. The increase will be higher in the continental regions rather than the islands and greater in the summer and autumn compared to spring and winter. Temperature is expected to increase by 4.5°C (annually) under the scenario A2 while the increase in winter and spring will be 3.9°C, 5.4°C in summer and 4.7°C in autumn. Based on the scenario A1B all regions would have 1.5°C great temperatures in 2012-2050. Scenario B2 projections show an increase in temperature of 1.3°C lower than the projections of scenario A2. Scenario B1 projections estimate an increase in mean annual temperature (2091-2100) by 2.4°C. The temperature increase per decade for all scenarios is expected to be as follows:

Scenario A2: 0.5°C/decade; scenario A1B: 0.4°C/decade; scenario B2: 0.25°C/decade, scenario B1: 0.1°C/decade.

Table 2. Mean annual temperature in Greece for scenarios A2, B2; temperature difference ΔT; and temperature difference in % (relative to reference period 1961-1990) (source: Bank of Greece, 2011)

Periods	A2 T(°C)	B2 T(°C)	A2 ΔT	B2 ΔT	A2 (%)	B2 (%)
1961-1990	16.17±0.68	16.14±0.56				
2071-2080	19.58±0.80	18.81±0.67	3.41±0.42	2.66±0.19	21.1±2.8	16.5±1.0
2081-2090	19.93±0.82	18.94±0.71	3.76±0.49	2.80±0.34	23.3±3.2	17.3±2.1
2091-2100	20.64±0.80	19.25±0.72	4.46±0.38	3.11±0.39	27.6±2.6	19.3±2.5

Table 3. Mean annual rainfall in Greece for scenarios A2, B2; rainfall difference ΔR; and rainfall difference in % (relative to reference period 1961-1990) (source: Bank of Greece, 2011)

Periods	A2 R(mm)	B2 R(mm)	A2 ΔR	B2 ΔR	A2 (%)	B2 (%)
1961-1990	510.1±108.0	524.1±113.8				
2071-2080	442.7±112.9	497.4±108.6	-67.4±34.6	-26.7±50.2	-13.8±7.6	-4.6±9.8
2081-2090	397.1±99.6	475.7±109.0	-113.0±29.5	-48.4±36.4	-22.6±5.5	-9.2±8.2
2091-2100	437.7±126.6	525.2±138.0	-72.4±51.1	1.1±54.5	-15.2±10.9	-0.4±11.2

The climate model simulations showed that annual precipitation levels will decline in the country (Table 3) (Bank of Greece, 2011). Scenarios A2 and A1B are milder than scenario B2. Scenario A2 projections show a decrease in precipitation of 17% on annual basis in the whole country. Western continental areas and eastern Peloponnese are expected to have a decrease of 20% in precipitation values while the decrease will be 15-20% in the rest of the country except of the Northern Aegean where the decrease is expected not to exceed 10%. The decrease will be greater in summer compared to winter. According scenario A1B projections precipitation levels will decrease by about 5% in2021-2050 compared to the reference period. The precipitation decrease is projected to be greatest at the end of the century (19% decrease in 2071-2100). Based on the projections of scenario B2, precipitation decrease will be smaller.

Except of the temperature increase and the rainfall decrease, climate change impacts will also include extreme events such as maximum summer and minimum winter temperatures, warm days and warm nights, days with precipitation, frost days, energy demand for heating and cooling, forest fires and days with increased thermal discomfort (Hellenic Republic, MEEC 2014). Based on the climate scenarios the future variation of flood and landslide risk regimes presents an increasing trend. The number of warm days is expected to increase by 20 additional very warm days per year in Central Greece, Thessaly, Southern Peloponnese and Central Macedonia in 2021-2050 and up to 40 in 2071-2090 (relative to the reference period). The annual number of warm (tropical) nights (temperature not falling below 20^{o}C) is expected to increase in the whole country. Coastal and island regions are expected to have more tropical nights. In particular in Crete, the coastal regions of eastern Greece and the Aegean islands are expected to have 40 additional warm nights in 2021-2050 and 80 in 2071-2100. In Western Greece and the Eastern Macedonia-Thrace this number will be less than 30 in 2021-2050 and 70 in 2071-2100. In Western Macedonia the number of warm nights is 15 or less in 2021-2050 and 30 or less in 2071-2100 (Hellenic Republic, MEEC 2014; Bank of Greece, 2011).

Based on the same studies (Hellenic Republic, MEEC 2014; Bank of Greece, 2011) the annual maximum consecutive 3-day precipitation is projected to increase in Greece. This fact along with the decrease in precipitation, means that extreme precipitation events will increase in intensity resulting in higher flood risk. An increase in maximum consecutive 3-day precipitation of 20% is expected in eastern continental regions. The length is dry spells will increase having its largest values in Eastern Central Greece, Eastern Peloponnese and Northern Crete. There 20 additional consecutive dry days are expected in 2021-2050 and 40 in 2071-2100. Extreme fire danger days are also expected to increase by 20 in 2021-2050 and 40 in 2071-2100. In Western Greece small increase are projected. Finally, the number of days with increase thermal discomfort (humidex value above 38oC) are expected to increase in coastal and island regions mostly. In particular, in coastal regions of Ionian and Dodecanese the period with humidex over 38oC is projected to be 20 days longer in 2021-2050 and 40 days longer in 2071-2100. In Crete this period is projected to be 15 days longer in 2021-2050 and 25 in 2071-2100 while mountainous regions are not expected to experience changes (Hellenic Republic, MEEC 2014; Bank of Greece, 2011).

3 Water Availability - Climate Change Impacts on Water Resources

3.1 Water Demand (annually)

The total population in Greece is 10,815,197 people (2011 census). The number of tourists in Greece exceeds 30 million people (in 2017). The coastal areas and the islands are touristic areas with increased water demand during the summer. The dominant water user in Greece is agriculture (81.5%), followed by domestic water use (15.25%), industry (2.42%) and livestock farming (0.8%). The total water use per water district is shown in Figure 10.

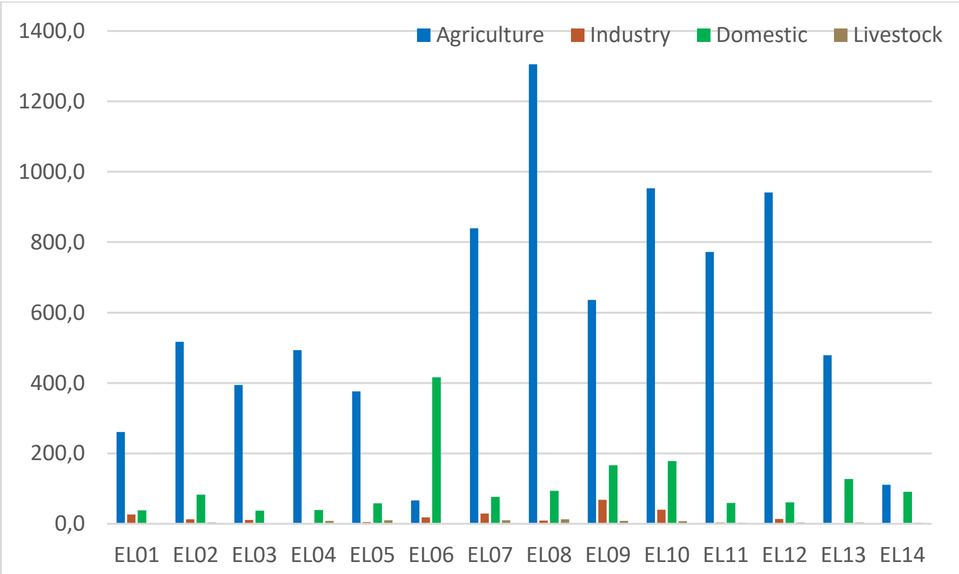


Figure 10. Water use per WD and per water user (in hm^3/year) (data gathered from the RBMPs, 2017)

The RBMPs revealed that there are water bodies at risk due to overexploitation.

3.2 Climate Change Impacts on Water Resources Availability

Climate change is expected to impact both on water and energy resources. Based on studies assessing climate change impacts on water resources (Hellenic Republic, MEEC 2014; Bank of Greece, 2011), these can be summarized to the following:

- Decreased rainfall will decrease aquifer infiltration and recharge;
- Increased temperature will impact on water resources evapotranspiration increase and increased water demand;
- Salinization phenomena will intensify at coastal aquifers;
- Pollutant load concentrations in coastal water bodies and the sea will increase;
- Faster degradation of deltaic regions, in cases where degradation has already begun as a result of transversal dam construction upstream;
- Water deficits will intensify desertification phenomena;
- Droughts determined by social factors such as population changes, population shifts, demographic characteristics, technology, government policies, environmental awareness, water use trends, social behavior, level of water development and/or exploitation, and water availability.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

3.3 Water Resources Availability

Using data from the RBMPs, the estimation of groundwater supply and water abstracted for all WDs took place. The results are presented in Table 4. Stressed groundwater bodies exist in Central Macedonia (EL10) where 80% of the available water from groundwater bodies is abstracted. Also, in Thessaly (EL08) 49% of the available water in groundwater bodies is abstracted.

Table 4. Groundwater supply and water abstracted in each WD (data are based on the RBMPs, 2017)

WD	Water Supply (hm^3)	Water abstracted (hm^3)				Total water abstracted (hm^3)	Water abstracted to water supply (%)
		Agriculture	Domestic	Industry	Livestock		
EL01	1905,00	222,85	41,08			263,93	13,85%
EL02	1611,00	353,24	72,70			425,94	26,44%
EL03	2110,10	365,26	32,46			397,72	18,85%
EL04	3072,00	130,13	28,78			158,91	5,17%
EL05	2461,50	95,80	66,40			162,20	6,59%
EL06	392,10	72,89	9,33	21,45		103,67	26,44%
EL07	2725,10	609,70	54,08	28,24	9,70	701,72	25,75%
EL08	1891,00	842,82	80,11			922,93	48,81%
EL09	1792,99	487,12	44,15	23,40		554,67	30,94%
EL10	940,68	612,81	106,57	33,10		752,48	**79,99%**
EL11	854,30	46,61	117,18	2,34		166,13	19,45%
EL12	981,98	226,04	57,08	2,39	4,00	289,51	29,48%
EL13	2172,31	443,81	88,21	0,48	2,10	534,60	24,61%
EL14	725,05	105,02	51,93	0,05	1,19	158,19	21,82%

To assess groundwater resources availability, WEI (Water Exploitation Index) index is used. WEI index is the rate of Water Demand (WD) to the renewable Water Resources (WR). WEI index has been estimated for all WD, both for total water use and for drinking water use. We studied 5 scenarios for water demand:

- Scenario 0: WD0 is the present water demand;
- Scenario 1: WD1 is the present water demand increased by 25%;
- Scenario 2: WD2 is the present water demand decreased by 25%;
- Scenario 3: WR future1 is the present renewable WR increased by 25%
- Scenario 4: WR future2 is the present renewable WR decreased by 25%

We also estimated six WEI indexes for each demand: total WD and drinking WD.

- WEI1= WD0/WR present
- WEI2= WD0/WR future1
- WEI3= WD0/WR future2
- WEI4= WD1/WR present
- WEI5= WD1/WR future2
- WEI6= WD2/WR future1

The results are presented in Table 5 (for all scenarios).

Table 5. WEI values (1;2;3;4;5;6) for the groundwater systems of each WD

	Total water use						Drinking water use					
	WEI1	**WEI2**	**WEI3**	**WEI4**	**WEI5**	**WEI6**	**WEI1**	**WEI2**	**WEI3**	**WEI4**	**WEI5**	**WEI6**
EL01	0.14	0.11	0.18	0.17	0.23	0.08	0.02	0.02	0.03	0.03	0.04	0.01
EL02	0.26	0.21	0.35	0.33	0.44	0.16	0.05	0.04	0.06	0.06	0.08	0.03
EL03	0.19	0.15	0.25	0.24	0.31	0.11	0.02	0.01	0.02	0.02	0.03	0.01
EL04	0.05	0.04	0.07	0.06	0.09	0.03	0.01	0.01	0.01	0.01	0.02	0.01
EL05	0.07	0.05	0.09	0.08	0.11	0.04	0.03	0.02	0.04	0.03	0.04	0.02
EL06	0.26	0.21	0.35	0.33	0.44	0.16	0.02	0.02	0.03	0.03	0.04	0.01
EL07	0.26	0.21	0.34	0.32	0.43	0.15	0.02	0.02	0.03	0.02	0.03	0.01
EL08	0.49	0.39	0.65	0.61	0.81	0.29	0.04	0.03	0.06	0.05	0.07	0.03
EL09	0.31	0.25	0.41	0.39	0.52	0.19	0.02	0.02	0.03	0.03	0.04	0.01
EL10	0.80	0.64	1.07	1.00	1.33	0.48	0.11	0.09	0.15	0.14	0.19	0.07
EL11	0.19	0.16	0.26	0.24	0.32	0.12	0.14	0.11	0.18	0.17	0.23	0.08
EL12	0.29	0.24	0.39	0.37	0.49	0.18	0.06	0.05	0.08	0.07	0.10	0.03
EL13	0.25	0.20	0.33	0.31	0.41	0.15	0.04	0.03	0.05	0.05	0.07	0.02
EL14	0.22	0.17	0.29	0.27	0.36	0.13	0.07	0.06	0.10	0.09	0.12	0.04

The WEI Index values calculated for the three aquifers are assessed based on the thresholds adopted in CCWaters project (Table 6). Up to 0.49 the system faces a low risk regarding its water availability. For values ranging from 0.5 to 0.69 there are possible difficulties, while for values ranging from 0.7 to 0.99 there is a strong risk. Systems with WEI values greater than 1, are not sustainable.

Table 6. WEI thresholds

WEI from - to		Comment
0	0.49	low risk
0.5	0.69	possible difficulties
0.7	0.99	strong risk
1		not sustainable

The results show that groundwater bodies are assessed at low risk regarding their availability. Exceptions include the groundwater bodies of Central Macedonia (EL10) being at strong risk at their present condition and are not sustainable when water demand increases, or available water resources decrease (Table 5). Thessaly groundwater bodies are at possible difficulties when water demand increases, and available water resources remain the same or when water demand remains, and available water resources decrease. When water demand increases, and available water resources decrease, then groundwater bodies are at strong risk (Table 5). Possible difficulties exist for the groundwater bodies of Western Macedonia when water demand increases, and available water resources decrease.

When only drinking water demand is taken into consideration, all groundwater bodies are found at low risk (Table 5).

4 Water Quality & Land Uses

4.1 Water Resources Quality Characteristics

All water bodies are assessed for their qualitative status in the RBMPs. In particular, surface water bodies are assessed for their ecological and chemical status while groundwater bodies are assessed for their quantitative and chemical status. The assessment methodologies can be found at the RBMPs and at http://wfdver.ypeka.gr/). The results showed that the majority of the rivers are found in good qualitative status (60.6%), while only 17.9% are found in moderate status and 14.5% in unknown status (Figure 11). The majority of the reservoirs are found to have an unknown qualitative status (45.5%) while 43.2% of them are found to be in good qualitative status. The majority of the lakes are found in be in moderate status (30%) and 20% of them in good status, while 26.67% of them are classified as unknown qualitative status (Figure 11). Transitional water bodies have unknown qualitative status (55%) while 22.5% of them are found to be in poor status. Finally, coastal water bodies have good qualitative status (41.2%) and high qualitative status (36.2%) (Figure 11).

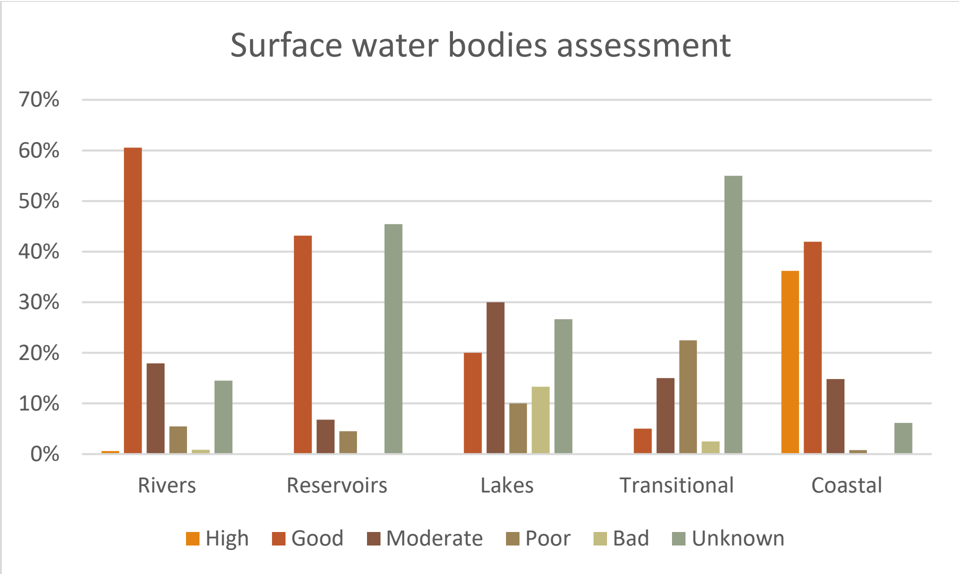


Figure 11. Surface water bodies qualitative assessment (data gathered from the RBMPs, 2017)

The assessment criteria for groundwater bodies are defined in the guidance documents provided by the European Commission (http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm). Groundwater bodies are assessed in two classification scales: good and poor. Based on the results from the RBMPs, groundwater bodies in Greece are found to be in good chemical status (84.75%) and good quantitative status (84.04%). Only 85 groundwater bodies are found in poor chemical status and 90 in poor quantitative status.

4.2 Land Use

The dominant land use in the country is forests (27.68%) followed by semi-natural vegetation (26.22%) and arable land (23.12%) (Figure 12). The biggest differences between 2000 and 2006 in land uses are met in open spaces (increased by 30%) and semi-natural vegetation (decreased by 22%). Forests are decreased by 15%, artificial areas are increased by 15% and pastures is reduced by 9% (Figure 13) between 2006 and 2012.

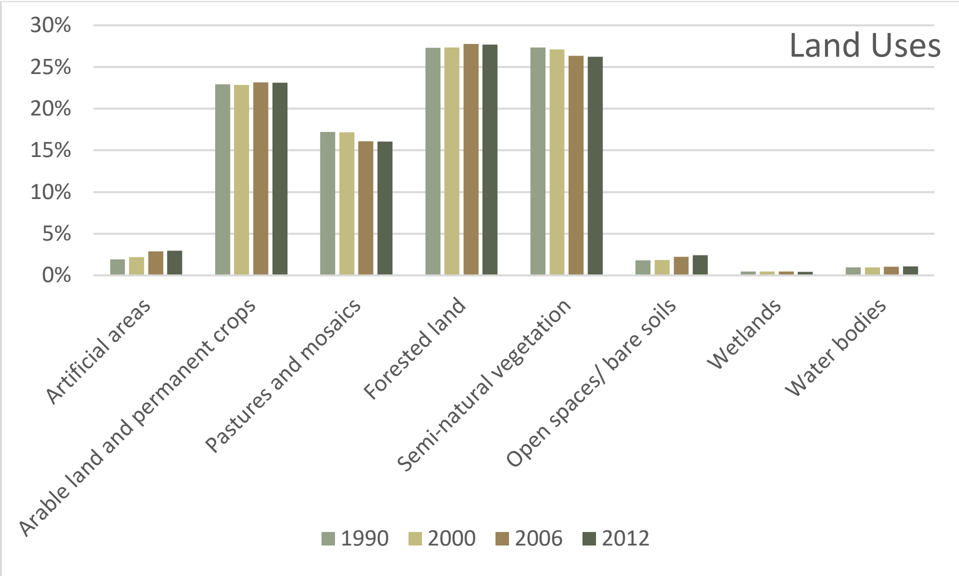


Figure 12. Land uses in Greece in 1990, 2000, 2006, 2012

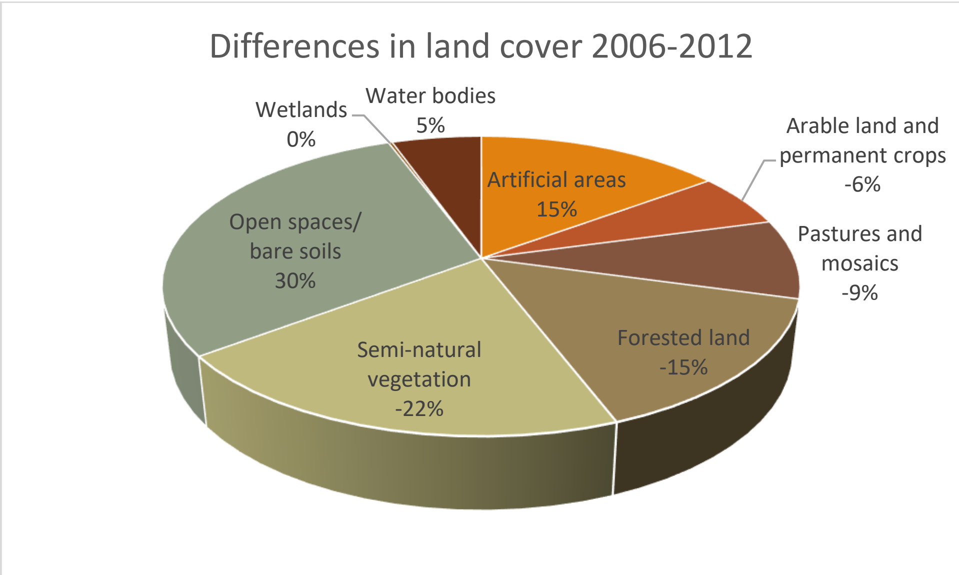


Figure 13. Difference in land uses in Greece between 1990 and 2000 (data from Corine Land Cover)

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

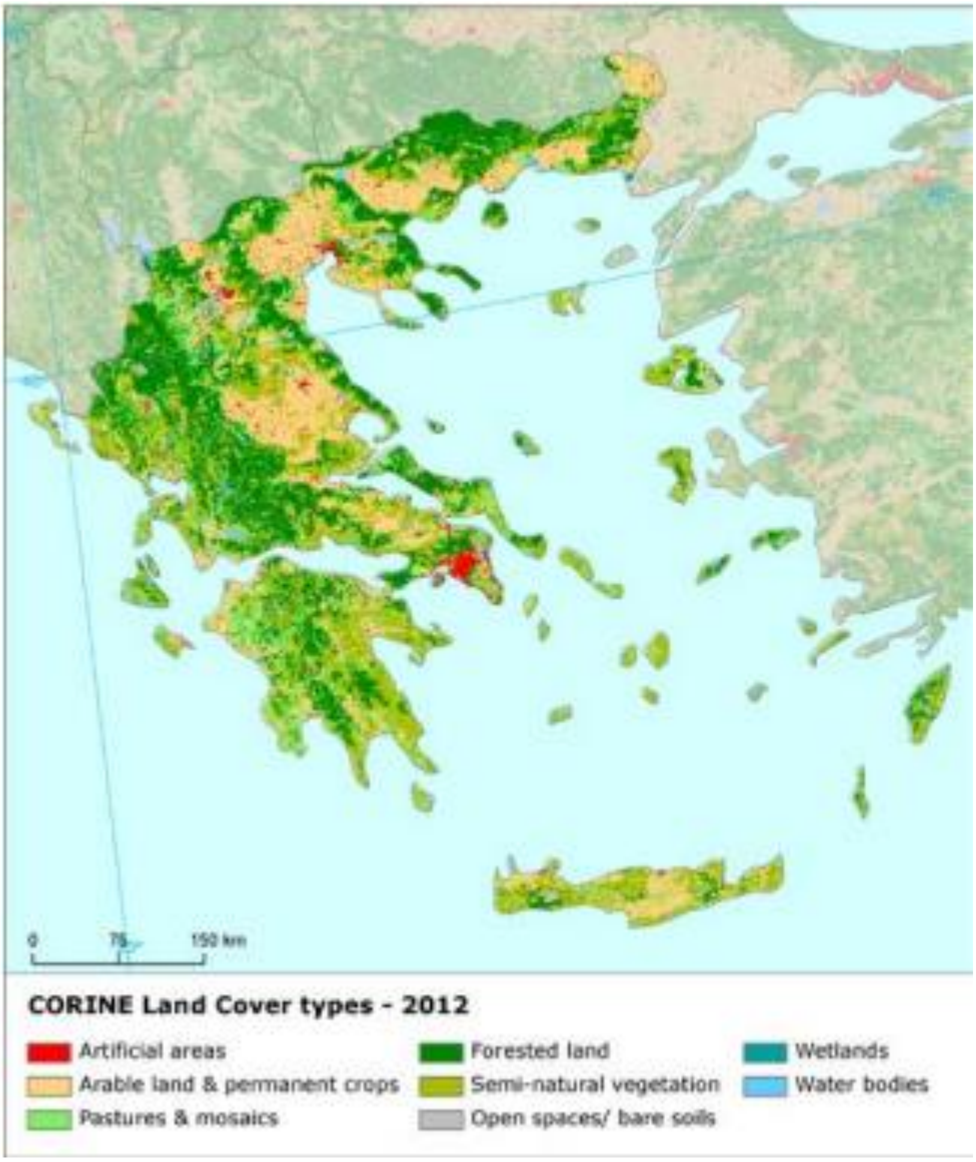


Figure 14. Land uses in Greece in 2012 (source: European Environment Agency)

4.3 DPSIR (Drivers, Pressures, Status, Impacts, Response) methodology

The DPSIR approach is followed to assess the impact of land use on water quality in the present state. Based on the land uses the predominant land use is forestry, followed by semi-natural vegetation and arable land. The DPSIR approach for agricultural activities, forestry, pasture, climate change and tourism is given in Table 7 below.

The DPSIR approach is also used for the assessment of the impact of land use changes on water quality. Climate change is expected to have an impact in the water quality. Land uses are expected to change but their variations are not expected to be big.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table 7: The DPSIR approach for land uses in Greece – present state

DRIVING FORCES	PRESSURES	STATE	IMPACT
Agriculture: use of fertilizers & pesticides	• Diffuse nitrogen contribution (runoff) • Nitrogen and phosphorus towards the aquatic environment	Groundwater and surface water quality deterioration	• Eutrophication • Contamination risks
Agriculture: irrigation	Water abstraction	Water quantity	Water shortage / drought
Urban areas: Sewage and wastewater	• Microbiological pollution • Pharmaceuticals • Heavy metals to groundwater	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Urban areas: transportation	Heavy metals and oil spills	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Industry	Pollutants in groundwater & surface water	Groundwater and surface water quality deterioration	• Contamination risks • Public health risks
Forestry: loss of trees due to urbanization & temperature increase	• Climate change conditions • Higher temperatures • Drought periods • Forest fires	Deforestation	Loss of forest cover; erosion process (may affect water quality)
Climate Change	Land uses	Increased temperature; decreased precipitation	Drought conditions Water unavailability
Tourism	• Land uses • Construction • Wastewater and solid waste	Limited cultivated land Pollutants in groundwater and surface water	• Contamination risks • Public health risks • Climate change

RESPONSE

European Legislation: WFD 2000/60/EC; Drinking Water Directive 98/83/EEC; GW directive 2006/118/EC; Urban Wastewater Treatment Directive 91/271/EEC; Nitrates Directive 91/676/EEC; Environmental Impact Assessment 85/337/EEC; Special Protection Zones Directives 92/43 & 2009/147/EC

Greek Legislation: Law 3199/2003; JMD Y2/2600/2001; PD51/2007; JMD 146896/2014; Law 4117/2003; JMD 146896/2014; MD 39626/2208/E130/2009; River Basin Management Plans; MD 85178/820/2000; JMD 161690/1335/1997; JMD 5673/400/1997; JMD 191002/2013; JMD 145116/2011; MD 33318/3028/1998; 37338/1807/E.103

Measures: Water Safety Plans; Drinking Water Masterplans; Drinking Water Protection Zones

5. SWOT Analysis

Strengths and weaknesses related to climate change impact on water resources in Greece are:

- Strengths: good qualitative status of water bodies; good quantitative status of groundwater bodies; institutional framework in place; RBMPs.

- Weaknesses: decreased precipitation; increased temperature; high water demand for irrigation; salinization phenomena; artificial land uses increase.

Opportunities and threats the country is facing in the European environment related to climate change impact on water resources include:

- Opportunities: implementation of WFD; adaptation measures for climate change.

- Threats: climate change.

References

Bank of Greece, 2011. The Environmental, Economic and Social Impacts of Climate Change in Greece. Climate Change Impacts Study Committee. ISBN 978-960-7032-58-4

ECSN, 1995. European Climate Support Network, KNMI, De Bilt.

Hellenic Republic, Ministry of Environment, Energy and Climate Change, 2014. 6th National Communication and 1st Biennial Report under the United National Framework Convention on Climate Change.

IPCC, 2001. Climate Change 2001: The Scientific Basis. in Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell and C.A. Johnson (eds), Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 881

River Basin Management Plans (updated) for all WDs, available at: http://wfdver.ypeka.gr/el/management-plans-gr/1revision-approved-management-plans-gr/

Hellenic National Meteorological Service, http://www.hnms.gr/emy/el/climatology/climatology

http://climatlas.hnms.gr/sdi/

http://www.statistics.gr/en/2011-census-pop-hous

http://www.ypeka.gr/Default.aspx?tabid=225&locale=en-US&language=el-GR

http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

https://www.eea.europa.eu/themes/landuse/land-cover-country-fact-sheets/gr-greece-landcover-2012.pdf/view?utm_source=EEASubscriptions&utm_medium=RSSFeeds&utm_campaign=Generic

https://www.eea.europa.eu/themes/landuse/land-cover-country-fact-sheets/gr-greece-landcover-2012.pdf/view?utm_source=EEASubscriptions&utm_medium=RSSFeeds&utm_campaign=Generic

https://upload.wikimedia.org/wikipedia/commons/2/21/EU-Greece.svg

http://ec.europa.eu/environment/water/water-framework/facts_figures/pdf/River%20Basin%20Districts-2012.pdf

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.4.1 Climate change impacts assessment report** *Questionnaire*
Project Beneficiary No	**PB4**
Beneficiary Institution	**Municipality of Kardjhali**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

Name of the organization/institution: Municipality of Kardjhali
Beneficiary number: PB4

1 Introduction

region (water basin): Water basins description

Rivers:

- Arda river – 241 km length and 5201 m2 km catchment area;

Water dams:

- Kardjali dam – 532,9 . 10^6 m3 total volume;
- Studen cladenets dam – 489,10 . 10^6 m3 total volume;

- Area

  6 492,7 km2;
- Altitude range

  200m minimum; 1463m maximum;
- Morphology

  Mountainous and hill;;
- Aquifer types

  Groundwater (karstic, mineral, artesian); surface water;
- Geology

  Metamorphic, magmatic, sediment rock formations;

2 Climate characteristics and Climate change

- Precipitation values

Annual precipitation 1961-1990, mm	Annual precipitation 2038(realistic scenario), mm	Annual precipitation 2038(pessimistic scenario), mm
720	680	640
Summer precipitation 1961-1990, mm	Summer precipitation 2038(realistic scenario), mm	Summer precipitation 2038(pessimistic scenario), mm
180	145	115

- Temperature values

  Average January from -1 to +1°C; average annual +24°C;
- Existing hydrological monitoring

  Surface water monitoring for physico-chemical indicators, priority substances and specific pullutants; tap water monitoring; underground water monitoring for basic and additional physicochemical indicators;

- Available hydrological data
- Arda River is the largest Rhodope River and one of the largest tributaries of the Maritsa River. It and all and its tributaries are characterized by great torrenteousness, due to the combination of continental and Mediterranean climate influences.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

The favorable topographical and hydrological conditions on the one hand and the development of agriculture by another have created prerequisites for the implementation of a significant and varied hydro-technical construction in the river basin.

Climate change is the shift in the average weather, or weather trends that are experienced over decades or longer.

Observations in the 20th century indicate rapid climatic change. A growing body of evidence indicates that the Earth's atmosphere is warming in a trend consistent with a changing climate.

Climate change affects water more than any other resource.

It leads to an **intensification of the hydrological cycle**, resulting globally in dryer dry seasons and wetter rainy seasons, and subsequently heightened risks of more extreme and frequent floods and drought.

It also has significant impacts on the **availability of water**, as well as the quality and quantity of water that is available and accessible.

Climate change projections for Central Region of Bulgaria

Date sources

In order to assess the impact of climate change on water supply and sewerage systems in Bulgaria, the following data were used:

Current conditions:

- Monthly and annual average precipitation (interpolations of observed data, representative of 1950-2000) – Source: WorldClim – Global Climate Data – http://www.worldclim.org/
- Monthly and annual average temperature (interpolations of observed data, representative of 1950-2000) – Source: WorldClim – Global Climate Data – http://www.worldclim.org/

Future conditions:

The Intergovernmental Panel on Climate Change (IPCC) brings together the available scientific and socio-economic information on climate change and on methods for its mitigation and for adaptation to its consequences. It was appointed in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environmental Programme (UNEP). Since 1990, the IPCC prepared a series of reports that are now standard works of reference frequently consulted by political decision makers, researchers and other experts.

In 2000, the IPCC published The Special Report on Emissions Scenarios (SRES) that describes six emission scenarios now commonly used with global climate models (IPCC, 2000) (Exhibit Cl-7). The SRES scenarios cover a wide range of the main drivers of future emissions, from demographic to technological to economic developments. None of the scenarios includes future policies that explicitly address climate change.

The medium (A1B) emission scenario is generally considered as representative of the climate futures we could reasonably expect to face. It represents medium emission pathways based on projected total emissions in 2100. The following analysis was performed with this scenario and the following data were collected from IPCC website:

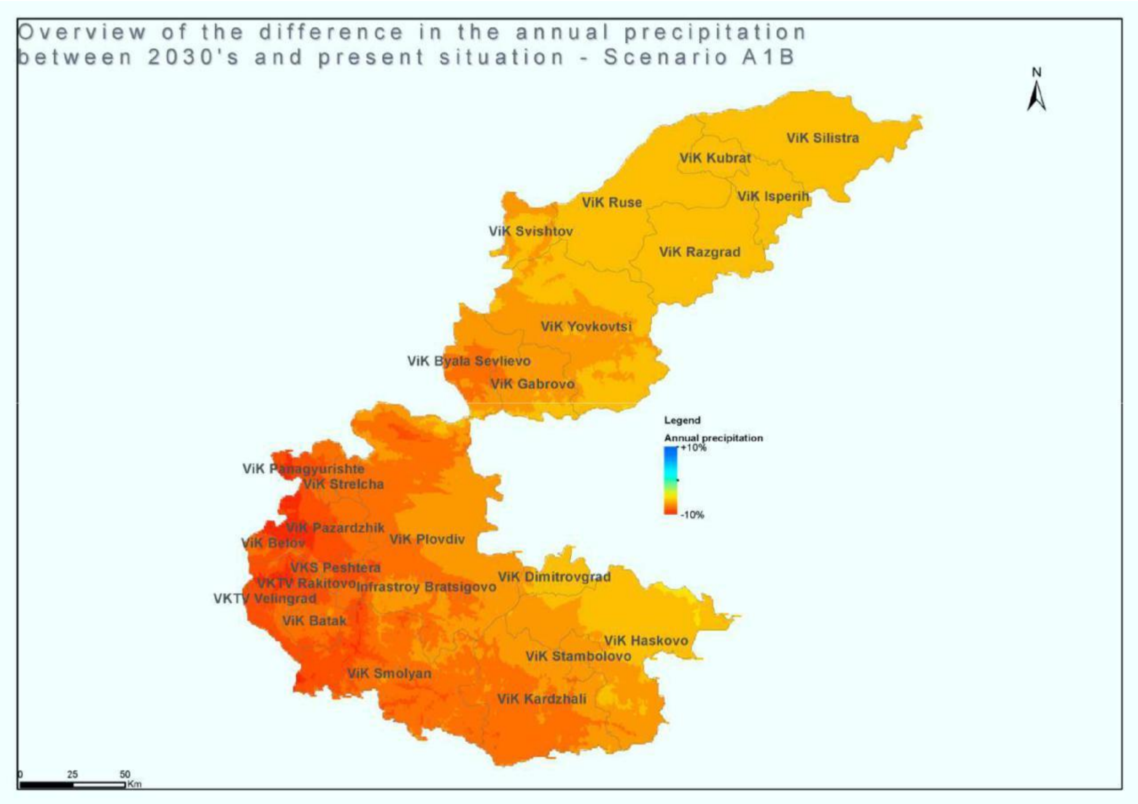
- Monthly and annual average precipitation in 2030's – Scenario A1B – Source: IPCC 4 – CIAT – http://www.ccafs-climate.org/data/

- Monthly and annual average temperature in 2030's – Scenario A1B – Source: IPCC 4 – CIAT – http://www.ccafs-climate.org/data/

Change in precipitation

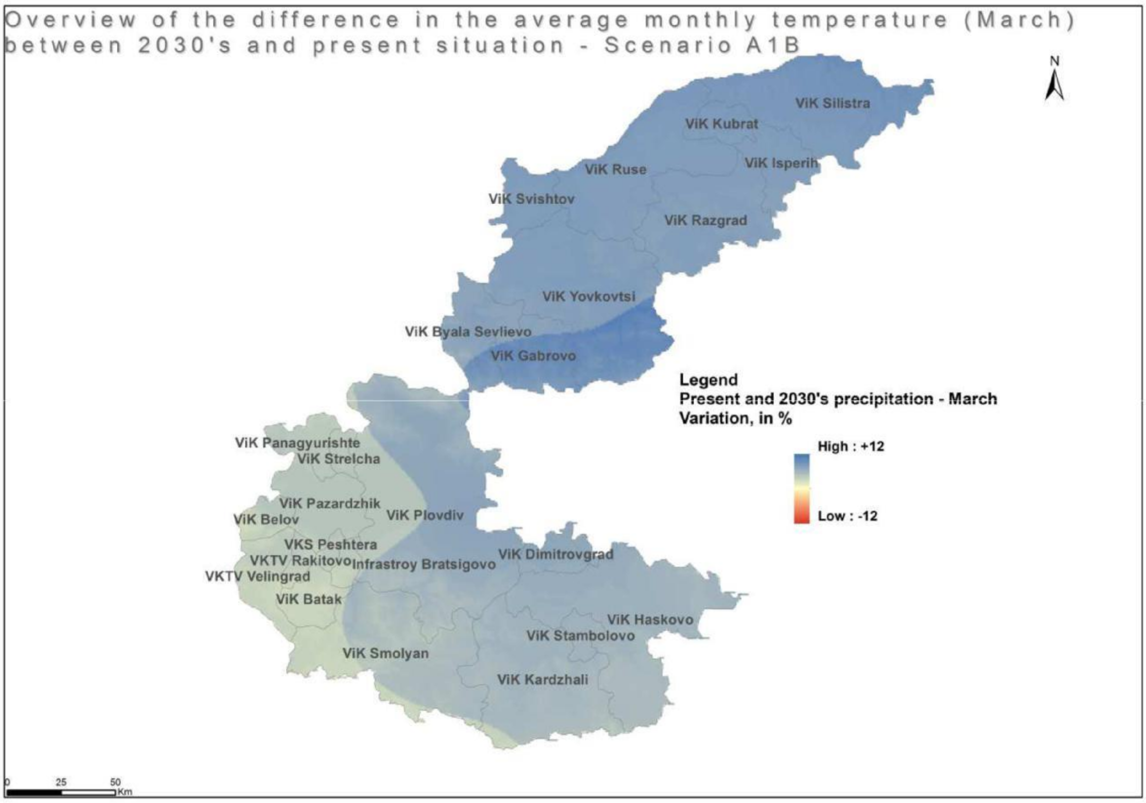
Annual precipitation and water deficit

The following figure emphasizes the variation of annual average precipitation between current and future conditions (scenario A1B – 2030's) in %.

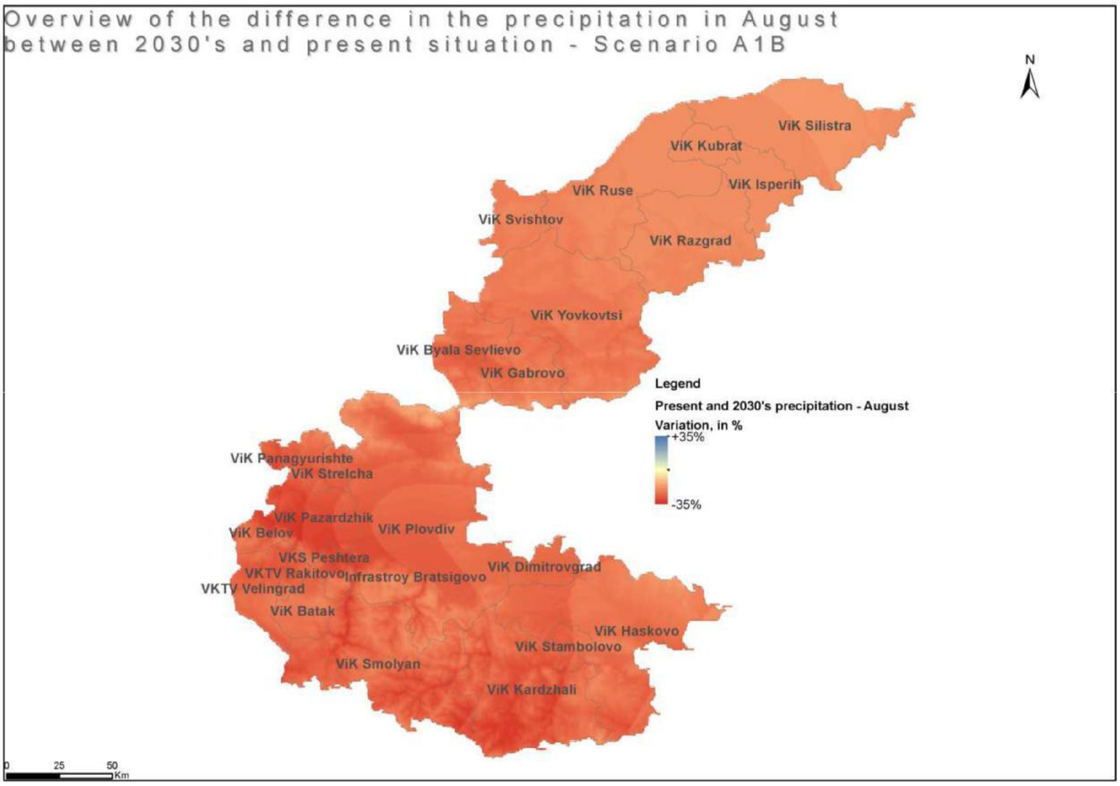


The average **annual precipitation** in current conditions over the study area is assumed to be **613 mm**, against **573 mm** in **2030's**, equivalent to a **decrease of 6.6 %**.

The corresponding total annual water deficit over the study area is approximately 1,500 Mm



The following figure shows the repartition of the decrease in the monthly precipitation in August. Higher increase is expected in high and steep areas.



Extreme events

According to IPCC, **extreme events are closely associated with changes in temperature and precipitation**, and with the frequency of events.

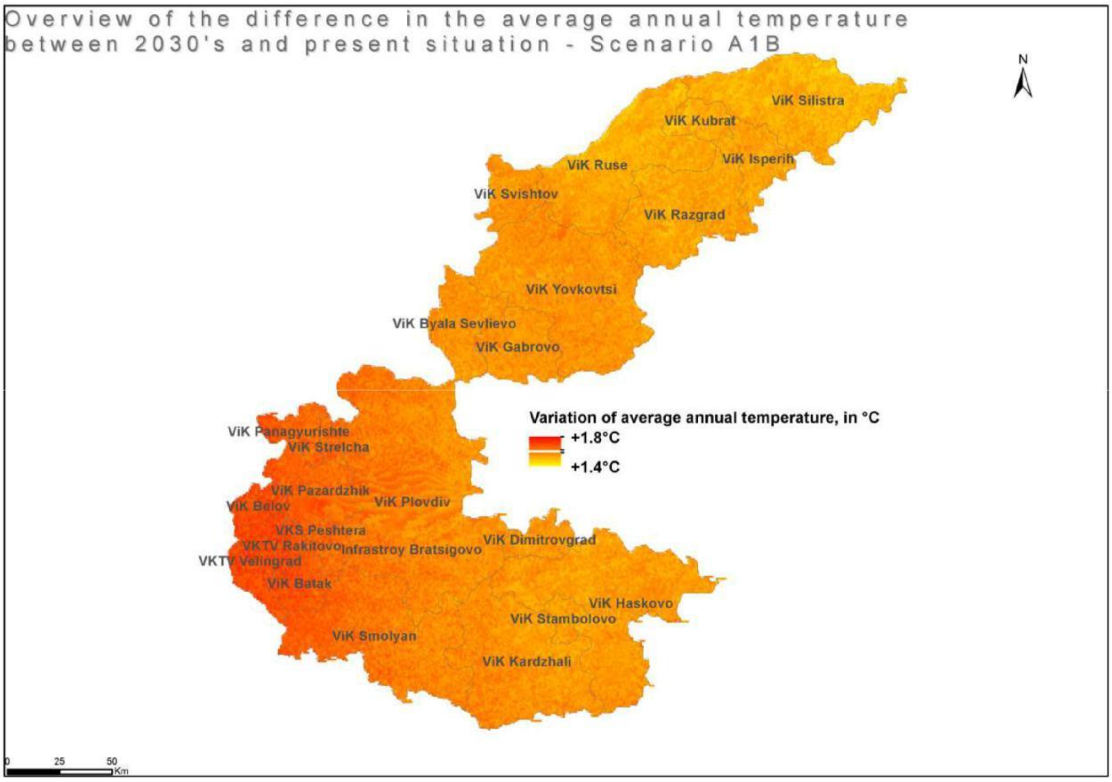
Widespread increases in heavy precipitation events (e.g., above the 95th percentile) have been observed, even in places where total amounts have decreased. These increases are associated with increased atmospheric water vapor and are consistent with observed warming.

Precipitation is therefore projected to be **concentrated in more intense events**, with longer periods of lower precipitation in between. **It is likely that heavy precipitation events will become more frequent**. Intensity of precipitation events is also projected to increase.

Change in temperature

Annual average

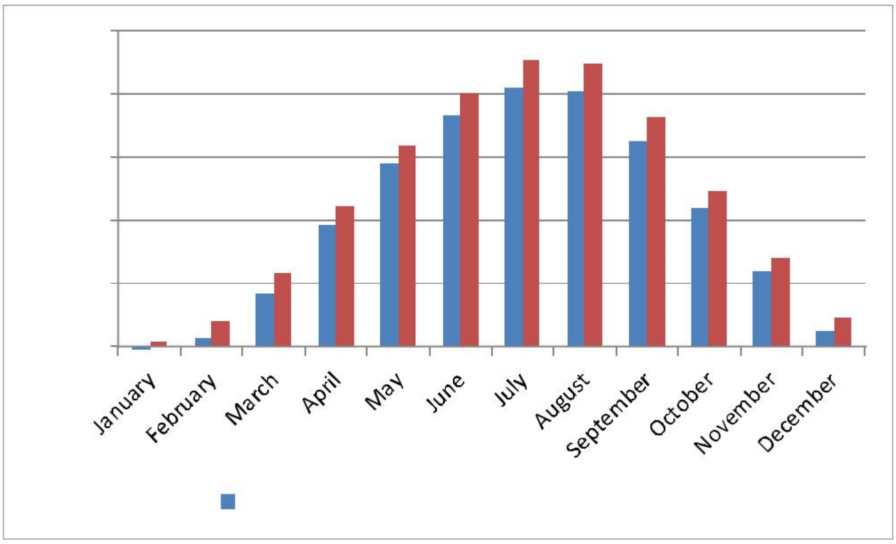
The following figure emphasizes the variation of average annual temperature between current and future conditions (scenario A1B – 2030's) in °C.

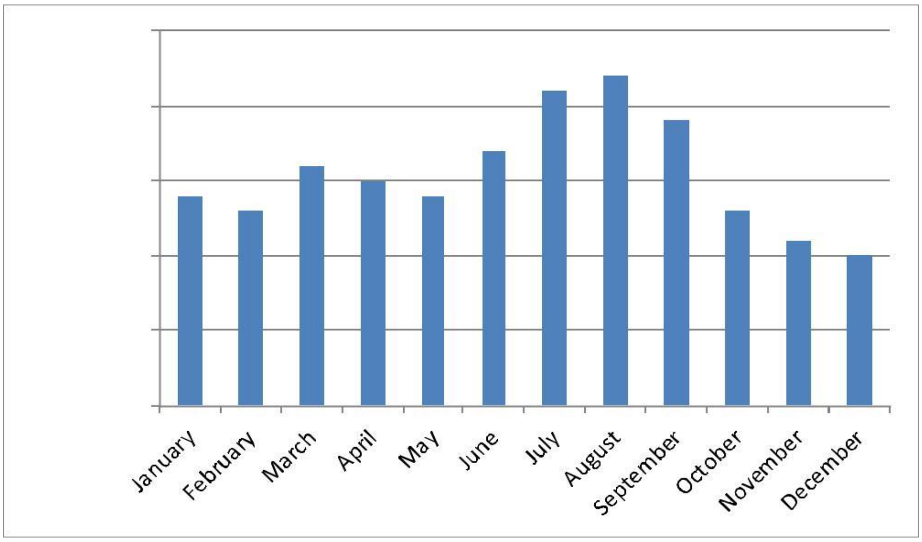


The average **annual temperature** in current conditions over the study area is assumed to be **10.1°C** , against **11.7 mm** in **2030's**, equivalent to an **increase of 1.6°C** which is quite homogeneous over the study area (see previous figure).

Seasonal variability

The increase in temperature is very dependent on the season, as shown in the following f

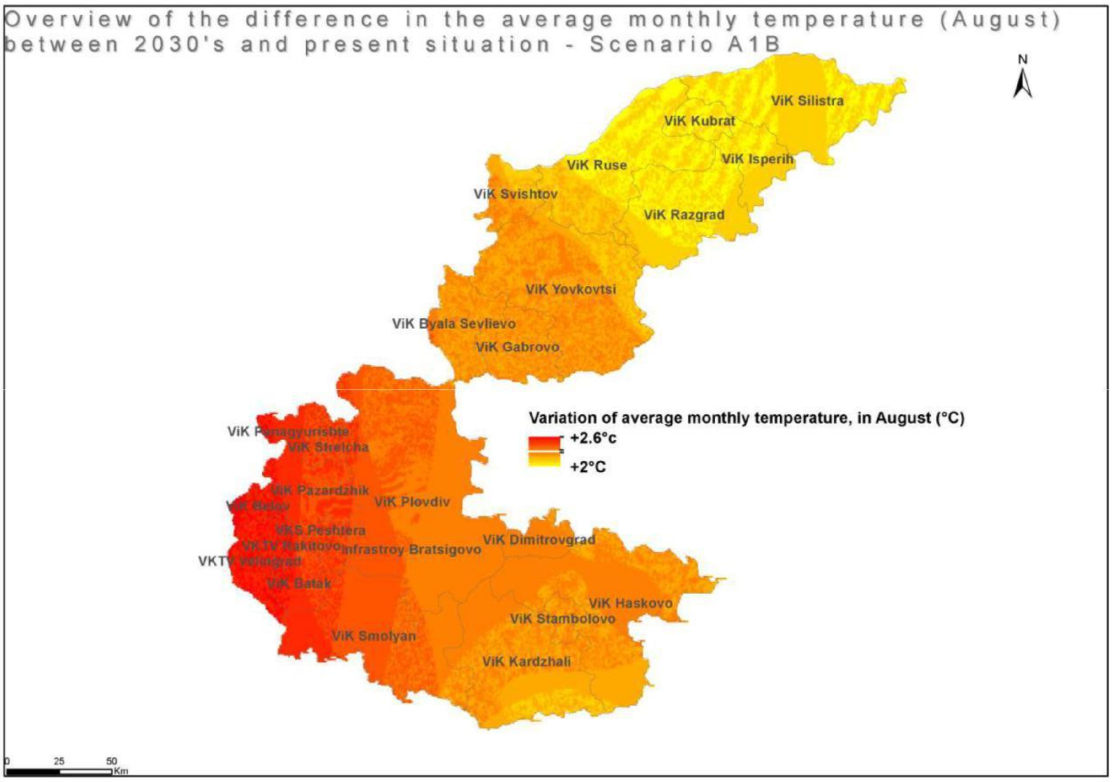




Two periods can be distinguished:

- From October until May, a quite constant increase in the average monthly temperature, between 1 and 1.5°C.
- From June until September, a significant increase is expected (from 1.5 to 2.2°C), which could lead to **serious drought events and consequent problems in relation with water resource quantity and quality.**

The following figure shows the repartition of the increase in the monthly precipitation in August. Bigger increase is expected in high and steep areas.



3 Water Availability - Climate Change Impacts on Water Resources

Impacts on water supply systems

Climate change will impact drinking water systems by altering the quantity and timing of water availability, changing water quality, and flooding related to extreme events.

Impacts on drinking water systems can be considered in two categories in the context of Central Region of Bulgaria:

Water availability

- **Changes in quantity of annual runoff**. Decreases in precipitation and increases in temperature, which were highlighted herebefore and are quite consistent from one to another climate model, are projected to lead to runoff decreases in Bulgaria. This is expected to reduce supplies in those geographies, causing drinking water utilities to seek additional water supply and management options to fill the gap between supply and demand.

- **Changes in runoff timing**. Not only will runoff quantity change, but the timing will also shift as a result of changes in precipitation timing and the melting of snowpack. These shifts will affect the amount of water that utilities can capture in current reservoir and conveyance systems.

Water treatment associated with water quality changes

- **Changes in maximum temperature**. Temperature increases may lead to increases in disinfection by-products (DBPs) and the incidence of algal blooms, leading to toxicity and taste and odor problems.

Impacts on sewerage systems

Climate change will impact wastewater utilities on a number of fronts:

Extreme storm events and overall precipitation increases will drive the need for wet weather program enhancements:

Changes in precipitation quantity and timing. Changes in the frequency and intensity of precipitation events are assumed to correlate with changes in wet weather program capital costs related to wastewater collection and treatment systems. Wet weather programs aim to reduce the volume and frequency of untreated sewer overflows, including combined sewer systems and separate sanitary sewer systems. It is important to note that in the Central Region of Bulgaria, despite the projected decrease in annual precipitation, the intensity of storm events is expected to increase, but the existing models diverge strongly and it is very difficult to assess quantitatively the impact of climate change on extreme storm events.

Effluent quality considerations such as temperature will lead to investments at treatment plants:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- **Changes in maximum temperature and other environmental variables**. Higher temperature effluent from wastewater treatment may have detrimental effects on aquatic life fisheries, requiring cooling and additional treatment of wastewater discharge. In addition, reduced summer river flows, in relation with the decrease in summer precipitation, increase the proportion of wastewater flow in a stream and may lead to stricter effluent water quality requirements for constituents such as dissolved oxygen, total dissolved solids, and nutrients. Strategies to deal with the increased degradation of receiving water quality are likely to be greater treatment of effluent prior to discharge.

Flood protection adaptation measures such as levees or retention zones will be needed to address rising floods associated with increased extreme precipitation and runoff:

- **Increased flood events**. To enable flow by gravity, many wastewater treatment plants and collection systems are in areas prone to flooding during extreme precipitation events. Anticipated increases in the frequency or magnitude of these events may put critical infrastructure at risk.

A. Water demand (annually)

- Number of inhabitants in the area

  152 808
- Number of tourists in the area
- Main tourist places in this area are Kardzhali district. During touristic season the population in these places increases two times.

Tourism in Kardjali Province		
	Winter	Summer
	68254	89356
Total	157 610	

- Annual water consumption

Water supply [l/p/d]	2009			2010		
	domestic	**industrial**	**total**	**domestic**	**industrial**	**total**
Ardino	107	0	**107**	107	0	**107**
Dzhebel	120	0	**120**	120	0	**120**
Kardzhali	96	26	**122**	96	26	**122**
Krumovgrad	128	0	**128**	129	0	**129**
Momchilgrad	130	0	**130**	126	0	**126**
Average Kardzhali Water Utility	**83**	**0**	**83**	**83**	**0**	**83**

- Identify possible problems in water use

  Quality: Most of the surface water is from mountain sources and therefore the chemical and microbiological composition is constantly changing. These waters are rich in organic substances

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

which causes to high levels of turbidity and color. In case of intense snow melting, rainfalls and other adverse climatic conditions, the physico-chemical or microbiological parameters exceed the limit values.
Quantity: The dynamics of household consumption tended to decrease in the period 2008 - 2010. The household consumption level in the region, measured in liters per person per day. The dynamics of consumption for business is influenced by the economic crisis. The water consumption for business in the region, measured by the amount of water consumed to create BGN 1000 is lower than the average for the country.

4 Water Quality & Land Uses

A. Water Resources quality characteristics

- Characteristics of water quality monitoring

The EU Drinking Water Directive (98/83/EC) sets quality standards for drinking water quality at the tap (microbiological, chemical and organoleptic parameters) and the general obligation that drinking water must be wholesome and clean. Annex 1, Part A determines microbiological parameters, part B chemical parameters and part C is required only for monitoring purposes.

The EU Drinking Water Directive is transposed in Bulgaria through a number of statutory documents, where the main one concerning water quality parameters, is Ordinance № 9/16.03.2001.

A water quality monitoring system is established in the regional water company i.e. ViK OOD – Kardzhali, which corresponds to the requirements of Ordinance № 9. The state water quality monitoring system includes regional environmental authorities (RIEW), operating within the Ministry of Environment and Water and health authorities (RHI), operating within the Ministry of Health. Additional operational monitoring is conducted by the Ministry of Regional Development and Public Works as a principal of the regional water company.

To identify the ecological and chemical status of surface water, physico-chemical monitoring is carried out in the following points of the designated territory:

- Varbitsa River at the village of Varli Dol;
- Kumovitsa River – before the mounth;
- Byala River – the village of Meden Buk;
- Kardzhali Dam;
- Studen Kladenets Dam - wall.

14 points for operational monitoring are identified on the territory controlled by Haskovo RIEW in 2011 - 11 on rivers and 3 on dams, and the study area of Kardzhali District includes the following points:

- Arda River upstream of Kardzhali Dam;
- Arda River downstream of the town of Kardzhali;
  Arda River downstream of Studen Kladenets Dam (bridge of the villages Potochnitsa and Rabovo);
- Varnitsa River upstream of Studen Kladenets Dam;

- Byala River before the border;
- Studen Kladenets Dam – middle part;
- Studen Kladenets Dam – tail.

Microbiological and physico-chemical monitoring is carried out in these points in order to determine the ecological and chemical status of surface water.The most significant polluter of surface water bodies in the area of Haskovo RIEW are the sewerage systems of the settlements. At the end of 2010, the deadline for construction of UWWTPs in settlements with more than 10,000 inhabitants has expired. On the territory of ViK OOD-Kardzhali, this is Kardzhali agglomeration. By the end of 2014, UWWTPs should be constructed for settlements with between 2,000 and 10,000 PE - Momchilgrad Krumovgrad, Ardino Dzhebel and the village of Benkovski (Kirkovo Municipality). However, the construction of WWTP has not been started for any of them. Wastewater from these settlements is still discharged into receiving rivers without being treated.
The deterioration of water bodies in many cases is due to discharge of wastewater as a result of business activity.
The following table provides more data on domestic and industrial wastewater as a source of surface water pollution.

Table 1 – Domestic and industrial wastewater – source of pollution.

River Basin	Source of Pollution	Volume of Wastewater discharged into receiving water body [million m³/year]	Pollution load discharged into receiving water body [kg BOD/year]	Assessment in compliance with the wastewater discharge permit (degree of treatment)
Arda River	The town of Kardzhali – urban collector	3.53	1,641,613	Ttreated. Kardzhali UWWTP is constructed.
	Industry	1.11	No data	Kardzhali Lead and Zinc Works, Gorubso, Bentonit, etc. LWWTP
Varbitsa River	The town of Momchilgrad	0.528	247,005	Treated. Momchilgrad WWTP is constructed.
	The village of Benkovski	0.114	43,817	Not treated. WWTP is to be constructed.
Ardinska River	The town of Ardino	0.246	109,390	Not treated. Ardino WWTP is to be constructed.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Krumovitsa River	The town of Krumovgrad	0.377	160,577	Not treated. Krumovgrad WWTP is to be constructed.
Dzhebelska River	The town of Dzhebel	0.180	94,831	Not treated. Dzhebel WWTP is to be constructed.
	Domestic solid waste landfill	No data	No data	No studies on the quality and quantity of infiltrated water. The existing landfills are subject to closure
	Agriculture	No data	No data	No data

For established violations - lack of treatment facilities, poorly functioning wastewater treatment plants, non-observance of the standards in the discharge permits, etc.., the responsible legal entities have been fined and issued penalty orders.

Excess values of the analysed parameters were found during inspection and periodic sampling of wastewater: meat processing plant - Musan OOD, the village of Valkovich, Dzhebel Municipality, industrial factory for rubber products - Teklas Bulgaria AD, Kardzhali, S&B Industrial Minerals AD, Kardzhali, Goroubso Kardzhali AD, Tufi Story OOD, Kardzhali, Izvor AM OOD, Delyo Voyvoda Milk OOD - dairy, the village of Dobromirtsi, Kirkovo Municipality.

The largest number of warnings and complaints for water pollution received by Haskovo RIEW are related to the activity of brandy stills and animal farms located both in towns and villages.

№	Water abstraction	Water body	Water supplied civil area	Physico-chemical characteristics	Microbiological characteristics
1	Borovica dam	Borovica dam	Kardzhali, Momchilgrad and 47 settlements in the municipalities of Kardzhali, Momchilgrad and Chernoochene	1	1
2	River catchment - the River Kosma dere	River Kosma dere	village of Raven	1	1

Surface water used for domestic and drinking water demand

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Underground water bodies – Arda River basin

№	Layer	Old code	New code	Name
1	Quaternary	none	BG3G000000Q010	Pore waters in the Quaternary - Arda River

Quantity of groundwater

- **Primary waters** are the waters formed in the first waterworks below the horizontal surface, which is why they are not pressured. Their regime is determined by the rainfall regime and the surface running water. The most favorable conditions for their formation exist in flooded river terraces and cone-shaped cones.
  There are two distinct phases in the ground water regime - low and high. The high-level valleys ranges from February to June. The low-level phase includes the July-December period. The average monthly maximum is in March and the average monthly minimum is in September and October.

- **Mineral waters:** These waters have a favorable physiological effect on the human organism with the dissolved salts, gases, rare elements, temperature, etc.. They can be both cold and warm, both with high and low mineralization. Depending on the thermal level, the mineral sources are divided to:
  - Cool (hyperthermal temperature up to 20C)
  - Warm (20-370C)
  - Hot (hyperthermal temperature above 370C).

Quality of groundwater

In assessing for quality of the groundwater bodies in Arda river, according to monitoring program data, there is no groundwater body in poor condition. Groundwater sources have good water quality - fresh, medium hard, calcium, hydrogen carbonate, which comply with Ordinance No. 9 from 16.03.2001 for water quality used for domestic and drinking water demand, according to art.84 of Ordinance No. 1 from July 7th, 2000 for the exploration, use and protection of groundwater of the Ministry of Environment and Water.

- Identify possible problems in water quality: There is two possible problems in water quality witch are point sources of pollution and diffuse sources of pollution.

  - Point sources of pollution includes discharges from urban waste water treatment plants and discharges of sewerage collectors from settlements with population over 2 000 without built and functioning WWTP.
  - Diffuse sources are agricultural activities, settlements without sewerage and discharge non channelized area.
- Indicate any salt water intrusion problems: Movement of saline water into freshwater aquifers can lead to contamination of drinking water sources, but this area is not surrounded of any salt water resources.

C. DPSIR (Drivers, Pressures, Status, Impacts, Response) methodology

Present state

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Driving forces:
- Pressure:
- State:
- Impact:
- Response:

Future state

- Driving forces:
- Pressure:
- State:
- Impact:
- Response:

5 Table with data

Name of region / area	Kardzhali	
Water Resources	Rivers	
	Arda	
Related City / Country	Turkey	
Geographical coordinates	41.43° N 24.6097° E	
Altitudinal range	average 900m	
Size	241km	
Morphology	mountainous and hill;	
Aquifer type	groundwater (karstic, mineral, artesian); surface water	
Surface water interacion		
Geology	metamorphic, magmatic, sediment rock formations	
Mean annual precipitation	600 mm	
Mean annual temperature	15°C	
Soil types	brown forest soil, alluvial and non-alluvial soils	
Land uses	15,2% of the total area is used for agricultural purposes	
Protection areas	Protected areas in the region are shown on the figures below	
Water abstraction	Surface, undeground	
Qualitative status		
Quantitative status		

6 SWOT Analysis

-Strengths:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Kardzhali region water demand is covered from different types of water sources – four rivers, two dam, lots of underground sources. This ensures that, following the scenarios for climate change in the future, there is no option for lack of water.

-Weaknesses:

Due to climate change scenario for dry year with low quantity of precipitations all the surface water sources capacity in the region could decrease seriously. This would lead Kardzhali city to use a nearly located underground source for covering its water consumption needs. The water quality itself is highly related to the use of pesticides and nitrates as the surrounding land is commonly used for agriculture.

-Opportunities:

-Threats:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.5.1 Climate change impacts assessment report** *Questionnaire*
Project Beneficiary No	**PB5**
Beneficiary Institution	**Municipality of Gotse Delchev**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

Name of the organization/institution: Municipality of Gotse Delchev
Beneficiary number: PB5

1 Introduction

Region (water basin): Water basins description

Rivers:

- Struma river – 290 km length and 10 797 m2 catchment area;
- Mesta river – 126 km length and 2767 m2 catchment area;

Water dams:

- Bersin dam – 4,600 million m3 total volume;
- Bagrentsi dam – 2,2 million m3 total volume;
- Stoykovtsi dam – 13,22 million m3 total volume;
- Kara-gyol dam – 2,252 million m3 total volume;

- Area
  6 492,7 km2;
- Altitude range
  200m minimum; 2914m maximum;
- Morphology
  Mountainous with valleys and plains;
- Aquifer types
  Groundwater (karstic, mineral, artesian); surface water;
- Geology
  Metamorphic, magmatic, sediment rock formations;

2 Climate characteristics and Climate change

- Precipitation values

Annual precipitation 1961-1990, mm	Annual precipitation 2038(realistic scenario), mm	Annual precipitation 2038(pessimistic scenario), mm
707	668	620
Summer precipitation 1961-1990, mm	Summer precipitation 2038(realistic scenario), mm	Summer precipitation 2038(pessimistic scenario), mm
163	139	102

- Temperature values
  Average January from -2 to +1°C; average annual +14°C;
- Existing hydrological monitoring
  Surface water monitoring for physico-chemical indicators, priority substances and specific pullutants; tap water monitoring; underground water monitoring for basic and additional physicochemical indicators;

- Available hydrological data

The Western Aegean Region covers the territory of the Struma and Mesta rivers in Southwestern Bulgaria. The catchments relief is predominantly alpine and hollow, highly cracked, deeply dissected and sculpted by the hydrographic network and glacial denudation.

The average annual runoff of the Struma River varies from 2,117 m³/s in Pernik to 76,167 m³/s in Marino Pole. The variations of the runoff are about 0,3. The annual runoff and the inflows have a low coefficient of variation of about 0,3 with the minimum being 0,22 l/s.km² for the Iliyna river at Brichibor and the maximum – 0,5 for the Sushichka-Polena river. Along the river the minimum water quantities increase from 1 m3 / s in Pernik to 33,49 m3/s in Marino Pole. The increase in the maximum runoff is much more sensitive: from 3,5 m3/s in Pernik to 149 m3/s in Marino Pole.

- Climate model used and results

  Current precipitation values and precipitation values for 2038 due to climate change:

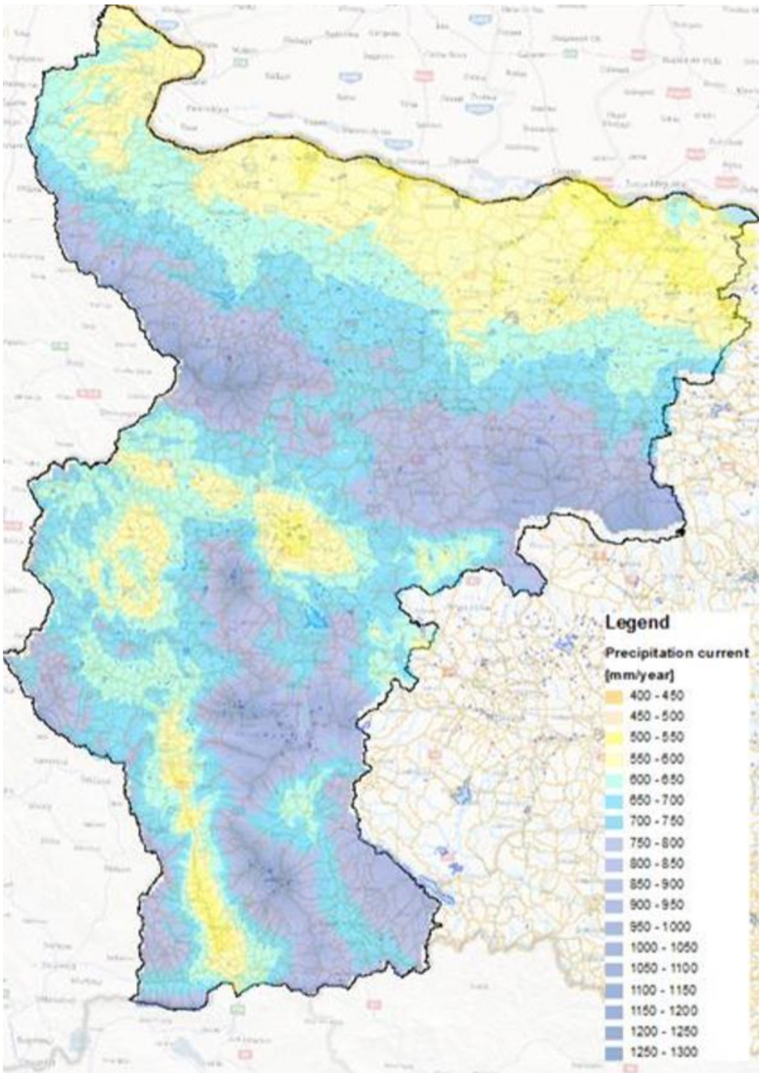


Figure 1. Current precipitation values

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

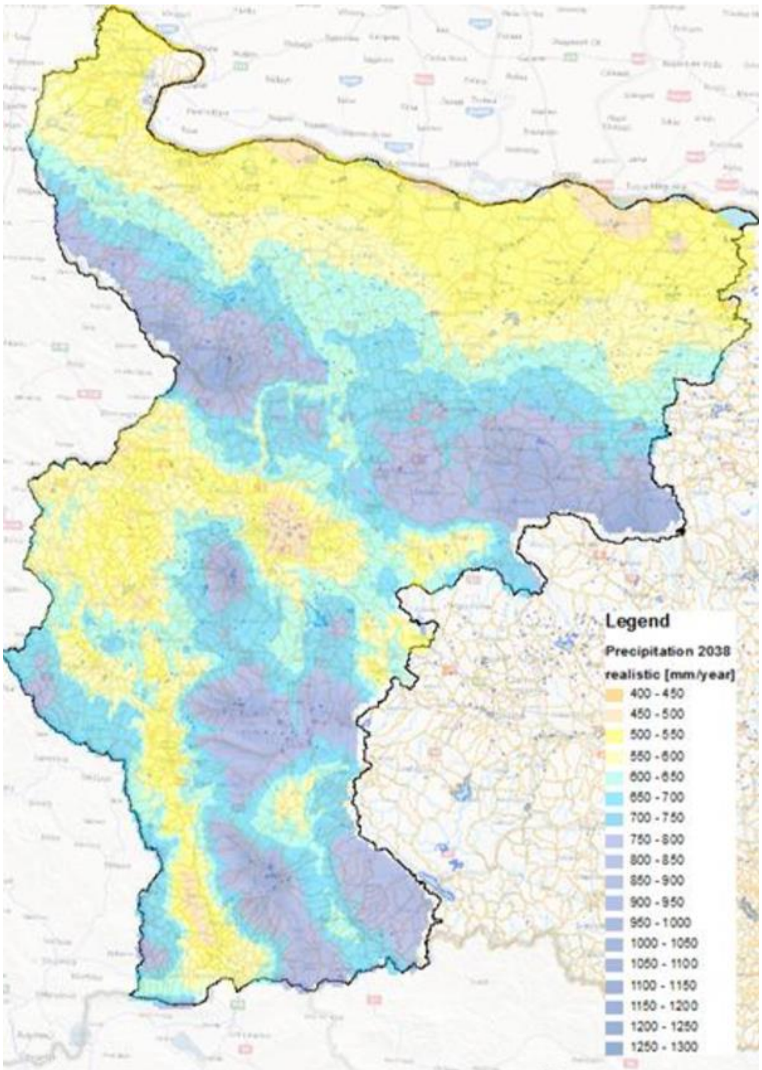


Figure 2. Realistic scenario 2038

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

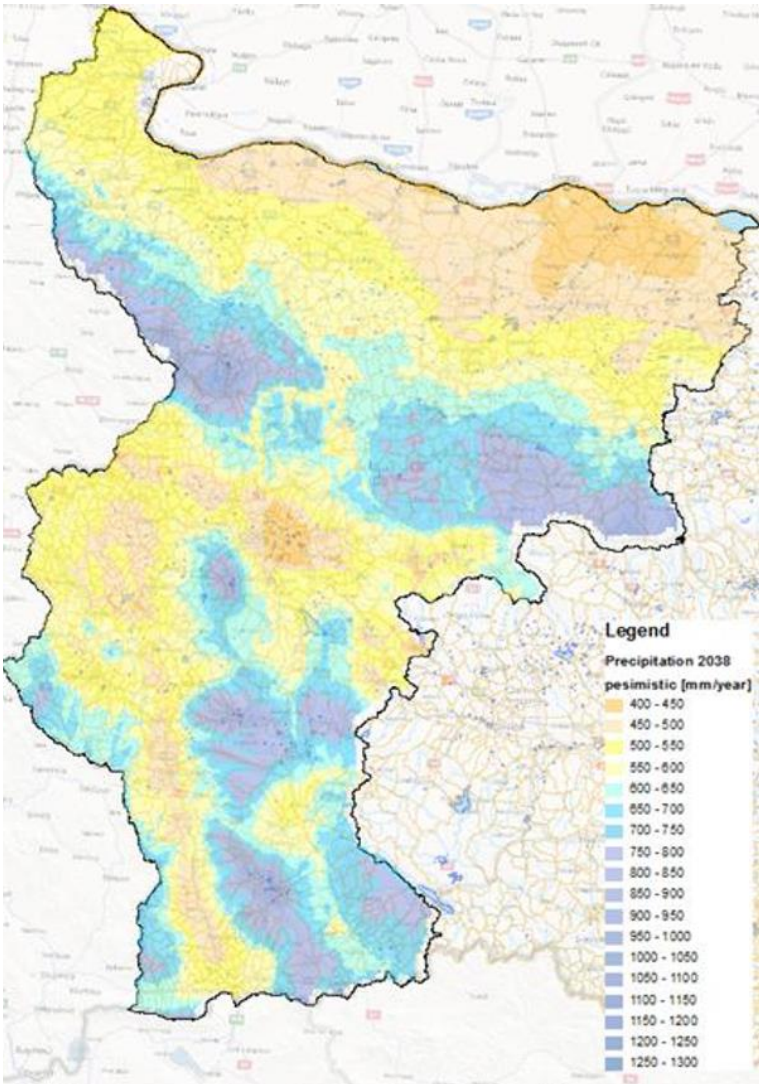


Figure 3. Pessimistic scenario 2038

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

3 Water Availability - Climate Change Impacts on Water Resources

A. Water demand (annually)

- Number of inhabitants in the area

  310 321

- Number of tourists in the area

  Main tourist places in this area are Bansko, Dobrinishte, Razlog and Banya. During touristic season the population in these places increases three times.

Tourism in Blagoevgrad Province		
	Winter	Summer
	193 447	97 522
Total	290 969	

- Annual water consumption

Water supply [l/p/d]	2009			2010		
	domestic	industrial	total	domestic	industrial	total
Bansko	138	131	**269**	132	149	**281**
Belitsa	92	20	**112**	89	20	**109**
Blagoevgrad	109	55	**164**	103	49	**152**
Gotse Delchev	102	28	**130**	99	25	**124**
Garmen	84	10	**95**	85	9	**93**
Razlog	118	57	**175**	116	51	**167**
Satovcha	70	15	**84**	73	17	**90**
Simitli	122	17	**139**	122	13	**136**
Hadzhidimovo	116	14	**130**	120	11	**131**
Yakoruda	81	17	**99**	79	15	**94**
Average Blagoevgrad Water Utility	**106**	**43**	**149**	**103**	**41**	**144**

- Identify possible problems in water use

  Quality: Most of the surface water is from mountain sources and therefore the chemical and microbiological composition is constantly changing. These waters are rich in organic substances which causes to high levels of turbidity and color. In case of intense snow melting, rainfalls and other adverse climatic conditions, the physico-chemical or microbiological parameters exceed the limit values.

  Quantity: The dynamics of household consumption tended to decrease in the period 2008 - 2010. The household consumption level in the region, measured in liters per person per day, is higher than the average for the country and the West Aegean area and tends to decrease. The dynamics of consumption for business is influenced by the economic crisis. The water consumption for business in the region, measured by the amount of water consumed to create BGN 1000 is lower than the average for the country and for the West Aegean region.

B. Climate change impacts on water resources availability

Water Supply System_	UCATTU_	Water supply resource	Water supply type	Alternative	Future precipitation difference (%)	Present capacity [l/s]	Future capacity [l/s]
WSS_Ablanitsa	00014	Ablanitsa	GW_1	1	3	3,5	3,5

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Water Supply System_	UCATTU_	Water supply resource	Water supply type	Altern ative	Future precipitation difference (%)	Present capacity [l/s]	Future capacity [l/s]
WSS_Bansko	02676	Asanitsa	GW_1	1	-12	1,74	1,57296
WSS_Bansko	02676	Karantiyata	GW_1	1	-14	6,69	5,94072
WSS_Bansko	02676	Martva polyana	GW_1	1	-14	14,9	13,2312
WSS_Bansko	02676	Motikata	GW_2	1	-13	4,76	4,51248
WSS_Bansko	02676	Pepev kladenets	GW_1	1	-14	2,22	1,97136
WSS_Bansko	02676	Tsigansko Kladenche	GW_1	1	-14	4,38	3,88944
WSS_Bansko	02676	Usipo	GW_1	1	-13	3,17	2,84032
WSS_Belitsa	02693	Dinkov dol 1, 2, 3	GW_1	1	-16	3,3	2,8776
WSS_Belitsa	03504	Martsenkovoto	GW_1	1	-10	0,06	0,092
WSS_Belitsa	03504	Muratovoto	GW_1	1	-14	1,8	1,5984
WSS_Belitsa	03504	Redzepitsa	SW_2	1	-6	0,03	0,02892
WSS_Belitsa	03504	Redzepitsa 1, 2	GW_1	1	-8	3,4	3,1824
WSS_Belitsa	03504	Stankova reka	GW_2	1	-13	1,84	1,74432
WSS_Belitsa	02693	Uzunitsa	SW_2	1	-9	0,03	0,02838
WSS_Belitsa	03504	Vapata	SW_2	1	-9	0,35	0,3311
WSS_Blagoevgrad	04217	Bachinovo	GW_1	1	5	3,49	3,49
WSS_Blagoevgrad	04279	Deyanski livadi	GW_1	1	10	10	10
WSS_Blagoevgrad	47370	Dereto	GW_1	1	8	0,38	0,38
WSS_Blagoevgrad	78464	Graviti Tserovo	GW_1	1	-2	0,2	0,1968
WSS_Blagoevgrad	04217	Chakalitsa	SW_2	1	-10	22,98	22,15272
WSS_Blagoevgrad	04217	Chakalitsa	SW_2	1	-8	22,98	22,15272
WSS_Blagoevgrad	04217	Chakalitsa	SW_2	1	-6	22,98	22,15272
WSS_Blagoevgrad	04217	Kartalska polyana	SW_2	1	-3	102,11	100,27202
WSS_Blagoevgrad	04217	Kovachitsa	SW_2	1	14	6,34	6,34
WSS_Blagoevgrad	Кр	Kriviya Uluk	SW_2	1	-4	25,7	25,0832
WSS_Blagoevgrad	04217	Predimir	SW_2	1	0	7,3	7,3
WSS_Blagoevgrad	04217	PS Bistritsa	SW_2	1	2	4,4	4,4
WSS_Blagoevgrad	78464	PS Dereto	GW_1	1	8	0,57	0,57
WSS_Blagoevgrad	04279	PS Struma	SW_2	1	-8	9,57	9,11064
WSS_Blagoevgrad	04279	PS Struma	SW_2	1	-7	9,57	9,11064
WSS_Blagoevgrad	04217	Slavovo	GW_1	1	1	19,7	19,7
WSS_Blagoevgrad	04217	Uzundzhi dere	GW_1	1	-1	X	X
WSS_Dobrinishte	21498	Lipev pozhar	GW_1	1	-21	2,16	1,79712
WSS_Dobrinishte	21498	Plaviloto	SW_2	1	-22	3,17	2,75156
WSS_Gorno Draglishte	21748	Klinets	SW_2	1	-18	3,68	3,28256
WSS_Gotse Delchev	38666	Barakata	GW_3	1	-13	3,17	3,00516

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Water Supply System_	UCATTU_	Water supply resource	Water supply type	Altern ative	Future precipitation difference (%)	Present capacity [l/s]	Future capacity [l/s]
WSS_Gotse Delchev	20331	Chuchura	GW_1	1	4	0,8	0,8
WSS_Gotse Delchev	20585	Papaz chair	GW_3	1	-21	4,44	4,12032
WSS_Gotse Delchev	20585	Papaz chair	GW_3	1	-18	4,44	4,12032
WSS_Gotse Delchev	23460	Papaz chair	GW_3	1	-24	4,44	4,12032
WSS_Gotse Delchev	49432	PS Dubnitsa	GW_1	1	6	1,05	1,05
WSS_Gotse Delchev	38666	Sofiyata	GW_3	1	-13	3,18	3,01464
WSS_Gotse Delchev	06306	Tufcha	SW_2	1	-12	53,6	49,7408
WSS_Hadzhidimovo	72374	Koriyata 1, 2	GW_1	1	-3	8,8	8,5888
WSS_Hadzhidimovo	77058	PS Hadzhidimovo	GW_1	1	2	2,85	2,85
WSS_Hadzhidimovo	52101	PS Lyaski	GW_1	1	-7	7,39	6,97616
WSS_Kochan	39089	Izvora nov	GW_2	1	-2	4,3	4,2656
WSS_Krupnik	40052	Izvora Krupnik	GW_1	1	0	0,22	0,22
WSS_Krupnik	57162	Livadevo	GW_1	1	-12	2,2	1,9888
WSS_Krupnik	35105	Sredorek	GW_1	1	-11	0,78	0,71136
WSS_Krupnik	35105	Tatarkite	GW_3	1	-26	7,3	6,5408
WSS_Krupnik	35105	Tatarkite	GW_3	1	-25	7,3	6,5408
WSS_Krupnik	35105	Tatarkite	GW_3	1	-22	7,3	6,5408
WSS_Krupnik	35105	Tatarkite	GW_3	1	-18	7,3	6,5408
WSS_Krupnik	40052	Tatarkite	GW_3	1	-29	7,3	6,5408
WSS_Razlog	61813	Izvora Razlog	GW_1	1	-11	225	205,2
WSS_Razlog	61813	Kalugeritsa	GW_1	1	-18	40	34,24
WSS_Razlog	61813	Rekata	GW_1	1	-12	0,25	0,226
WSS_Razlog	02676	Sv.Ivan	SW_2	1	-14	1	0,916
WSS_Razlog	61813	Zasetsite	GW_1	1	-19	14,7	12,4656
WSS_Ribnovo	62640	Ilisten	GW_2	1	-5	0,79	0,7742
WSS_Ribnovo	54184	Konsko dere	GW_1	1	-5	0,2	0,192
WSS_Ribnovo	62640	PS Osikovo	GW_1	1	3	0,6	0,6
WSS_Simitli	17405	Byalata reka	SW_2	1	-10	5,4	5,076
WSS_Simitli	66460	Shahtov kladenec	GW_1	1	0	48	48
WSS_Simitli	55107	Stara reka	SW_2	1	-8	90	85,68
WSS_Simitli	17405	Struzhka reka	SW_2	1	-12	2,2	2,0416
WSS_Simitli	17405	Uluko	SW_2	1	-15	2	1,82
WSS_Valkosel	56740	Dospat	SW_1	1	-5	27,1	26,9645
WSS_Valkosel	39726	Kavazovi cheshmi	GW_1	1	3	0,3	0,3
WSS_Valkosel	12499	Kochine	GW_1	1	-5	0,3	0,288
WSS_Valkosel	12499	Krake	GW_1	1	-4	0,3	0,2904
WSS_Valkosel	65440	Tuzla	GW_1	1	-4	0,3	4,84
WSS_Valkosel	65440	Vriz Satovcha	GW_1	1	-1	0,16	0,15872
WSS_Valkosel	12499	Vriz Valkosel	GW_1	1	-2	X	X

Water Supply System_	UCATTU_	Water supply resource	Water supply type	Altern ative	Future precipitation difference (%)	Present capacity [l/s]	Future capacity [l/s]
WSS_Yakoruda	87338	Banensko ezero	SW_1	1	-15	7,3	7,1905
WSS_Yakoruda	87338	Nehtenski chuchur	GW_1	1	-13	X	X
WSS_Yakoruda	87338	Treshtenik	GW_1	1	-12	6,75	6,102
WSS_Ablanitsa	00014	Ablanitsa	GW_1	2	3	3,5	3,5
WSS_Ablanitsa	00014	WSS_Ablanitsa _IP	GW_1	2	3	9,8	9,8
WSS_Bansko	02676	Asanitsa	GW_1	2	-12	5	5
WSS_Bansko	02676	Karamanitsa 2	GW_1	2		10	10
WSS_Bansko	02676	Karamanitsa 3	GW_1	2	-10	7	7
WSS_Bansko	02676	Karamanitsa	GW_1	2	-14	24	24
WSS_Bansko	02676	Martva polyana	GW_1	2	-14	16	16
WSS_Bansko	02676	Motikata	GW_2	2	-13	20	20
WSS_Bansko	02676	Pepev kladenets	GW_1	2	-14	5	5
WSS_Bansko	02676	Tsigansko Kladenche	GW_1	2	-14	8	8
WSS_Bansko	02676	Usipo	GW_1	2	-13	25	25
WSS_Blagoevgrad	04217	Bachinovo	GW_1	2	5	3,49	3,49
WSS_Blagoevgrad	04279	Deyanski livadi	GW_1	2	10	10	10
WSS_Blagoevgrad	47370	Dereto	GW_1	2	8	0,38	0,38
WSS_Blagoevgrad	78464	Graviti Tserovo	GW_1	2	-2	0,2	0,1968
WSS_Blagoevgrad	04217	Chakalitsa	SW_2	2	-10	22,98	22,15272
WSS_Blagoevgrad	04217	Chakalitsa	SW_2	2	-8	22,98	22,15272
WSS_Blagoevgrad	04217	Chakalitsa	SW_2	2	-6	22,98	22,15272
WSS_Blagoevgrad	04217	Kartalska polyana	SW_2	2	-3	102,11	100,27202
WSS_Blagoevgrad	04217	Kovachitsa	SW_2	2	14	6,34	6,34
WSS_Blagoevgrad	04217	Kriviya Uluk	SW_2	2	-4	25,7	25,0832
WSS_Blagoevgrad	04217	Predimir	SW_2	2	0	7,3	7,3
WSS_Blagoevgrad	04217	PS Bistritsa	SW_2	2	2	4,4	4,4
WSS_Blagoevgrad	78464	PS Dereto	GW_1	2	8	0,57	0,57
WSS_Blagoevgrad	04279	PS Struma	SW_2	2	-8	9,57	9,11064
WSS_Blagoevgrad	04279	PS Struma	SW_2	2	-7	9,57	9,11064
WSS_Blagoevgrad	04217	Slavovo	GW_1	2	1	19,7	19,7
WSS_Blagoevgrad	04217	Uzundzhi dere	GW_1	2	-1	X	X
WSS_Blagoevgrad	04217	WSS_Blagoevgr ad_IP	GW_1	2	0	296,1	296,1
WSS_Dobrinishte	21498	Lipev pozhar	GW_1	2	-21	2,16	1,79712
WSS_Dobrinishte	21498	Plaviloto	SW_2	2	-22	3,17	2,75156
WSS_Dobrinishte	21498	WSS_Dobrinish	GW_1	2	-21	17	17

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Water Supply System_	UCATTU_	Water supply resource	Water supply type	Altern ative	Future precipitation difference (%)	Present capacity [l/s]	Future capacity [l/s]
		te_IP					
WSS_Gorno Draglishte	21748	Klinets	SW_2	2	-18	3,68	3,28256
WSS_Gorno Draglishte	21748	WSS_Draglishte_IP	GW_1	2	-14	8,2	8,2
WSS_Gotse Delchev	38666	Barakata	GW_3	2	-13	3,17	3,00516
WSS_Gotse Delchev	20331	Chuchura	GW_1	2	4	0,8	0,8
WSS_Gotse Delchev	20585	Papaz chair	GW_3	2	-21	4,44	4,12032
WSS_Gotse Delchev	20585	Papaz chair	GW_3	2	-18	4,44	4,12032
WSS_Gotse Delchev	23460	Papaz chair	GW_3	2	-24	4,44	4,12032
WSS_Gotse Delchev	49432	PS Dubnitsa	GW_1	2	6	1,05	1,05
WSS_Gotse Delchev	38666	Sofiyata	GW_3	2	-13	3,18	3,01464
WSS_Gotse Delchev	06306	Tufcha	SW_2	2	-12	53,6	49,7408
WSS_Gotse Delchev	38666	WSS_Gotse Delchev_IP	GW_1	2	-12	143,9	143,9
WSS_Hadzhidimovo	72374	Koriyata 1, 2	GW_1	2	-3	8,8	8,5888
WSS_Hadzhidimovo	77058	PS Hadzhidimovo	GW_1	2	2	2,85	2,85
WSS_Hadzhidimovo	52101	PS Lyaski	GW_1	2	-7	7,39	6,97616
WSS_Hadzhidimovo	44464	WSS_Hadzidimovo_IP	GW_1	2	1	7,5	7,5
WSS_Kochan	39089	Izvora nov	GW_2	2	-2	4,3	4,2656
WSS_Kochan	39089	WSS_Kochan_IP	GW_1	2	1	7,4	7,4
WSS_Krupnik	40052	Izvora Krupnik	GW_1	2	0	0,22	0,22
WSS_Krupnik	57162	Livadevo	GW_1	2	-12	2,2	1,9888
WSS_Krupnik	35105	Sredorek	GW_1	2	-11	0,78	0,71136
WSS_Krupnik	35105	Tatarkite	GW_3	2	-26	7,3	6,5408
WSS_Krupnik	35105	Tatarkite	GW_3	2	-25	7,3	6,5408
WSS_Krupnik	35105	Tatarkite	GW_3	2	-22	7,3	6,5408
WSS_Krupnik	35105	Tatarkite	GW_3	2	-18	7,3	6,5408
WSS_Krupnik	40052	Tatarkite	GW_3	2	-29	7,3	6,5408
WSS_Razlog	61813	Izvora Razlog	GW_1	2	-11	225	205,2
WSS_Razlog	61813	Kalugeritsa	GW_1	2	-18	40	34,24
WSS_Razlog	61813	Rekata	GW_1	2	-12	0,25	0,226
WSS_Razlog	02676	Sv.Ivan	SW_2	2	-14	6	6
WSS_Razlog	61813	Zasetsite	GW_1	2	-19	14,7	12,4656
WSS_Ribnovo	62640	Ilisten	GW_2	2	-5	0,79	0,7742
WSS_Ribnovo	54184	Konsko dere	GW_1	2	-5	0,2	0,192
WSS_Ribnovo	62640	PS Osikovo	GW_1	2	3	0,6	0,6
WSS_Ribnovo	62640	WSS_Ribnovo_IP	GW_1	2	-4	16,6	16,6

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Water Supply System_	**UCATTU_**	**Water supply resource**	**Water supply type**	**Altern ative**	**Future precipitation difference (%)**	**Present capacity [l/s]**	**Future capacity [l/s]**
WSS_Simitli	17405	Byalata reka	SW_2	2	-10	5,4	5,076
WSS_Simitli	66460	Shahtov kladenec	GW_1	2	0	48	48
WSS_Simitli	55107	Stara reka	SW_2	2	-8	90	85,68
WSS_Simitli	17405	Struzhka reka	SW_2	2	-12	2,2	2,0416
WSS_Simitli	17405	Uluko	SW_2	2	-15	2	1,82
WSS_Valkosel	56740	Dospat	SW_1	2	-5	27,1	26,9645
WSS_Valkosel	39726	Kavazovi cheshmi	GW_1	2	3	0,3	0,3
WSS_Valkosel	12499	Kochine	GW_1	2	-5	0,3	0,288
WSS_Valkosel	12499	Krake	GW_1	2	-4	0,3	0,2904
WSS_Valkosel	65440	Tuzla	GW_1	2	-4	0,3	4,84
WSS_Valkosel	65440	Vriz Satovcha	GW_1	2	-1	0,16	0,15872
WSS_Valkosel	12499	Vriz Valkosel	GW_1	2	-2	X	X
WSS_Yakoruda	87338	Banensko ezero	SW_1	2	-15	7,3	7,1905
WSS_Yakoruda	02693	Dinkov dol 1, 2, 3	GW_1	2	-16	3,3	2,8776
WSS_Yakoruda	03504	Mratsenkovoto	GW_1	2	-10	0,06	0,092
WSS_Yakoruda	03504	Muratovoto	GW_1	2	-14	1,8	1,5984
WSS_Yakoruda	87338	Nehtenski chuchur	GW_1	2	-13	X	X
WSS_Yakoruda	03504	Radzepitsa	SW_2	2	-6	0,03	0,02892
WSS_Yakoruda	03504	Radzepitsa 1,2	GW_1	2	-8	3,4	3,1824
WSS_Yakoruda	03504	Stankova reka	GW_2	2	-13	1,84	1,74432
WSS_Yakoruda	87338	Treshtenik	GW_1	2	-12	6,75	6,102
WSS_Yakoruda	02693	Uzunitsa	SW_2	2	-9	0,03	0,02838
WSS_Yakoruda	03504	Vapata	SW_2	2	-9	0,35	0,3311
WSS_Yakoruda	87338	WSS_Yakoruda _IP	GW_1	2	-11	57,8	57,8
Total alternative 1				1		**940,26**	**889,23**
Total alternative 2				2		**1591,7**	**1544,65**

C. Water resources availability

- Estimate Water Exploitation Index (WEI) for total water demand and for drinking water demand.
  WEI=WD/WR, where: WD is the water demand and WR is the renewable water resources
  Please estimate WEI for the following scenarios:
  Scenario 0: WD0 is the present water demand
  Scenario 1: WD1 is the present water demand increased by 25%
  Scenario 2: WD2 is the present water demand decreased by 25%
  Please estimate the following indicators:
  WEI1=WD0/WR present

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WEI2=WD0/WR future
WEI3=WD1/WR future
WEI4=WD2/WR future

Estimations:
Total water demand WD0 = 22 166 400,00 m3/year;
Total water demand increased by 25% WD1 = 27 708 000,00 m3/year;
Total water demand decreased by 25% WD2 = 16 624 800,00 m3/year;
Drinking water demand WD0 = 17 295 911,91 m3/year;
Drinking water demand increased by 25% WD1 = 22 837 511,91 m3/year;
Drinking water demand decreased by 25% WD2 = 11 754 311,91 m3/year;
Renewable water resources WR present = 79 847 890,56 m3/year;
Renewable water resources WR future = 76 754 839,68 m3/year;

WEI (1)		WEI (2)		WEI (3)		WEI (4)	
Total use	Drinking water	Total use	Drinking water	Total use	Drinking water	Total use	Drinking water
0,28	0,22	0,29	0,23	0,36	0,23	0,22	0,15

4 Water Quality & Land Uses

A. Water Resources quality characteristics

- Characteristics of water quality monitoring

Struma River

Struma River- Krupnik

Oxygen content in the Struma river waters near the village of Krupnik has a slight tendency to improve.
The change in the nutrient content is difficult to determine. Regression analysis shows a decrease in nitrate nitrogen. This is more clearly supported by the indicator nitrite nitrogen (N-NO2). For phosphates (PO4), the values indicate that there is no trend of change over time.
Quantities of insoluble substances are in the range of 10 - 100 mg / l.

Struma River- Border

Oxygen content in the Struma River is high at the border. Most results ranged from 8-10 mg / l. Measured values of the order of 3-4 mg / l are taken as incidental. Diluted oxygen values above 11 mg / l are difficult to explain. There is no change in oxygen content over the period considered. Based on organic contamination, the oxygen content should be between 7-8 mg / l.
Trends in organic pollutants by BOD5, Residual Oxygen and Biogenic Elements are not observed.

Mesta River

For Mesta River are considered 4 hydrochemical stations:

Mesta River – Yakoruda

Oxygen content in the waters of the Mesta River, in the high mountain area of Yakoruda, is difficult to change. There are too high values of dissolved oxygen (O2).
Trends to change the two BOD5 and Residual Oxygen indicators characterizing organic content are mutually exclusive. but their values are too unevenly scattered over the period under consideration.
The biogenic content of water through the indicators (N-NO3), (N-NO2), (N-NH4) shows decreasing trends. The trend of ammonia nitrogen (N-NH4) can be assumed to be zero.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

In mountainous areas, the amount of undissolved substances, in the absence of anthropogenic impact, can hardly show a certain trend of change.

Mesta River – General Kovachev village
Oxygen content in the waters of the Mesta river at General Kovachev didn't show any trend of change. The amount of dissolved oxygen (O2) depends on so many factors that measurements on another plot are required for mountain areas to determine any trend. There can't be such a huge difference in the values except for the presence of spill releases that are not present in this area. The BOD5 and Residual Oxygen indicators show trends for increased organic pollution.

Mesta River – Momina Kula
There is no change in oxygen content in the Momina Kula area.
The organic content of the Mesta River, expressed by BOD5 and Residual Oxygen , doesn't show a certain trend of change.
The qualitative characteristics of the Mesta River in the Momina Kula area do not change for the period under consideration, but there is little change in the direction of reducing pollution.

Mesta River – Hadzhidimovo
The Oxygen regime of the Mesta River in the village of Hadjidimovo didn't show any particular tendency to change during the period under review. There are too high values that predict a certain tendency to increase the oxygen content.
The content of undissolved substances is within 50 mg/l.

Surface water used for domestic and drinking water demand

№	Water abstraction	Water body	Water supplied civil area	Physico-chemical characteristics	Microbiological characteristics
1	Bistritsa - drainage	Blagoevgradska Bistritsa river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	1
2	Byalata voda	Byalata voda river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	1
3	Byalata reka	Byalata reka river	Simitli, Gradevo vlg., Uranovo nbh.	2	2
4	Varbitsa	Varbitsa river	Oreshe vlg., Krushevo	1	2
5	Derivation Dospat - Satovcha	Satovchenska Bistritsa river	Satovcha vlg., Furgovo, Zhizhevo, Valkosel, Kribul, Slashten	1	1
6	Ismailitsa	Ismailitsa river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	1
7	Kartalska polyana	Blagoevgradska Bistritsa river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	1
8	Klinets	Klinets river	Dobarsko vlg.	1	1
9	Kovachitsa	Kovachitsa river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.		1

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

№	Water abstraction	Water body	Water supplied civil area	Physico-chemical characteristics	Microbiological characteristics
10	Kriviya uluk	inflow of Blagoevgradska Bistritsa river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	2
11	Plaviloto	Desilitsa river	Dobrinishte vlg.	1	1
12	Popova buka - 1	Brezhanska river	Brezhani vlg.	1	1
13	Popova buka - 2	Brezhanska river	Brezhani vlg.	1	1
14	Popova buka - 3	Brezhanska river	Brezhani vlg.	1	1
15	Predimir	Predimirska river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	1
16	Radzhelitsa	Redzhepitsa river	Belitsa	1	1
17	Ribno ezero (Banensko)	Banenska river	Yakoruda	1	1
18	Slavovo	Slavova river	Blagoevgrad, Riltsi vlg., Belo pole vlg., Izgrev vlg., Tsetovo vlg., Pokrovnik vlg.	1	1
19	Strane	Strane river	Bachevo vlg., Godlevo vlg.	1	1
20	Struzhka reka	Struzhka river	Simitli, Gradevo vlg., Oranovo nbh.	1	1
21	Studenata voda	Studenata voda river	Godlevo vlg.	1	1

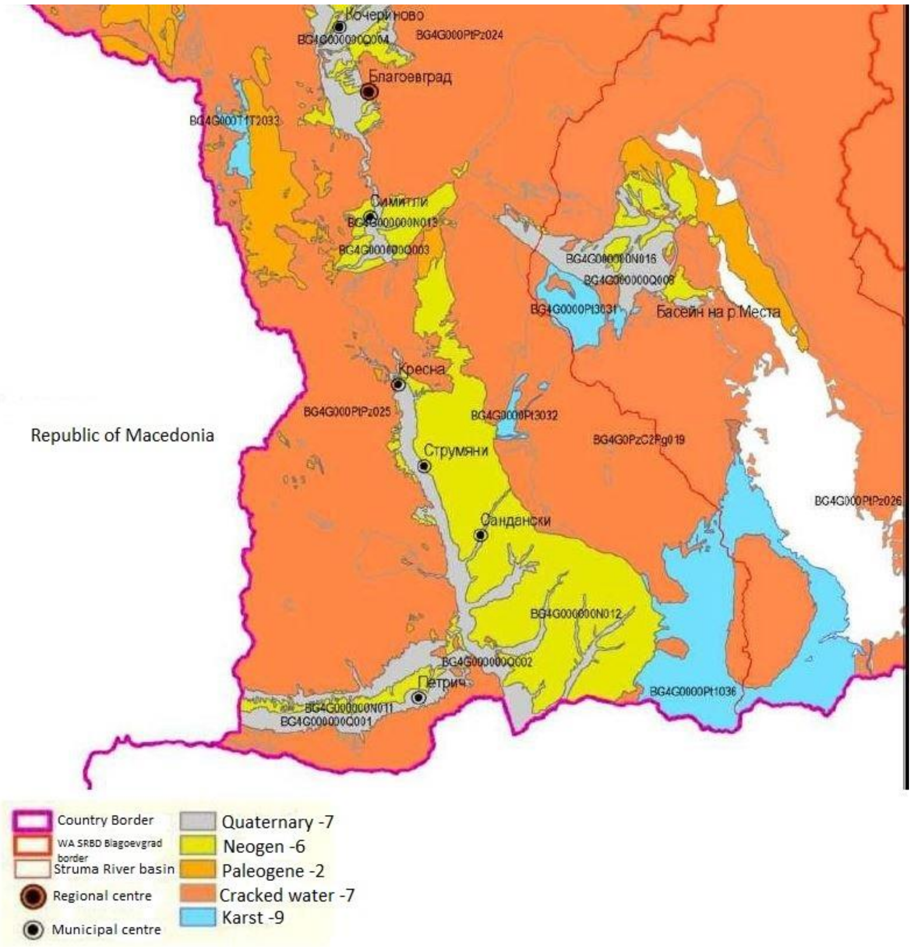


Figure 4. Underground water bodies – Struma River basin

№	Layer	Old code	New code	Name
1	Quaternary	BG141	BG4G000000Q001	Pore water in Quaternary- Strumeshnitsa
2		BG141	BG4G000000Q002	Pore water in Quaternary- Kresna-Sandanski
3		BG140	BG4G000000Q003	Pore water in Quaternary- Simitli
4		BG139	BG4G000000Q004	Pore water in Quaternary- Blagoevgrad
5	Neogen	BG141	BG4G000000N011	Pore water in Neogen- Strumeshnitsa
6		BG141	BG4G000000N012	Pore water in Neogen- Sandanski
7		BG140	BG4G000000N013	Pore water in Neogen- Simitli
8		BG139	BG4G000000N014	Pore water in Neogen- Blagoevgrad
9	Paleogene	none	BG4G00000Pg039	Cracked water in the Osogovo Paleogene volcanogenic sediment complex
10		none	BG4G00000Pg038	Pore water in Paleogene sediment complex
11	Cracked water	BG159	BG4G0PzC2Pg019	Cracked water in Teshovski, Slanchevski, Central Balkan, Bezbozhki, Igralishki, Kresnenski plutons
12		BG160	BG4G000PzC2021	Cracked water in South Bulgarian granitec, Kalinski pluton
13		none	BG4G00000Pz022	Cracked water in the Struma diorite formation

14		BG138	BG4G00000Pz023	Cracked water in Osogovo pluton
15		none	BG4G000PtPz024	Cracked water in Rila-Pirin metamorphisms
16		none	BG4G000PtPz025	Cracked water in Belasitsa-Ograzhdensko-Malesevo-Osogovo metamorphisms
17	**Karst (Pt-Cr)**	BG134	BG4G000T2T3028	Zemen karst basin
18		BG132	BG4G000T2T3029	Elov Dol karst basin
19		BG161	BG4G0000Pt3031	Razlog karst basin
20		BG162	BG4G0000Pt3032	Vlahinski karst basin
21		BG137	BG4G000T1T2033	Logodaj karst basin
22		BG136	BG4G000T1T2034	Smolyan karst basin

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

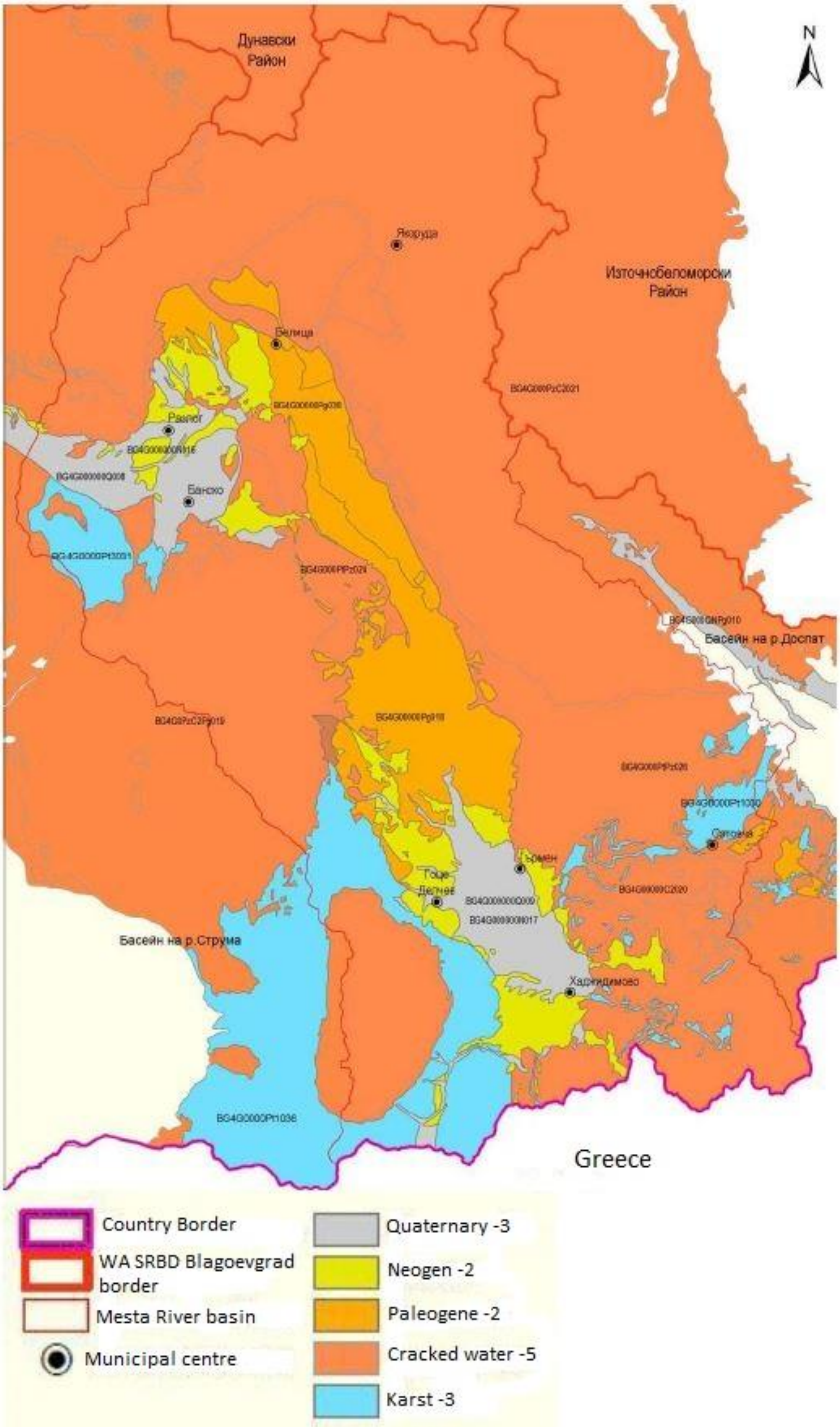


Figure 5. Underground water bodies – Mesta River basin

№	Layer	Old code	New code	Name
1	Quaternary	BG142	BG4G000000Q008	Pore water in Quaternary- Razlog
2		BG143	BG4G000000Q009	Pore water in Quaternary- Gotse Delchev
3		BG146	BG4G000QNPg010	Pore water in Quaternary-Neogen-Paleogene- Dospat
4	Neogen		BG4G000000N016	Pore water in Neogen- Razlog
5			BG4G000000N017	Pore water in Neogen- Gotse Delchev
6	Paleogene		BG4G00000Pg038	Pore water in a Paleogene sedimentary complex
7			BG4G00000Pg018	Cracked water in Gotse Delchev Paleogene aquifer
8	Cracked water		BG4G0PzC2Pg019	Cracked water in Teshovski, Slanchevski, Central Balkan, Bezbozhki, Igralishki, Kresnenski plutons
9			BG4G00000C2020	Crached water in Barutin-buinov intrusion, Dolno Dryanovo pluton
10			BG4G000PzC2021	Cracked water in South Bulgarian granitec, Kalinski pluton
11			BG4G000PtPz024	Cracked water in Rila-Pirin metamorphisms
12			BG4G000PtPz026	Cracked water in West-Rhodopian Metamorphites - Gneiss, Shale, Marble, Amphibolites
17	Karst (Pt-Cr)		BG4G0000Pt1030	Satovcha karst basin
18			BG4G0000Pt3031	Razlog karst basin
19			BG4G0000Pt 1036	Gotse Delchev karst basin

Quantity of groundwater

- **Primary waters** are the waters formed in the first waterworks below the horizontal surface, which is why they are not pressured. Their regime is determined by the rainfall regime and the surface running water. The most favorable conditions for their formation exist in flooded river terraces and cone-shaped cones. The total area of river terraces is 5 704 km2 which of it 806 km2 is located on the floodplain of the Struma river and 516 km2 for the Mesta river. The total annual water volume amounts to 8,130 billion m3.

  There are two distinct phases in the ground water regime - low and high. The high-level phase in the Struma and Mesta valleys ranges from February to June. The low-level phase includes the July-December period. The average monthly maximum is in March and the average monthly minimum is in September and October.

- **Karstic waters**

№	Name	Code
1	Elov Dol karst basin	BG4G000T2T3029
2	Razlog karst basin	BG4G0000Pt3031

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

3	Vlahinski karst basin	BG4G0000Pt3032
4	Logodaj karst basin	BG4G000T1T2033
5	Smolyan karst basin	BG4G000T1T2034
6	Gotse Delchev karst basin	BG4G0000Pt 1036
7	Golo Burdovo karst basin	BG4G0T1T2T3037

- **Mineral waters:** These waters have a favorable physiological effect on the human organism with the dissolved salts, gases, rare elements, temperature, etc.. They can be both cold and warm, both with high and low mineralization. Depending on the thermal level, the mineral sources are divided to:
    - Cool (hyperthermal temperature up to 20C)
    - Warm (20-370C)
    - Hot (hyperthermal temperature above 370C).

Quality of groundwater

In assessing for quality of the groundwater bodies in Struma river, according to monitoring program data, there is no groundwater body in poor condition.
Water Quality Report from 2010 listed 210 underground water sources in Blagoevgrad. Groundwater sources have good water quality - fresh, medium hard, calcium, hydrogen carbonate, which comply with Ordinance No. 9 from 16.03.2001 for water quality used for domestic and drinking water demand, according to art.84 of Ordinance No. 1 from July 7th, 2000 for the exploration, use and protection of groundwater of the Ministry of Environment and Water.

- Identify possible problems in water quality: There is two possible problems in water quality witch are point sources of pollution and diffuse sources of pollution.

    - Point sources of pollution includes discharges from urban waste water treatment plants and discharges of sewerage collectors from settlements with population over 2 000 without built and functioning WWTP.
    - Diffuse sources are agricultural activities, settlements without sewerage and discharge non channelized area.
- Indicate any salt water intrusion problems: Movement of saline water into freshwater aquifers can lead to contamination of drinking water sources, but this area is not surrounded of any salt water resources.

B. Land use

- Identify land uses: 13,2% of the total area is used for agricultural purposes, including 74,1% fields, 11,4% natural meadows, 1,6% artificial meadows and 12,9% fruit plantations, etc.
- Identify changes in land uses: N/A смяна на статута на земеделските земи около туристическите курорти

C. DPSIR (Drivers, Pressures, Status, Impacts, Response) methodology

Present state

- Driving forces:
- Pressure:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- State:
- Impact:
- Response:

Future state

- Driving forces:
- Pressure:
- State:
- Impact:
- Response:

5 Table with data

Name of region / area	Blagoevgrad	
Water Resources	Rivers	
	Struma	Mesta
Related City / Country	Greece, Serbia and Macedonia	Greece
Geographical coordinates	42.5603° N 23.285° E	42.0353° N 23.7103° E
Altitudinal range	average 900m	average 1 318m
Size	290km	126km
Morphology	mountainous with valleys and plains	
Aquifer type	groundwater (karstic, mineral, artesian); surface water	
Surface water interacion		
Geology	metamorphic, magmatic, sediment rock formations	
Mean annual precipitation	707 mm	
Mean annual temperature	14°C	
Soil types	brown forest soil, alluvial and non-alluvial soils	
Land uses	13,2% of the total area is used for agricultural purposes	
Protection areas	Protected areas in the region are shown on the figures below	
Water abstraction	Surface, undeground	
Qualitative status		
Quantitative status		

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

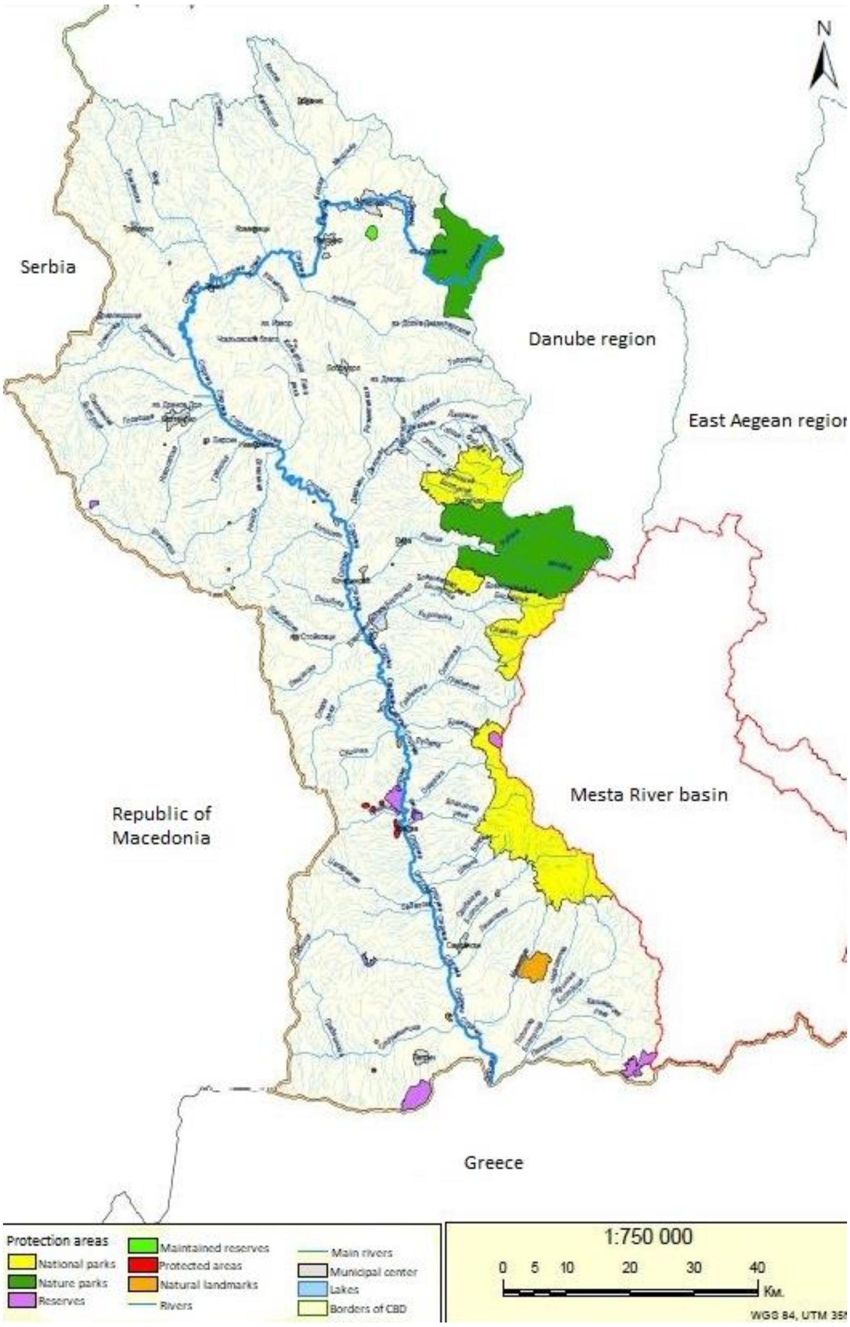


Figure 1. Protected areas in the region of Blagoevgrad – Struma river

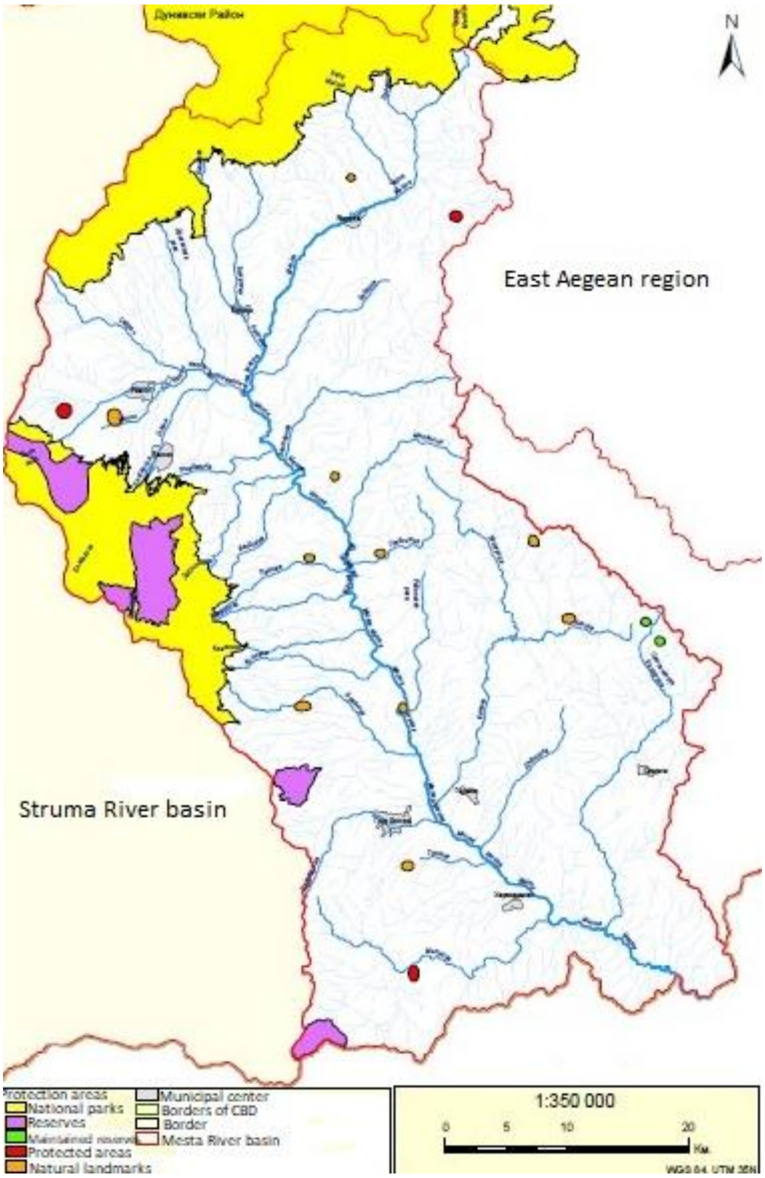


Figure 2. Protected areas in the region of Blagoevgrad – Mesta river

6 SWOT Analysis

- Strengths:

  Blagoevgrad region water demand is covered from different types of water sources – two rivers, four dams, lots of underground sources. This ensures that, following the scenarios for climate change in the future, there is no option for lack of water.

- Weaknesses:

  Due to climate change scenario for dry year with low quantity of precipitations all the surface water sources capacity in the region could decrease seriously. This would lead Blagoevgrad city to use a nearly located underground source for covering its water consumption needs. The water quality itself is highly related to the use of pesticides and nitrates as the surrounding land is commonly used for agriculture.

- Opportunities:
- Threats:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

WATER RESCUE

Water resources efficiency and conservative use in drinking water supply systems

WP	**3 Current Status Analysis and Assessment**
Deliverable *Tool*	**3.6.1 Climate change impacts assessment report** *Questionnaire*
Project Beneficiary No	**PB6**
Beneficiary Institution	**Municipal Water Supply and Sewerage Company of Thermaikos**

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Table of Contents

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Name of the organization/institution: MUNICIPAL WATER SUPPLY AND SEWERAGE COMPANY OF THERMAIKOS
Beneficiary number: PB6

1 Introduction

Water Utility Level

The Municipal Water Supply and Sewerage Company of Thermaikos is located in the River Basin of Central Macedonia (EL10). The River Basin of Central Macedonia, with an area of 13.975 km^2, is defined by Khersylia, Vertissos, Krousia and Beles to the east, Mount Paiko and the Regional Trench to the west and to the north by the Kerkini (Beles) Mountains and the border between Greece - FYROM. To the east it borders with the River Basin of Eastern Macedonia (EL11) and to the west with the River Basin of Western Macedonia (EL09) (Figure 1).

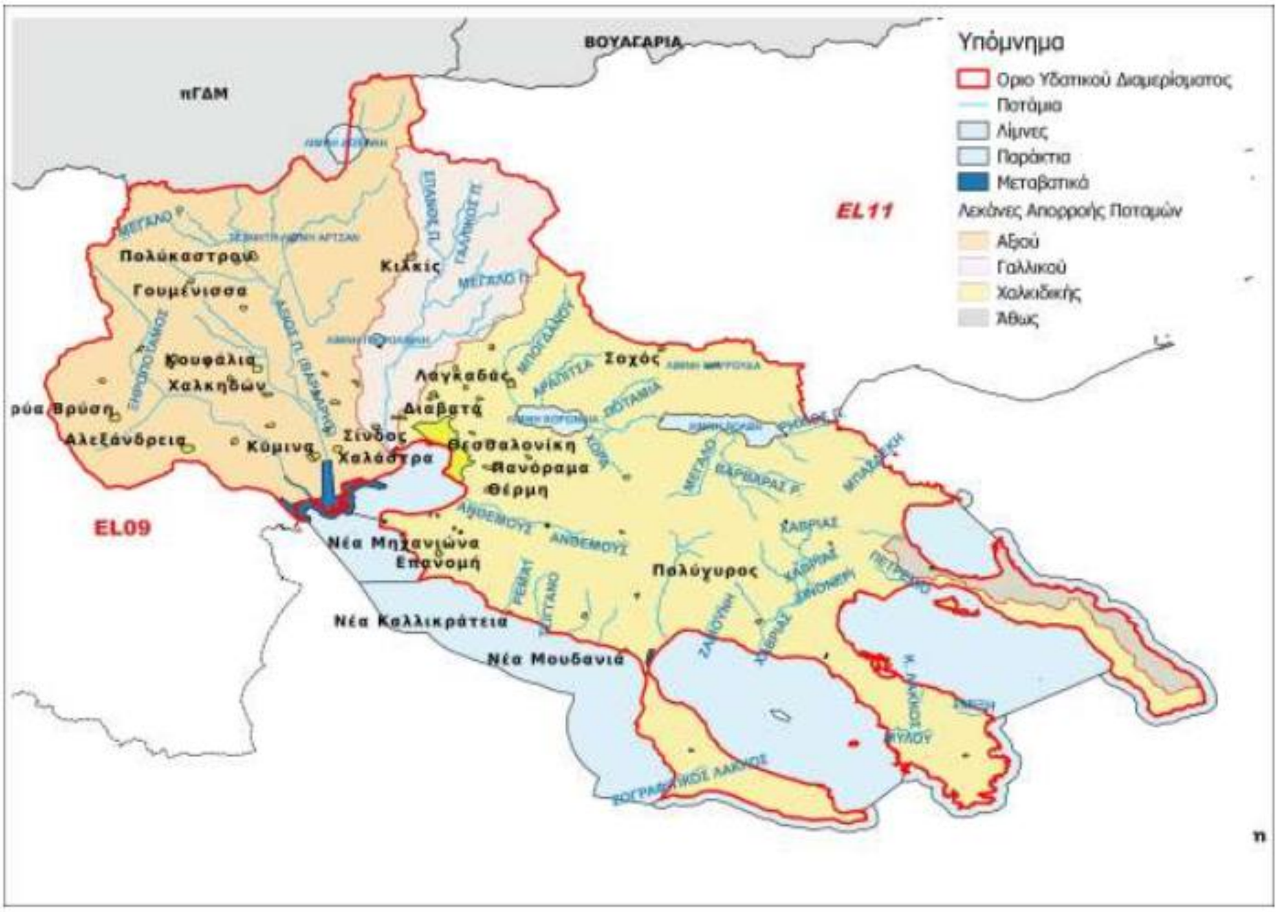


Figure 1. River Basin District of Central Macedonia (EL10)

EL 10 includes extensive plains, mainly in its western part, with most important those of of Thessaloniki, Giannitsa and Langadas, while on its eastern side the Halkidiki basin is located. Its morphology is mainly semi-mountainous with a medium altitude of approximately 245 m, while

36% of the area has an altitude of less than 100 m, and only 3% of its area has an altitude of more than 800 m.

Its coastline, with a total length of 910 km, is characterized by a strong relief, resulting in the formation of numerous roughened sinuses.

Regarding the water bodies in the River Basin of Central Macedonia:

- one hundred and four (104) rivers are identified, falling under six different types (NgL0, NgL1, NmL0, NsH1, NsL0, NsL1)
- six (6) lakes are identified in total, lakes Doirani and Koronia as D type, lake Pikrolimni as I type, lake Volvi as A type and lakes Artzan and Maurouda as L-MX type (artificial lakes).
- Three (3) transitional water bodies are identified in the River Basin District of Central Macedonia, including: two lagoons, as TW-1 type and Axios' Estuarine system, as TW-2 type (estuary or delta).
- All eleven (11) coastal water bodies identified in the River Basin District of Central Macedonia belong to the single national coastal water body type.

The statistical characteristics of surface water bodies of RBD of Central Macedonia (10), as these were identified per category, are presented in the table below:

Table 1. Statistical characteristics of surface water bodies of RBD of Central Macedonia (according to Management Plan of the River Basins of Central Macedonia River Basin District)

Type of WB	Number	Characteristic size	Minimum	Mean	Maximum	Total
Rivers	104	Length (km)	0.9	10.7	41.9	1,108.6
Lakes	6	Surface (km^2)	1.1	27.7	72.1	141.7
Transitional waters	3	Surface (km^2)	0.6	23.5	67.6	70.7
Coastal waters	11	Surface (km^2)	0.06	350	1,328.5	10,307.4

- Thirty-four (34) GWBs are designated at the RBD of Central Macedonia (10). The spatial characteristics of the groundwater bodies identified in the RBD of Central Macedonia (10) are presented in the table below.

Table 2. Spatial characteristics of groundwater bodies of RBD of Central Macedonia

Type of WB	Number	Minimum Area (km^2)	Average Area (km^2)	Maximum Area (km^2)	Total Area (km^2)
GWBs	34	1.40	280.08	1,598.56	10,082.79

2 Climate characteristics and Climate change

2.1 Climate characteristics

Climate characteristics at regional (water basin) level (present state, for example 1961-1990 & 1990-2016) wherever available, please do provide proofs e.g. tables, maps

- Precipitation values (please provide tables):

- Temperature values (please provide tables):

- Existing hydrological monitoring (what is monitored, how is responsible for the monitoring):

- Available hydrological data:

The River Basin is characterized by a variety of climates, including Mediterranean in the area of Halkidiki and the coastal areas, continental in the inland and mountainous in the areas of high altitude. The average annual rainfall varies from 400 to 800 mm, while in the mountains parts it exceeds the 1000 mm.

Snowfall is quite common between September and April. The average annual temperature varies between 14.5 ° C and 17 ° C, with coldest month in January and warmer in July.

The following Table 3 presents the average annual precipitation values in various locations in the River Basin for the period 1980-2010[1].

Table 3. Average annual precipitation

Area	Mean annual precipitation (mm)
Agios Prodromos	509.6
Anthofyto	513.0
Arnaia	662.0
Goumenissa	734.0
Evzonoi	518.4
Evropos	476.2
Theodoraki	472.1
Kariotissa	533.7
Kilkis	446.9
Kolindros	660.7
Krya Vrysi	537.1
Megali Panagia	676.9
Megali Sterna	592.6
Melanthio	610.7
Metaxochori	530.7
Mikra	459.3
Monospita	588.7
Nea Chalkidona	493.9

[1] Data from the Management Plan of the River Basins of Central Macedonia River Basin District

Ormylia	467.8
Paralimni Giannitson	507.9
Plana	554.5
Polykastro	612.2
Oraiokastro	390.7

Figure 2 presents the spatial distribution of precipitation in the River Basin District of Central Macedonia. Three discreet hydroclimate zones are presented in it:

a) A zone of high precipitation, with a mean annual value of >600mm, in the mountainous part of Halkidiki and a small part in the Northwest part of the District (in Loudia basin).
b) An intermediate zone, with a mean annual value of 500mm, which ranges in the perimeter of the District and in the three peninsulas of Halkidiki.
c) A zone of low precipitation, with a mean annual value of <450mm, in the central part of the District and mainly around the city of Thessaloniki.

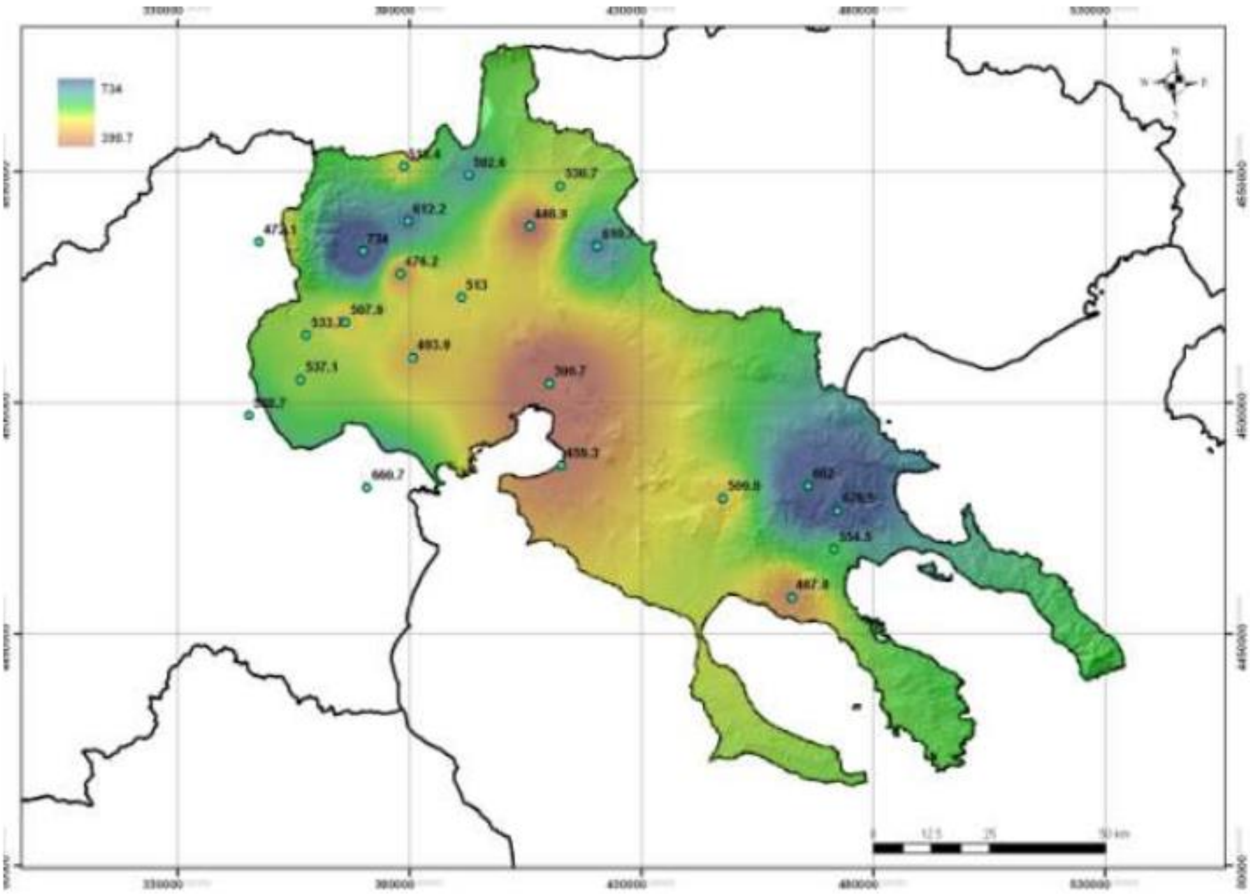


Figure 2. Spatial distribution of mean annual precipitation

The following Table presents statistical meteorological data in different locations in the District and for various time series[2]:

Variable	Mikra (1959-1997)	Sedes (1955-1972)	Polygyros (1979-1992)
Altitude (m)	4	30	544
Temperature (°C)	15.7	16.1	14.3
Min. daily temperature	-14.0	-12.8	-9.8
Max. daily temperature	42.0	43.2	36.2
Min. monthly temperature	2.9		
Max. monthly temperature	29.3		
Relative humidity	67.0%	65.0%	67.4%
Days with rain	108.9	109.3	43.0
Days with snow	6.6	7.7	8.6
Days with haze	0.4	0.7	0.5
Days with fog	21.9	33.1	30.2

Regarding the hydrological data for the District, the average annual total water supply is 5.3 x 109 m^3, of which 32% (1.7x109 m^3) comes from the same resources of the District, while the remaining 68% (3.6x109 m^3) comes from the water inflow of Axios River from FYROM. In addition, 356x106 m^3 is transported by Aliakmonas River from the neighboring District EL09, via the Aliakmonas-Axios Canal, for the irrigation needs of the Thessaloniki-Lagadas plain and the water supply needs of Thessaloniki.

According to the National Legislation (KYA 140384/19.08.2011) a monitoring programme was established in the District covering both the quantitative and qualitative characteristics of the water bodies. In particular:

- In the River Bodies of the District, 27 monitoring stations of which 5 operational and 22 monitoring. Of the 27 stations, 8 belong to Axios Basin (2 operational), 6 to Galikos Basin (1 operational) and 13 in Chalkidiki Basin (2 operational). To all of them biological, hydromorphological and physicochemical parameters are monitored. Determination of chemical variables (specific pollutants and priority substances is conducted in 12 stations.
- In the Lake Bodies, there are 5 monitoring stations, including 4 operational and 1 monitoring. Of the 5 stations the 2 are located in Axios Basin, 1 in GAlikos Basin and 2 in Halkidiki. In all lakes, biological parameters, hydromorphological, physicochemical and chemical parameters (specific pollutants and priority substances) are monitored.
- In Transient Bodies there is 1 operational monitoring station in the Axios Delta, in Axios Basin. This station monitors biological, hydromorphological, physicochemical and chemical (specific pollutants and priority substances) parameters.
- In Coastal Bodies 3 monitoring and 2 operational stations are located in Chalkidiki Basin and Athos Basin. All stations monitor biological, hydromorphological, physicochemical and chemical parameters.
- Regarding the Groundwater Bodies:

[2] Data from Management Plan of River Basins of the River Basin District of Central Macedonia

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- In Axios Basin, 3 monitoring stations and 41 operational stations are located, monitoring nitrate and heavy metals concentrations (in 26 locations), pesticides in 14 locations and chemicals in 9 locations.
- In Galikos Basin, 8 operational stations are located monitoring nitrate and heavy metals concentrations (in 2 locations), pesticides in 4 locations and chemicals in 3 locations.
- In Chalkidiki Basin 1 monitoring stations and 57 operational stations are located, monitoring nitrate and heavy metals concentrations (in 39 locations), pesticides in 8 locations and chemicals in 1 location.
- In Athos Basin 1 monitoring station is located.

The following Figures present the monitoring network of the surface water bodies and the groundwater bodies of the River Basin District of Central Makedonia.

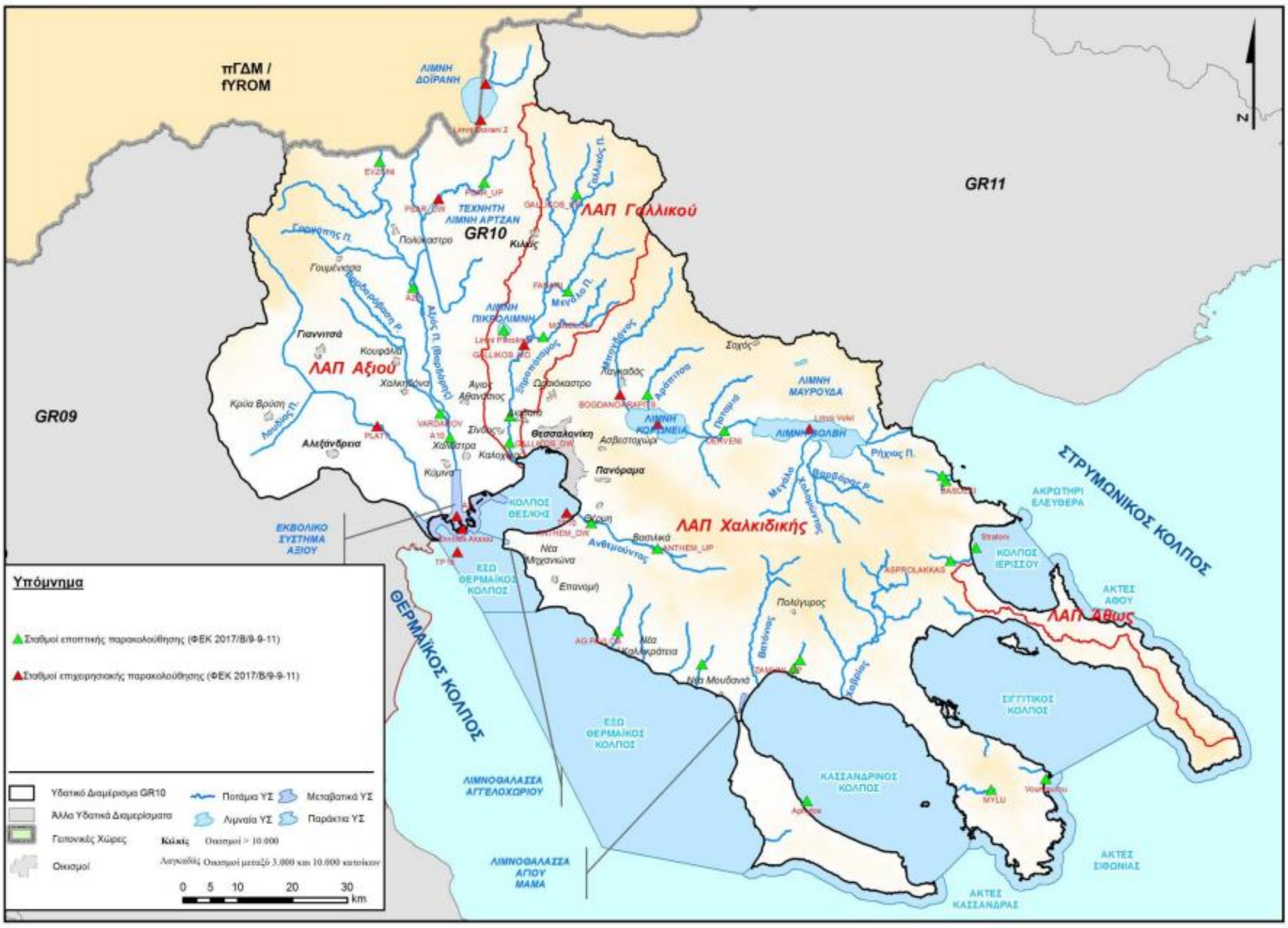


Figure 3. Monitoring network of surface water bodies of District EL10.

Figure 4. Monitoring network of groundwater bodies in EL10.

3 Water Availability - Climate Change Impacts on Water Resources

Water Utility Level

3.1. Water Demand (annually)

- Number of inhabitants in the area: 50.264
- Number of tourists in the area: -
- Annual water consumption (m^3/yr) per municipal district:

Municipal district	2015	2016	2017
Neoi Epivates	317,597	321,000	246,590
Agia Triada	113,681	107,799	107,119
Ano Peria	201,876	123,285	221,555
Nea Michaniona	648,407	641,377	620,581
Paralia Epanomis	266,244	271,234	227,842
Paralia Peraias	556,240	644,683	600,932
Epanomi	496,008	472,322	400,337
Mesimeri	107,620	139,484	132,978
Total	**2,707,673**	**2,721,548**	**2,557,934**

- Identify possible problems in water use (quality; quantity): Occasional problems of seawater intrusion due to the proximity of the area to the sea.

3.2. Climate Change Impacts on Water Resources Availability

- Estimate Characteristic Renewable Water Resources (hm^3/yr) for 1965-2010: 4,792.6

- Estimate long term average Water Resources conditions (hm^3/yr) for 1965-2010: -

- Estimate Characteristic Renewable Water Resources (m^3/s) for 2021-2050: -

- Estimate long term average Water Resources conditions (m^3/s) for 2021-2050: -

Data can be gathered by the River Basin Management Plans.

C. Water Resources Availability

wherever available, please do provide proofs e.g. sketches, diagrams, designs, tables, maps

- Estimate Water Exploitation Index (WEI) for **total water demand** and for **drinking water demand**.

WEI=WD/WR, where: WD is the water demand and WR is the renewable water resources

Please estimate WEI for the following scenarios:

Scenario 0: WD0 is the present water demand

Scenario 1: WD1 is the present water demand increased by 25%

Scenario 2: WD2 is the present water demand decreased by 25%

Please estimate the following indicators:

WEI1= WD0/WR present

WEI2= WD0/WR future

WEI3= WD1/WR future

WEI4= WD2/WR future

For the estimation of the above please consult the provided methodology.

Table to be filled in:

Country	Region / area	WEI (1)		WEI (2)		WEI (3)		WEI (4)
		Total use	Drinking water	Total use	Drinking water	Total use	Drinking water	Total Use
Greece	River Basin District of Central Macedonia	22.2%		29.3%		36.6		21.9%
								…

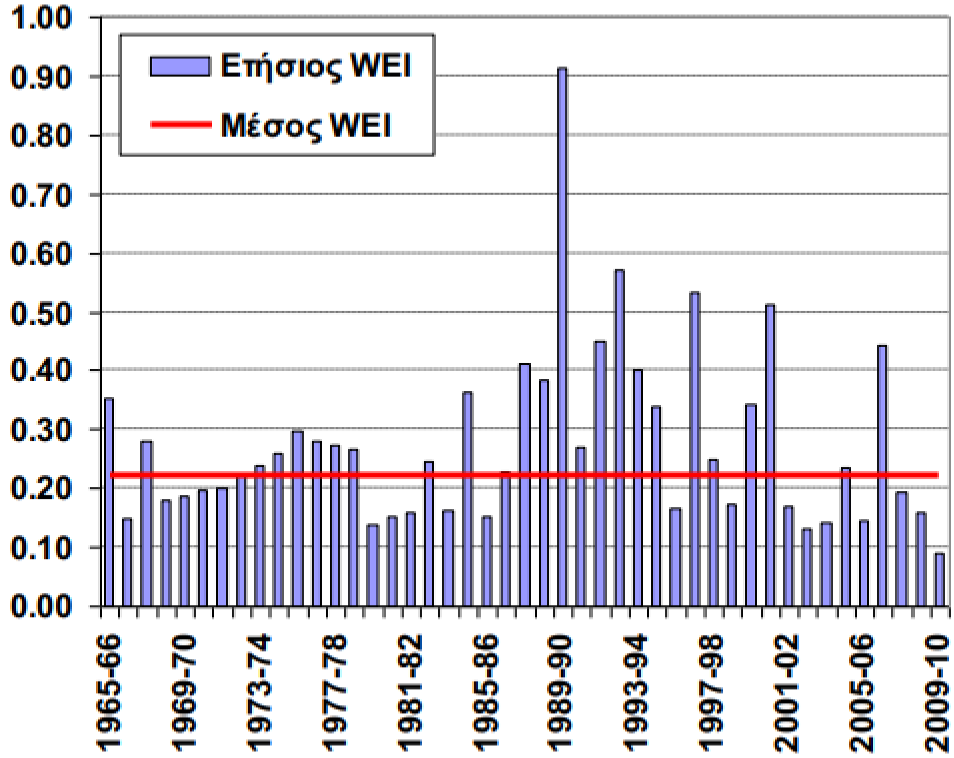


Figure 5.Time series of WEI in River Basin District of Central MAcedonia

4 Water Quality & Land Uses

Water Utility Level

A. Water Resources Quality Characteristics

The following Tables present the estimation of the status of water bodies in River Basin District of Central Macedonia:

A.1. River Bodies

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ/ ΔΥΝΑΜΙΚΟ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΟΣ ΕΜΠΙΣΤΟΣΥΝΗΣ[24]		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗ	ΧΗΜΙΚΗ	
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΞΙΟΥ (EL1003)									
1.	EL1003R000400031A	ΛΟΥΔΙΑΣ Π.	√	√	Μέτρια	Άγνωστη	1	0	Άγνωστη
2.	EL1003R0F0202014A	ΒΑΡΔΑΡΟΒΑΣΗ Ρ.	√	√	Ελλιπής	Καλή	3	3	Ελλιπής
3.	EL1003R0F0202015N	ΒΑΡΔΑΡΟΒΑΣΗ Ρ.		√	Μέτρια	Καλή	1	1	Μέτρια
4.	EL1003R0F0203006N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Καλή	1	1	Καλή
5.	EL1003R0F0203005N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Καλή	1	1	Καλή
6.	EL1003R0F0204017A	ΤΑΦΡΟΣ	√	√	Μέτρια	Καλή	1	1	Μέτρια
7.	EL1003R0F0202116N	ΒΑΡΔΑΡΟΒΑΣΗ Ρ.		√	Καλή	Καλή	1	1	Καλή
8.	EL1003R0F0205007N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Μέτρια	Καλή	3	3	Μέτρια
9.	EL1003R0F0204121N	ΜΕΤΑΛΛΙΚΟΝ Ρ.		√	Καλή	Καλή	1	1	Καλή
10.	EL1003R0F0204120A	ΤΑΦΡΟΣ	√	√	Μέτρια	Καλή	1	1	Μέτρια
11.	EL1003R000400035N	ΠΕΤΡΟΡΡΕΜΑ		√	Καλή	Καλή	1	1	Καλή
12.	EL1003R000400034N	ΞΗΡΟΠΟΤΑΜΟΣ		√	Καλή	Καλή	1	1	Καλή
13.	EL1003R0F0206026N	ΓΟΡΓΟΠΗΣ Π.		√	Καλή	Καλή	1	1	Καλή
14.	EL1003R0F0206024N	ΓΟΡΓΟΠΗΣ Π.		√	Μέτρια	Άγνωστη	1	0	Άγνωστη
15.	EL1003R0F0204018A	ΤΑΦΡΟΣ	√	√	Μέτρια	Καλή	1	1	Μέτρια
16.	EL1003R0F0208027N	ΚΟΤΖΑ Ρ.		√	Καλή	Καλή	1	1	Καλή
17.	EL1003R0F0208029N	ΜΕΓΑΛΟ Ρ.		√	Καλή	Καλή	1	1	Καλή
18.	EL1003R0F0208028N	ΜΕΓΑΛΟ Ρ.		√	Καλή	Καλή	1	1	Καλή

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ/ ΔΥΝΑΜΙΚΟ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΟΣ ΕΜΠΙΣΤΟΣΥΝΗΣ[24]		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗ	ΧΗΜΙΚΗ	
19.	EL1003R0F0207010N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Άγνωστη	1	0	Άγνωστη
20.	EL1003R0F0207009N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Καλή	1	1	Καλή
21.	EL1003R0F0207008N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Μέτρια	Άγνωστη	1	0	Άγνωστη
22.	EL1003R0F0208130N	ΛΥΚΟΡΕΜΑ		√	Καλή	Καλή	1	1	Καλή
23.	EL1003R0F0209013N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Καλή	1	1	Καλή
24.	EL1003R0F0209012N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Καλή	1	1	Καλή
25.	EL1003R0F0209011N	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)		√	Καλή	Καλή	1	1	Καλή
26.	EL1003R0F0204019N	ΜΠΑΓΙΑΛΤΖΑΣ Ρ.		√	Καλή	Καλή	1	1	Καλή
27.	EL1003R0F0204223N	ΨΑΡΟΡΡΕΜΑ		√	Μέτρια	Καλή	3	3	Μέτρια
28.	EL1003R0F0204222N	ΨΑΡΟΡΡΕΜΑ		√	Ελλιπής	Άγνωστη	3	0	Άγνωστη
29.	EL1003R000000001N	ΜΑΥΡΟΡΡΕΜΑ		√	Καλή	Καλή	1	1	Καλή
30.	EL1003R000000003N	ΞΗΡΟΡΡΕΜΑ		√	Μέτρια	Καλή	1	1	Μέτρια
31.	EL1003R000000002N	ΡΕΜΑ2		√	Μέτρια	Καλή	1	1	Μέτρια
32.	EL1003R000400033N	ΞΗΡΟΠΟΤΑΜΟΣ		√	Μέτρια	Καλή	1	1	Μέτρια
33.	EL1003R0F0206025N	ΓΟΡΓΟΠΗΣ Π.		√	Καλή	Καλή	1	1	Καλή
34.	EL1003R0F0201004H	ΑΞΙΟΣ Π. (ΒΑΡΔΑΡΗΣ)	√	√	Κακή	Κατώτερη της καλής	3	3	Κακή
35.	EL1003R000400032A	ΛΟΥΔΙΑΣ Π.	√	√	Ελλιπής	Καλή	3	3	Ελλιπής
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΓΑΛΛΙΚΟΥ (EL1004)									
36.	EL1004R000201003N	ΓΑΛΛΙΚΟΣ Π.		√	Ελλιπής	Άγνωστη	3	0	Άγνωστη
37.	EL1004R000201001N	ΓΑΛΛΙΚΟΣ Π.		√	Μέτρια	Καλή	1	1	Μέτρια
38.	EL1004R000202008N	ΞΗΡΟΠΟΤΑΜΟΣ		√	Ελλιπής	Καλή	3	1	Ελλιπής

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ/ ΔΥΝΑΜΙΚΟ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΟΣ ΕΜΠΙΣΤΟΣΥΝΗΣ[24]		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗ	ΧΗΜΙΚΗ	
39.	EL1004R000202110N	ΞΗΡΟΠΟΤΑΜΟΣ		√	Καλή	Καλή	1	1	Καλή
40.	EL1004R000203005N	ΓΑΛΛΙΚΟΣ Π.		√	Μέτρια	Άγνωστη	1	0	Άγνωστη
41.	EL1004R000204011N	ΜΕΓΑΛΟ Π.		√	Ελλιπής	Καλή	3	3	Ελλιπής
42.	EL1004R000205006N	ΓΑΛΛΙΚΟΣ Π.		√	Μέτρια	Καλή	1	1	Μέτρια
43.	EL1004R000202009N	ΞΗΡΟΠΟΤΑΜΟΣ		√	Καλή	Καλή	1	1	Καλή
44.	EL1004R000204113N	ΜΕΓΑΛΟ Π.		√	Καλή	Καλή	1	1	Καλή
45.	EL1004R000204012N	ΜΕΓΑΛΟ Π.		√	Καλή	Καλή	1	1	Καλή
46.	EL1004R000207007N	ΣΠΑΝΟΣ Π.		√	Μέτρια	Καλή	1	1	Μέτρια
47.	EL1004R000206014N	ΓΑΛΛΙΚΟΣ Π.		√	Μέτρια	Καλή	1	1	Μέτρια
48.	EL1004R000206116N	ΓΑΛΛΙΚΟΣ Π.		√	Καλή	Καλή	1	1	Καλή
49.	EL1004R000206015N	ΓΑΛΛΙΚΟΣ Π.		√	Μέτρια	Καλή	3	1	Μέτρια
50.	EL1004R000201002N	ΓΑΛΛΙΚΟΣ Π.		√	Ελλιπής	Καλή	3	3	Ελλιπής
51.	EL1004R000201004N	ΓΑΛΛΙΚΟΣ Π.		√	Μέτρια	Καλή	3	3	Μέτρια
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΧΑΛΚΙΔΙΚΗΣ (EL1005)									
52.	EL1005R001500028N	ΖΩΓΡΑΦΙΤΙΚΟΣ ΛΑΚΚΟΣ			Μέτρια	Καλή	1	1	Μέτρια
53.	EL1005R001300027N	ΜΥΛΟΥ		√	Μέτρια	Καλή	3	1	Μέτρια
54.	EL1005R001100026N	ΣΜΙΞΗ		√	Μέτρια	Καλή	1	1	Μέτρια
55.	EL1005R002701035N	ΒΑΤΟΝΙΑΣ		√	Μέτρια	Άγνωστη	1	0	Άγνωστη
56.	EL1005R003101042N	ΧΑΒΡΙΑΣ			Μέτρια	Καλή	1	1	Μέτρια
57.	EL1005R002500034N	ΣΑΛΙΔΙΚΑ ΜΑΝΔΙΑ Ρ.		√	Μέτρια	Καλή	1	1	Μέτρια
58.	EL1005R002900041N	ΖΑΜΟΥΝΗ		√	Ελλιπής	Καλή	3	1	Ελλιπής
59.	EL1005R003103043N	ΧΑΒΡΙΑΣ			Μέτρια	Καλή	1	1	Μέτρια
60.	EL1005R002300033N	ΞΗΡΟΛΑΓΚΑΣ		√	Μέτρια	Άγνωστη	1	0	Άγνωστη
61.	EL1005R003105044N	ΧΑΒΡΙΑΣ			Καλή	Καλή	1	1	Καλή

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ/ ΔΥΝΑΜΙΚΟ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΟΣ ΕΜΠΙΣΤΟΣΥΝΗΣ[24]		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗ	ΧΗΜΙΚΗ	
62.	EL1005R003102048N	ΚΑΠΡΙΝΙΚΙΑ			Καλή	Καλή	1	1	Καλή
63.	EL1005R002100032N	ΤΣΙΓΓΑΝΟ		√	Μέτρια	Καλή	1	1	Μέτρια
64.	EL1005R003106051N	ΞΙΝΟΝΕΡΙ			Καλή	Καλή	1	1	Καλή
65.	EL1005R000700024N	ΠΕΤΡΕΝΙΟ			Καλή	Καλή	1	1	Καλή
66.	EL1005R003107045N	ΧΑΒΡΙΑΣ		√	Μέτρια	Καλή	1	1	Μέτρια
67.	EL1005R002702038N	ΒΑΤΟΝΙΑΣ			Μέτρια	Καλή	1	1	Μέτρια
68.	EL1005R001900031N	ΡΕΜΑ1		√	Καλή	Καλή	1	1	Καλή
69.	EL1005R002703036N	ΒΑΤΟΝΙΑΣ			Καλή	Καλή	1	1	Καλή
70.	EL1005R003109046N	ΧΑΒΡΙΑΣ			Καλή	Καλή	1	1	Καλή
71.	EL1005R002704040N	ΒΑΤΟΝΙΑΣ		√	Καλή	Καλή	1	1	Καλή
72.	EL1005R003108052N	ΧΑΒΡΙΑΣ		√	Καλή	Καλή	1	1	Καλή
73.	EL1005R003104050N	ΜΗΛΙΑΔΙΝΟ		√	Καλή	Καλή	1	1	Καλή
74.	EL1005R003110053N	ΧΑΒΡΙΑΣ		√	Καλή	Καλή	1	1	Καλή
75.	EL1005R002705037N	ΒΑΤΟΝΙΑΣ			Καλή	Καλή	1	1	Καλή
76.	EL1005R000500023N	ΑΣΠΡΟΛΑΚΚΑΣ			Καλή	Άγνωστη	3	0	Άγνωστη
77.	EL1005R003111047N	ΧΑΒΡΙΑΣ		√	Καλή	Καλή	1	1	Καλή
78.	EL1005R000206014N	ΚΟΥΤΣΙΚΑΡΛΗ Ρ.		√	Καλή	Καλή	1	1	Καλή
79.	EL1005R000206216N	ΧΟΛΟΜΩΝΤΑΣ		√	Καλή	Καλή	1	1	Καλή
80.	EL1005R000208017N	ΜΕΓΑΛΟ		√	Καλή	Καλή	1	1	Καλή
81.	EL1005R000206013N	ΧΟΛΟΜΩΝΤΑΣ		√	Μέτρια	Καλή	1	1	Μέτρια
82.	EL1005R000206115N	ΒΑΡΒΑΡΑΣ Ρ.		√	Καλή	Καλή	1	1	Καλή
83.	EL1005R000300022N	ΜΠΑΣΔΕΚΗ		√	Μέτρια	Άγνωστη	3	1	Άγνωστη
84.	EL1005R000206012N	ΧΟΛΟΜΩΝΤΑΣ		√	Καλή	Καλή	1	1	Καλή
85.	EL1005R000204011N	ΑΣΠΡΟΠΕΤΡΑ		√	Καλή	Καλή	1	1	Καλή
86.	EL1005R000100021N	ΜΑΥΡΟΣ ΛΑΚΚΟΣ			Καλή	Άγνωστη	3	1	Άγνωστη

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ/ ΔΥΝΑΜΙΚΟ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΟΣ ΕΜΠΙΣΤΟΣΥΝΗΣ[24]		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗ	ΧΗΜΙΚΗ	
87.	EL1005R000201003N	ΡΗΧΙΟΣ Π.		√	Μέτρια	Καλή	1	1	Μέτρια
88.	EL1005R000201002N	ΡΗΧΙΟΣ Π.		√	Μέτρια	Καλή	1	1	Μέτρια
89.	EL1005R000201001N	ΡΗΧΙΟΣ Π.		√	Καλή	Καλή	1	1	Καλή
90.	EL1005R000212019N	ΧΩΡΑ		√	Καλή	Καλή	1	1	Καλή
91.	EL1005R000203005A	ΔΕΡΒΕΝΙ Ρ.	√	√	Μέτρια	Καλή	3	3	Μέτρια
92.	EL1005R000203004A	ΔΕΡΒΕΝΙ Ρ.	√	√	Μέτρια	Καλή	1	1	Μέτρια
93.	EL1005R000207007A	ΔΕΡΒΕΝΙ Ρ.	√	√	Μέτρια	Καλή	1	1	Μέτρια
94.	EL1005R000202010N	ΚΕΡΑΣΙΑΣ Ρ.		√	Καλή	Καλή	1	1	Καλή
95.	EL1005R000210018N	ΠΟΤΑΜΙΑ		√	Καλή	Καλή	1	1	Καλή
96.	EL1005R000214020N	ΑΡΑΠΙΤΣΑ		√	Μέτρια	Καλή	3	1	Μέτρια
97.	EL1005R000209009N	ΜΠΟΓΔΑΝΟΥ		√	Μέτρια	Άγνωστη	1	0	Άγνωστη
98.	EL1005R001700029H	ΑΝΘΕΜΟΥΣ	√	√	Κακή	Καλή	3	3	Κακή
99.	EL1005R001700030N	ΑΝΘΕΜΟΥΣ		√	Μέτρια	Καλή	1	1	Μέτρια
100.	EL1005R000900025N	Κ. ΛΑΚΚΟΣ		√	Μέτρια	Καλή	1	1	Μέτρια
101.	EL1005R000209008N	ΜΠΟΓΔΑΝΟΥ		√	Ελλιπής	Καλή	3	3	Ελλιπής
102.	EL1005R003104049N	ΜΗΛΙΑΔΙΝΟ			Μέτρια	Καλή	1	1	Μέτρια
103.	EL1005R002704039N	ΒΑΤΟΝΙΑΣ			Καλή	Καλή	1	1	Καλή
104.	EL1005R000205006A	ΔΕΡΒΕΝΙ Ρ.	√	√	Μέτρια	Καλή	1	1	Μέτρια
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΘΩ (EL1043)									
Δεν καθορίζονται ποτάμια υδατικά συστήματα									

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

A.2. Lake Bodies

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΙΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ/ ΔΥΝΑΜΙΚΟ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΟΣ ΕΜΠΙΣΤΟΣΥΝΗΣ		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗΣ	ΧΗΜΙΚΗΣ	
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΞΙΟΥ (EL1003)									
1.	EL1003L000000006A	Τεχνητή Λίμνη Αρτζάν	√	√	Άγνωστη	Άγνωστη	0	0	Άγνωστη
2.	EL1003L0F0000001N	Λ. Δοϊράνη		√	Μέτρια	Καλή	3	3	Μέτρια
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΓΑΛΛΙΚΟΥ(EL1004)									
3.	EL1004L000000005N	Λ. Πικρολίμνη		√	Άγνωστη	Καλή	0	3	Άγνωστη
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΧΑΛΚΙΔΙΚΗΣ (EL1005)									
4.	EL1005L000000002H	Λ. Μαυρούδα	√	√	Άγνωστη	Άγνωστη	0	0	Άγνωστη
5.	EL1005L000000003N	Λ. Βόλβη		√	Μέτρια	Καλή	3	3	Μέτρια
6.	EL1005L000000004N	Λ Κορώνεια		√	Κακή*	Καλή	3	3	Κακή*
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΘΩ (EL1043)									
Δεν καθορίζονται λιμναία υδατικά συστήματα									

A.3. Transient Bodies

Α/Α	ΚΩΔΙΚΟΣ ΥΔΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	ΟΝΟΜΑΣΙΑ ΥΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΌΣ ΕΜΠΙΣΤΟΣΥΝΗΣ		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗΣ	ΧΗΜΙΚΗΣ	
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΞΙΟΥ (EL1003)									
1	EL1003T0001N	ΕΚΒΟΛΙΚΟ ΣΥΣΤΗΜΑ ΑΞΙΟΥ		√	Άγνωστη	Καλή	0	3	Άγνωστη
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΓΑΛΛΙΚΟΥ(EL1004)									
Δεν καθορίζονται μεταβατικά υδατικά συστήματα									
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΧΑΛΚΙΔΙΚΗΣ (EL1005)									
2	EL1005T0002N	Λ/Θ ΑΓΓΕΛΟΧΩΡΙΟΥ		√	Άγνωστη	Άγνωστη	0	0	Άγνωστη
3	EL1005T0003N	Λ/Θ ΑΓΙΟΥ ΜΑΜΑ		√	Άγνωστη	Άγνωστη	0	0	Άγνωστη
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΘΩ (EL1043)									
Δεν καθορίζονται μεταβατικά υδατικά συστήματα									

A.4. Coastal Bodies

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Α/Α	ΚΩΔ. ΥΣ	ΌΝΟΜΑ ΥΣ	ΙΤΥΣ/ΤΥΣ	ΣΥΝΔΕΣΗ ΜΕ ΠΡΟΣΤΑΤΕΥΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΟΙΚΟΛΟΓΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΒΑΘΜΌΣ ΕΜΠΙΣΤΟΣΥΝΗΣ		ΣΥΝΟΛΙΚΗ ΚΑΤΑΣΤΑΣΗ
							ΟΙΚΟΛΟΓΙΚΗΣ	ΧΗΜΙΚΗΣ	
ΛΕΚΑΝΗ ΑΠΟΡΡΟΉΣ ΑΞΙΟΥ (EL1003)									
Δεν καθορίζονται παράκτια υδατικά συστήματα									
ΛΕΚΑΝΗ ΑΠΟΡΡΟΉΣ ΓΑΛΛΙΚΟΥ (EL1004)									
Δεν καθορίζονται παράκτια υδατικά συστήματα									
ΛΕΚΑΝΗ ΑΠΟΡΡΟΉΣ ΧΑΛΚΙΔΙΚΗΣ (EL1005)									
1	EL1005C0001N	Ακρ. Ελευθέρα			Υψηλή	Καλή	1	1	Υψηλή
2	EL1005C0007N	Ακτές Κασσάδρας		√	Υψηλή	Καλή	1	1	Υψηλή
3	EL1005C0005N	Ακτές Σιθωνίας		√	Καλή	Καλή	1	1	Καλή
4	EL1005C0009N	Έξω Θερμαϊκός κόλπος - Καλλικράτεια		√	Μέτρια	Καλή	1	1	Μέτρια
5	EL1005C0010N	Έσω Θερμαϊκός κόλπος - Ν. Μηχανιώνα		√	Μέτρια	Καλή	3	3	Μέτρια
6	EL1005C0008A	Κανάλι Ποτίδαιας	√		Καλή	Καλή	1	1	Καλή
7	EL1005C0006N	Κασσανδρινός κόλπος (Χαλκιδική)		√	Καλή	Καλή	3	3	Καλή
8	EL1005C0011H	Κόλπος Θεσσαλονίκης	√	√	Μέτρια	Καλή	3	3	Μέτρια
9	EL1005C0004N	Σιγγιτικός κόλπος (Χαλκιδική)		√	Καλή	Καλή	3	3	Καλή
ΛΕΚΑΝΗ ΑΠΟΡΡΟΗΣ ΑΘΩ (EL1043)									
10	EL1043C0003N	Ακτές Άθου			Υψηλή	Καλή			Υψηλή
11	EL1043C0002N	Κόλπος Ιερισσού (Χαλκιδική)		√	Μέτρια	Καλή	3	3	Μέτρια

A.5. Groundwater Bodies

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ-ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
1	EL1000010	ΥΥΣ Λουδία	ΚΑΛΗ	ΚΑΛΗ	Fe, Mn, As, Cd, Al, E.C., Cl	NO_3, NO_2, NH_4, Cr	Γεωργία Λύματα Βιομηχανία Κτηνοτροφία-Πτηνοτροφία	ΝΑΙ Τοπικά	ΟΧΙ	Al (διήθηση από γειτονικά ΥΥΣ), As (λόγω οργανικής ύλης)
2	EL1000020	ΥΥΣ Πάικου	ΚΑΛΗ	ΚΑΛΗ	As	ΟΧΙ	Κτηνοτροφία	ΟΧΙ	ΝΑΙ	
3	EL1000030	ΥΥΣ Αξιού	ΚΑΚΗ	ΚΑΚΗ	Fe, As, Mn, Ni, Cd, Al, E.C., Cl	EC, Cl, NO_3, NH_4, NO_2, As, Fe, Mn	Γεωργία Κτηνοτροφία-Πτηνοτροφία Βιομηχανία Υπεραντλήσεις	ΝΑΙ Στην παράκτια ζώνη	ΟΧΙ	
4	EL100F040	ΥΥΣ Δοϊράνης	ΚΑΛΗ	ΚΑΚΗ	F, Fe, Al	NO_3	Γεωργία Κτηνοτροφία Λύματα Υπεραντλήσεις	ΟΧΙ	ΟΧΙ	Al (διήθηση από γειτονικά ΥΥΣ)
5	EL1000160	ΥΥΣ Μαυρονερίου	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Λύματα	ΟΧΙ	ΝΑΙ	
6	EL100F230	ΥΥΣ Ανατολικού Πάικου	ΚΑΛΗ	ΚΑΛΗ	As	-	Κτηνοτροφία Λύματα	ΟΧΙ	ΟΧΙ	As (λόγω διάσπαρτης μεταλλοφορίας και θειούχων ορυκτών – γεωθερμία)
7	EL100F240	ΥΥΣ Ευζώνων	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Κτηνοτροφία Λύματα	ΟΧΙ	ΟΧΙ	
8	EL100F250	ΥΥΣ Ποντοηράκλειας - Μεταμόρφωσης	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Γεωργία	ΟΧΙ	ΟΧΙ	
9	EL100F260	ΥΥΣ Μύτακα	ΚΑΛΗ	ΚΑΛΗ	-	-	ΟΧΙ	ΟΧΙ	ΟΧΙ	
10	EL1000270	ΥΥΣ Βαφειοχωρίου	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Γεωργία Λατομεία Κτηνοτροφία	ΟΧΙ	ΟΧΙ	

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ-ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
							Υπεραντλήσεις			
11	EL100F280	ΥΥΣ Μεγάλης Στέρνας	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Κτηνοτροφία Λύματα Γεωργία	ΟΧΙ	ΟΧΙ	

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ-ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
1	EL1000050	ΥΥΣ Γαλλικού	ΚΑΛΗ	ΚΑΚΗ	Mg, Fe, Mn, E.C., Cl	SO_4, NO_3, As	Γεωργία Βιομηχανία ΧΥΤΑ Κτηνοτροφία Πτηνοτροφία Υπεραντλήσεις	ΝΑΙ Τοπικά	ΟΧΙ	Mn (γηγενή αίτια), Cl (υφάλμυρα στρώματα)
2	EL1000210	ΥΥΣ Μεσαίου	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Κτηνοτροφία Λύματα	ΟΧΙ	ΟΧΙ	
3	EL1000220	ΥΥΣ Ντεβέ Κοράν	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Γεωργία Κτηνοτροφία Λύματα Λατομεία	ΟΧΙ	ΝΑΙ	

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ-ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
	EL1000060	ΥΥΣ Μουδανιών								
1	EL1000061	Υποσύστημα Μουδανιών	ΚΑΚΗ	ΚΑΚΗ	Mn, Ni, B, As, Fe, F, Al	Cl, Pb, Ni, NO_3	Γεωργία Κτηνοτροφία Βιοτεχνία Υφαλμύρινση Υπεραντλήσεις	ΝΑΙ	ΟΧΙ	Al (γηγενή ρύπανση)
2	EL1000062	Υποσύστημα Νέας Τρίγλιας	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	ΟΧΙ	ΟΧΙ	ΟΧΙ	
	EL1000070	ΥΥΣ Μυγδονίας								
3	EL1000071	Υποσύστημα Κορώνειας	ΚΑΛΗ	ΚΑΚΗ	SO_4, Fe, Mn, F, B, E.C.	Fe, Mn, SO_4, NO_3, NO_2, NH_4, SO_4, Ni, Pb, Al	Γεωργία Κτηνοτροφία Βιοτεχνία Λύματα	ΟΧΙ	ΟΧΙ	E.C.(λόγω γεωθερμικών ρευστών)
4	EL1000072	Υποσύστημα Βόλβης	ΚΑΛΗ	ΚΑΚΗ	Fe, Mn, F, B, As, E.C.	Ph, NO_3, NH_4, Fe, Mn, Al, As	ΟΧΙ	ΟΧΙ	ΟΧΙ	E.C.(λόγω γεωθερμικών ρευστών)
	EL1000080	ΥΥΣ Ανθεμούντα								
5	EL1000081	Υποσύστημα Κάτω ρου Ανθεμούντα	ΚΑΚΗ	ΚΑΚΗ	Fe, Mn, B, Cr, As, Cl, E.C.	NO_3, Cl	Γεωργία Κτηνοτροφία Αστικά Λύματα Υφαλμύρινση Υπεραντλήσεις	ΝΑΙ	ΟΧΙ	As (λόγω γεωθερμικών ρευστών)
6	EL1000082	Υποσύστημα Γαλαρινού - Γαλάτιστας	ΚΑΛΗ	ΚΑΛΗ	-	ΟΧΙ	ΟΧΙ	ΟΧΙ	ΟΧΙ	
7	EL1000083	Υποσύστημα Θέρμης – Ν.Ρύσιο	ΚΑΛΗ	ΚΑΛΗ	Fe, Mn, B, As, Cl, Na, H_2S	ΟΧΙ	ΟΧΙ	ΟΧΙ	ΟΧΙ	Γεωθερμικά ρευστά/Ρήγμα Ανθεμούντα

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ-ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
8	EL1000090	ΥΥΣ Κασσάνδρας	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	Cl, Fe, Mn	Γεωργία Κτηνοτροφία Αστικά Λύματα Υφαλμύρινση	ΝΑΙ	ΟΧΙ	
9	EL1000100	ΥΥΣ Ορμύλιας	ΚΑΚΗ	ΚΑΚΗ	ΟΧΙ	Cl, NO_3, As	Γεωργία Κτηνοτροφία Αστικά Λύματα Υφαλμύρινση Υπεραντλήσεις	ΝΑΙ	ΟΧΙ	
10	EL1000120	ΥΥΣ Μαυρούδας	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	ΟΧΙ	Γεωργία Κτηνοτροφία Αστικά Λύματα	ΟΧΙ	ΟΧΙ	
	EL1000130	ΥΥΣ Ασπρόλακκα								
11	EL1000131	Υποσύστημα Ασπρόλακκα	ΚΑΛΗ	ΚΑΛΗ	Fe, Mn	-	Γεωργία	ΟΧΙ	ΟΧΙ	
12	EL1000132	Υποσύστημα Κοκκινόλακκα	ΚΑΚΗ	ΚΑΛΗ	SO_4, Βαρέα Μέταλλα	ΟΧΙ	Μεταλλεία	ΟΧΙ	ΟΧΙ	Υπόλοιπα παλαιάς μεταλλευτικής δραστηριότητας, Τοξικά Στοιχεία
13	EL1000140	ΥΥΣ Ολυμπιάδας	ΚΑΛΗ	ΚΑΛΗ	Fe, Mn, Zn, B	-	Γεωργία, Μεταλλεία, Αστικά Λύματα	-	ΟΧΙ	
14	EL1000200	ΥΥΣ Ν. Ρόδων	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Γεωργία	ΟΧΙ	ΟΧΙ	
15	EL1000150	ΥΥΣ Κρουσίων – Κερδυλλίων	ΚΑΛΗ	ΚΑΛΗ	Mn, Fe	ΟΧΙ	Κτηνοτροφία Αστικά Λύματα	ΟΧΙ	ΟΧΙ	
16	EL1000180	ΥΥΣ Σιθωνίας	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Γεωργία Κτηνοτροφία Βιοτεχνία Υφαλμύρινση (Τοπικά)	ΝΑΙ Στην παράκτια ζώνη	ΟΧΙ	

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ -ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
	EL1000190	ΥΥΣ Χολομώντα - Ωραιοκάστρου								
17	EL1000191	Υποσύστημα Σκουριών	ΚΑΚΗ	ΚΑΛΗ	As, Pb	-	Μεταλλεία	ΟΧΙ	ΟΧΙ	Pb (γηγενής προέλευση)
18	EL1000192	Υποσύστημα Ολυμπιάδας	ΚΑΛΗ	ΚΑΛΗ	As, Pb	-	Μεταλλεία	ΟΧΙ	ΟΧΙ	Pb (γηγενής προέλευση)
19	EL1000193	Υποσύστημα Χολομώντα - Ωραιοκάστρου	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	ΟΧΙ	ΟΧΙ	ΟΧΙ	
20	EL1000290	ΥΥΣ Αμολιανής	ΚΑΛΗ	ΚΑΛΗ	-	-	ΟΧΙ	-	ΟΧΙ	
21	EL1000300	ΥΥΣ Διάπορος	ΚΑΛΗ	ΚΑΛΗ	-	-	ΟΧΙ	-	ΟΧΙ	

Α/Α	ΚΩΔΙΚΟΣ ΥΥΣ	ΟΝΟΜΑΣΙΑ ΥΥΣ	ΧΗΜΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΠΟΣΟΤΙΚΗ ΚΑΤΑΣΤΑΣΗ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΛΟΓΩ ΦΥΣΙΚΟΥ ΥΠΟΒΑΘΡΟΥ	ΑΥΞΗΜΕΝΕΣ ΤΙΜΕΣ ΣΤΟΙΧΕΙΩΝ ΑΝΘΡΩΠΟΓΕΝΟΥΣ ΕΠΙΔΡΑΣΗΣ	ΚΥΡΙΕΣ ΠΙΕΣΕΙΣ	ΘΑΛΑΣΣΙΑ ΔΙΕΙΣΔΥΣΗ	ΠΡΟΣΤΑΤΕΥ -ΟΜΕΝΕΣ ΠΕΡΙΟΧΕΣ	ΠΑΡΑΤΗΡΗΣΕΙΣ
1	EL1000170	ΥΥΣ Αγίου Όρους	ΚΑΛΗ	ΚΑΛΗ	Mn, Fe	-	Κτηνοτροφία Αστικά Λύματα	ΟΧΙ	ΟΧΙ	Fe λόγω γηγενούς ρύπανσης
2	EL1000110	ΥΥΣ Ιερισσού	ΚΑΛΗ	ΚΑΛΗ	ΟΧΙ	-	Γεωργία Κτηνοτροφία Αστικά Λύματα	ΟΧΙ	ΟΧΙ	

B. Land Use

Dominant use is that of agricultural land with 56.74% of the total. Permanently irrigated agricultural land constitutes a large proportion (9.72% of the total and 17.5% of all agricultural land) and is located mainly in the southern and western parts of the District, in the areas of the Municipalities of Delta, Alexandria, Chalkidon and Pella, while some sections are located in the area of Polykastro in the Municipality of Paionia and in the area of Apollonia in the Municipality of Volvi. The majority of the agricultural land is in the category ‘arable agricultural land’ with a percentage of 30.40% of the total land area and is mainly located in lowlands of the Kilkis, Pella and Imathia Regional Districts, as well as in areas of Thessaloniki, mainly of the Municipality of Lagada and Volvi. Permanent crops, with 2.22% of the total, are mainly found in Halkidiki.

Forest areas covers a 37.89% of the total area. The mountainous areas covered by mixed forests and broadleaved forests, while to a lesser extent coniferous forests are located mainly in the peninsula of Athos and in mountainous areas of Halkidiki, but also in the mountainous part of the Paionian and Pella Regional Districts Of Kilkis and Pella, respectively.

4.26% of the total area is covered by natural pastures and grasslands and sparse vegetation forests.

The artificial surfaces (Residential Areas - Industrial and Commercial Zones – Networks Transport, etc.) occupy a small percentage of coverage in the entire District. The larger areas covered by the settlements are located as it is natural, in the Thessaloniki area, but also to the coastal areas of the Halkidiki Peninsula.

As for transport networks, they occupy a small percentage (0.12%). The remaining area (2.1%) of the District is occupied by water areas and wetlands, including mainly land-based waters (rivers, lakes, marshes, etc.), while only a small percentage of them occupy transitional waters (estuaries).

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

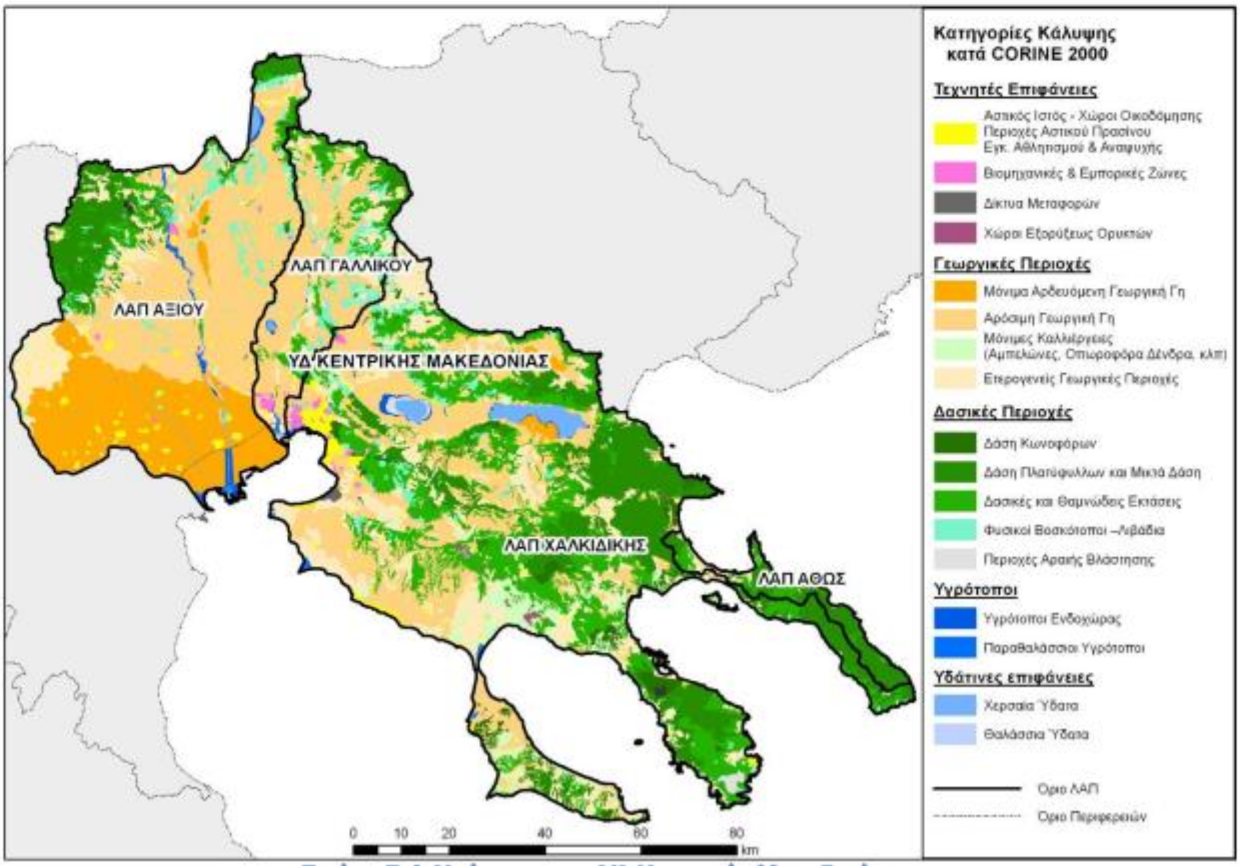


Figure 6. Land uses in River Basin District of Central Macedonia, according to CORINE (from Management Plan of The River Basin District of Central Macedonia)

C. DPSIR (Drivers, Pressures, Status, Impacts, Response) methodology

Please identify the following (please consult the methodology):

Present state

- Driving forces:
- Pressure:
- State:
- Impact:
- Response:

Future state (include climate change)

- Driving forces:
- Pressure:
- State:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Impact:
- Response:

5 Table with data

Please fill in the following table:

Name of region / area			
Water Resources			
Related City / Country			
Geographical coordinates			
Altitudinal range			
Size			
Morphology			
Aquifer type			
Surface water interaction			
Geology			
Mean annual precipitation			
Mean annual temperature			
Soil types			
Land uses			
Protection areas			
Water abstraction			
Qualitative status			
Quantitative status			

6 SWOT Analysis

Please identify any strengths and weaknesses your region has related to climate change impact on water and energy resources:

- Strengths:
- Weaknesses:

Please identify any opportunities and threats your region is facing in the European environment related to climate change impact on water and energy resources:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".

- Opportunities:
- Threats:

7 Comments

Please provide any comments.

Appendix A:

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020".