Environment and Climate Regional Accession Network ECRAN

Environment and Climate Regional Accession Network (ECRAN)

Task 2 - Qualitative Vulnerability Assessment (Two sectors: Water and another sector)

Task 3 – Adaptation Needs

Compilation of outputs of Task 2 and Task 3 by the ECRAN beneficiary countries

Support to adaption planning - Step A

ENVIRONMENT AND CLIMATE REGIONAL ACCESSION NETWORK - ECRAN

CLIMATE ADAPTATION EXERCISE

TASK 2: QUALITATIVE VULNERABILITY ASSESSMENT

TAKS 3: ADAPTATION NEEDS

SUPPORT OF THE IDENTIFICATION OF ADAPTION OPTIONS (ADAPTION PLANNING) – STEP A: CLIMATE ADAPTION TOOL: PRIORITISATION OF ADAPTION NEEDS

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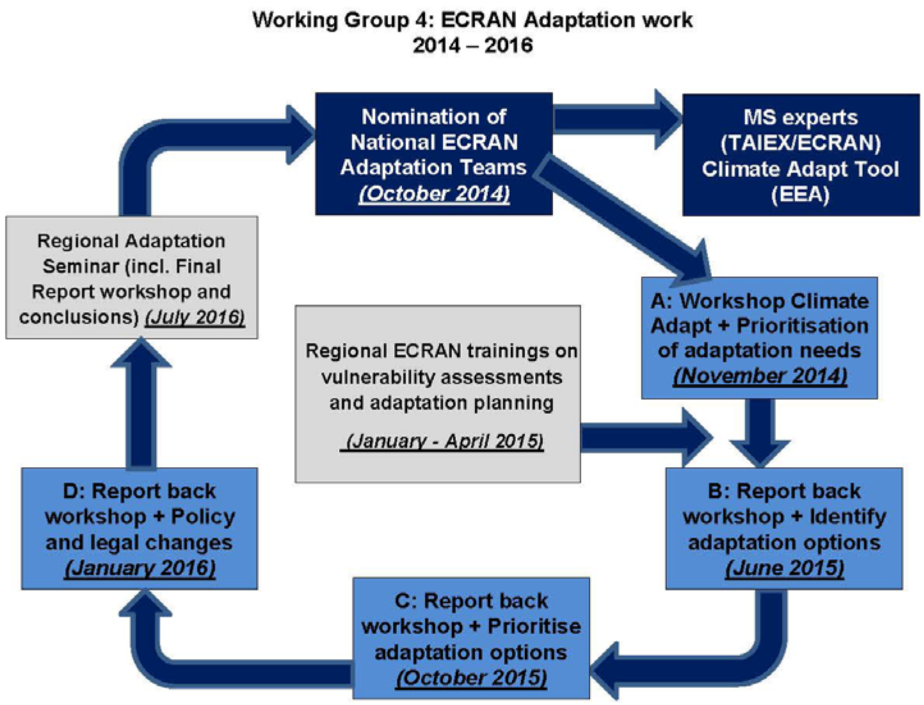
[1] *This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence

Background

ECRAN Climate Adapt Activities

Within its Climate Component, ECRAN will promote 'climate-proofing' action by further encouraging adaptation in key vulnerable sectors which would in turn, enable planning for a more resilient infrastructure, and would support better informed decision-making by addressing gaps in knowledge about adaptation. ECRAN will address adaptation action by coordinating adaptation activities with the European Climate Adaptation Platform (Climate-ADAPT) as the 'one-stop shop' for adaptation information in Europe.



The ECRAN Adaptation Programme includes a series of workshops that will guide the National ECRAN Adaptation Teams through the different stages towards developing a national climate adaptation policies and legislation (Activity 4.2). This will be combined with regional training sessions that support Beneficiary Countries' experts from the selected technical areas to carry out risk and vulnerability assessments and adaptation planning (Activity 4.1.b).

Knowledge base for adaptation

Reference is made to the EEA studies and activities on the climate change impacts, vulnerability and adaptation, all available on the EEA website[2]. Two particular publications are of particular importance:

- Climate change, impacts and vulnerability in Europe (EEA indicator report, Nov 2012)[3]

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[2] http://www.eea.europa.eu/themes/climate/publications?b_start:int=0

[3] http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012

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- National adaptation policy processes in Europe (EEA report published 14 Oct 2014)[4]

As a part of a first step to prepare the ground for adaptation there is a need to develop a sound knowledge base. The importance of having *'better informed decision-making'* is also highlighted in the EU Climate Change Adaptation Strategy, which includes this as one of its three main objectives (EC, 2013). Scientific knowledge, however, needs to be combined with practical and administrative knowledge. In this context cooperation between scientists, policy actors and other stakeholders such as civil and business NGOs is fundamental.

- As a first step Establish *Exposure Units*, *Receptors* and *Risk Assessment Endpoints* (climate thresholds):
    - The *exposure unit* represents the system considered to be at risk, often defined in terms of geographical extent, location and distribution of a variety population of *receptors* at risk.
    - These *receptors* are selected to represent important aspects of the exposure unit, particularly those of significance to the decision-making process.
    - *Assessment endpoints* are chosen to help establish the acceptability of the risk posed to the exposure unit(s) by future circumstances and decisions, including those regarding climate change risk management.
- For a preliminary screening:
    - Identify and define a set of climate and non-climate variables or factors for the exposure unit and for which the receptors may be sensitive;
    - Collect and assess the available data set;
    - Assess the available models and model data (climate, hydrological, impacts);
    - Use climate scenarios to help determine the climate change dependent risk to the receptors;
    - Use non-climate scenarios (population, socio-economic scenarios) to help determine the nature of the non-climate dependent risk.
- There are open sources and references of the main observational station datasets (temperature and precipitation) that can be used for vulnerability assessment work:
    - Global Historical Climatology Network (GHCN-Monthly and GHCN-daily): Global daily data of temperature (max, min and mean) and precipitation from over 43,000 stations (about 8,500 of which are regularly updated with observations from within the last month) for a period starting already from the 19th century[5].
    - E-OBS gridded dataset: E-OBS is a daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe. The full dataset covers the period 1950-01-01 until 2013-12-31. Currently it is maintained and elaborated as part of the UERRA project (EU-FP7).[6]
    - MED-HYCOS (Mediterranean Hydrological Cycle Observing System): Network of hydro-meteorological real time or near real time data collecting platforms (DCPs) on the main rivers of the Mediterranean catchments. (Albania, Bosnia, Croatia, former Yugoslav Republic of Macedonia).[7]
- The CORDEX tool is providing global coordination to produce improved regional climate change projections of all land regions world-wide. The results are fed into the climate change impact and adaptation studies within the timeline of the Fifth Assessment Report (AR5) of the IPCC. [8]

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[4] http://www.eea.europa.eu/publications/national-adaptation-policy-processes

[5] http://www.ncdc.noaa.gov/data-access/quick-links#ghcn

[6] http://eca.knmi.nl/maxtemp_EOBS.php

[7] http://medhycos.mpl.ird.fr/

[8] http://cordex.dmi.dk/joomla/ and http://www.euro-cordex.net/ and http://wcrp-cordex.ipsl.jussieu.fr/

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Development of position papers on specific adaptation topics

During the November 2014 ECRAN Adapt STEP A Workshop (see above and also at www.ecranetwork.org), it was agreed to complete the following three tasks and report on their progress to the ECRAN team by the deadlines indicated. The outputs will serve as input and background to the so called STEP B Workshop to be held in June 2015.

Task 1. Position paper on modelling activities (climate models, impact models) performed in your country.

Considering past weather events will help to gain a better understanding of the current vulnerability of a country and current impacts of climate change. It will help determine a country's sensitivity to current weather and thus, provide significant insight for the current adaptation needs. From there climate models give an outlook on the long-term changes/changes over time and give directions for related adaptation action and needs.

The countries were invited to prepare a position paper on the available relevant existing work, such as national risk or vulnerability assessments and the availability and use of climate models, which can provide an excellent starting point for answering these questions. It was expected that information could be obtained from national Met Offices.

The Task 1 Position papers from all ECRAN beneficiaries can be downloaded from:

http://www.ecranetwork.org/Files/Country_Position_Papers_ADAPT_Climate_Modelling.pdf

Task 2: The countries were asked to make a qualitative vulnerability assessment of **2 sectors** in their respective countries (first sector: Water resources and links to DRM and cross border aspects) and the second sector of their own choosing. Method: Use the Adaptation Support Tool of Climate-Adapt.

The countries were invited to prepare two short qualitative vulnerability studies for the water sector and a second sector, which they selected themselves.

- As a first step, available information for the country's future threats (e.g. sectoral vulnerability assessments) and opportunities would need to be collected and analysed.
- If the available information base was not sufficient for elaborating adaptation responses for the two sectors (water and the other chosen sector), additional assessments would need to be carried out. Various approaches for risk assessments are available, e.g. from the UK and Germany and were addressed in the November workshop. Methods of measuring physical vulnerability normally range from the empirical methods to the use of models. The following empirical methods could be considered for the studies:
  - **Analysis of observed damage** Based on the collection and analysis of statistics of damage that occurred in recent and historic events. Relating vulnerability to different hazard intensities.

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- **Expert opinion** Based on the asking groups of experts on vulnerability to give their opinion, for instance on the percentage damage they expect for a particular sector having different intensities of hazard/impact.
- **Score Assignment:** Method using a questionnaire with different parameters to assess the potential damages in relation to the different hazard levels.

Task 3: the countries were asked to identify the adaptation needs and prepare a position paper based on vulnerability assessments of their two sectors. Method: Use the Adaptation Support Tool.

The countries were asked to prepare a position paper based on vulnerability assessment for each of the two studied sectors, and identify the adaptation needs and a list of options. These will be later assessed and elaborated.

The results of Tasks 2 and Task 3 from all ECRAN beneficiaries can be found in Annex I to this document.

Annex I hereafter includes the position papers on

- Task 2: qualitative vulnerability assessment (water sector and other sector chosen at the discretion of ECRAN beneficiary)
- Task 3: Adaptation Needs

For:

- Albania
- Croatia
- Bosnia and Herzegovina
- The former Yugoslav Republic of Macedonia
- Kosovo*
- Montenegro
- Serbia
- Turkey

Please note that the attached papers have not been reviewed by the ECRAN Team. The National Adapt Teams agreed to distribute the Task 1, 2 and 3 position papers among the regional stakeholders.

* * this designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo* Declaration of Independence.

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The content of the position papers does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in the position papers lies entirely with the ECRAN beneficiary(ies).

Annex I: Position Papers of Beneficiary Countries

The position papers from the ECRAN beneficiaries are included in this section, which is a compilation of the documents submitted to the project and have not been reviewed by the ECRAN Adaptation Team.

The content of the position papers does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in the position papers lies entirely with the ECRAN beneficiary(ies).

Albania

Task 2 – Vulnerability Assessment

Vulnerability Assessment in Water Resources

Referring to First National Communication (2003), the expected climate change will modify rainfall, evaporation and soil moisture storage, leading to an increase in the irrigation requirements and a decrease in the capacity of reservoirs and irrigation distribution systems. Because of the reduction of stream flows in the wetlands, FNC (2003) stated that the western part of Albania would experience both increasing demands for water and reduced supplies of water, which would decrease wetland areas. The increase in the extreme events may lead to a badly designed reservoir for potential flood risk. Comparing the results of the changes in river runoff obtained for the CCSA, which expect an increase of the long term mean annual and seasonal air temperature and a decrease of mean annual and seasonal precipitation, it can be stated that a decrease in the long term mean annual and seasonal runoff has to be expected for the whole territory and for all three time horizons (2025, 2050, 2100).

Based on FNC (2003) the ground water supply will be affected by decreased percolation of water, due to decrease in the amount of precipitation and stream flow and as well as losses of soil moisture from increased evapotranspiration. This can lead to the increase of pumping costs.

The predicted sea level rise of 20-24 cm by 2050 is not expected to have significant impact on ground water, whereas the sea level rise of 48-61 cm expected by 2100 will cause the increase in the salinity of aquifers especially for the coastal area. This effect will be more significant in Fushe Kuqe and Durresi plain. Fushe Kuqe has very important aquifers, because it supplies drinking water to the northern coastal cities as well as Durresi and Kavaja.

The other areas that will be influenced, though less than Fushe Kuqe and Durresi plain, are Velipoja (Zadrima plain in Shkodra city) and Vlora plain. Reduction in ground water supply in combination with the increase of salinity of the ground water supply will bring shortage of adequate quality of drinking water.

Moreover, the demand for drinking water and water use for social and economic purposes may be expected to increase because of population growth. Table IV.2 shows the expected increase of water demands for some municipalities up to year 2025, estimated according to national standard (150 l/p/d) and European standartd (350 l /p / d). The problem of drinking water will be more acute especially by 2100.

A sea level rise of 48-61 cm for 2100 would result in direct flooding of coastal area. Due to the increasing of the sea level, flooding will be intensified both directly by the sea and indirectly by changes in water tables. In non-protected lagoons, accretion is expected to occur, following destruction of the low strands separating them from the sea. Such situations are expected to occur in the north and south of the Mati delta, (Patok) in the north of Erzeni delta, in the old Semani delta, in the area between Seman and Vjosa and the south of Vjosa river.

An increase in sea level may also be expected in Ceka lagoon, while the formation of new wetlands is expected in Mati delta.An increase in the wetland surface in the area between Vjosa and Semani rivers is also expected. Infrastructure components such as sewers, water supply, electricity and other service could be flooded and corrosion of pipes and intrusion of seawater into pipes and sewage systems will occur.

The River Drini is the main source of electricity for Albania; delivering power for local industry and households, and providing about 90% of domestic electricity generation. Meanwhile, Albania’s rainfall and snow is among the more variable in Europe.

In general, the Drini River Cascade (area from Kukës up to the Lezha Plain) in accordance with Second National Communication (2009) is characterized by heavy rainfall. Over the years there were some events of flood, with heavy rainfall on 2 October 1946, when 398 mm fell in Shkodra in 24 hours. This amount of precipitation caused flooding in a part of Shkodra city and the fields around it. Regarding their report, the maximum values recorded were 420mm in Boge station (Albanian Alps) on 15 December 1963 and 228.9 mm in Iballe on 19 November 1969. The same situation in Shkodra and Lezha occurred again in January and December 2010.

Figure 1 Floods occurred in Shkodra and Lezha region in (2010)

According to Islami at. al., 2009. It is mentioned that the changing patterns of water resources are broadly similar to the change in annual precipitation: increases in high altitudes but decreases in mid-altitudes. But the general increase in evaporation means that a reduction in runoff is probable. The figure bellow shows the expected changes in runoff for coming decades.

Figure 2: Annual runoff changes.

Source: SNC (2009)

Based on the climate change scenario for Albania in the second national communication temperature is expected to increase while precipitation is expected to decrease. This tread is shown in the table below.

Table 1: Climate change scenarios for Albania

Source: Islami at, al,. (2009).

Based on this table, the climate change scenarios for Albania leads to an annual increase in temperature up to 1°C, 1.8°C, 3.6°C respectively by 2025, 2050 and 2100 and a decrease in precipitation up to -3.8%, -6.1%, -12.5%, by the same time horizons.

Drought is expected during summer due to increased temperature (likely increase up to 5.6 °C) and potential evaporation, not balanced by precipitation (reduction by 41%).

Owing to higher average temperatures in winter more precipitation is likely to fall in the form of rain rather than snow that will increase both soil moisture and run-off. Increase in total precipitation rate may induce greater risks of soil erosion, depending on the intensity of rain episodes.

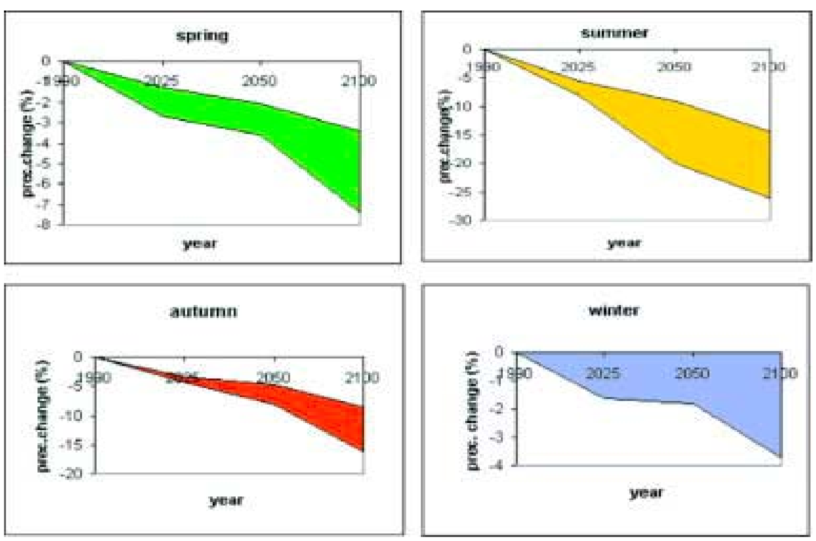

Figure 3 Seasonal changes of precipitation expected in Albania

This expected result are also shown in the draft of the Third national communication of Albania

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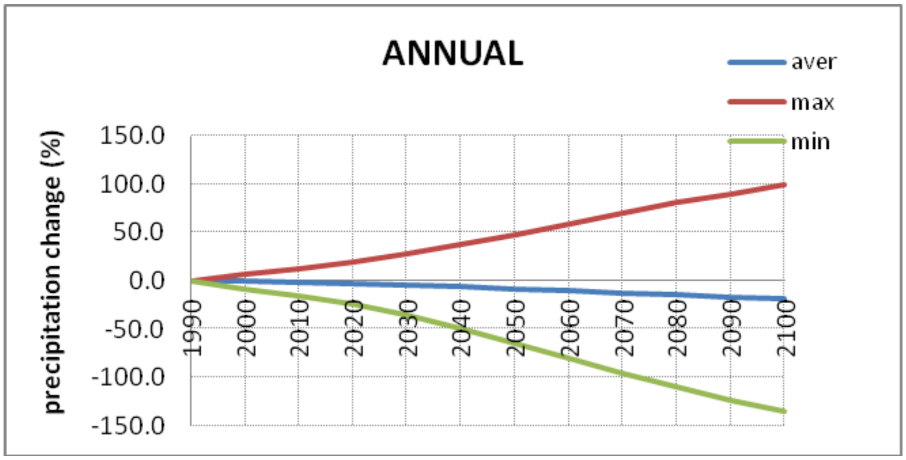
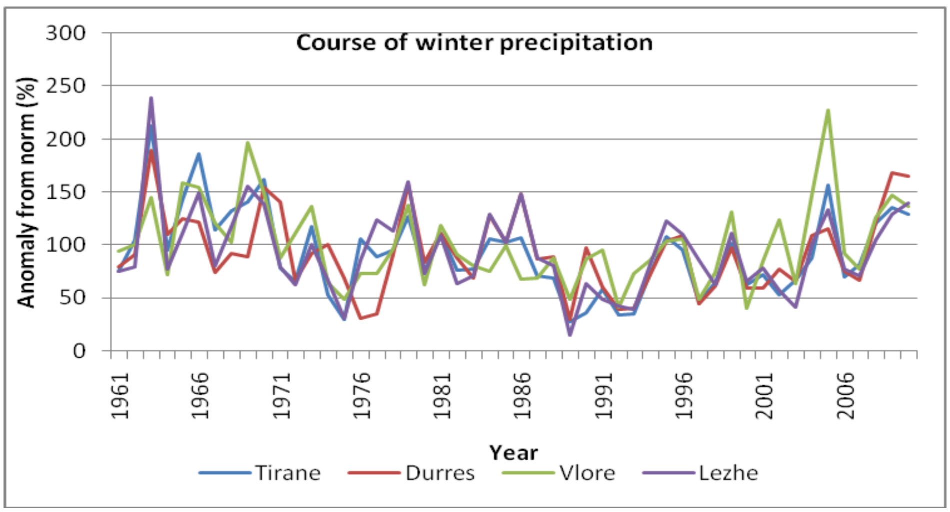
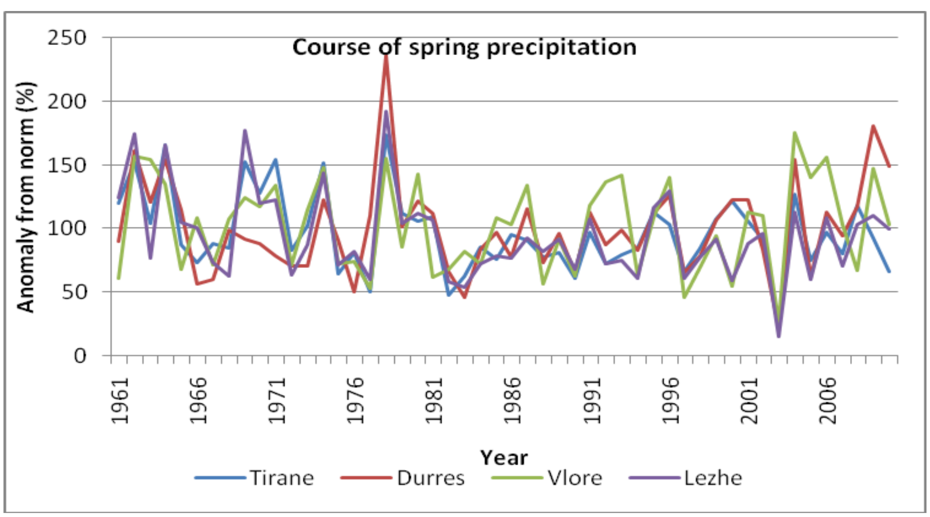


Figure 4: Projections of annual precipitation in Albania (%)

As result of the reduction in annual total precipitation the study area could experience a general decrease in runoff. The demand for water could increase, especially in summer.





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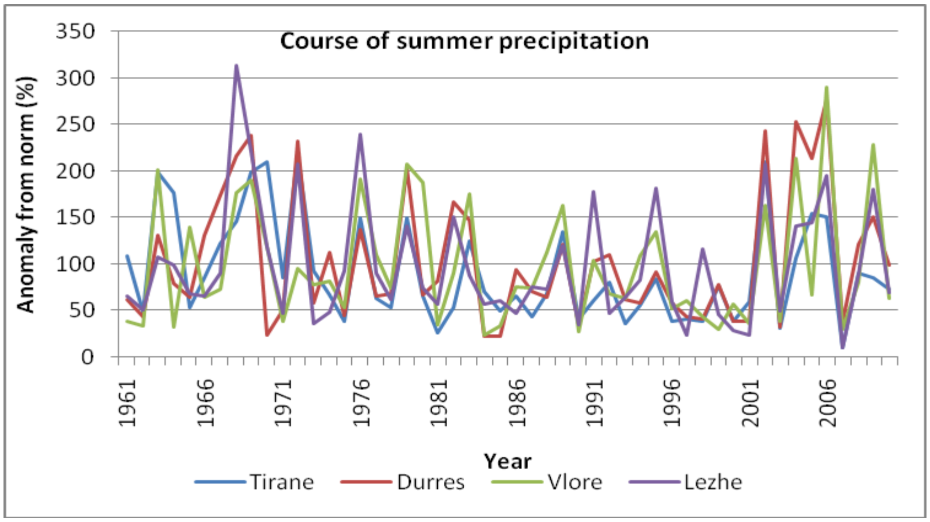

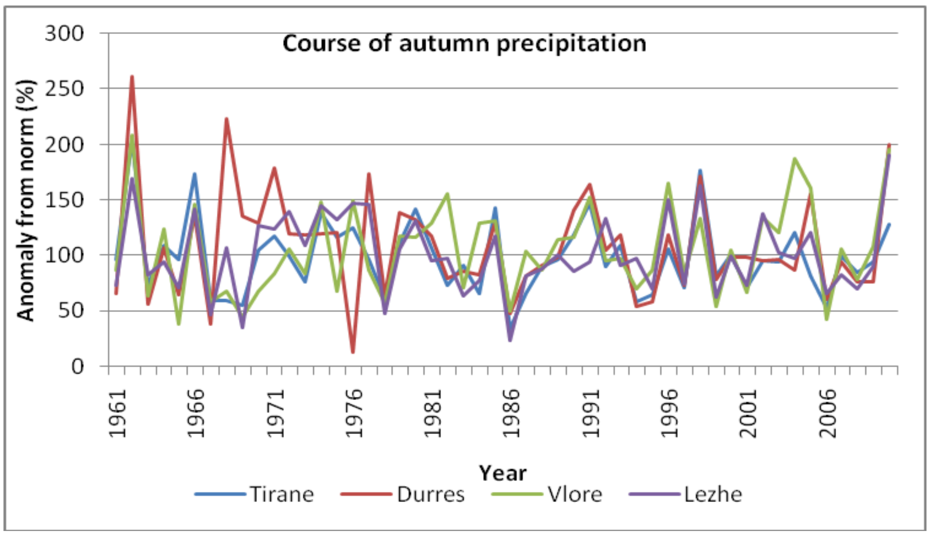

Figure 5 Seasonal anomaly of precipitation in Albania

Source: Report of third national communication.

Source: Report of Third National Communication

The variability from year to year of seasonal precipitation is almost the same for the 4 stations taken into consideration.

Winter precipitation presents a decreasing trend, from 150% (relatively to the norm) at beginning of the period to 50% at year 1992. From 1992 to 2004 the precipitation of this season is below the norm (50-100%). After the year 2004 during the winter season a light increasing of precipitation amount is observed.

Variation of spring precipitation doesn't present any tendency during the years for all the stations. The wettest spring is that of 1978 year when the precipitations were twice of the respective norms. The driest spring is observed in the year 2003 when the precipitation of this season is 15% relatively to the respective norms.

Regarding summer precipitation, a decreasing trend can be observed from 1968 (200%) to 2001 (25%). After 2001 the most of the years are characterized by precipitation over the norm..

Vulnerability assessment in agriculture sector

Agriculture is one of the most climate-sensitive sector. Related research has reached a conclusion that climate change, and mostly extreme events, are becoming a great concern of policy makers, as far as effects of these changes in food supply are significant.

In response to these challenges on climate change, the World Bank and the government of Albania conducted a joint study to identify and prioritize options for climate change adaptation in the agricultural sector (Sutton et al. (2009)).

Sutton et al. (2009) states that Albanian agriculture is already being stressed by the consequences of climate change with increased exposure to high temperatures, drought, shifting seasonal patterns, increased diseases, pests, and more soil erosion.

Following are provided the forecasted impacts of climate change in the agricultural sector respectively:

- on crops and horticulture;
- on livestock (results of the screening-level assessment of the direct effects of climate change);
- effects of climate change on water available for agricultural irrigation.

Impacts of climate change on crops and horticulture

Overall, the effects of climate change on crops in Albania could be relatively modest, especially for wheat, alfalfa, and pasture. There is potential for more substantial effects on vegetable and fruit crops, such as tomatoes, watermelons, and grapes, which could suffer from heat and drought stress, particularly during critical periods of their growth. One reason for the relatively modest effects is the widespread use of irrigation in Albania. However, since the irrigation infrastructure is in poor repair, water may not be available at critical times of the growing season, which would mean that the severity of effects of future climate change for irrigated crops may be underestimated.

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Table 3.1 Effect of Climate Change on Crop Yield 2040–50 Relative to Current Yields under Medium-Impact Scenario, No Irrigation Water Constraints and without New Adaptation Measures
% change

Irrigated/rainfed	*Crop*	*Intermediate*	*Lowlands*	*Northern Mountains*	*Southern Highlands*
Irrigated	Alfalfa	6	4	6	13
	Maize	–3	–4	–11	1
	Tomatoes	0	–11	–8	–4
	Watermelon	N/A	–6	N/A	N/A
Rainfed	Alfalfa	–6	–3	–2	7
	Grapes	–17	–20	–21	–18
	Grassland	–5	–3	–7	10
	Olives	–3	–21	N/A	N/A
	Wheat	10	7	24	20

Note: Results are average changes in crop yield, assuming no effect of carbon dioxide fertilization, under medium-impact scenario (no adaptation and no irrigation water constraints). Declines in yield are shown in shades of orange, with darkest representing biggest declines; increases are shaded green, with darkest representing the biggest increases. N/A = crop is not grown in that AEZ, according to local stakeholders.

Table 3.1 shows the results for the medium scenario, where the most crops are affected negatively by climate change, except for alfalfa and winter wheat.

The table 3.2 shows the range of results for the low-, medium-, and high-impact scenarios.

Table 3.2 Effect of Climate Change on Crop Yields through 2040s across the Three Climate Scenarios
% change

Irrigated/rainfed	*Crop*	*Intermediate*	*Lowlands*	*Northern Mountains*	*Southern Highlands*
Irrigated	Alfalfa	5 to 7	5	6 to 7	14 to 16
	Maize	–7 to –5	–17 to 2	–24 to –7	1 to 3
	Tomatoes	–1 to 0	–11	–14 to –7	–7 to –5
	Watermelon	N/A	–6 to –5	N/A	N/A
Rainfed	Alfalfa	–10 to 6	–6 to 6	–1 to 4	7 to 10
	Grapes	–25 to –10	–23 to –17	–28 to –18	–24 to –22
	Grassland	–14 to 5	–7 to 8	–2 to 4	9 to 14
	Olives	–6 to –2	–20 to –11	N/A	N/A
	Wheat	6 to 7	4 to 5	11 to 16	13 to 24

Note: N/A = the crop is not grown in the AEZ.

The high-impact climate scenario has the strongest impact, with less rainfall and higher evapotranspiration due to the higher temperature projection.

For the medium climate scenario the impact of climate change is a little less severe than the high impact scenario, as this scenario is less pessimistic in terms of rainfall projections.

The study results (2009) indicate that: grape and olive yields decline under two of the three scenarios; pasture and wheat yields increase under all scenarios (but wheat yield analysis did not consider the effects of pests, which may underlie recent historical declines in wheat yields); tomato yields fall modestly under all scenarios; and irrigated alfalfa yields increase significantly under climate change for all scenarios.

The low-impact scenario shows a net positive impact for most crops, as the increased rainfall amounts increase the water available to the plants. The higher temperatures result in a higher evaporative water demand, but only a part of the increased rainfall is lost and therefore most of the crops are affected positively by the increased water availability also under the medium- and high-impact scenarios.

The yield of rain-fed crops especially is enhanced by the increased rainfall amounts, as in the current situation they experience a certain amount of water-stress and growth is water-limited.

This results do not incorporate the effects of higher CO2 concentrations that are expected as a byproduct of increased CO2 emissions. Higher CO2 concentrations can enhance growth for some crops.

Table 3.3 Irrigation Water Requirement Changes Relative to Current Situation to 2040s under the Three Climate Scenarios, for Each Crop and AEZ (Assuming No CO_2 Fertilization)
% change

Scenario	*Crop*	*Intermediate*	*Coastal Lowlands*	*Northern Mountains*	*Southern Highlands*
High	Alfalfa irrigated	5	0	−7	−23
	Maize	46	25	36	16
	Tomatoes	100	61	14	61
	Watermelon	N/A	31	N/A	N/A
Medium	Alfalfa irrigated	−2	−5	−12	−16
	Maize	22	14	24	6
	Tomatoes	46	83	7	41
	Watermelon	N/A	23	N/A	N/A
Low	Alfalfa irrigated	−12	−7	−12	−21
	Maize	7	7	5	3
	Tomatoes	32	103	8	60
	Watermelon	N/A	16	N/A	N/A

Note: N/A = the crop is not grown in the AEZ. Orange indicates an increase in crop irrigation water requirements, while green indicates a decrease.

In table 3.3, orange indicates an increase in crop irrigation water requirements, while green indicates a decrease. For the medium- and high-impact scenarios, the overall trend is that more water is required to maintain the current yields.

Especially tomatoes and maize will need substantial increased amounts of water.

The low-impact scenario forecasts more rainfall, including during the cropping period, which results in a slight decrease in water demands.

Climate Impacts on Livestock

Effects on alfalfa and rainfed pasture crops mentioned above, present one type of climate change risk to livestock, an indirect effect. Effects of climate change on maize yields may also be linked to effects on livestock. As noted above, for the medium scenario, rainfed alfalfa and grassland yields are expected to increase in the Northern Mountains and Southern Highlands AEZs, where livestock makes up a larger percentage of overall agricultural productivity.

Even under the high-impact scenario, effects on these crops in the higher-elevation regions of Albania are relatively modest, with temperature effects being a boost to yield that generally balances or outweighs the negative effects of less precipitation.

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As a result, the indirect effects of climate change in areas where livestock are most important would range from relatively modest in the worst case, to beneficial in the best case.

The direct effect of climate change on livestock is also important, and is linked to higher-than-optimal temperatures for livestock, in which heat can affect animal productivity and, in the case of extreme events, may lead to elevated mortality rates related to extreme heat stress.

There is limited information to characterize the direct effects of climate on livestock; the methodologies currently available are far less sophisticated than the crop modeling techniques and are generally not applicable to Albania.

A screening analysis suggests that the direct effects of climate change on most livestock, in the absence of adaptation, could be negative and potentially large. For many livestock type/AEZ combinations, climate change is a major risk, with potential for as much as 35 % loss in net revenue by the 2040s, with effects on goats and sheep being less than those for chickens and cattle.

Climate Impacts on Water Availability for Agriculture

A water availability analysis was conducted at the river basin level (for four major river basins).The analysis focuses on changes in water supply and demand within Albania's territory.

Overall results states that water supply decreases under the high- and medium-impact scenarios, and increases under the low-impact scenario. Irrigation water demand is higher for all scenarios, however, particularly in the summer months. Nonetheless, in each of the four river basins, the WEAP analysis indicates that there is no unmet water demand through 2050, meaning that there will continue to be ample water available for both current levels of irrigation and any expansion of irrigated areas, as necessary.

The figure shows that, with climate change, runoff increases slightly under the low-impact scenario, but decreases as much as 20 percent under the other scenarios. Demand for irrigation water is widespread throughout Albania. The most intensively irrigated area is in the Lowlands AEZ, but some of the more mountainous areas also have high concentrations of irrigated land.

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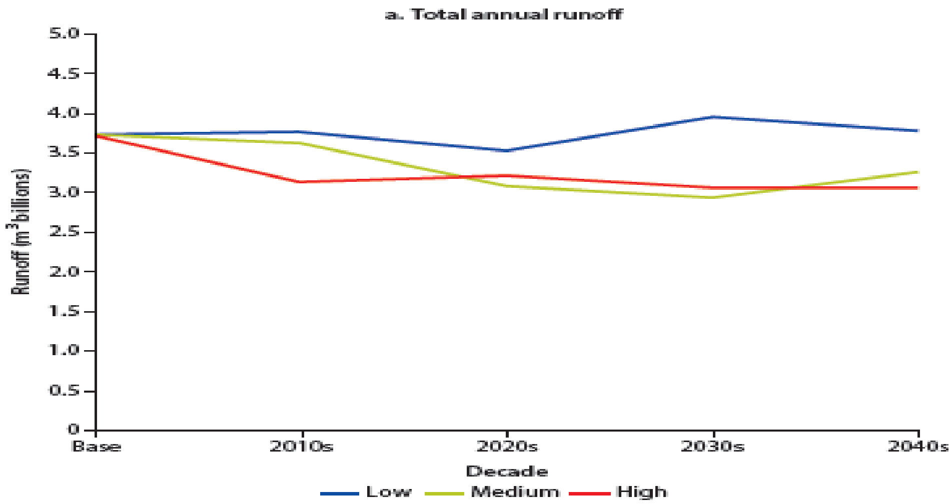
Figure 3.1 Estimated Effect of Climate Change on National Water Runoff



Although the impact of climate change on runoff is substantial, and demands for water are projected to increase substantially with climate change, water resources are so abundant in Albania that there is a wide gap between supply and demand. Thus, it is unlikely that climate change will decrease irrigated agricultural production, and there exists ample capacity to pursue increased irrigation where and when needed, provided that current water storage facilities operate at or near their stated capacities.

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Task 3 – Adaptation Needs

Adaption Needs in the Agriculture and Water Sector

Gaps:

- Lack of capacities in all areas of government;
- Low staff capacities for climate change;
- Data is crucial- special challenge regarding Climate Change;
- Relatively low climate change knowledge level in line ministries;
- Policy and public awareness don`t acknowledge relevance on Climate Change;
- Limited consistency among different areas of policy making.

Needs:

- Building capacity among national and local stakeholders to assess the impacts of climate change and to develop adaptation measures in climate risks sectors;
- Strengthening institutional and legal framework to enable adaptation;
- Improving the way that institutions monitor, forecast, and disseminate information on meteorological and hydro-meteorological conditions;
- facilitate thinking of a long-term growth model;
- development and implementation of policy instruments and estimate potentials for new green employment opportunities in the country/region level;
- Flood Risk Management essential for adapting to Climate Change; Flood Directive good guidance but needs to be adopted to local realities;
- Focus on land-use planning is essential;
- Raising awareness of the threat of climate change;
- Improve cooperation and coordination among donors.

Future priorities

- Building capacity among national and local stakeholders, including business associations, academia, youth, NGOs, media is a high priority
    - thinking of a long-term growth model, which is particularly opportune now, given the beginning of economic recovery;
    - learning about practical models of generating green jobs, incomes and investments in the region-specific context.
- Mainstreaming the identified adaptation actions in the Energy , Agriculture , Water and Health

Sector policies;

- Implementation of identified adaptation actions coming from different studies, plans etc.;
- Ensuring the management and development of water resources integrates all sectors energy, agriculture, water supply and sanitation, and cross-border concerns along with environmental and social concerns;
- **Public awareness** important and many stakeholders need to be involved and have to take over responsibilities.

What could be some priority areas for a Regional Climate Resilience Program?

- Water resource management (especially for cross-boundary river basins):
  - Prevention and minimizing the flood effects;
  - Flood warning systems/data exchange between countries, etc.;
  - Identification of join investment projects;
  - Improve water efficiency (for example: developing the drip irrigation projects);
- Capacity building activities at national level with key stakeholders (including private sector) and regional cooperation to share relevant knowledge, experiences, information and materials (improved crop varieties) among respective institutions;
- Programs with practical models of “green jobs” in the region- specific context.
- Increase the access of farmers to technology and information, for adapting to climate change. It is recommended strengthening the capacity of the existing research and extension agency: (1) to support better agronomic practices at the farm level, and access to better information on the availability and best management practices of high-yield crop varieties; and (2) to support the same measures but with a focus on maintaining yields during extreme water stress periods that are likely be more frequent with climate change.
- Improve the dissemination of hydrometeorological information to farmers. In every farmer noted the need for better local capabilities for and access to hydrometeorological data, particularly for short- to medium term temperature and precipitation forecasts.

Enhanced capabilities and a better institutional focus on farmers are acutely needed in the short-term to support better farm-level decision-making and, in the medium-term, better policy-level decision-making in Albania.

- Improve information collection and dissemination on soil types, drainage potential, and crop suitability. It is recommended that the existing capacity at the Agriculture Technology Transfer Centres (ATTC) to analyse soil information throughout Albania be enhanced and better linked to both policy initiatives at the national level and local farmer education efforts, with a focus on developing crop suitability assessments to inform national policy and outreach to farmers.
- Rehabilitate irrigation and drainage infrastructure. The water is generally available for irrigation, as the quantitative modelling indicated, but the secondary and, in some cases, primary irrigation infrastructure is in disrepair and limits crop production in some areas, and overall drainage infrastructure needs to be improved.

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- Increase institutional capacity. Need to increase the capabilities and the reach of extension services. Other capacity building options included technical training, seed and crop selection from both international and national private markets, and increasing the availability of region-specific hydro-meteorological information.

Croatia

Task 2 – Vulnerability Assessment

The Republic of Croatia belongs to the Central European, Adriatic-Mediterranean and Pannonia-Danube group of countries. According to the Köppen classification for a standard period 1961-1990, the largest part of the Republic of Croatia belongs to the climate type C, a moderately warm rainy climate. Trends in air temperature show warming all over Croatia, annual temperature trends are positive and significant (higher on the mainland than at the coast and the Dalmatian hinterland). Statistically significant decreases in precipitation during the recent 50-year period (1961-2010) are found in the mountainous region of Gorski Kotar and in the Istria peninsula (northern Adriatic) as well as in the southern coastal region.

Total area of the Republic of Croatia amounts to 87,661 km^2. The inland area covers 56,594 km^2, while the area of territorial sea and internal sea waters amounts to 31,067 km^2. According to the 2011 Census the total number of inhabitants in the Republic of Croatia is 4,284,889. Based on the criteria in the Act on Local and Regional Self Government there are 128 cities in Croatia. According to the 2011 Population, Households and Dwellings Census number of inhabitants in cities is 2.221.029 (or 51,83%). Out of a total of 6755 settlements in Croatia, 2630 (38.91%) are urban and suburban areas.

Physical planning in the Republic of Croatia and the existing legal framework

Physical planning in the Republic of Croatia is regulated by a number of documents.

Ordinance on measures for protection against natural disasters and war threats in spatial planning and development (Official Gazette 29/83, 36/85, 42/86) defines the content of spatial plans, guidelines for spatial planning, spatial standards and norms, protection measures that are planned in the spatial plans and their implementation in order to decrease the number, scope and consequences of natural disasters to the lowest possible level.

This Ordinance defines natural disasters:

- storm and hurricane strength winds, floods, drought, hail, extreme height of snow, snowdrifts and avalanches, landslides and other natural disasters that threaten human lives or cause damage to property of considerable value,
- accidents caused by fire, demolition of dams, diseases, epidemics, as well as depletion or destruction of certain natural resources (water supply, wastewater drainage, etc.).

This Ordinance, among other, defines the content of spatial plans in such a way that the obligation is set for planning sensitivity zones, protection measures, population distribution, structure, capacity, distribution of commercial and non-comercial activities, capacity, distribution, manner of operation of the infrastructure network and facilities (roads, water supply, sewerage, energy, etc.), capacity and distribution of green spaces in settlements and outside of settlements, manner of operation during natural disasters for all activities, and through all indicated contents and requirements.

Ordinance on the content, criteria for map projections, required spatial indicators and the standards of physical planning studies (Official Gazette 106/98, 39/04, 45/04 corrigendum and 163/04) sets guidelines for planning of space.

The concept and solution of the spatial plan have to be based on the principles of space organisation which reduces its vulnerability to the lowest possible extent. It determines that particular attention needs to be given to natural resources, that is, prescribing of specific measures by which pollution of soil, surface, and in particular groundwater will be prevented.

Furthermore, the Ordinance also prescribes protection measures when planning urban spaces, such as uniform planning of settlement network – promotion of growth of lower order centres, even distribution of population, secondary activities, to balance steering of functions in space, etc.

- guidelines when planning energy supply such as organisation of city districts in such a way to achieve maximum effect of passive use of solar energy, wind energy, etc.
- by construction and reconstruction of cities and densely populated areas enable organisation of cities into a number of independent units with regard to infrastructural systems of social standard facilities of self-supply, self-protection and system of shelters

Ordinance on the content, criteria for map projections, required spatial indicators and the standards of physical planning studies (Official Gazette 106/98, 39/04, 45/04 corrigendum and 163/04) prescribes the following for spatial plans:

- provisions for implementation contain measures for protection of natural values and guidelines and measures for the protection of space, measures for prevention of adverse environmental impacts, as well as all other development requirements and protection measures related to all building areas (not only settlements but also economic activities outside settlements) which form a constituent part of a spatial plan;
- the graphic part has to contain special map projections: „Requirements for use, development and environmental protection " which are synthetic sensitivity maps and vulnerability maps according to all activities and individual sectors of importance for recognising potential consequences of climate change and other sources of danger to human life and material goods.

Map projections of implementation spatial plans contain special spatial indicators for protective green spaces (Z) and public green spaces (Z1) the active role of which was recognised not only in adaptation but also in reduction of climate change impacts.

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In spatial plans at county and local level are mandatorily planned and prescribed guidelines and measures as well as capacities for elements of water use and protection (water supply, usage of water, wastewater drainage, regulation of watercourses, amelioration drainage). Special measures protect aquifer and water protection areas as well as the coastal part of the sea and waters. Protection measures include hydromelioration, afforestation, green-up, etc.

References:

1. Sixth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change (UNFCCC);
2. Physical Planning Strategy of the Republic of Croatia;
3. Report on the situation in space 2008-2012;
4. Ordinance on measures for protection against natural disasters and war threats in spatial planning and development – consolidated text (Official Gazette 29/83, 36/85, 42/86);
5. Ordinance on the content, criteria for map projections, required spatial indicators and the standards of physical planning studies (Official Gazette 106/98, 39/04, 45/04, 163/04, 9/11).

Task 3 – Adaptation Needs

Urban areas/physical planning

In the Draft proposal of the Spatial development strategy of the Republic of Croatia the topic of adaptation to climate change and reduction of climate change impacts is elaborated from the aspect of vulnerability, or rather exposure of particular areas to certain risks, as well as at the level of specific features of urban and rural areas. Consequences of climate change have been considered which, besides being a threat to lives and the quality of human life, have the most significant impact on space and built structures, and are a result of the increase of the average annual air temperature, decrease in precipitation and frequent occurrence of extreme weather (thunderstorms, extreme precipitation, and heat waves).

Recommendations for adaptation are focused on strengthening resilience of new and built structures to the effects of climate change and/or directing development to areas of less risk.

Of particular importance is efficient and sustainable flood protection aimed at reducing the risk of flooding. In this regard the construction of a flood protection system (a greater number of accumulations and retentions), under the responsibility of a special state authority, has a major role, along with the concurrent systematic improvement of risk management and implementation of flood protection measures in the entire territory of the Republic of Croatia, for which also a network of appropriate authorities and institutions was established at the state level. From the spatial aspect it is important that all these systems and measures are in line with the strategic commitment of spatial development, and at the implementation level with spatial plans. In this regard it is essential to have a clear division of responsibilities, competence and obligations, as well as to establish an efficient model for cooperation and coordination at the level of portfolio – from the preparation and adoption of strategic and operational documents to the instruments for their implementation.

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With the aim of long-term reduction of the impact of climate change it is also important to prescribe requirements in the sense of increasing energy efficiency of buildings.

A response to climate change at the level of settlements is primarily connected to the efficiency of the utility infrastructure system (drainage, public transport, water supply security, etc.) as well as to prescribing adequate spatial standards and requirements which are realised through execution of spatial plans. Climate change impact in urban areas is a specific topic which has to date not been elaborated enough and which should be paid more attention in the future. In this regard the greatest impact is expected in the four macro regional centres (Zagreb, Rijeka, Split and Osijek), and the prescribing of measures will depend on the results of carried out expert analyses.

Proposed measures at the level of local government are:

- Utility infrastructure – investment into construction and maintenance of the precipitation drainage system with the adequate carrying capacity for torrents resulting from increased precipitation (in the case of Rijeka and other coastal cities also flooding by the sea)

  The amount of precipitation is significantly increasing, not only as a result of meteorological conditions but also due to the ever increasingly built environment in which there remains an ever smaller number of areas that can absorb the water. Also, the increased levels of ground water sources also pose a problem, which has already been recognised in practice as a potential issue, or rather as a limitation.

  Maintenance and construction of the precipitation drainage system is a significant burden on local self-government units, and the manner of resolving this issue should certainly involve the possibilities and ways for reuse of precipitation water.

  Improvement and development of the public transport system (with the aim of emission reduction):

  - increase in the number of public transport vehicles (buses) that use fuel with lower CO_2 emissions (gas, combined diesel and gas, electricity, etc.);
  - increase in the number of utility company vehicles that use fuel with lower CO_2 emissions (gas, combined diesel and gas, electricity, etc.);
  - basing public transport of passengers on organising tram transportation and light rail transit;
  - adequate planning of routes for public transport vehicles in order to avoid unnecessary rides;
  - organise a ”car-pooling” and ”car -sharing” model;
  - increase in the number of cycle lanes and introduction of city cycle hire scheme;
  - increase in the number of footpaths.
  - maintenance of the current and planning of new public green spaces that can accept greater quantities of water due to torrents (planning through spatial plans)
  - preparation of systematic solutions for precipitation drainage in an integrated manner, for certain parts of town or parts of the basin
  - reconstruction of existing greens spaces with the aim of accepting greater quantities of precipitation

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- construction/design of an integrated system of public green spaces, at least at the level of main district parks

  The proposed measure is linked in its implementation to the lower, project levels, but the obligation of such planning and the preparation of systematic solutions can be carried out at the level of individual parts of town or basin. Cities with a higher density of built-up areas are certainly facing more significant limitations in this way of solving the issue of precipitation drainage.

- Avoidance of paving large areas with impermeable materials
  - use of grass sheets in large parking areas, infrequently used cart tracks, etc. (this can also be prescribed through requirements for implementation of spatial plans).
- Increase in energy efficiency of buildings
  - education of the public regarding energy efficiency and the related legislation;
  - encourage the public to carry out energy efficiency measures in households - family houses and multi-residential buildings (renewal of facades and thermal insulation, use of renewable energy sources) by financial incentives from local self-government unit budgets, certain subsidies related to utility services, funds from the Environmental Protection and Energy Efficiency Fund and combination of the indicated;
  - increase in energy efficiency of public buildings (administration, schools, hospitals) by using funds from the Environmental Protection and Energy Efficiency Fund and other revenue sources.
- Care for the part of the population at risk (children and elderly) from effects of heat waves
  - planning and design of green spaces for sheltering during the hot part of day
  - planning and design of ”living rooms” with adequate cooling system for stay during the hot part of day
  - organisation of ”door-to-door” medical services available to the population at risk (in cases of medical emergencies)
  - organisation of”door-to-door” delivery services for the population at risk (food, water, medicine).

Qualitative Vulnerability Assessment for Floods, High Sea Level and Droughts in the Croatia

Republic of Croatia is a Central European and Mediterranean country. It is located between Podunavlje (the Danube region) in the north and the Adriatic Sea in the south. According to the Köppen classification, almost all of Croatia has a moderately warm climate. Due to meteorological data which have been continuously collected since the 19 th century, Croatia marked an increase in air temperature and slightly declining rate of annual precipitation. From all natural disasters caused by climate changes Croatia is most vulnerable to floods, because of her geographical location. Other disasters which can be caused by climate changes, and which are identified as high risks are high sea levels and droughts.

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Floods Risk Assessment

Floods are natural phenomena which can not be avoided. However, taking different preventive construction and non – construction measures can reduce flood risks to anacceptable level. Floods are among the most dangerous natural disasters and can cause loss of human lives in many places, great material and ecological damages, as well as devastation of cultural heritage.

Description of River Basin Districts in Croatia

The territory of the Republic of Croatia hydrographicly belongs to the Adriatic and the Black Sea basins. It is divided into two river basin districts: the river basin district of the Danube River and the Adriatic river basin district. (Figure 1).

Figure 1: River Basin Districtsand Sub – Basins

In Croatia, border between those river basin districts, follows the natural hydrographic and hydrogeological line between the Adriatic and the Black Sea basins. Other borders are defined with state line border, respectively with coastal waterdemarcation line.

River basin district of the Danube River covers 35.101 km^2 and includes part of the Croatian territory from which water flows towards the Danube River by surface or underground paths. In this area there are two sub - basins: the sub – basin of the Sava River and the sub – basin of the Drava and the Danube River. River basin district of the Danube River is characterized by wide plains of lowland watercourses of the Danube River with its tributaries: Drava, Mura and Sava River.

The Adriatic river basin district covers 35.289 km^2 and include terrestrial partof the Republic of Croatia, and islands, from which water flowsby surface or underground paths into the Adriatic Sea and its belonging transitional and coastal waters. The terrestrial area covers series of basins of the Adriatic rivers (Neretva, Lika, Zrmanja, Krka, Cetina, etc.) and considerable areas of land without surface flow.

Vulnerability Assessment

Floods that appear in Croatia can be divided into seven basic groups:

- river floods due to heavy rains and/or suddensnowmelting ,
- flash floods of smaller watercourses due to high intensityshowers,
- floods at karstic fields due to heavy rains and/or suddensnowmelting or insufficient permeable capacity of natural abysses,
- inland water floods in lowland areas,
- icefloods,
- sea floods and
- artificial (accidental) floods due to eventualfailureof dams and dikes, activation of landslides, inappropriate construction, etc.

Floods in urban areas are also a significant problem due to short precipitation of high intensity which, due to high population on relatively small areas, often cause great material damages.

Lowland part of the Danube river basin district is endangered by floods due to high water levels of the Danube River, Drava River, Mura River, Sava River, Kupa River and Una River as well as high levels of mountain waters which flow from the slopes of peripheral mountains to the main receivers. Hilly and mountainous areas are favorable for all kinds of land erosion caused by water and formation of torrential flows. The state of maintenance of watercourses and protection from flooding and erosion are different for each river basin and each watercourse. Mostly, the level of regulation and construction of protection systems is proportional to the size of watercourse. Instead of partial solutions, priority is given to the multifunctional systems of regulation and water use which are, in general, economically more favorable and ecologically more acceptable.

Intensive construction of protection systems in the second half of the 20th century significantly reduced the risks of flooding in most areas of Croatia, but recent experiences show that floods occur in areas where they are not expected and that there is an occurrence of higher water levels than those systems were dimensioned for (designated as high water levels with very long return periods).

Lately, regardless of the cotroversy about the causes, scientists, predict extreme dynamics of future climate changes. Also, prognostic climate models indicate frequent appearance of climate extremes, both on global and local levels. Consequently, in the future we can expect apperances of extreme air temperatures and heavy rain, as well as extremely dry periods with storms and destructive winds and high tidal waves in coastal areas. Over the last decade, throughout the world and in the Republic of Croatia, there is a rise in frequency of so far unrecorded extreme hydrological conditions with apearrance of high waters and extreme water levels with floods that threaten human lives and cause great material damages. In these conditions, flood protection is often very difficult and in some situations almost impossible.

Due to the hydromorphological features of the territory, existing construction of the flood protection systems and forecast of extreme climate changes in the future, Republic of Croatia is exposed to flood risks to a large extent.

Depending on the intensity of extreme hydrological conditions and the functionality of flood defense system, inhabited areas, infrastructural and economical objects are defended as much as possible, but the main damages are recorded in the agriculture. Damage assessments after floods all over the world and also in Croatia, have shown that they are always much greater than the costs of implementation of preventive measures.

Today, an additional dimension to the issues of flood protection is given by environmental protection from uncontrolable spreading of pollutants with known and unknown origin through flood waters.

The biggest recorded floods in Croatia during the last century:

- Danube River floods : years 1926. and1965.;
- Drava River floods: years 1964., 1965., 1966., 1972. and 2012;
- Mura River floods: years 1965. and 1972.;
- Sava River floods: years 1933., 1964., 1966., 1990., 1998., 2010., 2013. and 2014.;
- Kupa River floods: years 1939., 1966., 1972., 1974., 1996., 1998., 2013. and 2014.;
- Una River flood: year 1974.;
- Neretva River floods: years 1950., 1995., 1999. and 2010.

Preliminary flood risk assessments in the Danube River basin district have shown that the available and accessible information of flood events are incomplete for periods prior to the year 2000, while there are more detailed available information for period starting with the year 2010.

Table 1: Chronological overview of recorded floods in the Danube River basin district

Period	Danube River Basin District			
	rainfall	watercourses	rainfall	TOTAL
2010 -	133	**2010 -**	133	**2010 -**

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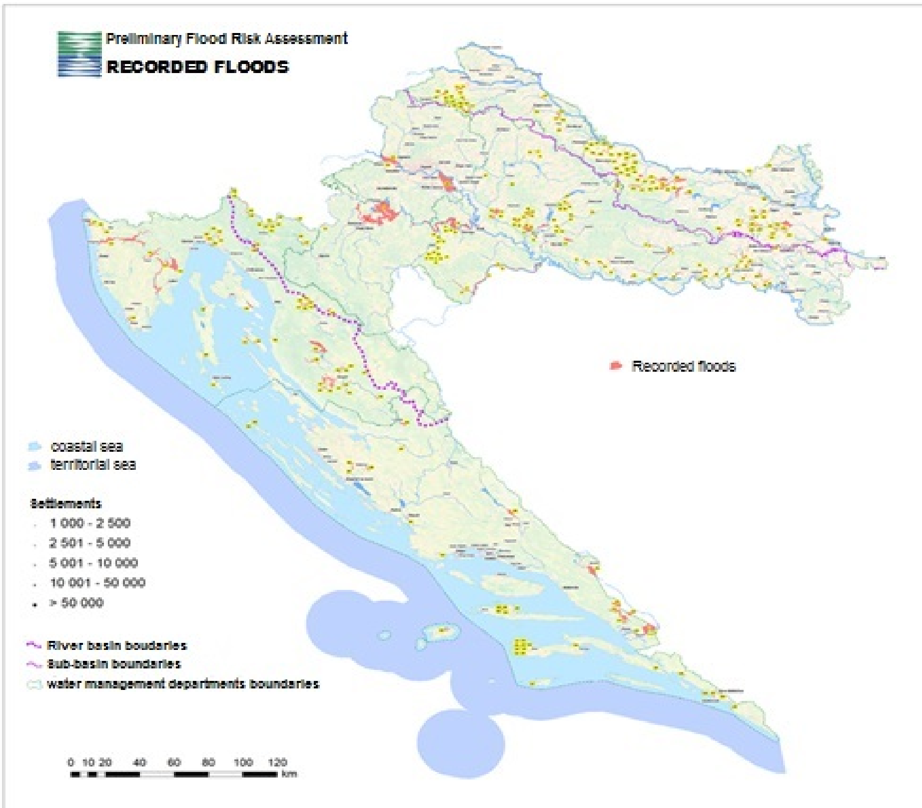

Figure 2: Recorded floods

Continental climate dominates the area, but there is an influence of Mediterranean climate in peripheral areas towards the Adriatic river basin district to a large extent which gradually weakens from the sea towards north. Average annual precipitation in this district is about 1000 mm.

During the last several years there is an obvious increase in frequency and intensity of flood events in Croatia, especially along the Sava river basin.

Key Reasons for Disaster Occurance

Year 2010.

Direct key reason for the 2010 flood event was overtopping and breach along the Sava River embankments and the June 2010 flood was directly caused by extreme rainfall periods which continued one after another.

Year 2012.

Great water wave of the Drava River which was flowing from Austria, at the beginning of November 2012, through Slovenia and towards Croatia caused a formation of a breach in the hydrotechnic embankment near the Otok Virje settlement.

Year 2013.

Key causes for the floods during the year 2013 were extreme rainfall periods which continued one after another and exceeded the riverbeds capacities.

Year 2014.

Flood in 2014 was directly caused by an extremely high water wave of the Sava River, as well as breaches of the left side of the Sava embankment at Račinovci and Rajevo Selo settlements. The breaches occured almost simultaneously, in the afternoon of 17^{th} of May, during the peak of the Sava River water level.

The probabilities of the described events are as follows:

- Great water wave of Sava River from September 2010, according to statistical analysis, was estimated as one in 100 years.
- In the year 2012, in Virje Otok settlement, measured Drava River flow was 3300 m^3/s which is the level that Drava River reaches once in a 1000 years.
- According to the occurance probability criteria flood waves of Danube and Kupa Rivers, from the year 2013, can be classified as events of high probability.
- Flood wave of the Sava River from the year 2014 was estimated for the return period of 1000 years.

Flood Management in Croatia

Water management in Croatia should strive to the sustainable protection from floods and other forms of adverse effects of water, which implies achievement of economicaly justified levels of protection of population, material goods and other endangered values, in addition to encouragement of preservation and improvement of ecological water status and flood prone areas.

While planning the activities, special attention was payed to the selection of adequate combination between:

- management of river basins, improvement of retention capacities of land and
- construction and hydrotechnical measures which implicate:
  - reduction of flood waves with the intention to sustain and increase safety of people and goods,
  - provision of necessary water quantities during dry periods which is a priority for preservation of good water status and ecosystems associated with water and
  - protection of water and ecosystems associated with water from negative impacts of floods.

Document named "Multiannual Programme for Construction of Regulation and Protection Water Structures and Meliorative Structures 2013-2017" was created for that purpose and in accordance with Water Management Strategy, River Basin Management Plan and, after the year 2015, also with Flood Risk Management Plan.

Flood Risk Management Plan in Croatia is under development and it will contain goals for flood risk management and measures for realization of these goals, including prevention measures, protection, preparedness, flood forecasting and warning systems and is going to be integrated in the River Basin Management Plan.

Assessment of the High Sea Levels for the Croatian Coast of the Adriatic Sea

One of the relevant sources for assessment of extreme sea level values for the Croatian coast of the Adriatic Sea (including the islands) are tide gauge data. The data have been collected during long period of tide gauge measurements at sites along the Adriatic coast (Figure 3). The mean extreme tide ranges during syzygy calculated from the long time series of measurements on the eastern Adriatic coast increases from south 0.29 m in Dubrovnik to north 0.67 m in Rovinj. However, so-called forced sea level fluctuation caused by dynamic influence of the atmosphere disturbs the regular course of tides over the 18.6 year period. For this reason, the estimates of extreme high sea levels, by statistical methods for any location (port) on the coast, are associated by their nature with a high degree of uncertainty. This is particularly true in complex coastal areas (coastal or shore) with shallow bathymetry and variable coastline, where the tides, storm surges and seiches can change from one to the other coastal areas in many nonlinear ways. Although, the long time series of sea levels measurement are primary source for calculating estimates of occurrence the extremely high sea levels, they are usually rare in space and in time. Thus, for example, there are spatially limited database tide gauge measurements for large areas of coastal areas of the Croatian part of the eastern Adriatic coast.

Figure 3 Tide gauge stations on the eastern Adriatic coast with long time series of sea level measurements

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All available annual absolute maximum data recorded on tide gauge stations Dubrovnik, Ploče, Sućuraj, Split – luka, Zadar, Bakar and Rovinj on the Croatian coast have been used to estimate the extreme height of sea levels.

In the analysis we used the so – called access "location by location" method which is best known, simplest and most widely used method of annual maximum (AMM), where trend is not excluded (increase or decrease) on a time scale of 1 – 55 years of the mean sea level. Based on the analyses and the obtained results we can summarize preliminary flood risk for the selected areas as shown in **Table 2**.

Table 2 Estimates of flood risk for south, middle and north Adriatic coast

		South Adriatic		Middle Adriatic			North Adriatic	
	Return period (years)	The maximum sea level relative to HVRS71/MSL (cm)						
		Dubrovnik	Ploče*	Sućuraj*	Split	Zadar*	Bakar	Rovinj
Floods with a low probability	1000	81.7	85.6	78.5	109.1	97.1	126.7	143.2
Floods with a medium probability	100	76.6	85.1	76.2	94.6	92.6	119.3	128.6
Floods with a high probability	10	67.8	82.1	71.2	78.8	83.3	106.6	109.5

* Maximum sea level is given in relation to a long time series of mean sea level (MSL) at these stations

This analysis is only the first step in the approach based on spatial analysis, which includes knowledge of Croatian Adriatic coast topography and seabed bathymetry (respectively in key areas) and a number of short time series of sea level measurements of high frequency (on the minute level, which are available on the tide gauge stations in Dubrovnik, Ploče, Split-luka, Zadar, Bakar and Rovinj after 2003) in selected key areas.

At the same time these are the preconditions for the development of flood hazard and flood risk maps for key areas of the coastal area.

For this reason, the maximum heights of the sea level are estimated using expert evaluation in the area of internal waters and territorial sea waters of the Republic of Croatia and compared to Croatian vertical reference system for epoch 1971.5 (HVRS71), for return periods of 50 and 100 years (**Figures 4 and 5**).

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Areas where the observed oscillations have bigger range then seiches are allocated and shown in **Figures 1.4 and 1.5**: Mali Lošinj, Ist, Stari Grad, Vis, Vela Luka, Ubli, Salt, Koločep, the wider area of Dubrovnik and Cavtat.

It should be noted that in **Figures 4 and 5** area north of Rovinj is extrapolated taking into account the fact that the range of tidal oscillations and seiches grows toward the closed end of the northern Adriatic Sea.

Also, in **Figures 4 and 5** possible contributions in sea level oscillations caused by the tsunami is not shown.

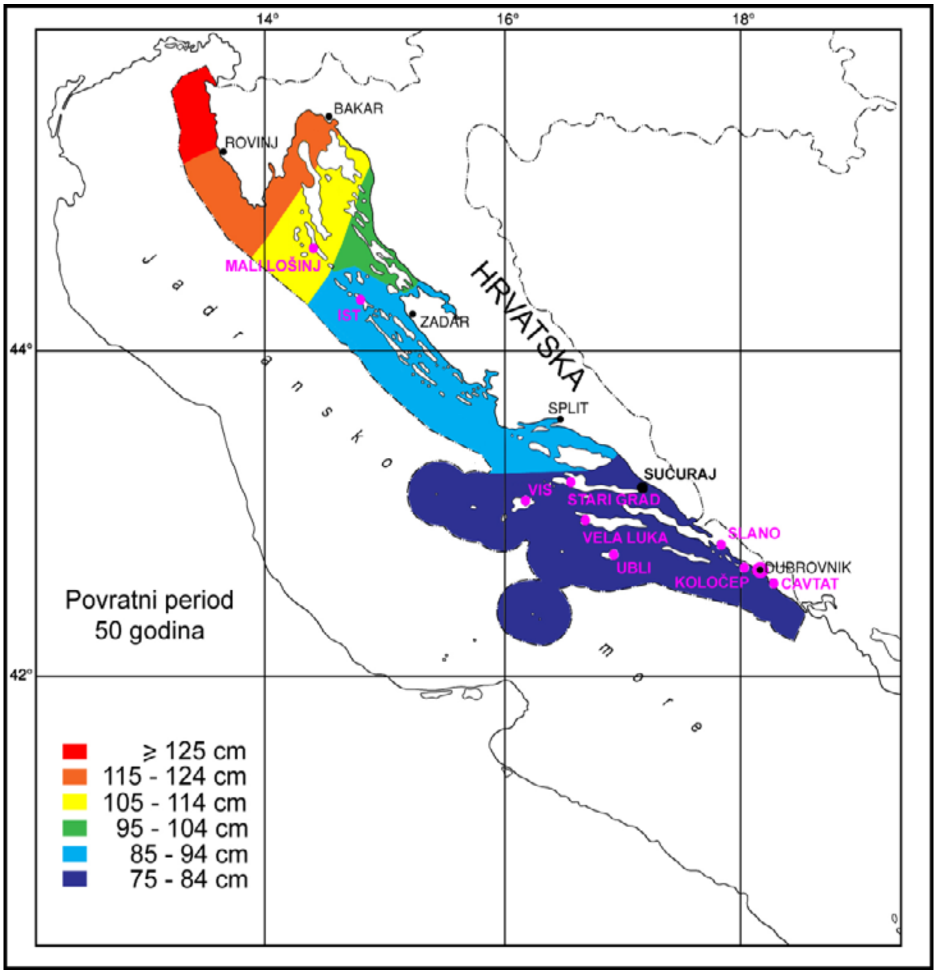


Figure 4 Maximum heights of the sea level are estimated using expert evaluation in the area of internal waters and territorial sea waters of the Republic of Croatia and compared to Croatian vertical reference system for epoch 1971.5 (HVRS71), for return period of 50 years. Areas where the observed oscillations have bigger range then seiches are allocated: Mali Lošinj, Ist, Stari Grad, Vis, Vela Luka, Ubli, Salt, Koločep, the wider area of Dubrovnik and Cavtat.

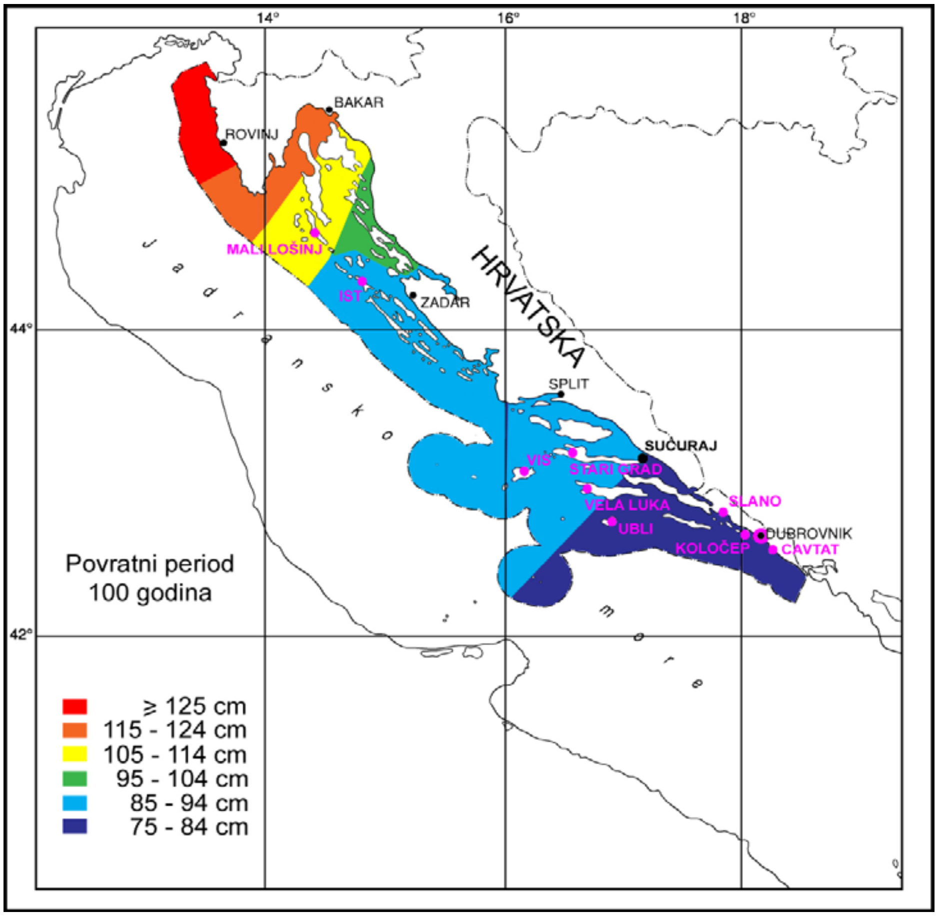
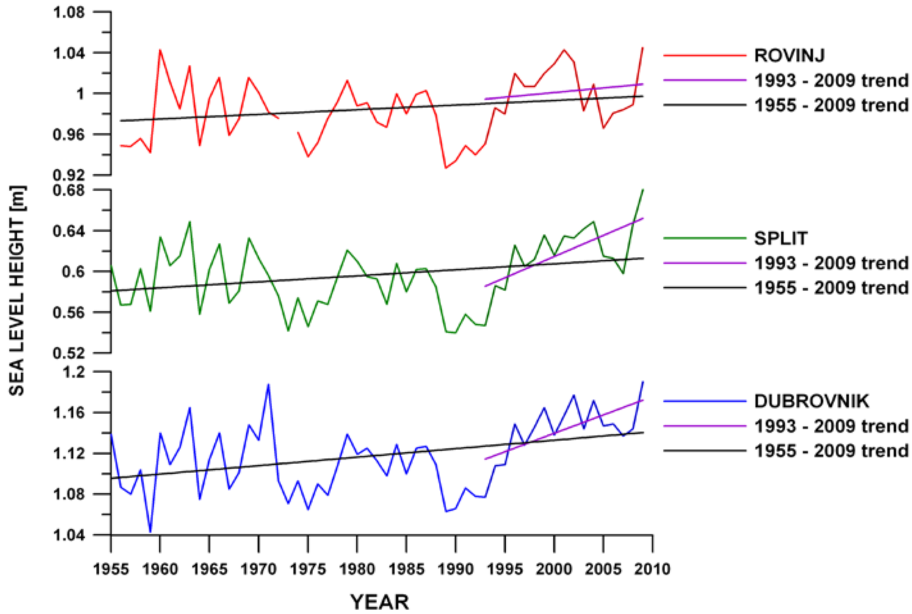


Figure 5 Maximum heights of the sea level are estimated using expert evaluation in the area of internal waters and territorial sea waters of the Republic of Croatia and compared to Croatian vertical reference system for epoch 1971.5 (HVRS71), for return period of 100 years. Areas where the observed oscillations have bigger range then seiches are allocated: Mali Lošinj, Ist, Stari Grad, Vis, Vela Luka, Ubli, Salt, Koločep, the wider area of Dubrovnik and Cavtat.

Climate Change, Sea Level Rise Along Croatian Adriatic Coast

Global sea level rise is in the centre of the interest of the general public and many experts who deal with this issue in Croatia. Climate change and its impact on sea level rise on the Croatian Adriatic coast can be monitored on the tide gauge stations. The results of the analysis of sea level measurements from tide gauge stations Rovinj, Split and Dubrovnik obtained using the linear regression analysis method of the annual mean sea level indicate a statistically significant positive trend in the sea level rise in Split and Dubrovnik, which is after 1993 increased and compared to the entire measurement period (0.6 mm / year in Split and 0.8 mm / year in Dubrovnik for the period from 1955 to 2009 .; 4.2 mm / year in Split and 3.6 mm / year in Dubrovnik after 1993, Figure 6).

Figure 6 Annual values of mean sea level with linear trends



This is in agreement with satellite measurements and predictions of IPCC for the 100 years return period, which predict a rise in mean sea level of 20 to 50 cm.

It should be noted that the analysis of changes of annual mean sea level by linear regression does not answer the question of whether the established trend depends on the length of the data series, or if there are any non-linearity in the series. Also, sea-level rise is influenced by various effects (increased sea and air temperature and air pressure, steric effect, fluctuations in the balance of water on the surface of the sea, tidal effects, vertical movement of soil and some local meteorological effects) which are not analysed in detail here.

Based on previous discussion it can be concluded that the existing tide gauge stations should be upgraded with anemometers and microbarographic pressure sensors. As well, linking upgraded tide gauge stations in the bigger network and the development of oceanographic - meteorological models will provide the basic elements in building a system for an early detection and alert on possible flooding of threatened areas.

Drought Risk Assessment

National Meteorological and Hydrological Service (MHS) assessments for Croatia show that in period 2000-2012 eight of twelve years were categorized as ‘warm’ years. Croatia’s dry months in a year are steadily increasing. According to NMHS, the period between 2003 and 2012 have seen the most frequent dry months in recent history and thus categorized as the driest years for Croatia.

The increasing dry seasons which categorically translate to less rainfall and thus droughts have implications for crop production. In Croatia, the impact of droughts have been particularly felt strongly in years 2000, 2003, 2007, 2011 and 2012 (see Figure 7). Drought hits mostly small-agricultural holdings on which. Most of the agricultural production in Croatia takes place (average farm size is 5.5 ha).

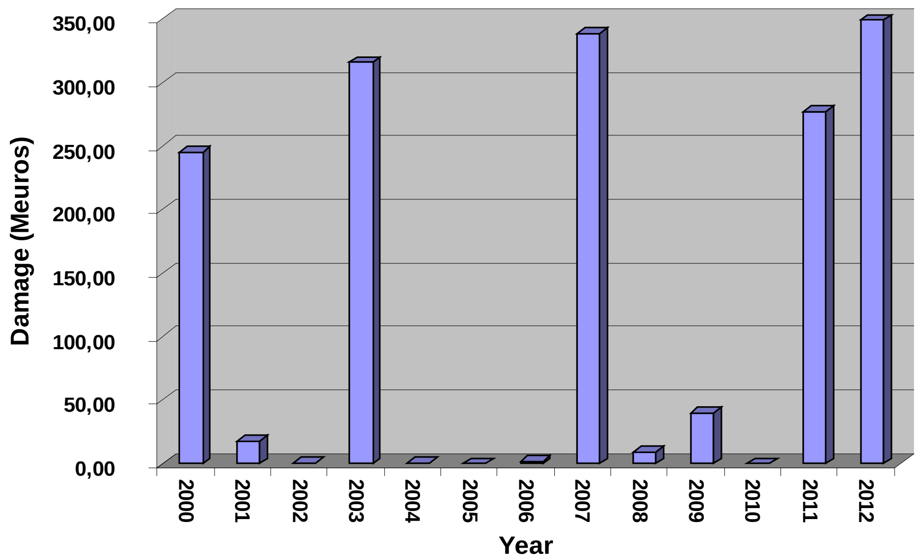


Figure 7 Damages (in Million Euros) due to drought in Croatia during the period 2000–2012

Drought Monitoring and Early Warning Systems

NMHS of Croatia is a key institution in the collection and processing of meteorological and hydrological data needed to guide policy monitoring on drought in vulnerable segments of the development of the society as a whole.

Vulnerability Assessment

In accordance with Figure 8, the areas covered with vegetation in eastern Croatia are classified as "not vulnerable", "slightly vulnerable" and/or "moderate vulnerable". The north-western inland area is mainly "not vulnerable", while the arable land and cultivated areas are "slightly vulnerable". "Slightly vulnerable" are also the Istria peninsula and Lika region where only some smaller parts are categorized as "not vulnerable" (mixed forests) and/or "moderately vulnerable" (cultivated land or pastures). Vulnerability rises when we go towards the northern Adriatic coast. In the middle Adriatic coast the transitional woodlands are mostly "moderately vulnerable" while grassland and cultivated areas are "vulnerable".

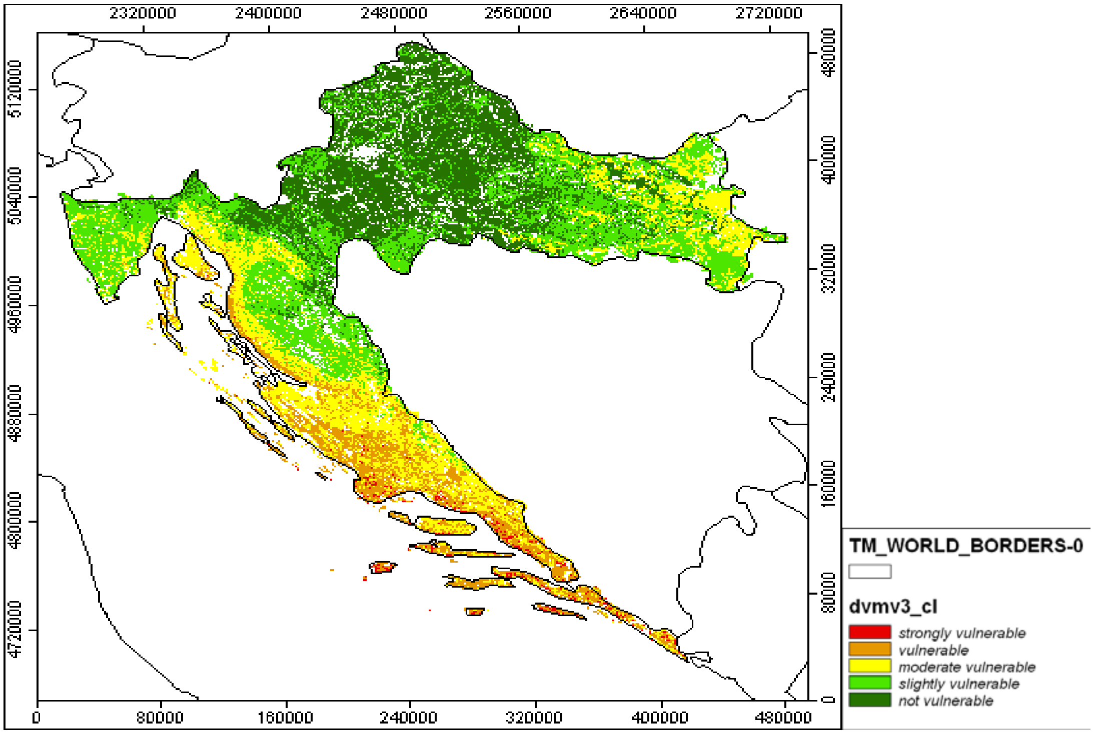


Figure 8 Categorical drought vulnerability map for the areas covered with vegetation. It is calculated from the category maps of slope, irradiation, coefficient of variation of precipitation, soil type and land cover type (Source: http://meteo.hr/DMCSEE/).

Analysis of the current status and developmental needs show that Croatia possesses sufficient quantities of water for its own needs and that water resources, in terms of their quality and quantity are not a limiting factor for economic development or to grow food. However the lack of sufficient water – mostly during the summer months in dry years- usually affects agricultural production because small farms (the majority in Croatia) cannot afford irrigation practices.

Recovery of agricultural damage due to drought usually owes to 'Declaration of Natural Disaster' and supported often by financial aid from the government. Based on the assessment of crop damage, local authorities allocate approved financial resources from governmental fund to drought affected farmers as a measure of mitigation.

Irrigation of agricultural land is insufficient and uses only a negligible part of the water potential. For example, in 2003 only 9, 264 hectares (just 0.86 percent of agricultural land in Croatia) were irrigated, and in latest years that number is slightly increased, and estimate value of irrigated area now is around 15000 ha. As the Republic of Croatia is endowed with good quality soil and rich water resources, the under exploitation of irrigation potential in the country is evident.

Emergency Relief and Drought Response

Regarding measures for drought response, the Government of the Republic of Croatia has taken a few steps. For example, in October 2005, the Government adopted a strategy of 'development of irrigation' in Croatia, with the aim of improving the management of natural resources, organization of agricultural infrastructure, and market economy of agricultural products under the title of the *National Project of Irrigation and Management of Agricultural Land and Water in the Republic of Croatia* – NAPNAV.

More so, more than six existing irrigation systems have been totally or partially repaired (3,800 ha), five new systems were built (1.200 ha) and total irrigable land increased to around 15.000 ha in 2012. According to NAPNAV construction of irrigation systems in Croatia is planned at 65.000 ha of irrigable land by the end of 2020. With the increased drought prevalence, the government is almost bound to increase the level of irrigated agricultural land in a sustainable manner. It is expected that the measures of systematic organization of infrastructure in agriculture, consolidation of agricultural land and introduction of irrigation and new technologies of production shall result in a more efficient and stabile agricultural production.

Practices to Alleviate Drought Impact and the Need of Raised Capacity on Drought Management

To reduce the impact of drought to food production, loss of organic matter in soil, water, temperature, and socio-economic indicators, it is necessary-at the national level- to implement the recommendations of 'sustainable development. In the process of strengthening environmental and drought institutions, special attention has to be paid to the integration of all existing data into one database with the possibility of rapid issuance of certified data on the state of the environment and the realization - polluter pays principle.

Bosnia and Herzegovina

Compiled by: Ozren Laganin, Milica Djordjevic, Ines Cizmic, Igor Kovacic, Goran Trbic, Sabina Hodzic, Nenad Trbic, Tatjana Kapetanovic, and Bakir Krajinovic

Models and projections used for the long-term climate change vulnerability and impacts assessment in the Initial and Second National communication have shown that the following sectors are the most vulnerable to climate change in Bosnia and Herzegovina: agriculture, water resources, human health, forestry and biodiversity, and vulnerable ecosystems.

Impact on agriculture, based on climate scenarios

Agriculture is the economic sector that is in general most vulnerable to climate change (Spasova et all, 2007, Majstorovic, 2008, Trbic 2012) given the climate-sensitivity of the sector, the share of agriculture in the Bosnia and Herzegovina (BIH) economy, the number of people employed in the sector, and closely related socio-economic issues of food security.

Because of the varied topography and diversity of BiH, scenarios must take into account the prevailing patterns of land use in each of the country's regions. For example, in north-western BiH, orchards would benefit from the projected reduction in exceptionally cold winters and late spring and early autumn frosts. These would be significantly minimized in the A1B scenario (2001-2030). Scenario A1B (2001-2030) envisages extension of the growing season (days with temperature above 5°C) in lowlands from 32 to 75 days, as well as the extension of the period with temperatures above 20°C from 38 to 69 days (Federal hydro meteorological institute FBIH, Republic hydro meteorological institute RS), which can have a positive effect on crop yield levels, as well as on the quality of crops in general. An increase in minimum temperature, i.e. in the number of days with physiologically active temperatures, can also enable the breeding of late crops, thereby providing greater yields and crops which are more convenient to store. Results from this scenario also indicate that climate change affecting the southern part of BiH (the Herzegovina Region), can maximize agricultural production and spread Mediterranean crop varieties. Because agricultural products comprise a significant share of current imports, these preconditions for exports could eventually decrease the foreign trade deficit.

Positive impacts can also be expected with Maloideae fruits (primarily apples and pears) and, to a certain extent, with the common grape vine. Positive impacts can also be expected with garden crops, especially those produced in greenhouses, where significantly less thermal energy will be needed during production cycles. Improved yields would also increase competitiveness compared to crops that are currently imported from countries with warmer climates and lower production costs.

Negative impacts can also be expected under the scenarios examined. While the extension of the growing season in arable crops can increase winter crop yields, the absence of optimum low temperatures (0-10°C) may have a negative impact on the vernalisation process. In stone fruits, for example, warmer winters can reduce yield due to the lack of optimal winter cooling. Summer crops may be threatened by higher air temperatures and summer droughts. According to the regional A1B climate change scenario (2001-2030), it is also expected that the frequency of abundant precipitation followed by storms will increase, accompanied with significant surface runoff and soil salinization, primarily in southern parts of BiH. These changes will cause the further depletion of pastures in given regions and reductions in grazing fodder, which can result in lower quality and reduced milk yields, especially in small ruminants.

These impacts will require major changes in agricultural equipment and practices, as well additional work on the selection and introduction of new crop varieties adapted to emerging climate conditions. In the long-term, it will also be necessary to carry out field trials with varieties that are not presently cultivated or are cultivated only in very limited areas of BiH. One such example is sorghum bicolour (Sorghum vulgare var. sudanense), which has a major economic value as an energy crop (for biogas) and as ruminant fodder.

A warmer and drier climate will certainly reduce the spread of phytopathogenic fungi (which are fostered by frequent rainfall and high relative humidity), making some plant diseases easier to control. However, a drier climate will require changes in the use of agricultural technology, such as the intensification of irrigation, which can increase the incidence of some phytopathogenic bacteria. Treating these bacteria can increase production costs, and when they result in quarantine (as with Ralstonia solanacearum and Clavibacter michiganensis ssp. sepedonicus (Spiec. et Kott.), they can cause significant financial losses.

In addition, mild winters can increase the prevalence of pest insects (for example, intensified migration of one of the most dangerous pests for stone fruits, Capondis tenebrionsis, from southern BiH towards northern BiH) or even the emergence of new species that could would require pest control measures that would significantly increase production costs or even damage perennial plants. For example, the warmer climate could enable the spread of invasive thermophilic weeds such as Amorpha fructicosa, Ambrosia sp., Xanthim strumarium, Helianthus tuberosus and others, generating substantial costs for pest control.

The total quantity, distribution and intensity of precipitation are of exceptional importance for provision of optimum field water capacity. If adequate crop irrigation is not ensured during a drought period, a reduced yield or even total yield loss will be unavoidable if the dry period affects the crops in a sensitive phenophase. In other words, an exceptionally dry period during pollination may completely prevent fertilization and seed formation and prevent crop growth. In the past, droughts in BiH occurred every three to five years and, depending on their duration and intensity, the reduction of yields on averaged from range of 30- 95%. Droughts were registered in 1992, 1995 and 1998, whereas in 2000, 2003, 2007, 2011 and 2012, a state of natural disaster was declared in some regions. Irrigation can alleviate yield reductions during drought periods, but the amount of arable land with installed irrigation systems is extremely limited (approximately 0.65%), so it would be necessary to undertake significant measures to expand areas with installed irrigation systems.

The growth, behaviour and health of domestic animals depend both on hereditary traits and on external conditions. Climate conditions and climate change affect the appetite and health of livestock and directly influence the profitability of cattle breeding. The direct climate impact, heat exchange between animals and the environment, is linked to the temperature and relative humidity, as well as to the pace of airstream circulation and heat radiation. These factors have a specific impact on animal health and wellbeing that depends on a species, race and class of each individual head of cattle. Warming in general encourages the spread of pathogenic microorganisms and parasites. The indirect impact of a warmer climate is reflected in increased crop yields and the quality of pasture, forage plants and grains. Since plants are autotrophic organisms, they are the main source of food for ruminant livestock in the food chain of ecosystems around the world. Pastures provide more than 90% of food for wild ruminants, and an elevated concentration of CO_2 in many ways improves fodder, as opposed to reduction of nitrogen, which causes a low protein value of fodder.

Socio-economic impact of climate change to agriculture

The share of agriculture, hunting, forestry and fishery in GDP in BiH in 2010 was 7.11%, which is a slight decrease compared to 2009 (7.4%) and 2008 (7.5%). Much more important are the facts that sector of agriculture of Bosnia and Herzegovina employs the greatest number of people -- approximately 160,000 -- especially in rural territories. In 2009, the sector employed 166,000 workers.

In terms of crops, total production of grain in 2010 was slightly more than 1.1 million tons, and approximately 77% of that total was corn (more the 850,000 tons) and wheat. There were some sharp decreases in grain production in 2010, with 11.4% less corn and 43.2% less wheat than in 2009. Tendencies

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are similar for other agricultural products (rye, oats, barley, hay, vegetables, milk, etc.). Climate change has undoubtedly had a substantial impact on total yields.

At this moment, climate change adaptation measures in the BiH agricultural sector are marginalized. A simplified analysis performed under SNC preparation of potential climate-related damages and the possible advantages of climate change adaptation implies a need for further research and investment in agriculture to reduce vulnerability to extreme climate change. Considering the fact that average price of wheat and corn in 2010 was 300 KM/T, a 15-20% decrease in production would cause approximately KM 45–60 million of damage. Together with damage to industrial plants, fruits, vegetables and other crops, losses could easily reach KM 165 million – the total budget for agriculture in BiH (which includes only KM 90 million for direct support to farms, as approximately KM 60 million is allocated to rural policy measures).[9] The consequences of reduced production are visible in increased prices of agricultural products.

A crucial factor in vulnerability of agriculture has been the insufficient utilization of agro-technical measures, and especially undeveloped and obsolete irrigation systems and hail-protection systems. Damages caused by droughts, flooding and hail in Bosnia and Herzegovina has for quite some time been a reality. Consequently, it is expected that agriculture will suffer from the greatest damage caused by climate change and, unless drastic improvements are made, extreme precipitation and temperatures can be expected, along with other extreme weather conditions and evaporations, which together will cause reductions in total agricultural production (Popovic, 2008). Therefore, the existing climate variability already significantly affects the agricultural sector, meaning that extreme weather conditions resulted in average losses of at least 200 million KM annually. Damages caused by climate change are far greater than annual incentives that are paid to farmers.

Rural areas in Bosnia and Herzegovina are neglected, and rural development strategies have only recently been adopted and involve only minimal investments. Rural areas are more vulnerable due to lack of infrastructure and poorer living conditions than in urban areas. Only about KM 60 million (approximately EUR 30 million) is invested annually in rural development. In the EU accession process, CEFTA (Central European Free Trade Agreement) trading advantage should be used, along with other available EU resources such as the Agricultural and Rural Development Programme (ARDP), the Instrument for Pre-Accession Assistance (IPA), and the Technical Assistance and Information Exchange Instrument (TAIEX). Particular attention needs to be paid to the sustainable aspect of rural development; i.e., protection of waters, forests and forest ecosystems, protected biodiversity areas, etc. Inhabitants of rural areas have low incomes and are most vulnerable to negative effects in almost all sectors. They are particularly vulnerable due to high adaptation costs, and rightfully expect activities and assistance from state institutions.

Climate change also has a significant impact on food production and food safety. Frequent changes in climate conditions and new pathogens and plant diseases are evident (FAO, 2007). These and other changes cause reductions in production due to reduced crop yields and the reduction of arable land, which

[9] 1EUR equals 1.95583 KM, BiH Central Bank, Jun 2013

leads to short-term price instability and long-term increases in food prices in the world. FAO Reports indicate that global food prices increase as a consequence of bad climate conditions, energy prices increase etc. According to FAO data from 2007 (FAO, 2007), nearly 11% of arable land in developed countries could face impacts from climate change, which also include reduced crop yield in 85 countries and a reduction in agricultural production as a share of GDP for 16% of countries. According to this report, the key socio-economic impacts are as follows:

- Decrease in crop yield and agricultural production;
- Decline of agriculture production as a share of GDP;
- Fluctuation of prices on world markets;
- Increase in the number of people without access to sufficient amounts of food;
- Migration and social unrest.

According to climate scenarios A1B and A2, the agriculture, forestry and fishery sectors will face land degradation and erosion (due to extreme weather), a loss of arable land, and a decrease in livestock (due to frequent cases of livestock deaths), etc. In a 2008 FAO Report (FAO 2008), which is based on the IPCC projections from 2007, the biggest decrease in crop yields in Europe is expected in the Mediterranean, the South-western Balkans and the Southern region of the European part of Russia. It may be expected that there will be a geographic redistribution of certain crops (e.g. sunflowers and maize, which will be cultivated in northern areas, unlike today). This study is of specific interest and concern for Bosnia and Herzegovina, because it is situated in the risk area when it comes to food production. The overall situation is exacerbated by price increases and demand on the world food market, an increase in energy prices, and more frequent financial crises that will create general macroeconomic instability and insecurity. As a result, the foreign trade deficit in agricultural product exchange would be worsened. In addition, it is expected that there will be increased needs for irrigation, an increased risk of forest fires, increases in 'barren' land and reduced biodiversity, etc.

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Water resources

Average annual precipitation in BiH is about 1,250 l/m^2, which - given that the surface area of BiH is 51,129 km^2 - amounts to 64 x 109 m^3 of water, or 2,030 m^3/s.

Basin	Surface area	Length exceeding 10 km	Average outflow
	[km^2]	[km]	[m^3/s]
Immediate basin of Sava River in BiH and Ukrina	5,506	1,693.2	63
Una in BiH	9,130	1,480.7	240
Vrbas	6,386	1,096.3	132
Bosna	10,457	2,321.9	163
Drina in BiH	7,240	1,355.6	124
DANUBE RIVER BASIN	38,719	7,947.7	722
Neretva and Trebišnjica in BiH	10,110	886.8	402
ADRIATIC SEA BASINS	12,410	1,063.8	433
Bosnia and Herzegovina	51,129	9,011.5	1,155

Table 1. Specific indicators of basins and sub-basins in BiH (Source: IPA 2007 PROJECT – Support to the Water Policy in BiH, 2011)

The outflow from the territory of BiH is 1,155 m^3/s, with an average discharge coefficient of 0.57[10]. The average outflow towards the Danube River basin, which has a surface area of 38,719 km^2 (75.7%) in BiH, amounts to 722 m^3/s, while the outflow from the Adriatic Sea basin, which has a surface area of 12,410 km^2 (24.3%) in BiH, is 433 m^3/s.

Low water levels in basin and sub-basin areas are highly prominent. The value of minimal median monthly flows with assuredness levels of 95% (which are the ones most often referred to when discussing minimal water flows that ensure the survival of ecosystems in and around the water bodies) amounts to around 15% of median annual flows. That indicator points to the poor conditions existing in the sub-basin of River Bosna. The non-linearity is even more prominent in the watershed of Adriatic Sea, where certain water streams have gone dry.

High water levels in the territory of BiH appear in the form of torrential flow regimes, with brief flooding waves and large outflow modules (1–1.5 m^3/s/km^2).

For the watershed of River Sava, the average ratio of median annual flows and high water levels at a 1% probability level of the phenomenon amounts to $Q_{(1\%)}$ =18.5Q annual average, which means that the watershed in question is unfavourable, judged by the regime of both low and high water levels with the highest population density and the most pronounced water requirements (IPA 2007 Project – Supporting Water Policy in BiH, 2011).

[10] IPA 2007 PROJECT – Support to the Water Policy in BiH, 2011

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Previous hydrological analyses in BiH have faced the problem of a complete absence of data regarding the outflows of rivers in BiH in the 1990s, and the same problem occurred again during the development of the Second National Communication[11]. In particular, the absence of sufficiently processed outflow data for the Adriatic Sea basin meant that it was not possible to conduct a reliable analysis of this very important basin in BiH.

The Bosna River basin analysis does not show changes in values of average monthly outflows over time. A trend analysis of monthly precipitation for the period 1961-2011 (calculated as average value of monthly precipitation in meteorological stations Sarajevo, Zenica and Tuzla), and the average monthly outflow of the Bosna River in Maglaj during the same period[12] does not indicate any significant change.

The same conclusion is reached when comparing statistical parameters of sequences in mean monthly outflows of the Bosna River in Maglaj during the periods 1961-1990 and 1991-2010 with statistical parameters of monthly precipitation (expressed as average value of monthly precipitation in MS Sarajevo and MS Zenica), during the same periods.

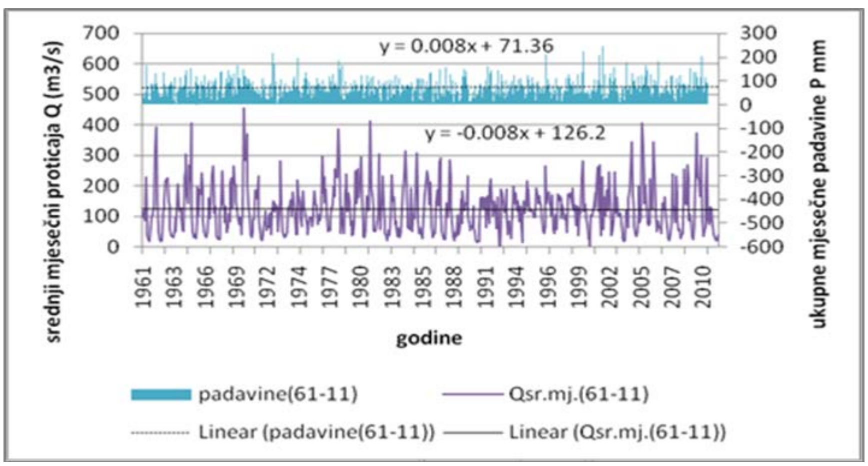

Chart 1. Sequence of mean monthly outflow of the Bosna River in Maglaj, with a trend, and average value of monthly precipitation (MS Sarajevo, MS Zenica, MS Tuzla) with a trend (period 1961-2010)

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[11] This problem is in more details elaborated in INC.

[12] Values of Bosna River outflows in Maglaj, Qmean av. for January 1992 - December 2000 calculated based on multiple correlation between values of Qmean av. for Bosna in Maglaj in period January 1961 – December 2010, with following monthly values during the same period:

- MS Sarajevo (total monthly precipitation, mean monthly temperature);
- MS Zenica (total monthly precipitation, mean monthly temperature);
- MS Tuzla (total monthly precipitation, mean monthly temperature).

Multiple correlation calculated by months (Multiple R: 0.610220455-0.857194005; R Square: 0.372369004-0.734781563).

Statistical parameter	Mean monthly outflows		Monthly precipitation	
	Bosna (Maglaj)		average (MS Sarajevo, MS Zenica)	
	1961-90	1991-2010	*1961-90*	*1991-2010*
Mean value	123.28	132.05	71.31	78.33
Median	108.78	111.73	68.98	71.70
Stand. dev.	79.94	85.12	36.95	40.43
Variance	6389.69	7244.97	1365.14	1634.50
Flatness	1.38	0.45	0.84	0.61
Obliqueness	1.12	0.97	0.71	0.80
Range	437.93	387.07	224.65	208.10
Minimum	16.29	19.28	0.50	8.45
Maximum	454.22	406.35	225.15	216.55

Table 2. Statistical parameters – sequences of mean monthly outflows of Bosna River in Maglaj, for periods 1961-90 and 1991-2010, and statistical parameters of monthly precipitation in MS Sarajevo and MS Zenica, during same periods

One should emphasize that the sequences analysed are relatively short. The sensitivity of results based on short sequences is evident from the results of the trend-based analysis, which, in addition to the trends for 1961-1990, also shows the trends for equations for 2001-2010, as well as for 1991-2011. The equations show that a single year or two may have a significant impact. In this particular case, the extremely humid 2010 and the extremely dry 2011 had had such a strong impact on median monthly flow values that they had led to the trend being reversed from positive (a growth trend) to negative (a trend of decline).

Exceedingly drier periods in Bosnia and Herzegovina are manifested in the occurrence of low water levels; i.e., reduced and small outflows on all significant waterways in the Republic of Srpska and whole Bosnia and Herzegovina. In RS, winter (January – February) and summer (July-August) periods of low water levels are experienced. The majority of rivers are supplied from ground water during low water periods, and this significantly reduces the supply of ground water in Bosnia and Herzegovina. Because drought is a highly adverse weather phenomenon, numerous research activities around the world are focused on its prevention or on the mitigation of its adverse effects.

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Impacts on water resources, based on climate scenarios

Overall, all two scenarios for the periods 2001-2030 and 2071-2100 (A1B 2001-2030; A1B 2071-2100; A2 2071-2100) predict the increase of air temperature in BiH in all observed seasons throughout the year. At the same time, all three models depict reduced amounts of precipitation. Changes in the rainfall regime will also be experienced in the timing, frequency and intensity of extreme events – floods and droughts. The highest increase in air temperatures is predicted during the growing season (June, July and August), and a somewhat more moderate increase during the months of March, April and May. This means increased evapotranspiration and more pronounced extreme minimums in the water levels of waterways. On the other hand, increasingly frequent precipitation of a significant intensity will cause sudden outflows, often in the form of floods. The impact of snowfall is also significant for waterway outflow, and there is a significant predicted increase in air temperatures during the winter season (the months of December, January and February). All of the findings above imply various different scenarios leading to even more pronounced inter-annual nonlinearity of water outflows in BiH. On one hand, there will be a general reduction in the availability of water resources during the growing season, when needs are greatest; on the other, the risk of flooding will be increasingly pronounced.

In addition, projections indicate even more frequent and intensive occurrences of droughts and flooding that will be more widespread and last longer. It can be concluded that additional and more complex research of climate change and its effects on water resources are required, along with the development of a sectoral climate change adaptation strategy with an action plan and specific measures.

Socio-economic impact of climate change on water resources

Even though Bosnia and Herzegovina is rich in water resources, pressures, problems and shortages are very frequent. Huge amounts of drinking water are still wasted in distribution systems, additionally creating enormous economic losses. Although there are no exact indicators to quantify these negative impacts, it is certain that these losses are at least EUR 25 million a year (for example, Croatia, which has more inhabitants and better infrastructure, experiences annual losses estimated at approximately 286 million EUR). In addition, greenhouse gas emissions are constantly increasing due to the increased consumption of energy required for production of drinking water. An additional problem is the shortage of water in agriculture, especially in risky periods when soil needs minimum quantities of moisture.

The energy sector of Bosnia and Herzegovina is also potentially vulnerable, particularly due to the fact that climate change could cause reductions in river flows. Such extreme situations could lead to reductions in generation of hydroelectric power, which would put in danger the energy safety and production of electricity intended for export. Droughts have in past affected the level of losses in production of hydroelectric power. Reduced production of hydroelectric power caused by reduced river flows must often be replaced by other domestic sources or by imports, which is unfavourable from the aspect of increased greenhouse gas emissions (additional production in electric power plants), but also from a macro-economic aspect (increases in the foreign trade deficit).

All of these challenges together have a negative impact on the socio-economic status of the population and all economic actors, because the lack of a stable supply of electricity may lead to price increases. Even

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though there are no exact indicators of direct and indirect losses caused by reduced water flows, it could still be concluded that such losses are much greater than losses caused by the inadequate water supply network; i.e., they could easily exceed KM 100 million (for example, if water flows decrease by 5-10%). Anyhow, according to the World Bank data (2008), planned investments in electric power sector in BiH by 2020 amount to slightly over 4 billion EUR, where certain finances should be redirected towards reduction of vulnerability in the sector of hydro energy. Therefore, adaptation measures must be focused on strategies and regulations, as extreme climate change has a negative impact on water cycles, which could lead to droughts and impacts in other sectors, especially in agriculture and natural ecosystems. BiH decision-makers have still not taken into account all the climate change dangers in their strategies and water resource management plans. In parallel, there is a need to research the socio-economic effects of climate change on protected areas and wetlands and to study risks of floods or reduced river flows. Scientific and expert research is also needed with respect to necessary adaptation measures, including cost-benefit analyses of measures, and on climate change interactions, the production of hydropower, and the supply of drinking water.

Task 3 – Adaptation Needs

Identifying adaptation needs involves two equally important and complementary sub-tasks: 1) analysing observed or expected *impacts* of climate change (with and without adaptation); and 2) analysing the potential *capacity* to prevent, moderate or adapt to these impacts. Since an analysis of potential impacts and vulnerability of agricultural and water sector was provided in our previous submission, herein below we will give an overview of the adaptation needs, as analysed in the official documents submitted to the UNFCCC, namely the Second national communication of Bosnia and Herzegovina to the UNFCCC, and the Climate Change adaptation and Low Emission Development Strategy.

Overview of climate change adaptive capacity

Adaptive capacity is a broad concept that refers to the availability of all kinds of resources – such as natural, financial, cognitive, social, and institutional capital that may be mobilized for adapting to climate change. The methodology for assessing capacity, used in the Second National Communication and a Climate Change Adaptation and Low Emission Development Strategy is consisted of the following: information, skills and management, economic resources, physical capacity, and institutions and networks. It summarizes the general political and administrative framework for climate change adaptation, the financing environment for investments in projects that directly or indirectly support adaptation, and then discusses adaptive capacity by sector.

Overall policy framework and climate change adaptation policies

At the regional level, Bosnia and Herzegovina supported the creation of the Southeast Europe Climate Change Policy Framework Action Plan for Adaptation (SEE/CCFAP-A) under the auspices of Belgrade Initiative on Climate Change (SEE, 2007). This general policy framework and other relevant activities are

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described in details in Section 5.5 of this report on International Cooperation. In the implementation of this adaptation framework, it is necessary to develop a system of indicators that is compatible with EU standards and that will also be suitable to the specific needs of Bosnia and Herzegovina. Monitoring the impacts of climate change will require building capacity in development management that is oriented towards these specific needs.

Economic incentives

Climate change adaptation measures are impossible to accomplish without adequate economic instruments. The most important instruments and measures are those at the state and entity level. The RS Law on the Fund for Environmental Protection (2002,2011, and 2013) and the FBiH Law on the Fund for Environmental Protection (2003) established funds to collect and distribute funds for environment protection and a new schedule for allocating funds for energy efficiency projects and modifies the name of the fund.

At present, it is possible to access funds for financing energy efficiency and renewable energy projects in the Western Balkans. In addition, funds from private investors should not be underestimated, because these investors are often searching for opportunities in this sector. It seems that the combination of funds and public and private capital would be able to resolve various climate change adaptation issues in Bosnia and Herzegovina. This could be one of the basic tasks for both institutions and decision makers. As there are no relevant strategic projects yet, it is necessary to make advance steps and continually allocate funds for the following: project promotion, technical guidance development, the development of documentation with regard to execution of obligations (due diligence), competition for funds (loans or funds), approvals, and other types of stimulus. Finally, it can be concluded that financing is key to planning and implementation of plans for climate change.

As is the case with other developing countries, BiH is already affected by climate change, but it lacks the necessary human and financial resources to adapt. Therefore, Bosnia and Herzegovina is turning to the European Union, which has committed itself to strengthening dialogue on climate change with candidate countries and potential candidate countries (the current status of BiH). However, this also represents a general message of all strategies tackling expansion issues, hence it is no surprise that in several key joint policies of EU and the budgets of EU and country members, there are significant resources allocated for sustainable development (including direct and indirect investments in the climate change mitigation measures.) Scientific research shows that climate change may significantly impact water resources, agriculture, forest and forest ecosystems, coastal areas, tourism, energy, land use and buildings, transport infrastructure conditions, natural ecosystems, human health, socioeconomic status and demographic trends in the countries of South-eastern Europe. Potential financial sources for adaptation include the Global Environmental Facility, including the Adaptation Fund; the Special Fund for Climate Change; and the Green Climate Fund. Other funders include the World Bank, the European Bank for Reconstruction and Development (EBRD) and FAO, the European Union (including pre-accession instruments, the EU Seventh Framework Program, and EIB funds), the WMO Technical Cooperation Program, the South East Initiative for Disaster Relief and Adaptation administered by the World Bank, and bilateral donors (UK, Spain, Switzerland, Sweden, and others). There is also potential funding for adaptation from private funds and investors, and it would also be possible to attract funding through an existing Multilateral Environment Agreement – MEA -- that could provide synergies with adaptation measures. Relevant MEAs include the Convention on Biological Diversity, the UN Convention Combating Desertification and the Ramsar Convention on Wetlands. In other cases, technical assistance that emphasizes education and cooperation on climate change issues can increase adaptive capacity.

Difficulties and risks in implementing proposed adaptation measures

The implementation risks of proposed measures are numerous, and it will be necessary to overcome many difficulties. The most significant barrier is the lack of funding necessary to implement adaptation measures. Some of the measures suggested assume the implementation of different types of research and the development of a system for climate change monitoring, all of which will require financing. Therefore, the provision of financing is a key first step in implementation. A second set of barriers consists of a lack of research capacity in addressing climate change adaptation, insufficient research on climate change impacts, and a lack of well-defined roles for various stakeholders. At the same time, it is necessary to further promote the importance of climate change and strengthen existing capacities.

Adaptive capacity in agriculture

At present, adaptive capacity to climate threats in the agricultural sector is low. In terms of available information and knowledge, there is a lack of detailed analysis on regional changes within BiH and a lack of crop modelling. Climate data is not fed into early warning systems for farmers, and farmers lack information about adaptive farming techniques, seed varieties, and crops that may be more appropriate with changes in season temperature and precipitation patterns.

In terms of skills and management, there is a general need for training farmers in less labour-intensive methods of agriculture, cultivation techniques for better-adapted crops, and hail protection techniques. In the economic sector, there is an overall lack of investment and a lack of crop insurance, which will become increasingly important with future increases in extreme weather.

In terms of physical capacity, there is a lack of modern technology (many farmers use obsolete farm equipment, and there is a low uptake of new technologies due to lack of funding and the small-scale structure of farming). There is also a lack of infrastructure that could address climate threats, such as irrigation systems and reservoirs and rainwater collection. In addition, farmers lack access to broader varieties of climate-suitable seeds and plant varieties.

In the institutional sector, there is a lack of integration of climate change issues into policies on agriculture and rural development, a lack of coordination and clear jurisdiction for agricultural policies, and a lack of support for agricultural extension programs.

Adaptive capacity in the water sector

In matters of adaptive capacity in the water sector, little has changed since the Initial National Communication. In terms of information, there is still a critical lack hydrological modelling, which makes

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it very difficult to determine the potential implications of climate change for uses such as energy, drinking water, and irrigation. While a general vulnerability assessment of the sector has been performed, there is a lack of a detailed vulnerability assessment and a need to assess climate change adaptive capacity for water resources.

In addition, there is a lack of vulnerability maps and risk charts of the threat of flooding using GIS techniques. There is also a lack of high-water early warning systems for flooding based on comprehensive, real-time data. In economic terms, this lack of information results from a lack of financing for monitoring systems and institutions. More broadly, low levels of investment also affect the water sector and water utilities, which still lack the resources to make important upgrades and to maintain water distribution systems effectively, and there is still a need for major investments in the sector.

As far as infrastructure is concerned, the condition of water supply systems is on the whole quite poor. Repairs and long-term maintenance are inadequate, and as a result, aging water supply systems “waste” lots of water. In some systems, the amount of water that is unaccounted for exceeds 85%, meaning that companies that manage these systems cannot operate with economic efficiency. Cost-effective technologies and practices such as more efficient pumps and leak detection programs, which would have co-benefits in terms of climate change mitigation, are not common. Thus, loss reduction represents the most important “resource” for households and could reduce vulnerability in this sector significantly.

Flood protection measures are another area where adaptive capacity is low. In terms of institutions and networks, there is still need to mainstream climate change issues into sectoral legislation and programs and to harmonize those programs.

The Former Yugoslav Republic of Macedonia

Vulnerability assessment of two sectors: water resources and agriculture

As it was agreed at the Launch Adaptation Workshop (Step A workshop) held in Tirana on 24-25 November 2014, the team of the representatives of Republic of Macedonia has prepared its Task 2 and 3 (homework) on ***vulnerability assessment of two sectors*** and hereby is submitting it.

Sectoral vulnerability and adaptation analyses

As a country party to the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex I country and party to the Kyoto Protocol Republic of Macedonia adopted three National Communications on Climate Change (in the year 2003, 2008 and 2014).

The preparation and adoption of the Third National Communication on Climate Change (2014) came as an obligation according to the Law on Ratification of the United Nations Framework Convention on Climate Change, the Law on Environment and The Programme on Adoption of the EU Acquis. The preparation of these three plans was supported by the Global Environmental Fund (GEF) and the UNDP. The thematic reports were prepared by the relevant scientific and specialized institutions: MANU

(Macedonian Academy of Science and Arts), The Research Centre for Energy and Sustainable development and UHMR (National Hydro-met Office) as well as by other relevant experts.

In the following text, the vulnerability assessments of water resources and agriculture sectors are presented.

Water resources in the Republic of Macedonia are sensitive to climate change with regard to both quantity and quality. Total average precipitation is expected to decrease by 8% in 2075 and 13% in 2100. Reductions in available surface water for the Vardar River are estimated at 7.6% in 2025 and 18.2% in 2100 and for the Bregalnica River at 10% in 2025 and 23.8% in 2100. Groundwater recharge in the Vardar River Basin will decrease continuously, reaching approximately 57.6% of current recharge levels in 2100. In conclusion, overall water availability in the Republic of Macedonia is expected to decrease by 18% in 2100. The Strumica River Basin (1,649 km^2, or 6.4% of the territory of the Republic of Macedonia), which is relatively poor in water resources, is a vulnerable region in both cases/scenarios.

Significant barriers to adaptation in the water sector include poorly designed and maintained irrigation systems, unregulated use of surface and groundwater, lack of reliable data on water consumed for irrigation, water pricing practices, and ineffective implementation of the Law on Water. Priority adaptation measures should therefore focus on the development and improvement of water storage and supply infrastructure; coordination of water use; introduction of water-saving measures; improvements in water supply and use techniques in agriculture and industry; pricing and management measures for the energy sector; and measures related to disaster risk reduction.

The negative effect of climate change on **agriculture** in the Republic of Macedonia is increasing. The agricultural sector as whole, and particularly small farms, are expected to be exposed to prolonged heat waves, more severe droughts and floods. The climatic events in 2007/2008 and 2011/2012 with long dry periods and heat waves led to significant production losses. Less than 10% of agricultural land is irrigated, and with the exception of the western parts of the country, water deficiencies occur in summer, resulting in significant moisture stress for summer and annual crops.

The vulnerability assessment for this sector, which used models to analyse the SE Region, found that all crop families with a base temperature of 5.6°C and higher would start growing earlier, and that growing stages would shift dramatically in time. In the SE region, crop modelling for the baseline scenario indicated a reduction in wheat yields of 21% between 2000 and 2025 and 25% between 2040 and 2050 and a reduction in maize 56% in 2025 and by 86% in 2050. At the same time, all scenarios with adaptation measures contributed towards increased yields and a reduction in the negative impacts of climate change compared with the baseline scenario. The simulations presented above indicate that adjustment in sowing dates and depth as well as irrigation could produce substantially improved yields of wheat and maize in the SE region of the country under future climate change. However, these high yield scenarios also placed a great demand on water resources.

The economic analysis of impacts and vulnerability found that economic losses in all scenarios with adaptation measures for wheat were lower than the losses from traditional production practices. For maize, from 2015 to 2025, the proposed scenarios easily counterbalanced the negative climate change

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effects, but in the second period from 2025 to 2050 most of the scenarios show negative financial results, even with adaptation interventions.

A case study on the influence of the excessive heat on **livestock breeding** found that the yearly number of live born pigs was 2.14% less per litter when taking high temperatures into account. Higher temperature was also associated with prolonged conception of the sows, which increased non-productive days. The economic losses were evident: total annual losses reached 386,928 MKD (~EUR 6,260). Adaptation options identified included the following: genetically heat-tolerant breeding animals; adoption of special feed and feeding techniques in excessive heat; housing conditions with proper ventilation, in-house air conditioning and cooling systems; and continuous productivity monitoring. Clear economic calculations are also needed in order to determine the most appropriate time to invest in adaptation measures.

Additional analysis of **viticulture** showed that table and wine grapes are both vulnerable to increases in temperature – which can be ameliorated by effective irrigation and UV nets.

Adaptive capacity in the agricultural sector is low due to a variety of key factors: (a) small primary producers with low annual income and ability to implement adaptation measures, which in some cases can be costly; (b) small plots, which prevent effective implementation of adaptive measures; (c) insufficient financial support to the farmers to cope with the negative impacts of climate change; (d) low awareness among the key players about climate change and its negative effects in agriculture; (e) weak networking and an insufficient level of cooperation between scientific institutions; (f) lack of effective organizations to disseminate good practice to farmers; (g) lack of modern production technologies and practices and a lack of dissemination of research results to potential users; (h) insufficient experience with implementing modern approaches in assessing impacts and projecting future trends. Proposed adaptation measures for the sector include possible support programs for certain crops, modern irrigation practices, and an increase in organic farming.

Kosovo*

Task 2 – Vulnerability Assessment

Agriculture, Forestry and biodiversity management

Kosovo is in the process of restructuring the agricultural and forestry sector with a view to sustainable economic development based on European environmental standards, especially in legislation. The Government of Kosovo is in support of an integrated approach aiming to find a balance between economic developments, environmental protection and land use.

Kosovo has inherited many environmental problems accumulated over decades, affecting the uncontrolled exploitation of natural resources, high population density, uncontrolled construction on

* this designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo* Declaration of Independence.

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agricultural land, uncontrolled use of forest, illegal logging, economic and industrial activities, including mining and processing industry which affect the environment. Additional to all those factors which are affecting the agriculture, forestry and land use then climate change adds to the existing complexities of achieving just socio-economic development.

A legal framework for agriculture, forestry and land use sectors is almost completed and approximated to a large degree with the relevant EU legislation, although implementation and enforcement of laws is weak.

The Agricultural Household Survey 2012 accounted for about 378,768 ha overall and 277,364 ha (73 %) of private agricultural land in 2012. 41 % of this area is used as arable land and 26.0 % as meadows and pastures. 5 % of the agricultural land – an decreasing amount - was left fallow in 2012. The use of orchards increased during the period 2009 to 2012 by 10.1 %. Also areas used for arable crops, vineyards and greenhouses substantially increased during the last years.

Livestock production has a high economic importance and is a profitable agricultural sector promoting also other agricultural sectors like plant production, processing industry etc. It is estimated that about 94,000 farms (52 % of the total farms) are active in livestock production. Most livestock production is done in an extensive way in rural households. Semi commercial and commercial farms have more intensive livestock production with higher quality animal breeds.

Agriculture used to account for 25% of GDP in the 1980s and early 1990s, reduced its share to about 14.1% of GDP in 2011. (Source: KAS data from 2011). Agriculture accounts about 35% of total employment (Country Snapshot 2013 April WB report). The agricultural sector also accounts for 16% of total export value and remains an important economic sector and as a creator of national wealth.

As regards forestry, 41% of Kosovo's land area is covered by forests (464,800 ha), of which 60% are state-owned forests (278,880 ha) and 40% are private forests (185,920 ha) (Source: Policy and Strategy Paper on Forestry Development 2010-2020). The forest cover in Kosovo* is larger than in neighbouring countries however, the quality and productivity of the existing forests are a cause of concern. In particular in steep, mountainous terrain there are alarming signals of desertification due to serious soil erosion:

- 32.200 ha are considered as forests "without trees";
- 171.200 ha are forests created through natural seeding, categorized as high forests (h > 16 m);
- 115.800 ha are categorized as low forests (created by stems), which dominate in the central part of Kosovo;
- 21.200 ha are called low forests with standards (low forests with a presence of trees with height);
- 2.200 ha are forests created through forestation.

There are about 120,000 private forest owners in Kosovo*, who manage their forests in the traditional coppice system and usually do not plant trees. They rely on natural seeding to regenerate their forests, which is said to regenerate abundantly, and practice replanting only in a few exceptional cases. It is estimated that the area that is replanted in private forests does not exceed 30 ha/year in entire Kosovo. The average size of a private forest estate is 2 ha spread over several plots and usually complemented by pasture and agricultural land. The management objectives of most forest owners are the production of

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fuel wood for subsistence purposes, the increase of the growing stock, and the protection of soil from erosion. Only very few forest owners are willing to convert their coppice forest to high forest. Most private forest owners do not have management plans.

As regards biodiversity, Kosovo* is rich with plant species, considering its relatively small surface. There are identified 13 species of plants that grow only in Kosovo and approximately 200 species are grown in Balkan. Total number of plant species is larger than in some European countries. This diversity is a result of complexes activities of physical factors, as the soil and climate that create diversity of habitats and conditions for growth of plants. In the territory of Kosovo* there are around 24 species of threatened plants as a result of human activities. These are mainly concentrated in mountain areas but also in field areas.

There are approximately 46 species of mammals in Kosovo* - the majority of them with regional and global importance. Some species of water birds have lost as a consequence of wetland destruction, pollution and degrading of rivers. Hunting was very intensive during the years of 1990, and now there are reports of a reduction in illegal hunting. Illegal hunting resulted in an increase of endangered animal populace. Biggest part of land plant and animal biodiversity wealth is found in the high mountains of south and west part of Kosovo*. Biodiversity of water ecosystems have decreased seriously, especially regarding the species of fish as a result of pollution of waters and degradations of river beds. (Source: Strategy and Action Plan for Biodiversity 2011 – 2020).

The majority of land in Kosovo*, around 94% of total territory of Kosovo*, is agriculture and forest land, while only 5-6 % of the land is used for construction or water. From the total agricultural land around 90% is private property. Based on MAFRD estimation each year around 400 ha are changing destination from agricultural to construction land. One of the key developments is uncontrolled construction, due to a lack of urban and municipal development plans as well as weak implementation of legislation in order to protect the agricultural land. Other factors include:

a) lost/degradation of agricultural surfaces,

b) deforestation;

c) stone-gravel and separations;

c) dumpsites.

Deforestation and forest degradation agents have been identified. Commercial logging agents drive forest degradation most, is the illegal cutting of round wood from living forest biomass for commercial use of fuel wood provides an extensive overview on the drivers of forest resource loss and confirms the illegal logging for commercial purposes to be among the most important drivers. It has also been cited that poor villagers living nearby forests cut wood for subsistence purposes, which is at magnitude of 10 % of illegal wood harvest and negligible. The harvest of wood by private forest owners after the delayed submission of harvest permits is also considered illegal logging, but not focused on hereafter.

The outbreak of forest fires takes place due to the careless burning of nearby harvested agricultural plots or grassland by farmers and pastoralists. The lack of awareness in the civil society also contributes to the outbreak of forest fires nearby camp grounds and picnic places.

Inadequate forest planning and implementation of management due to insufficient cooperation between KFA and municipality authorities undermines needed investment in the forest sector.

Underlying causes, not being the principal motor or the climate change, can also affect to the climate. In the case of Kosovo*, there is also underlying causes affecting to climate change in the forestry sector. The below mentioned underlying causes are directly related with the agents and drivers of deforestation and forest degradation:

a) Poverty:

- The lack of economic resources potentiates the illegal activities in the forestry sector, as they result to be highly lucrative business.

b) Unemployment:

- High rates of unemployment in Kosovo can be a motor for illegal activities in the forestry sector. The lack of a fix economic income drives to an impoverishment potentiating illegal and more profitable activities.

c) Illegal logging:

- The volume of wood tendered out by the municipalities is lower than the volume prescribed by KFA. The municipalities increase their economic benefits by confiscating and selling the wood from illegal loggers. This potentiates certain permittivity within the municipalities in terms of illegal logging.
- Some Kosovo* experts claim forest guards are suborned to not to interfere illegal practices and wood trade around the frontiers.

d) Level of Knowledge:

- The lack of knowledge and expertise in Kosovo brings to ignorance in terms of implementation of more friendly methodologies and uses in the sector.
- Social awareness is of the principal tools to increase and ensure the involvement and acceptance of the population

e) Implementation of laws:

- One of the biggest problems of the forest sector in Kosovo* is the importance of illegal activities in the sector. Although there are laws trying to fight these activities, the implementation of them has not been successful until the moment.
- Delays in court processes lead to the expiration of deadlines. As consequence of this, some processes cannot take place.

Mitigation activities are to be identified in the fields of:

Preventing illegal logging

- Silviculture (restore degraded coppice forest for bio-energy use, forest conversion to middle and high forest, timely pre-commercial thinning, improved success rate of regeneration, mixed species to improve stand stability and diversify income);
- Shift of production of fuel wood from all forest types with environmental functions to designated bioenergy forests, preferable coppice forests nearby infrastructure, on good soils (ALS high) with

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long term conversion to coppice with standards forest for joint timber production;

- Increase carbon sequestration rate in commercial forest for timber production by silvicultural treatment towards long-term wood products (HWP);
- Increase carbon storage in soils in conservation/protection forests through restoration of these forests;
- Forest protection (remove wood residues after calamities, good practice in wood harvest more effective monitoring and combating of pest and diseases, more effective monitoring and combating of wildfires);
- Promotion of Awareness Rising activities;
- Avoid deforestation.

Outside the forest sector:

- Improve fuel wood use efficiency (no fresh wood burnt);
- Improve land use efficiency remaining land for timber, reduce imports.

<u>Task 3 – Adaptation needs</u>

Adaptation needs in Agriculture Sector

Identify the adaptation needs and prepare a position paper of the Agriculture, Forestry and Biodiversity management vulnerability assessment.

Forests are largely contributing to the global greenhouse gas balance, in maintaining the

Biodiversity and in preventing of desertification. The importance of protecting forests and managing them sustainably has been acknowledged globally. It has also been acknowledged that the climate change will have an impact on forests. As these impacts will have socioeconomic and environmental consequences, it is opportune to prepare now so that forests can continue to perform all their functions under changing climate conditions.

With the support of the EU twinning project, Kosovo* is benefiting in improving forest

infrastructure, roads, national park forest management, better use of bioenergy, transfer of know-how and best practice examples Italy and in strengthening the dialogue with the private forest owners. The cooperation further strengthened the development of forest institutions as well as the development of economic performance and market orientation in the forest sector and supported the preparation of Kosovo* to respond to EU standard more efficiently.

The Kosovo* should also contribute to the sustainable forest management as this is the only path to sustainable use of natural resources and economic development.

Forest and biodiversity management

<u>Adaptation needs of High priority:</u>

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1. Strengthening forest protection policy;
2. Educating people about the benefits of forest & the harmful effects of deforestation and biodiversity loss;
3. Strictly handling cases of illegal cutting /deforestation;
4. Planting trees/reforestation;
5. Removal of fuel wood in order to decrease vulnerability to forest fires;
6. Ecological corridors to help species migrate;
7. Incorporating local biodiversity objectives into the planning, delivery and management of green infrastructure measures.

Adaptation needs of Medium priority:

1. Choosing tree species and forestry practices less vulnerable to storms and fires.
2. Creating micro-climatic variation and ecologically resilient landscapes through varied topology to help species respond to changes in temperature and increase the chance that species will be able to migrate locally into newly favourable habitat.
3. Public awareness programs on climate change
4. Training on climate change adaptation for advanced professionals in, agriculture, forestry, land use planning and biodiversity.

Task 2 – Vulnerability Assessment

Vulnerability Assessment in Water Sector

Climate change can directly affect the hydrological cycle and, through it, the quantity and quality of water resources. An increase in the surface temperature of water, and changes in the hydrological cycle could result in changing rainfall patterns over the region. Some areas may experience intense rainfall resulting in heavy floods, while other areas may witness less rainfall, and also frequent droughts (IPCC, 2013; IARU, 2009; World Water Development Report, 2009). Climatic changes can lower minimum flows in rivers, affecting water availability and quality for its flora and fauna and for drinking water intake, energy production (hydropower), thermal plant cooling and transportation via rivers, channels and lakes. As a direct result, many sectors are extremely vulnerable to the impacts of climatic changes, in particular agriculture, fishery, industry, navigation, tourism, human health, public safety, biodiversity and environmental services from ecosystems.

Pro-active integration of climate change adaptation, disaster risk reduction, and sustainable development strategies is often needed. Often, technical measures are not sufficient anymore, and public authorities, non-governmental organizations and private companies are looking for other solutions to ensure that the vulnerable water resources are managed in a sustainable manner.

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Climate change impacts in Kosovo*

Current and expected impacts presented in the National Adaptation Strategy of Kosovo* (NAS Kosovo*) include (Sources: IPCC, 2007, 2013, UN-Habitat 2009, OSCE 2008, UNDP/WMO 2009):

- Exposure to hazards such as droughts, floods, and forest fires will become greater with climate change. Climate variability has already increased in the Western Balkans;
- Rising intensity and frequency of precipitation extremes like heavy rain events, as well as more severe drought, particularly since the 1980s. Flash floods are getting more common in mountain areas, while river floods occur more often in plains and lowlands;
- Higher temperatures will make heat waves and forest fires more likely. Since 2000 there have been an increasing number of forest fires in Kosovo*;
- Kosovo* has been struck by drought several times in the last two decades (1993, 2000, 2007, and 2008);
- Increased temperatures, more uncertain rainfall, and reduced runoff combined with socio-economic developments and increased use of water resources will heighten exposure to drought;
- Since 2004, 80% of Kosovo* municipalities have suffered from water shortages due to hydrological drought and the misuse of water resources (OSCE, 2008);
- Ecosystem degradation and reduction of ecosystem services;
- Increase and new forms of pollution and water-related diseases.

Furthermore, it is important to take into account that climatic hazards have a much greater impact than should normally be the case in country such as Kosovo*, owing to a high degree of vulnerability. This is the result of a variety of factors, including (source: UN-Habitat 2009, OSCE 2008, UNDP/WMO 2009):

- Unprecedented construction boom and urbanization since 1999;
- High socio-economic vulnerability due to a high incidence of poverty (among 45% of the population) and a fragile economy, combined with limited provision in the health, social welfare and employment sectors;
- Illegal construction in hazard zones and failure to adhere to building codes;
- Lack of maintenance and destruction during wartime;
- Inadequate design of drainage and sewage systems;
- Inadequate land use and municipal planning increase population exposure to hazards;
- Unsustainable water management and agronomic practices, deforestation, and destruction of slopes by mining activities.

The following subsections provide a more detailed problem definition for different sectors especially vulnerable for climate change impacts.

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Current state of Water resources in Kosovo*

Kosovo* has relatively small and limited amounts of fresh water resources. Fresh water resource shortages are most likely to occur in near future dry years if appropriate adaptive actions are not implemented right now.

Kosovo* is surrounded by high mountains. Its area is about 10,877 square kilometres. Yearly average rainfall goes from about 600 mm in the northern plains (640 mm in Mitrovica) up to 1400 mm in mountainous areas. The majority of Kosovo* yearly rainfall ranges between 700-800 mm, with an average of 720 mm. Kosovo*'s climate is continental with Mediterranean influence, average temperature ranges between 0°C in January and February and 40°C during hot summers.

Kosovo* is a very diverse country in terms of geology and present mostly volcanic (basalts, vulcanite), metamorphic (granites) and sedimentary (fly ash) rocks. Surface soils mainly derive from limestone, serpentine rocks or alluvial deposits. Karstic zones are largely present, in particular in the north and north-east (Mokna Mountain). Few hydro-geological studies and related data are available, only the previous WMP (ref 3) includes a rather comprehensive description of Kosovar* hydro-geological main features. Surface water resources are organized in five different watersheds, as described in the following table:

Kosovo surface water resources organization in five different watersheds

Nr.	Main river	S(km^2)	Q(m^3/s)	q(l/(s*km^2))	Outlet	Flowing direction
1	Drini i Bardhë	4360	61.0	14	Albania	West to Adriatic sea
2	Lumi i Plavës	252	5.3	20.8	Albania	South west to Adriatic sea
3	Ibri	4701	32.6	6.9	Serbia	North to Danube and Black sea
4	Morava e Binçës	1018	6.1	6.0	Serbia	South east to Danube and Black sea
5	Lepenc	582	8.7	14.9	Macedonia	South to Aegean sea

All these rivers are part of large international watersheds: Danube, Vardar, Drini. The watershed of Ibri is the only one to get water from an upstream watershed located in Serbia and Montenegro.

There are four large dams in Kosovo* with height greater than 40 m:

- Gazivoda on Ibër River;
- Batllava on Batllava river (tributary Llap river => Sitnica river => Ibër river);
- Badovc on Graçanka river (tributary Sitnica river => Ibër river);
- Radoniqi on Prue river (tributary of Drini river => Drini river).

For the purpose of water resources management, the Government of Kosovo is in the process at national scale of creating, two River Basin District Units (RBDU). The first one is called the Drini i Bardhë RBDU and will encompass watershed number 1 and 2 as described in table above. Watersheds number 3, 4 and 5 will constitute the second one, named the Ibër Lepenc and Morava e Binçës RBDU. The process for establishing these two Public Bodies has started several years ago, it is still on-going.

Measured by population served, 60% of raw water supply of the water utilities is based on surface water. Rural population and smaller municipalities mainly use ground or spring water (Hart & Hines, 1992). The quality of raw water from surface water in Kosovo* is, general, moderate, because water is abstracted from artificial reservoirs. Some water sources are reported to be polluted or potentially endangered by organic contamination, due to lack of wastewater treatment, neglected maintenance of sewerage system, intensive deforestation, or agriculture. The raw water supply of the public water utilities is mainly (60%) abstracted from surface waters.

Furthermore, available water resources are unevenly distributed throughout the territory, divided into four river basins/watersheds: Drini i Bardhë, Ibër, Morava e Binçës and Lepenci. The average annual renewable water supply per person in Kosovo* is about 1’987 m3/person/year, and is classified as no stress (Falkenmark indicator), which is significantly low compared to the world average of 7’243 m3 (CEDARE AWC, 2006). Because the water availability differs from one river basin to other, there is a need to conduct research to explore the possibilities and potentials for additional water storage reservoirs within river basins. Development of environment impact assessment, feasibility studies analysing viability of water transfer options, shall precede the final establishment of appropriate infrastructure to transport water from one to the other river basin.

The western and southern parts of Kosovo*, known as Dukagjini Plain, are richer in surface and groundwater resources. The northern and eastern parts of Kosovo, known as Kosovo Plain, have less water resources available. Yet, this area has the largest concentration of population and the most hot spots sites that causes extreme water pollution.

Main user categories of fresh water resources are: Drinking Water Supply for households, Water Supply for Industry and Energy (for hydro-power and for cooling power plants) and for Irrigation purposes. Based on the Annual Performance Report of Water Service Providers in Kosovo* for the year 2012, the water industry in Kosovo* is still weak; showing deficiencies in most of performance indicators such as service coverage which is at the level of 78%. A lot of rural villages are not covered by the regional water supply schemes and some villages are still using ground water from shallow wells of deteriorated quality. Kosovo* possesses approximately 237’800 hectares of agricultural land, of which only 42’200 hectares are irrigated, or about 17.7%. Despite the figures provided above, Kosovo* is most advanced in the region in relation to utility performance. E.g. 78% coverage does not mean the rest of the population does not have access to water services. Instead they may have own systems, or use wells.

River water quality in Kosovo* is poor owing to the lack of wastewater treatment plants, disposal of wastes along / or near the river banks, poor or no maintenance of river beds. Usually the quality of rivers upstream represents a healthy aquatic habitat and meets the environmental standards. Some of the main rivers downstream of larger municipalities and industries are heavily polluted that the water cannot be used for water supply or for irrigation purposes. The main rivers in Kosovo belong to the pollution category 2 and 3, while the Sitnica River is categorised as "Dead River".

The impact of climate change may further aggravate the quality of water courses, in particular during summer months when it is expected the variation in the precipitation pattern that will be reflected in lower river stream and by the increase of temperatures, while the sources of contamination remain

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constant. Pollution of surface and groundwater resources would have serious effect on people's health, it may hamper economic growth and can impact food sufficiency and security.

An extensive study of water supply and sanitation coverage in Kosovo*, done by CDI and funded by SCO, provides a coverage rate of 66% country wise during 2012. WWRO usually reports on the service area of the licensed companies, which excludes some municipalities/ villages yet to be integrated in the Regional Water Companies. Most of rural and urban population not having the sewage network are using septic tanks or discharge, on the individual base, the waste waters to nearby rivers or creeks. Lack of sewage network and lack of adequate treatment of waste waters is increasing additionally the stress on fresh water resources. Sewerage network, in overall, is assed to be in a very poor condition. In 1999, there was around 30% sewerage coverage. This would indicate that most of the network is relatively new. Some districts in main urban centres still lack a drainage network; and where it exists, it is deteriorated and under-dimensioned, which causes floods after every rain and/or storm. Most of the urban centres, at least the bigger ones, have separate storm water systems, except on occasions some neighbourhoods may have combined systems. Even in this case, plans are to separate them. Except the municipality of Skenderaj that has wastewater treatment plant, other urban centres and rural villages in Kosovo* do not have yet wastewater treatment. As of 2013, works have started for Prizren WWTP. Also feasibility studies have been completed for Prishtina, Peja, Gjakova and Gjilan. For the last two works are anticipated to commence next year. A feasibility study for Ferizaj is in its completion stage too. As of the end of 2013, most urban wastewater is discharged directly to the rivers without pre-treatment. In addition to the pollution of water resources from the discharge of residential wastewaters, discharges of industrial wastewaters contribute to the pollution of water resources in Kosovo. In particular pollution with heavy metals and other toxins is of major concern. The anticipated water policy paper and the water law also obligate mandatory industrial wastewater treatment.

Pressure on the already limited natural water resources is being enhanced by human activities, which are contributing to the depletion and deterioration of resources through increases in water demand in all sectors and pollution along the water courses.

The expected temperature increase and decrease in rainfall patterns will be directly reflected in river flow regimes, in the groundwater levels and amount of recharge to groundwater, as well as the evaporation of water from the soil. Furthermore, climate change will increase vulnerability to extreme flooding and drought events with unpredictable socio-economic impacts on human well-being and environmental conditions.

Precipitation and run-off

The western part of Kosovo* belongs to the Drini i Bardhë river basin. Drini i Bardhë discharges its water to Albania and finally to the Adriatic Sea. The area consist of several small stream from the mountains, water flows into tributaries and Drini i Bardhë River. The mean runoff in the area is 141 l/s/km2 but it varies considerably (5 to 50 l/s/km2) (Anonim 2003).

Precipitation varies from 600 to 1400 mm/a. The dry season is in July-August and the wet season in November-December.

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The eastern part of Kosovo* belongs to the Ibri and the Morava e Binçit river basin, which are upstream areas of one tributary of the Danub. Annual precipitation is mainly less than 700mm, but in some areas it is 900mm. The specific run-off (average 7 l/s/km2) in the area is much smaller than in the western part of the country, from 2 -10 l/s/km2. In southern Kosovo* the Lepenci river basin with an area of about 800 km2 belongs to Axios river basin discharging into Aegean Sea. The annual rainfall is 670-1,000 mm and specific run-off 8-10 l/s/km^2 (average 10 l/s/km^2). There are also steep mountains in this area.

Strategic Objectives in the Water Sector

The most important Strategic Objectives of water sector in Kosova* are:

- Efficient Exploitation of Water;
- Effective Protection of Water;
- Effective Protection from Water;
- Efficient, Effective and Equitable Governance;

Exploitation of Water

The term "exploitation of water" (is used here to cover the wide cross-sector aspects of human interaction with the aquatic environment and includes:

- Use of Water (Art 1.25 of Water Law)
- Extraction (Art 1.21 of the Water Law)
- *Retention (Art 1.35 of the Water Law)*
- Water Utilization (Art 1.38 of the Water Law)
- *Other activities made in support of these actions, such as hydro-morphological alteration of water bodies.*

In essence, the exploitation of water in this context includes any activity that requires a water permit.

Through the Water Strategy the Republic of Kosovo* will seek to exploit to the optimal extent the water resources available to it whilst respecting the international agreements to which it is signatory.

Key elements in the achievement of this objective for the exploitation of water include:

- Secure fundamental rights:
    - Access to health safe drinking water for all;
    - Access to adequate sanitation for all.
- Maximize the economic benefit for the Republic of Kosovo* from the exploitation of water resources without jeopardizing the fundamental rights
    - Agricultural production;
    - Industrial Production;

  - Energy Generation;
  - Fisheries;
  - Tourism, Recreation and Thermo-mineral Spas.
- Sustainability
  - Environmental Objectives.
- Environmental needs (such as minimum ecological flow as defined in Article 1.29 of the Water Law)
- Ecological quality: hydro-morphology
  - Resilient to climate variation including projected changes.

In exploiting water resources for the benefit of the inhabitants of the Republic of Kosovo the Strategy priorities the efficient use of both water resources and financial means.

Protection of Water

The "protection of water" is used here in the sense of water quality rather than water resources (which is addressed above under "Use of Water"). As such the protection of water is concerned with:

- All waters:
  - Surface Waters (Article 4 - 1.45 of the Water Law)
  - Underground Waters (Article 4 - 1.44 of the Water Law)
- Pollution (Article 4 - 1.19 of the Water Law) through:
  - Point source pollution: Discharge (Article 4 - 1.39 of the Water Law)
  - Diffuse pollution: (not defined in the Water Law)
- Achievement of environmental objectives, and in particular good status of water bodies:
  - Good chemical status
- Good surface water chemical status (Article 4 - 1.10 of the Water Law)
- Good groundwater chemical status (Article 4 - 1.11 of the Water Law
  - Good biological status (not defined in the Water Law)
  - Good hydro-morphological status (not defined in the Water Law)

The protection of water entails:

- economically balanced: sets environmental objectives for specific water bodies in an economically efficient and proportionate manner
- Compliance with European standards (environmental objectives and the associated derogation provisions as set out in Article 4 of the Water Framework Directive)
- Cost effectiveness: the measures employed to protect water utilize methods and means that

represent the most cost-effective combination of measures to achieve the desired level of protection

- Equity – polluter/user pays: the financial and economic burden of implementing protection measures should fall upon the entity responsible for the pressure

Protection from Water

This objective relates to:

- *Harmful water impact (Article 4 - 1.6 of the Water Law);*
- *Protection from harmful water actions (Article 4 - 1.16 of the Water Law);*
- The objective entails:
- Provision of protection from floods to an acceptable standard including:
    - Flood warning;
    - Flood prevention;
    - Flood mitigation;
    - Emergency relief;
- Need for coordination with land use plans including:
    - Spatial Planning;
    - Agricultural Planning;
- Economic efficiency – achieving benefits from protection that are far greater than the costs;
- Cost effective – using the most effective means of achieving the desired level of protection.

Adaptation Needs in the Water Sector

Recommendations

As a result of issues related to its status, Kosovo* is still not recognized by United Nation Institutions. Consequently, it is not eligible to be party to international conventions and also to participate in negotiations as an observer. However, compliance with international laws, including Multi-National Environment Agreements remains extremely important for the future of Kosovo* in its domestic strategy as well as for its international relations.

Hence, it is widely acknowledged by responsible authorities that Kosovo* needs to be planning to adapt to the challenges and opportunities that a changing climate will bring. Institutions responsible for water, agriculture, forestry, navigation, industry, public health, land use planning, and environment related issues are under pressure to respond to the unprecedented impacts of climate change such as larger floods, more severe droughts, ecosystem degradation and reduction of ecosystem services, water supply shortages, increase and new forms of pollution and water related diseases.

Based on above considerations, freshwater vulnerability assessment to identify potential risks, providing decision makers with an early warning signal about the need to monitor potential variation over time is crucial. This is highly important in order to detect the occurrence of threats as early as possible, for being able to properly design and implement appropriate measures to reduce negative impacts. Moreover, the assessment enhances public awareness about the threat that the entire society may face.

- To adequately respond to the challenges of climate change, Kosovo* shall urgently develop new policy papers and/ or amend existing policy framework to mainstream the climate change mitigation and adaptations measures within the legal framework and within the overall national development strategy. Development of new policy papers and/ or amendment of existing policy framework shall be based on a comprehensive scientific research to evaluate potential climate change impacts on water resource in all four river basins in Kosovo*. The following issues are recommended to be mainstreamed with the water strategy and river basin management plans, under the legal framework for water resources management: Policy papers and regulation on wastewater treatment, water reclamation and reuse, including incentive packages for water reclamation and reuse;
- Policy papers on groundwater management, replenishment of groundwater aquifers, mandatory groundwater withdrawal restrictions and groundwater monitoring;
- Program for risk management, including flood protection and identification of the flood prone areas;
- Program for management for droughts, water allocation/ portioning and prioritizing the customer categories under the drought situations;
- Policy paper for stimulating rainwater harvesting. Incentive programmes for rainwater harvesting.

Alternatives considered: Priority listing of adaptation measures for NAS Kosovo*

Below list presents a possible adaptation measures with high or medium priority. Potential adaptation measures with low priority have not been included. Hence, the list provides a first and important step in the selection of possible adaptation measures for the NAS Kosovo*.

Additionally, it highlights municipalities where scores for implementation and/or planning are significant higher than in other municipalities, in order to identify best practices and/or lessons learned.

The priority list is based on the results of 15 questionnaires at the local level[13] and voting rounds by 12 members of the Inter ministerial Working Group (IMWG) at the national level[14]. Hence, below list represents priorities for the national as well as the local level, although the current state of implementation and/or planning is only specified for the local level.

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[13] The local questionnaire survey took place from 6th of June 2013 until 10th of July 2013

[14] The voting took place during the Second Roundtable Meeting on 27th of June 2013 in Prishtina by the Inter-Ministerial Working Group for developing the NAS

Below priorities are presented in high-low ranking, related to necessity as indicated by the stakeholders at national and local level.

Flood protection

High priority (>4):

1. Restriction of settlement/building development in risk-prone areas > see Municipality of Podujevo, Shtime, Istog, Klina, Kacanik Peje and Gjakove;
2. Deepening of summer bed > see planning and implementation in Municipalities of Podujevo and Rahovec;
3. Upgrade and/or raise dykes to prevent flooding > see advanced planning in Municipality of Podujevo, and some implementation and planning in Municipalities of Istog and Mamusha;
4. Adjustment or removal of hydraulic obstacles in river bed (e.g. buildings, trees, infrastructure, trash, etc) > see implementation in Municipalities of Obiliq and Kacanik;
5. Construction of retention areas (also called inundation areas to reduce flood run-off) > see full implementation in Municipality of Klina, advanced planning in Municipality of Rahovec, and some degree of planning and implementation in municipality of Istog;
6. Upgrade drainage systems > see some degree of implementation and planning in Municipality of Istog and full implementation in Municipality of Klina
7. Standards for building development (e.g. permeable surfaces, greening roofs etc.) > see Rahovec;
8. Floodplain restoration (which involves lowering/deepening of floodplain) > see Municipality of Podujevo and Istog;
9. Reforestation areas to reduce flood run-off > see implementation in Mun. of Obiliq and Kacanik.

Medium priority (<4):

1. Replacement of dykes to enlarge river bed capacity > see implementation in Municipality of Rahovec;
2. Change of land use (for enabling natural retention of flood water) > see implementation in Rahovec and planning in Kacanik;
3. Enlarge reservoirs to increase buffer capacity > see advanced planning in Municipalities of Rahovec and Kacanik;
4. River bypasses (also used as 'green rivers' when there is no peak discharge) > see advanced planning in Municipality of Rahovec.

Drought / low flow / water scarcity

High priority (>4):

1. Landscape planning measures to improve water balance (e.g. change of land use, reforestation, reduced sealing of areas) > see implementation and medium advanced planning in Municipality of Obiliq, Municipality of Klina, and planning in Municipality of Podujevo;
2. Leakage reduction > see implementation in Municipality of Rahovec and Klina, advanced planning

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in Municipality of Shtime, Rahovec and Klina, while medium advanced planning in Municipality of Istog and Podujevo;

3. Water recycling and re-use, e.g. use of grey water, treated sewage and industrial water > see implementation in Municipality of Rahovec and advanced planning in Municipality of Shtime and medium planning in Municipality of Podujevo;
4. Point-of-use conservation in households and industry > see implementation in Municipality of Rahovec and advanced planning in Municipality of Shtime and initial planning in Municipality of Podujevo;
5. Water transfers (for more explanation see annex 3)> see initial implementation in Municipality of Istog and medium advanced planning in Municipality of Podujevo;
6. Securing minimum flows in dry periods > see medium advanced implementation in Municipality of Istog, advanced planning in Municipality of Kacanik and medium advanced planning in Municipality of Podujevo and Istog;
7. Crop adaptation: High resilient crop seeds & Crop choice (crops with more efficient water use) > see for implementation and further planning in Municipality of Klina, medium advanced implementation in Municipality of Istog and medium advanced planning in Municipality of Podujevo and Istog;
8. Water saving technologies in irrigation > see for medium advanced planning and implementation in Municipality of Istog;
9. Rainwater harvesting > no implementation or planning in any of municipalities;
10. Sustainable groundwater management (including recharge measures) > see implementation and further planning in Municipality of Obiliq and advanced planning in Municipality of Kacanik;
11. Increase Reservoir volumes > see implementation and medium advanced advanced planning in Municipality of Obiliq and Rahovec, implementation in Municipality of Klina and advanced planning in Municipality of Kacanik and medium advanced planning in Municipality of Podujevo;
12. Restriction of water uses > see implementation and advanced planning in Municipality of Obiliq and Kacanik.

Medium priority (<4):

1. Crop rotation (for soil recovery) > see implementation and medium advanced planning in Municipality of Klina and Municipality of Obiliq, medium advanced implementation in Municipality of Istog, advanced planning in Municipality of Obiliq and Mamusha and medium advanced planning in Municipality of Podujevo.

Recommended Course of Action

The NAS for Kosovo* envisages effectively anticipating on and responding to, the impacts of climate change, taking into account internationally endorsed principles for sustainable development. Adaptation to climate change is crucial for reducing the risk and damage from current and future impacts of climate change in a cost-effective manner and to exploit potential benefits stemming from climate change. The NAS intends to disseminate and upscale lessons learned, good practices, experiences and advocacy to influence policy and decision making processes at local, national and regional levels.

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Groundwater needs to be adequately factored into IWRM planning

Where Integrated Water Resources Management (IWRM) planning has been adopted, whether at the level of national master plans or at the local river basin level, specific dedicated human and financial resources should be devoted to groundwater. Some activities, of course, are common between groundwater and surface water, so creation of entrenched "empires" needs to be avoided. Cross-fertilization is also useful. For example, groundwater management can benefit from the experiences in surface water with regard to participatory approaches and collective choice arrangements, which are often more developed for surface water management. Nonetheless, groundwater requires specialized capacity in term of knowledge and resource monitoring and additional efforts for information and communication compared to surface water. Before anything, Kosovo* needs to develop a groundwater monitoring network, since there is no baseline data on groundwater availability, amount and quality. The only information available is a hydrogeological map.

Montenegro

Task 2 – Vulnerability Assessment

Vulnerability Assessment in Water Sector

Analysis of past weather events[15]

In accordance with Adaptation support tool[16], it was analysed how past weather events have affected territory of Montenegro.

Current situation - Observed extreme events (*Source: The observations of IHMS*[17]):

- more frequent extremely high maximum and minimum temperatures;
- more frequent and longer heat waves;
- a larger number of very hot days and nights;
- a smaller number of days with frost and very cold days and nights
- more frequent droughts;
- higher number of forest fires;
- interruption of the dry periods followed by strong precipitation;

[15] http://climate-adapt.eea.europa.eu/adaptation-support-tool/step-2/past-weather-events

[16] http://climate-adapt.eea.europa.eu/adaptation-support-tool

[17] A series of measurements since 1949, and at individual stations and from 1958 until now

- more frequent storms (cyclones) during the colder half of the year;
- decrease in the number of consecutive rainy days
- decrease in the number of days with heavy precipitation;
- increase in the precipitation intensity
- decrease in the overall annual amount of snow.

Four representative Montenegrin municipalities (Zabljak, Pljevlja, Podgorica and Bar) were selected on the basis of belonging to a particular type of climate, taking into account data availability and quality.

Table 1. Mean annual air temperature for 4 municipalities- representatives of climate types

	Climatological normal	Decade						
Regions	**'61-'90[2]**	**'51-'60**	**'61-'70**	**'71-'80**	**'81-'90**	**'91-'00**	**'01-'10**	**Δ**
Municipality of Zabljak	4,6	5,1	4,7	4,5	4,7	5,4	6,0	+1,4
Municipality of Pljevlja	8,1	8,6	8,1	7,9	8,2	8,8	9,1	+1,0
Municipality of Podgorica	15,3	15,5	15,4	15,0	15,4	15,8	16,3	+1,0
Municipality Bar	15,5	15,7	15,7	15,3	15,6	15,9	16,8	+1,3

(Δ- deviation of the Decade (2001-2010) annual temperature of climatological normal)

As for the precipitation, (as described in the INC):

- no significant reduction in total annual precipitation;
- in the normal range of rainfall increases in the fall, and decreases in the spring, summer and winter;
- In statistical terms, there is a significant increase in rainfall in September in the Zeta-Bjelopavlicki region.

Overall, these changes indicate a change in precipitation regime that takes extreme character.

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Table 2. Decadal annual precipitation (mm)

	Climatological normal	Decade						
Regions	**'61-'90**	**'51-'60**	**'61-'70**	**'71-'80**	**'81-'90**	**'91-'00**	**'01-'10**	**Δ**
Municipality of Zabljak	1.455,4	-	1.514,2	1.564,4	1.287,5	1.370,1	1.610,6	+155,2
Municipality of Pljevlja	796,5	735,7	783,8	865,4	740,4	733	839,86	+43,4
Municipality of Podgorica	1.657,9	1.632,1	1.756,7	1.695,2	1.521,7	1.593,7	1.781,6	+123,7
Municipality Bar	1.390,9	1.414,1	1.473,2	1.480,5	1.218,9	1.241,9	1.463,9	+73

(Δ - Deviation of the Decade (2001-2010) annual precipitation of climatological normal)

Climate was analysed decade by decade. The summary of the observed extreme events in the last 15 years in Montenegro and in parallel with that the projections according to the EBU-POM regional model. One thing that can immediately be noticed is that there is a good match between the trends of the observed and of the projected climate change.

Table 3. Decadal Records largest maximum air temperature in the period 1951-2010

		Decade				
Regions	**'51-'60**	**'61-'70**	**'71-'80**	**'81-'90**	**'91-'00**	**'01-'10**
Municipality of Zabljak		30,4	28,2	30,6	31,3	32,4
Municipality of Pljevlja	38,0	35,0	33,2	36,2	38,2	38,1
Municipality of Podgorica	41,2	40,6	39,2	41,4	41,6	44,8
Municipality Bar	35,4	35,9	36,8	37,7	37,0	36,6

Table 4. Decadal records the smallest minimum air temperature in the period 1951-2010

		Decade				
Regions	**'51-'60**	**'61-'70**	**'71-'80**	**'81-'90**	**'91-'00**	**'01-'10**
Municipality of Zabljak		-26,4	-22,7	-26,4	-25,7	-24,6
Municipality of Pljevlja	-29,4	-29,0	-27,0	-29,2	-26,7	-23,5
Municipality of Podgorica	-9,7	-9,2	-8,5	-9,6	-8,4	-6,7
Municipality Bar	-7,0	-7,2	-4,9	-4,4	-5,3	-4,3

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Table 5. Decadal records largest maximum daily rainfall during the period 1951-2010

		Decade				
Regions	**'51-'60**	**'61-'70**	**'71-'80**	**'81-'90**	**'91-'00**	**'01-'10**
Municipality of Zabljak		207,4	146,5	122,6	144,2	141,3
Municipality of Pljevlja	55,5	79,4	90,2	123,5	77,9	81,1
Municipality of Podgorica	128,4	128,2	133,7	226,8	108,4	145,9
Municipality Bar	180,8	135,4	157,1	224,0	124,2	200,7

Droughts

Before the 2012 IPA project Drought Management Centre for South East Europe, DMCC co-financed by the European Commission, Montenegro had not had any established permanent drought monitoring. This project brought to:

- homogenization of data on precipitation;
- development of an archive on drought impact since 2000;
- establishment of the permanent drought monitoring through SPI index;
- testing of the application of WINISAREG model for irrigation planning;
- testing of the application of the remote drought monitoring (i.e. satellite model),
- Assessed vulnerability of Montenegro to drought.

Table 6. Typical dry year in Montenegro arranged by decades

Decade	'51-'60	'61-'70	'71-'80	'81-'90	'91-'00	'01-'10
Dry year	1953	1962, 1967, 1969	1978	1981, 1982, 1985, 1988, 1989	1993, 1994, 1996, 1999	2003, 2007, 2008, 2011

The results show that the decade of the '81 -'90 drought more frequent. The following figure was done by analysis of the SPI index for three typical dry year in Montenegro:

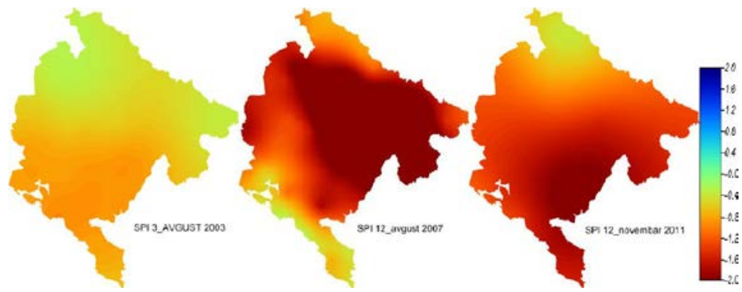

Figure 1. Map intensity of droughts in 2003, 2007 and 2011 expressed through anomalies SPI index: SPI3 - agricultural drought of 2003, SPI12 - hydrological drought in 2007 and 2011

Heat wave

Monitoring and evaluation of climate in Montenegro shows that the heat waves are increasingly frequent and that their length shows a high year-to-year variability. From a long-term perspective, there is a trend of continuous increase in the heat waves length.

Heavy rains

Heavy rains that lead to floods most frequently affect the area of Tara and Lim in the season of colder weather (October-March). A research within the CAMP project used the observed data and the data on the damage caused by storms, to show that the storms (strongly developed cyclones) have become more frequent and more intensive since 1998, bringing with them huge amounts of precipitation, storm to hurricane wind blows, high waves and flooding of the broad area along the coast. Series of cyclones and local instabilities were registered in the 2001-2010 decade. They came together with strong rains, floods, snow precipitation and storm winds

Table 7. Average rainfall intensity on days with heavy rainfall

	Climatological normals	**Decade**					
Regions	**'61-'90**	**'51-'60**	**'61-'70**	**'71-'80**	**'81-'90**	**'91-'00**	**'01-'10**
Municipality of Zabljak	37,4		39,3	36,5	37,3	38,2	38,9
Municipality of Pljevlja	29,2	27,1	29,9	29,4	30,9	29,1	30,7
Municipality of Podgorica	39,8	34,6	38,1	39,7	41,6	40,1	50,0
Municipality Bar	38,8	36,7	38,6	39,3	38	37,1	63,3

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The results show that:

- the intensity of heavy precipitation shows a decadal variability except in the northern mountainous region above 1,000 mnm, where it has been on the increase for the last two decades;
- the strongest precipitation were recorded in the 2001-2010 decade in the coast and in the Zeta-Bjelopavlići region, and then in the northern mountainous region up to 1,000 mnm, where the intensity was almost the same in the 1981-1990 decade;
- long term changes in relation to the climate normals are positive and they are in line with the expected qualitative changes of the EBU-POM model.

Water Resources

Annual river flow can be used as an indicator of climate change since it represents a response of the overall river basin to the meteorological factors like precipitation or temperature.

Annual flow is an indicator of availability of fresh water in the river basins, and it is also the first assessment of whether the river flow is low or high. If the annual flow grows, the risk of floods also grows. Low annual flow could lead to the series of dependant events that have a negative impact on e.g. the possibility of river navigation.

The most important political framework in Europe for the river flow is the Framework Water Directive. According to this Directive every EU member state has to establish a programme for monitoring the water flows and volumes of water in their key basins. With these data, the observed river flow could be brought into connection with the climate data, and projections of future trends caused by the climate change could be provided.

Hydrology - Trend analysis

Using the analysis of hydrological records, like river watercourses, water levels etc. hydrologists can assess future hydrological phenomena. This means that the characteristics of the process remain unchanged. Observations of hydrological processes are primarily used for predicting future trends and amounts of water.

These hydrological analyses have been done for the Skadar Lake that is the most important hydrological entity in Montenegro. The analysis used the data for the period 1948- 2012.

The hydrological analysis for the Skadar Lake, as the most important hydrological entity in Montenegro is presented here to ensure a better overview of the current state of play and a better insight into the hydrological regime in the last 60 years. Assessments and analyses of the impact of the envisaged climate change on water resources will require continuous and high quality hydrological observations and measuring in the future.

Trend of the mean annual water levels in the hydrological station (HS) Plavnica on the Skadar Lake for the analysed period is negative.

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The five-year moving averages vary in the range of 0932 m. The lowest average was reported in the period 1989–1993 and it amounted to 5.971 mnm, while the highest average was registered in the period 1968–1972, when it amounted to 6.903 mnm (Graph 4.19 Five-year moving averages)

The maximum and minimum annual elevation lakes in the HS Plavnica show a slight negative trend.

Analysis of the trends of the medium, maximum and minimum levels of the Skadar Lake has shown that in the entire period that was observed there was a negative trend for all three analysed sets of characteristic waters. It was not very explicit, so we can say that there are no significant deviations from the usual periodic exchanges of the dry and wet periods. The maximum that was recorded in 2010 was a consequence of a combination of several factors happening at the same time - from the extreme rain series to the inadequate management of the Drim accumulations.

Analysis of water balance

Analysis of the water balance in all river basins shows the reduction in the amount of precipitation on average by 4% in the period 2001-2030 and the reduction in the amount of precipitation on average by 14% in the period 2071-2100 in comparison to the period 1961-1990. It can be expected that the average increase of evapotranspiration in the near future will be around 8.5% and that it will reach 25% by the end of the 21st century, compared to the baseline period.

On the basis of both climate scenarios, by the end of 21st century we can expect the reduction in the average annual value of flow by 27% in comparison to the period 1961-1990 At 4:22 and 4:23 graphs shows the values obtained for the sub-basin Plav of river Lim.

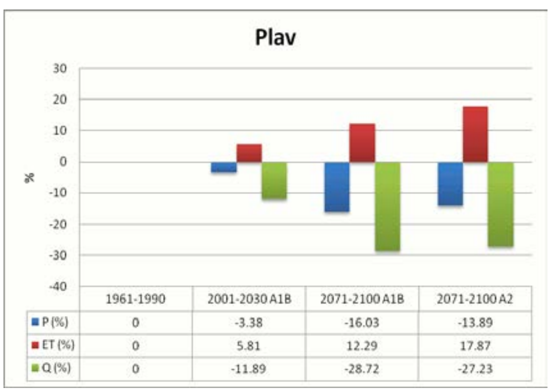

Figure2. Expected changes in the components of the water balance for sub-basin Plav in relation to the value of the reference period (P-precipitation, evapotranspiration ET, Q-flow)

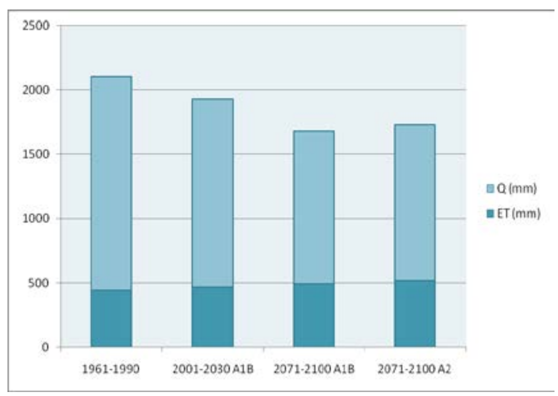

Figure 3. Central perennial water balances for reference and future periods for sub-basin Plav (P-precipitation, evapotranspiration ET, Q-flow)

Analysis of medium water flows

In the period (1961-1990), in winters, significant amounts of accumulated snowfalls were recorded. Due to the projected increase in temperatures in the future period more precipitation in form of rain will be recorded in winter months as well as smaller accumulation of snow. Thus, it is expected that in the period from January to March the mean monthly flows of Tara and Lim will rise in comparison to the baseline period. In the period from April to August, i.e. to November for the Tara river, we expect to see a reduction in the mean monthly value of the flow which will be a direct consequence of the small accumulation of water in the snow during winter. The example of the percentage change of the mean monthly flows for the periods 2001-2031 and 2071-2100 according to both climate scenarios in comparison to the period 1961-1990, for the sub-basin of Trebaljevo Polje, , is shown in Figure 4.

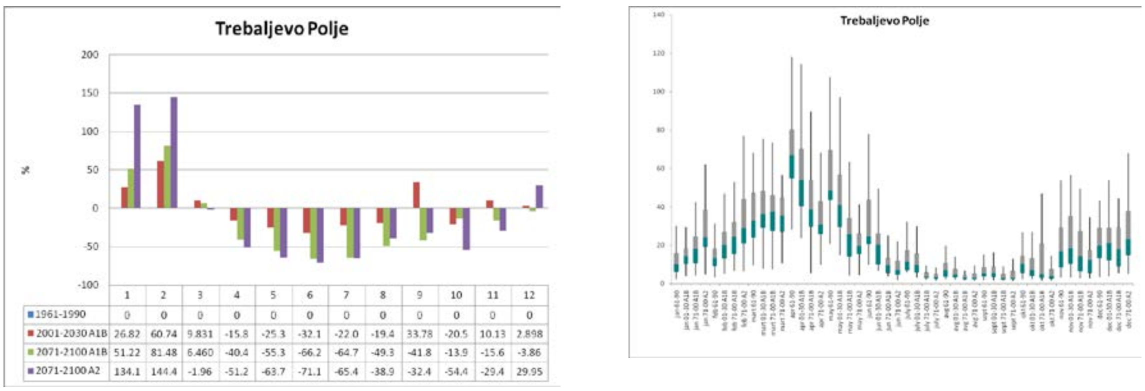

Figure 4 Percentage changes of monthly flow values for the period (2001-2031) and (2071-2100) compared to the reference period (1961-1990) for sub-basin Trebaljevo Polje, the river Tara

Analysis of large waterflows

Series of the maximum annual flows for the periods 1961-1990, 2001-2031 and 2071-2100 for both basins and both climate scenarios were used for calculating the maximum annual flows of various return periods

In the Plav profile we expect to see a reduction of the values of the maximum annual flows of all return periods by 2% in the period 2001-2031 and by about 12% by the end of the 21st century, while in the profile of Bijelo Polje we can expect that the near future will bring to 5% higher values of flow of all observed return periods. In the future, the values of flow in this profile will be larger or at least equal to the flows of the return periods of 25, 50 and 100 years from the baseline period.

For all flows in the near future in the profile Crna Poljana we can notice the trend of increase in the values (12-15) %, while the value of the flow at the end of 21st century will be equal or higher than the flows from the period 1961-1990. In the profile Trebaljevo Polje we can notice a slight increase in the values of flow from all return periods

Analysis of small waterflows

In the basin of the river Lim in the period 2001-2031 we do not expect to see any significant increase in the total number of hydrological droughts in comparison to the period (1961-1990), but there is a noticeable explicit migration of the dry periods from the winter to the summer period. This is a consequence of transformation of the recent snow into rain precipitation and of the reduction in accumulation of snow which was the cause of hydrological droughts in the baseline period. We can note a slight increase in the number of droughts that last for more than 30 days. By the end of 21st century a significant increase (in comparison to the baseline period) in the number of droughts of various length will be recorded in the basin of the river Tara, sub-basin Crna Poljana.

Projected changes in the temperature field and the regime of precipitation will inevitably impact the change of the water balance in both river basins. Reduction in the amount of precipitation in comparison to the period 1961-1990 will cause a significant decrease of the average annual value of the flow by the end of 21st century in comparison to the flows in the baseline period. Due to the envisaged increase in temperatures by 2100 in both climate scenarios, the precipitation that had a character of snow in winter months will become rain and will bring to the increase in the mean monthly flows in that period, while the reduced accumulation of snow will bring to the decrease in the values of the mean monthly flows in spring months

The analysis of the maximum annual flows has not produced any uniform change scheme, but a different one for each of the hydrological stations. The overall number of hydrological droughts will not increase in the period before 2100 in the basin of the river Lim, but it will increase in the upper stream of the basin of the Tara river. The change in the regime of precipitation in winter period will lead to the re-distribution of the number of summer and winter droughts in the total number of the small water periods. It is expected that the number of winter droughts will decrease, while the number of summer droughts will increase. The slight increase in the number of droughts of over 30 days in length is also expected.

Climate change risks and vulnerability assessment[18]

Related to the trend of vulnerability to natural hazard[19], it is important to highlight demographic changes, socio-economic conditions, unplanned urbanization, construction in high-risk zones, which endanger the natural environment and climate change in Montenegro, making the area very vulnerable to natural disasters, particularly its southern part, which was recognized in the Strategy of regional development of Montenegro 2010 – 2014.

About 40% of Montenegro (around 5.524,8 km2) is in the zone of significant seismic intensity higher than 8 degrees of the Richter scale. This affects about 60% of the Montenegrin population (over 372.000according to the 2003 census). On April 15, 1979 Montenegro was affected by a disastrous earthquake which destroyed the coast and the wider area of the Skadar Lake, creating a damage of about 4 billion dollars, affecting more than 100.000 people, and killing 136 persons.

During 2010 alone, there were 435 earthquakes, 70% of which happened in December, 193 earthquakes were in the north-western part, in the wider accumulation zone of the hydro power plant Piva. After the long lasting rain period, the accumulation was at its maximum for a longer time period. Large hydrostatic pressure stimulated the release of seismic energy (smaller tectonic activities and consequent earthquakes). Even though so far the connection between precipitation and seismicity has not been

[18] http://climate-adapt.eea.europa.eu/adaptation-support-tool/step-2/risk-vulnerability-assessment

[19] Information about natural disasters is available in EM-DAT (The OFDA/CRED International Disaster Database)

proven yet, there is a consensus with the hypothesis that atmospheric precipitation is also an earthquake stimulator. Local seismicity is activated by water being pumped into the ground at greater depths.

There is a high probability that future earthquakes will start large landslides.

The vulnerability of groundwater to climate change

Most of the settlements in Montenegro use of karst spring waters that are very vulnerable to climate change. Such is the case with Vidrovanska vrela, including the water system Niksic, Uganjska vrela involved in the plumbing system of Cetinje; karst springs Breznice involved in the plumbing system of Pljevlja as well as a number of sources in the coastal karst (Rezevica Rivers, Risan caves, Škurda).

The growing climate change, which in the last decade manifested through increased air temperature, prolonging the dry season, uneven rainfall, rainfall intensity, intermittent record several days of stormy rainfall during the dry season, the reduction of annual snowfall, leading to disorders aquifer flows, turbidity sources, formation of torrential flows, floods, landslides and rockslides.

At low coastal karst aquifers periods of prolonged drought lead to the disturbance of equilibrium boundary zones between salt and fresh water sources and salinization. Such is the case with karst springs Škurda involved in the plumbing system of Kotor, Spilje involved in the plumbing system Risan and Plavda involved in water supply system of Tivat.

To a certain extent, vulnerable to climate change are dense aquifers that are hydraulically connected to surface flows Zeta, Moraca, Cijevna, Lim and Tara, and partly to recharge and from karst aquifers.

In the richest dense aquifers in Montenegro Zeta plain, an area of about 200 km2, at which underground water flow is assessed at about 15 m3 / s, the amplitude of fluctuations in aquifer water during the year is mainly within the limits (3-5) m.

Scenarios of climate extremes

The two widely spread methods are the statistical method and the dynamic method. The dynamic downscaling requires the introduction of the Regional Climate Model - RCM of high resolution that uses the results of the global model as the side marginal conditions, producing through its own integration the results with the breakdown on the level of 10 km of the selected area.

On the basis of monitoring and evaluation of climate in Montenegro and the analysis of the extremes, 5 climate indices for air temperature and 3 for precipitation have been selected from the set of climate indices. These are: the number of frost days, the date of the last day with frost (in the first half of the year) and the date of the first day with frost (in the second half of the year), the number of very warm days, the length of the heat waves and the length of the vegetation period, the number of consecutive days without rain, the number of consecutive days with rain and the number of days with heavy precipitation (more than 20 mm).

These indices have been analysed in the conditions of normal climate (considered to be the climate of 1961-1990) and in the conditions of projected climate, which would happen in the scenarios A1B and A2 in the periods 2001–2030 and 2071–2100. The regional climate model EBU-POM was used for such calculations.

In addition to these 8 indices, we also analysed the change in the overall annual amount of snow and the change in the mean daily maximum wind speed. These changes have been calculated from the direct outputs of the EBU-POM model and they are expressed in percentages in relation to the baseline period 1961–1990.

The results of the climate model

- **Days with frost** (index number of frosty days-FD): Projections EBU-POM model indicate a decrease in the number of frosty days in the future.
- **Duration frost pe**riod: Length frost period will be shorter and shorter, depending on the analysed scenarios and time period. This means that the last frost (frost Spring Time) increasingly move to the beginning of the year, and the first frost (autumn frost) towards the end of the year. Therefore, it could be expected longer periods of frost in the future.
- **Warm days** (index of the number of hot days-TX90p) will significantly increase during the year and up to several times by the end of the twenty-first century.
- **Heat waves (heat waves Index-WSDI**) will appear more often and last longer in all areas of Montenegro, and especially on the coast.
- **The duration of the growing season** (index vegetation length-GSL) is longer for both scenarios during the 21st century where the major changes in the beginning of the occurrence of the vegetation period of change in its completion.
- **Drought periods** (Index consecutive days without rain-CDD) are longer in both scenarios considered, especially in northern areas.
- **Rainy period** (index number of consecutive days with rain exceeds 1 mm day-CWD) for both scenarios and time periods, decreases, which is in line with all the long dry periods, and supports the thesis about possible arid climatic conditions in the future.
- **Days of heavy rains** (index number of days with precipitation greater than 20 mm RR20mm) are reduced or only in a few cases, very little increase.
- **Changes in the total annual snowfall** are negative for both scenarios and both time periods. This decrease in the annual snowfall is greater than the decrease in total rainfall, which was expected due to the fact that due to the increase in air temperature snowfall excreted in the form of rain.
- **Changes in mean daily maximum wind speed:** Average daily wind speed according to EBU-POM projections decreases during the year by about 5% over the period (1961-1990) and it more or less uniformly for both scenarios and time periods in all areas of Montenegro.

Floods are among the most common natural disasters and they cause the heaviest damages. They have direct and indirect effects. Direct effects are human losses and damages to households, while indirect losses include the increased exposure to other hazards like, for example, polluted water stocks, landslides and chaos in transport and trade.

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Given the geo-morphological characteristics of the territory of Montenegro, the floods can jeopardize settlements, agricultural, forest and other land and transport routes in the river plains and pits. We should particularly have in mind that in their upper stream, and in some cases in their overall stream, all the rivers in Montenegro are currents. This means that there are large differences in flow of higher and lower waters and regular current waves with significant concentration of sediments.

In this respect there are 2 problems that are particularly prominent and that make Montenegro highly vulnerable to floods:

- a large number of towns and settlements are located on the large river banks which makes them potentially more vulnerable to the overflow of water from the watercourses;
- there is the problem of the Skadar Lake and the Bojana river, as well as of the Cetinje and Nikšić plains where large agricultural surfaces, material goods and the urban zone of the municipality of Cetinje can be jeopardized.

Table 9. Summary of projected changes in extreme events compared to the period from 1951 to 2010 [8]

Index / variable	Expected qualitative change	Quantitative changes			
		units of changes	A1B 2001-2030	A1B 2071-2100	A2 2071-2100
The number of frosty days	The decrease in all locations	days / year	-1 to -16	-5 to -43	-6 to -61
Last Spring starting frost	Moving to the beginning of the year	days / year	-0.6 to -13	-13 to -30	-19 to -36
The first autumn frost	Moving towards the end of the year	days / year	0 to 9	5 to 22	8.9 to 28
Number of very hot days	Significant increase during the year and up to several times by the end of the twenty-first century	days / year	33 to 48	110 to 182	144 to 239
The average length of heat waves	The extension at all locations	days / year	0.5 to 2	2 to 9	4 to 15
The frequency of heat waves	Significant increase in all locations	days / year	2 to 3.8	7 to 10	9 to 10
Length of growing season	prolongation	days / year	0 to 16	3 to 56	3 to 70

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Number of consecutive days without rain	increase	days / year	1 to 5	3 to 6	5 to 7
Number of consecutive days with rain	reduction	days / year	0.5 to -0.7	-0.2 to -2	-0.1 do -2.4
Number of days with precipitation over 20mm	reduction	days / year	0 to -3.6	-0.5 to -10	0 to -7
Average rainfall intensity on days with more than 20mm	mostly increase	mm / day	0.9 to 4.1	-2.4 to 1.3	0.9 to 4.7
Annual accumulated snow	The reduction, significant in the northern regions	%	-25	-50	-50
Mean daily maximum wind speed	The annual reduction.	%	-5	-5	-5
	Increase the seasonal level in the south-eastern part of Montenegro, for the summer season	%	+2	+2	+3

Scenarios and projections

Scenarios and projections of regional climate model[20] that includes extreme events for the reference period 2000-2100 show that, in Montenegro, it can be expected constant increase of temperature during successive thirty-year period in the twenty-first century.

Under this scenario, the rate of increase in temperature will be higher in the second half of the twenty-first century to the final annual mean temperature anomalies for the last thirty years averaged + 3.5 ° C compared to the normal climatological period 1961-1990.

Scenarios and projections of regional climate model that includes extreme events for the reference period 2000-2100 show that changes in precipitation regime complex and according to the considered scenario in the first half of this century, the territory of Montenegro is divided into the northern areas of positive and negative anomalies to the south.

[20] *Source: Results of the EBU-POM regional climate model, SNC*

In mid-century, the area negative anomalies will slowly spread to northern parts so the two penultimate thirty-year periods we have a situation that approximately 90% of the territory has a negative anomaly of precipitation.

Finally, for the last thirty-year period we have the situation that the whole territory of a deficit in relation to the reference period 1961-1990, with a maximum of 10% of annual accumulation.

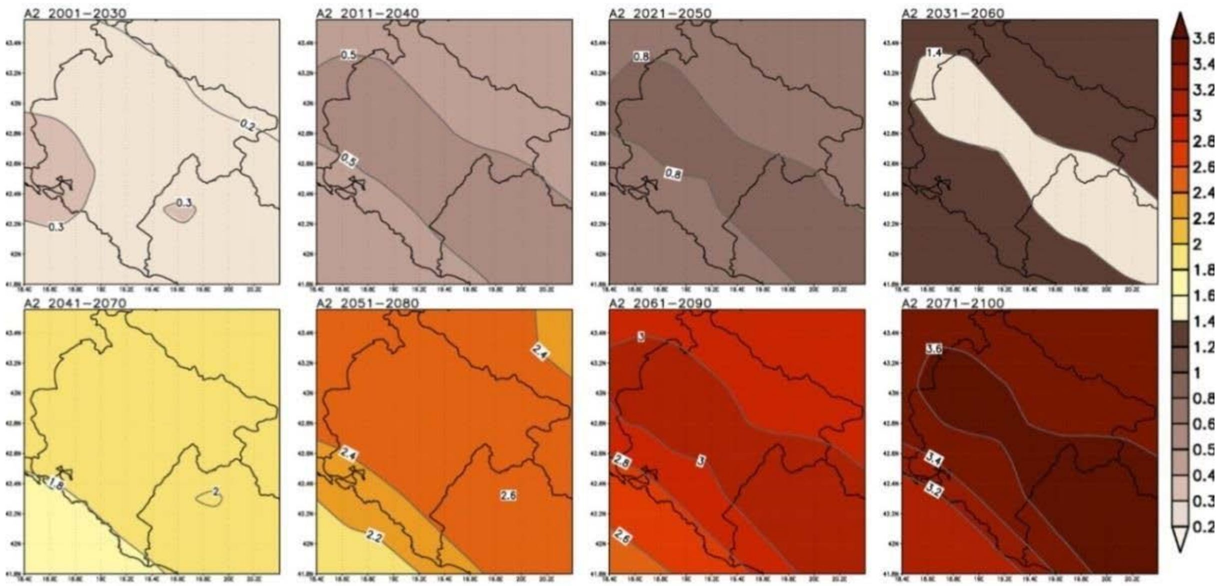

Figure 5. Change in mean annual temperature (° C) compared to the period 1961-1990, for the indicated sliding period of thirty years from 2001 to 2100 under scenario A2

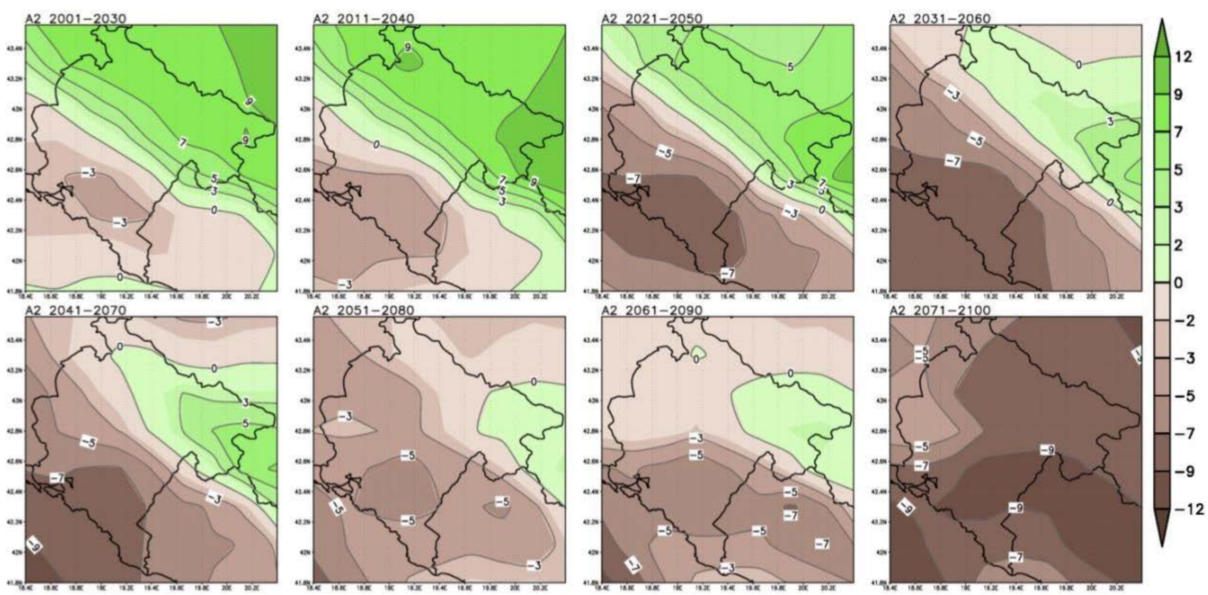

Figure 6. Change in mean annual rainfall accumulation (%) compared to the period 1961-1990, for the indicated sliding period of thirty years from 2001 to 2100 under scenario A2

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Table 10. Air temperature changes and projected precipitation changes in the 21st century with reference to 1961-1990

Air temperature changes in the 21st century with reference to 1961-1990	Projected precipitation changes in the 21st century with reference to 1961-1990
2001-2030, A1B	**2001-2030, A1B**
Summer: 1.3°C in the north and 1° C in coastal areas. **Winter**: 0.5°C in the coastal part, 0.9°C in the northern part **Spring**: 0.8°C in the south, 1.1°C in the north **Autumn**: almost no differences in temperature change going from south to north, with more or less steady change in the entire territory of about 0.7°C.	**Summer**: positive changes up to 5% for the central area of Montenegro. **Autumn**: positive changes up to 5% near the border with Bosnia and Herzegovina. **Winter, spring**: a decrease in precipitation up to 10%
2071-2100, A1B	**2071-2100, A1B**
Summer: along the coastal area 2.4°C temperature increase, in the northern mountainous region 3.4°C **Winter and spring**: temperature increase of 1.6°C the coastal area and 2.6°C in the north **Autumn**: temperature increase of 1.6°C in the coastal region and 2.4°C in the northern area along the border with Serbia.	**Winter**: 30% less in the central parts of Montenegro, values of up to -30% in the northern and coastal parts; **Spring**: about 10% less in the whole territory; **Summer**: a significant decrease in coastal areas, and a decrease in the central and northern parts of 15 to 20% less; **Autumn**: a significant decrease in precipitation from 30 to 50%.
2071-2100, A2	**2071-2100, A2**
Summer: the greatest increase in the mountainous region in the north, with values over 4.8° C **Winter**: temperature increase along the Adriatic coast of about 2.6°C, and about 3.4°C in the northern parts **Spring**: temperature increase along the Adriatic coast of about 2.8°C, and about 3.6°C in the northern parts **Autumn:** spatial distribution of changes is far more uniform, in relation to other seasons, in the range of 2.6°C to 3°C	**Winter**: a precipitation increase of 5-10% is projected in the north-western parts, and a decrease of -5% to -10% in the other parts of the country; **Summer**: the biggest decrease, especially along the coast, of -50%. A decrease of -10% in the northern parts; **Spring and autumn**: a more uniform decrease with a mean value of -20%.
2001-2100, A2	**2001-2100, A2**
The increase in air temperature during successive 30-year periods, and in the last 30th years up to 3.5 ° C;	In the first half of the 21st century, Montenegro is divided into the northern areas with increasing

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The speed of growth is greater in the second half of the 21st century; Except for periods at the beginning of this period, the temperature increase is greatest in the central parts of Montenegro, and the lowest mainly in the region's coast.	precipitation and south with a reduced amount of rainfall; Mid-century the area of reduction of rainfall will slowly spread to the northern parts, so that the two penultimate 30-year period, about 90% of the country have less rainfall compared to the 1961-1990; The last 30 years of this century the whole territory will have a deficit of rainfall up to 10% per annum; Viewed in relation to the total annual amount of precipitation, the most vulnerable part of the Montenegrin coast would be due to the fact that this area was adversely affected by deficit rainfall throughout the 21st century.

Analysis of large water developed within the catchment hydrological models of Lim and Tara on selected profiles

The analysis of large waters done within the hydrological models of the Lim and Tara basins in the selected profiles was done by the Swedish semi-distributed conceptual HBV model, with the available hydrological and climate data.

The data obtained from the model for the adopted A1B and A2 climate scenarios, and the input parameters from EBU-POM regional climate model in the form of the flow in the zone of the selected profiles did not contain the z component (water levels) for the given conditions. It was therefore necessary to translate the flow Q (m3/s) to the appropriate water level - H (mnm). It was done on the basis of the existing data of the hydrological service for the given profiles, by the analysis of the defined curve of flow Q=f (H) (rating curve). The data on water levels obtained in such a way were to be "located" in space in order to define the zones of impact (flooding) of the possible extreme waters. That was done by the geodetic survey of the field and by identifying the possible areas prone to floods on the basis of the hydrological data obtained through hydrological modelling.

For the municipality of Bijelo Polje (Figure 8) is identified the stretch in the direction of the former Wool plant (Vunarski kombinat) to the settlement Sutivan, along the river Lim on the level of 595 m. The measurements had to be done on both sides of the river.

In the municipality of Kolašin (Figure 7) is identified a slightly smaller zone in the area of the settlement Rovačko Trebaljevo, downstream along the river Tara on the level of 900 m. Survey was also done on both sides of the river.

For the survey we used the GPS Leica GS09, which ensures to the centimetre precise position in the network of the permanent stations in the RTK measuring mode. For both locations we calculated the transformation parameters (we did not use the parameters of the Real Estate Directorate) in order to ensure as high quality accuracy of the Z coordinate as possible. The data were transformed into the State Coordinate System (DKS). Geodetic surveys were done on 21 and 22 December 2013 in favourable weather conditions, so that none of the meteorological parameters could distract the process of work. The surveying was done on each 100 to300 m, depending on the configuration of the terrain.

The data from the field surveys were transposed to the maps of the appropriate proportion with the indicated area of catchment of large waters in the some of the selected hydrological profiles.

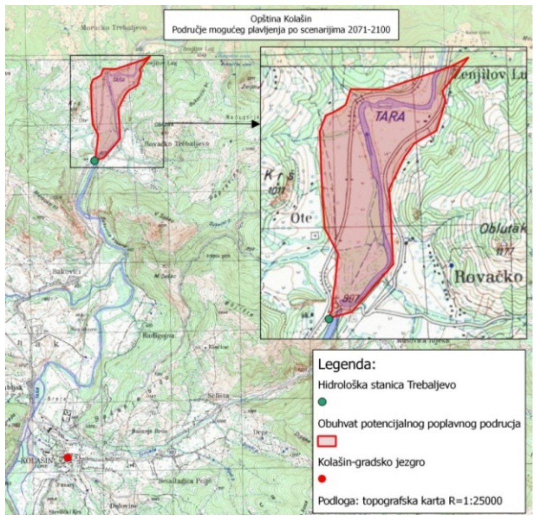

Figure 7. Kolasin - area of potential flooding in scenarios (2071-2100)

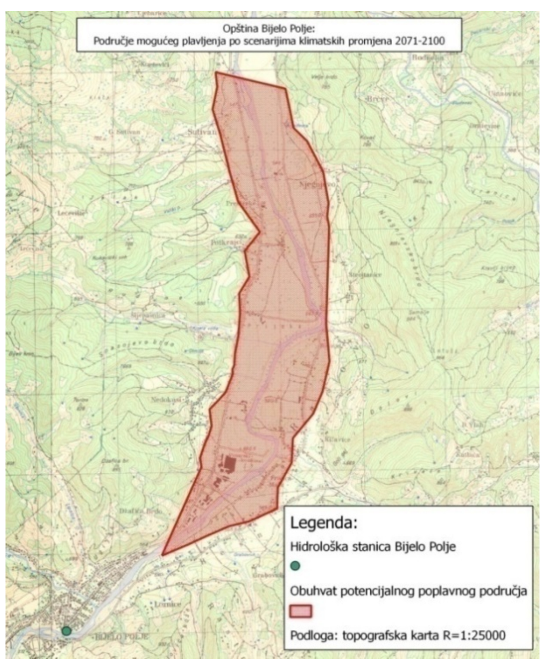

Figure 8. The Municipality of Bijelo Polje - an area of possible flooding in scenarios (2071-2100)

Coast and coastal area

One of the consequences of warming is also the sea level rise. There are several causes for that, the primary being the thermal expansion of water due to the sea temperature increase (Gregory et al., 2001). According to the last IPCC report (IPCC 2007, Chapter 10), 75% of the projected sea level rise by the end of the century will be a consequence of the thermal expansion of water, while 25% will be caused by melting of the glaciers and eternal ice areas (Arctic, Antarctic, Greenland).

In addition to the sea level rise and melting of the glaciers, the increase in the sea temperature will influence the sea ecosystems, fish, aquaculture, damaging algal bloom and the increase in the risk for human health due to the epidemiological bacteria, development of pathogenic bacteria that can have a negative impact on human health.

Sea level rise will be particularly important due to floods, erosion of the coast and loss of the flat area of the surface of the cast, which is the case with Ada Bojana in the furthest South-East of Montenegrin coast. The sea level rise will also increase the probability of storm waves, penetration of the salty water into the land and endangering of the coastal ecosystem and marshlands.

High flood risks do not threaten only the natural systems, but also human lives, property, tourism, infrastructure, transport etc. On the global level the projections of the sea level rise for the 21st century, mostly due to the thermal expansion of the ocean, range between 9 and 88 cm.

The study within the CAMP project that deals with the climate change impact and vulnerability to climate change, includes the analysis of the sea level rise in the Montenegrin coast. The analysis used the global projections according to IPCC, but without the technique of downscaling to the regional level. These were the projections that are based on semi-empirical methods. The digital terrain model (DTM) was used and the impact of storms (cyclones) and storm waves was not taken into account.

Four possibilities for the sea level rise have been analysed for the scenarios A1B and A2 by 2100 within which various projections of the sea level rise were taken into account. Thermal expansion of the sea was taken into account as well as melting of the glaciers and the highest local sea level rise in the period 1978-2013.

On the basis of comprehensive analyses two key recommendations are given for the size of the flooding zone and the vulnerability of Montenegrin coast:

- that currently and in the near future, in terms of the coverage of the flooding zone the scenario that gives the sea level rise by 96 cm should be applied (Image 4.13.). This projection matches mareographic data of the Institute for Hydrometeorology and Seismology measured in the station in Bar, where the sea level rise is already 69 cm in storms (cyclones), i.e. 96 cm if we take into account the calibration of the sea level in comparison to the normal zero of Trieste which is 27 cm.
- for the purposes of assessment of vulnerability of the area in terms of the extension of coastal delineation, CAMP project recommends, as the most realistic and the most probable, the scenario according to which the projection of the sea level rise is 62 cm (Figure 4.13) by the end of XXI century. This recommendation should be applied in all spatial plans, including the short term planning, particularly in the context of the fact that for planning of the urbanization the relevant

level is the level of pressure on the environment.

The results show a good match between the possible flooding locations due to the sea level rise and the assessment of the intensity of flooding on one side and the results of the analysis of impact of the storm winds in real time, i.e. by applying real data on the other side.

Thus, the possible locations that according to the CAMP project can be indicated to as the most vulnerable include:

- the areas for which the measurements in the meteorological stations in Herceg Novi, Bar and Ulcinj are representative;
- Buljarica lagoon, Jaz lagoon, delta of the river Sutorina, Solila and Kotor (particularly the southern part), Čanj lagoon, Ulcinj beach and the delta of the river Bojana to the channel Porto Milena;
- coast of the open sea of Montenegro because it does not have any natural protection from waves in the form of island chains and underwater cliffs, and
- the major part of the Boka Kotor Bay.

Experience from the CAMP project shows that there is a small number of available and high-quality data and that there is the need to establish local meteorological, hydrological and hydrographic observation programmes, as the basis for risk assessment and development of the plan for mitigating the consequences of the changed climate.

In terms of the risk assessment of the coastal area and the mitigation due to the climate change, CAMP project corresponds to the integrated THESEUS project financed by the European Commission.

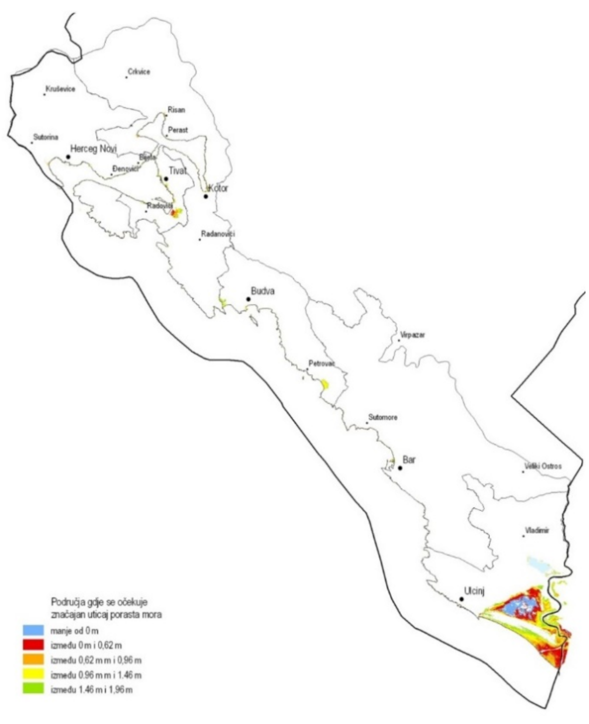

Figure 9. Sea level rise

Trans-boundary issues[21]

Investing in cross-border cooperation is a way to minimize the costs of adaptation action and to maximize its benefits by developing synergies in adaptation measures and integrating consequences for neighbourhood jurisdictions.

Urban areas, areas along rivers, lake watersides especially in plains and coastal areas are exposed to these threats. Extreme meteorological events will mostly affect the poor population which is mostly dependent on agriculture (especially in the north.). Climate hazards and illegal buildings[22] seriously influence Montenegro's vulnerability. These influences have potentially serious consequences to human health, livelihood and property particularly urban poor made informal settlements[23].

According to the findings of CVA Montenegro, 2011, from the point of view of disaster risk, the possible domino effect of earthquakes and other climate disasters, including floods, is likely to happen. Unplanned creation of new and expansion of old settlements, investments in high-risk coastal areas and exposure of an increasing number of people and property to floods, create and worsen the vulnerability, while also increasing the risk of large damage and death tolls during disasters. This trend combined with a greater frequency and intensity of the so called water-related hazards creates a larger risk of a big economic influence and health impact.

The most frequent natural hazards in Montenegro and Albania are floods. The biggest floods were recorded in 1963, 1979, 1999, 2000, 2010 and 2011. Areas potentially most vulnerable to floods are the hydrological system Zeta – Moraca – Skadar Lake – Bojana, the river Lim with its tributaries (confluences of Lim's Tributaries) and Tara before entering the canyon.

Cross-border activities in the fight against climate change and the joint development and management, for the identified hazard-water response adaptation between Albania and Montenegro achieved a pool of Skadar Lake catchment of the river Drin in the Albanian territory (increase in water level during heavy rains could lead to flooding in the municipality of Podgorica, Bar, Ulcinj), which has been respected request EU Floods Directive and Water Framework Directive that require cross-border cooperation in the water sector (including activities such as risk assessment and planning, the exchange of good practice, improving the knowledge base training and exercises), and thus there is a real possibility of obtaining funds from the EU to resolve the problem.

Integrated, cross-border character of spatial planning

There are many examples of the need for more coherent and integrated approach to the challenges of climate change through intervention in the wider spatial coverage in order to minimize damage in the cities. For this reason, Spatial Planning provides a comprehensive instrument for systemic treatment of

[21] http://climate-adapt.eea.europa.eu/adaptation-support-tool/step-2/trans-boundary-issues

[22] There are 100.000 illegal buildings, so it seems that every other household has this type of building

[23] Guide to Climate Change Adaptation in Cities, The World Bank Group, 2011

these topics. The risks of flooding in the basin of Lake Skadar open this topic as a need for integrated planning and consideration of the potential risks of space between Montenegro and Albania.

For the purpose of elaboration of this part of Homework 2 we used a findings of literature of the Ministry of Interior/Directorate of Emergency- planning documentation of safety and protection from floods (national and municipal plans) and planning documentation of safety and protection from forest fires (national and municipal plans) and relevant data and metadata of the Institute of Hydrometeorology and seismology of Montenegro.

In the period from 1955 to 1985 in Montenegro recorded 1,730 forest fires and burned area was about 15,500 ha. According to available data, the number of fires has increased over the past three decades.

From 2007 to 2009, over the territory of Montenegro there were 1,788 forest fires, and in the period from 2010 to 2013 were recorded 10,397 fires in the open air.

Past experience shows that forest fires can occur and the transfer of fire from neighbouring countries. A border area with Croatia and Bosnia and Herzegovina consists mainly of rugged terrain covered with underbrush, making it difficult, and in some locations impossible to firefighting from the ground. The most critical area of the basket (from the Cape to Vitaljina Mare, on the one hand, and from the Cape to Njivice Mare, on the other hand), because in case of fire transfer was marred tourist resort and complex Njivice. Border crossing trifle, given the configuration of the terrain, not as threatened by a possible fire (lowers population density, easy and quick intervention in mesh communication Meljine - Petijevici –Sitnica and further in the direction of Trebinje).

All border crossings in Niksic and Pluzine to Bosnia and Herzegovina (Ilino Brdo, Vracenovici, Scepan field, Nudo and Krstac) fire are endangered because they are located in an area that is covered with grass, small bushes and trees.

The transfer of fire from the territory of the Republic of Albania on the territory of our country, too, is possible, and that the move: border crossing Bozaj-the transverse troughs. Therefore, it is necessary to maintain a border strip and perform its cleaning from combustible material, especially since it is a rugged terrain.

In the municipality of Bijelo Polje there Dobrakovo border crossing to the Republic of Serbia, but in this area there is no possibility of transferring fire, due to the fact that on one side of the river Lim, the other meadows lined with tiny plants.

In the border zone between the municipality of Berane and Kosovo are forest districts Krstac, Glodjija Small, Large Glodjija, Vlajko hill, Sekular rivers (conifers) and in the border zone with the Republic of Serbia (according to Tutin and Sjenica) is a forest area Dobrodolski omar (larch). In the last ten (10) years in this area there was no occurrence of transferring forest fires.

In the border zone of the municipality Rozaje and the Republic of Serbia and Kosovo* There are forest sawmills: Jablanica, Balotic, Kula, Haile, Krstac and Bukovica. It has been noted that in the previous period (2006 and 2007) was the emergence of transferring forest fires in this area.

In the border zone between the territory of the municipality Plav and territories of Kosovo* and the Republic of Albania, there are areas of forest sawmills Dale, Vusanje, Budojevice, Trokuz, Treskavac, Baba field, Rock, Vrmosa, Popadija, pottery and Trojan (with Albania) and Baba mountains, Vaganica and Sipovica (on Kosovo*), but the last ten (10) years of age have not been cases of transmission of forest fires. The same applies to the border area of Andrijevica the Republic of Albania, where the coniferous complex Kutskova river.

In the municipality of Pljevlja there are four border crossings, including two with the Republic of Serbia and two from Bosnia and Herzegovina, but in the last ten years, there was no occurrence of fire transfer from the territory of one state to another.

Approach for addressing knowledge gaps and for dealing with uncertainties[24]

A problem for most developing countries, Montenegro included, are financial matters for efficient climate change adaptation. Thus adaptation approaches depend on the financial resources. According to the recent document Country Strategy Paper of Montenegro (2014-2020CSP MNE) the main weaknesses identified are the lack of strategic planning, underdeveloped infrastructure and a lack of systematic integration of environment climate change in all sectors' policies.

A National Environment Approximation Strategy and National Strategy and Action Plan for Combating Climate Change are currently under preparation. In particular, it is important that investments are made in full compliance with the Environmental Impact Assessment and the Strategic Environmental Assessment Directives with proper public consultations conducted, disaster resilience and risk prevention and management are integrated in the planning, preparation and implementation of projects and that sustainability of the investments is ensured.

Also, Montenegro is located in one of the area's most vulnerable to climate change impacts, and adaptation to these conditions necessitates building resilience and strengthening of disaster risk management. The needs regarding climate change adaptation and mitigation have been identified in the context of the preparation of the National Communication report to United Nations Framework Convention on Climate Change (UNFCCC) and of the 'Technical Needs Assessment for Climate Change Mitigation and Adaptation for Montenegro' report.

The overall responsibility for the development, management and coordination of environment and climate change policies lies with the Ministry of Sustainable Development and Tourism. In addition, the Ministry of Agriculture and Rural Development is responsible for water policy. The capacity to produce good environmental statistics, both historical and projected data, needs to be developed.

Montenegro, in the context of its Development Directions 2013-2016, has identified the national priority measures in environment sector. One of the main results, to be achieved under this sector with the help of IPA support is the water framework directive transposed and implementation started.

As regards investment needs the priority areas are, among others, waste water treatment and water management facilities in line with the EU standards.

[24] http://climate-adapt.eea.europa.eu/adaptation-support-tool/step-2/knowlegde-uncertainty

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The participation of Montenegro in the Environment and Climate Regional Accession Network (ECRAN), funded under the IPA multi-beneficiary programme, has been also recognized as instrument to provide an interface between the regional aspects and the national priorities in this sector.

One of the main risks identified relates to the lack of the human resources and administrative capacity for strategic planning, as well as project preparation and implementation, in particular for infrastructure projects.

With reference to the existing documentation the identified gaps in water management are no proper registry and protection of springs, losses in the water supply system, inefficient consumption, environmental data not enough transparent, overlap in institutional authorities, insufficient application of water melioration measures, small accumulation space for water management, unequally distributed regime and unregulated level of high waters, insufficient systematic testing of water quantity and quality, inadequate regulation and protection of river beds, low level of waste and atmospheric water purification, lack of pre-treatment of industrial waste waters drained into public sewage system, low level of connectedness of the population to sewage systems.

Second, when future society and environment might undergo rapid and unexpected change, the future does not appear to be predictable through simple extrapolation of historical trends. This can happen in the case of climatic developments and systems' response to them, but also in terms of socio-economic developments (e.g. economic crises, unexpected conflicts). It is crucial to identify, prepare for, and practice actions under several future scenarios. It is important to emphasize that National Adaptation Strategy of Montenegro is in preparation process.

Dealing with uncertainty in adaptation planning is an important and challenging issue. It requires awareness of the key uncertainties associated with the analysis, and an understanding of the quality of the information on which it is based. Due to the previously explained complexity of climate change and perceived gaps in technical capacities and human resources of Montenegro, the lack of relevant research in this area, the existence of only rudimentary strategic and legal framework, relatively low level of relevant *Acquis Communautaire* adoption, low level of public awareness in Montenegro about the negative impacts of climate change and other perceived lacks, there is a need for comprehensive approach to the climate change issue. Research, social learning, exchange of good practice and stakeholder cooperation can help reduce the lack of knowledge related to the climate change adaptation.

Area's main concerns and set strategic direction[25]

In connection with the process of adaptation to climate change in the fundamental role of urban planning is to ensure adequate use of space, allowing or not specific purposes in specific areas.

Spatial planning can be helpful in building the capacity of protected area that has recognized the potential for adaptation, at the same time, thus reducing the exposure of the existing urban complexes

[25] http://climate-adapt.eea.europa.eu/adaptation-support-tool/step-2/strategic-direction

consequences of climate change. It provides the necessary forum for the participation of many stakeholders, and creates the possibility for the realization short-term, medium and long term strategies.

In particular, long-term planning is essential for the growth and development of cities, particularly in the area of infrastructure that is often projected onto a shelf life of 70 years or more.

Bearing in mind the assessment of the dynamics of the upcoming climate change will require a number of interventions in the segment that involves adapting the principles of design and practical design solutions to new needs (application of new standards in the planning and construction). Extreme weather conditions with all the risks and threats of a direct threat to urban areas.

Spatial planning system must provide an opportunity for all stakeholders to influence decision-making in response to the challenges posed by the layered policy of adapting to climate change in Montenegro.

With increasing awareness on the topic of climate change can be expected and capacity building in city governments and state levels, with the aim of establishing integrated and synchronized responses to climate change.

Prepared by Montenegrin team WG4 ECRAN 2014-2015

Task 3 – Adaptation Needs

Montenegro recognizes the importance of the visibility of adaptation to climate change in the policy process. The overall responsibility for the development, management and coordination of environment and climate change policies lies with the Ministry of Sustainable Development and Tourism. In addition, the Ministry of Agriculture and Rural Development is responsible for water policy.

Adaptation to Climate Change in Terms of Water Resources

Recommended adaptation measures for water resources:

- Efficient water management and the introduction of a water information system
- Strengthening the network of measuring stations for monitoring hydrology and meteorology in Montenegro is necessary;
- There is a need for better coordination between the government, the Environment Protection Agency and the Institute of Hydrometeorology and Seismology in order to ensure the development of a system of quality national water archives to store and make available data;
- There is a need to encourage relevant agencies to use GIS tools and to identify all GIS needs relating to the environment in Montenegro;
- There is a need to harmonize data set standards and to clearly define responsibilities and "ownership" regarding specific sets of data, as well as defining procedures for controlling data versions managing data exchanges between institutions;
- Exploring ground water in Montenegro and carrying out GIS mapping of hydrogeological boundaries of ground water used to supply water;

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- There is the need for a water information system; options for the implementation of a better software information system for a water/cadastre should be considered (e.g. Water Ware, WISYS or WISKI) and decisions should be made about the structure of an information system for a options for the implementation of a better software information system for a water/cadastre should be considered (e.g. Water Ware, WISYS or WISKI) and decisions should be made about the structure of an information system for a water/cadastre.

All climate change has an impact on water resources, particularly on karst watercourses and karst aquifers, because of their vulnerability to climate change.

This is why a number of activities must be taken into consideration, including the following:

- Analysis of accessibility of water for future water-supply systems for larger settlements and summer pastures in the karst terrains of Montenegro;
- Detection and protection of new alternative wells;
- Changes in the urban planning strategies with a greater focus on the protection of arable land and potential ground water sediments;
- Establishment of an adequate monitoring system for the quantitative and chemical status of water in accordance with Directive 2000/60/EC (in case of good water status measures must be taken to preserve it, and where it is bad, measures must be taken to improve it);
- Establishment of water utilization controls to prevent excessive exploitation;
- Restoration of of river beds in risk areas in order to prevent further sinking;
- Regulation of aquifers with limited yields at the times of their hydrological minimum levels;
- Use of artificial supplements for those aquifers that are used for water-supplies and that would face significant losses in yield;
- Establishment and expansion of sanitary protection zones for all wells included in water-supply systems, as well as for potential wells within karst and inter-granular water-bearing formations;
- Drafting and harmonization of regulations and instructions that may contribute to the mitigation of potential negative effects of climate change and the better use of such areas for water-supplies;
- Regulation of water-supply management systems;
- Restoration and improvement of hydrological and meteorological monitoring networks;
- Selection of test areas in the karst terrains of Montenegro for the monitoring of climate change (air temperature, precipitation, evapotranspiration, etc.);
- Creation and development of regional climate models as instruments for the simulation and projection of future climate changes;
- Assessment of available water resources at present and in the future based on the results obtained from test areas to represent the territory of Montenegro and the broader region.

To both stabilize and improve the yield of some karst wells, measures must be taken to regulate aquifers at time when there are favourable geological and hydrogeological conditions. Examples of some successful regulations in Montenegro's karst include the karst aquifers of the Rezevica River (Budva) and Uganjski Wells (Cetinje), as well as the compressed aquifers in the glacial sediments of Bare Bojovica.

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Adaptation to Climate Change in urban planning

City climate and the impact of climate change in urban areas have not been thoroughly studied in Montenegro to date.

A step forward in this field is the GIZ project “Climate Change Adaptation in Urban Areas in the Western Balkans”, where, in addition to the capitals of Serbia, Macedonia and Albania, the project has also analysed the urban structure of Podgorica, the capital city of Montenegro, its climate, the so called “islands of heat”, its future climate projections, its potential adaption measures, and its recommendations for support by GIZ in terms of adaptation measures.

The priorities of physical planning are to overcome urban development issues, and relate to clearly defining urban development policies, including stopping illegal construction by fully observing the principles of the Vienna Declaration, by improving the quality of living in urban environments, and by establishing a responsible attitude from citizens towards their urban environment. This is particularly important bearing in mind that 63.23% of the total population of Montenegro lives in urban zones, and 36.77% in rural ones.

The Spatial Reform Agenda, adopted by the Government of Montenegro, discussed the Report on the State of Physical Planning for 2013 and set new goals for the physical planning policy. This is an important and necessary segment of the overall development policy for Montenegro and includes:

- Preservation of spatial potential with sustainable development;
- Preservation of spatial identity and distinctiveness of Montenegrin landscape;
- Physical planning policy reform;
- Land policy reform;
- Solutions for illegal construction problems;
- European spatial integration.

The challenges of the physical planning policy include: spatial limitations and non-renewability, the creation of a modern spatial identity based on the potential and unique nature of the landscape, the relationship between ecology and the economy, defining the difference between growth and development, the differences between physical growth and damage to the environment, the problems of severe pollution, issues arising from climate change, the need to increase public awareness about preserving and planning space usage, education and the strengthening of capacity.

List of Potential Measures and Actions in the Area of Spatial Planning with Respect to Adaption to Climate Change

In Montenegrin practice, just like in the global context, there is manifest discrepancy between the potential and the role of spatial planning in the area of adapting to climate change on one hand, and the implementation of such potential in practice on the other. With growing awareness regarding climate change, growth in administrative capacity at both national and local levels can be expected with a view to establishing a comprehensive and synchronized response to climate change. The following is a list of potential measures and actions in the area of spatial and urban planning in relation to climate change adaptation.

Development of planning techniques and methods and implementation of these plans

- Impact assessment and data collection. strategic environmental impact assessment;
- identification of space particularly vulnerable to climate change;
- analysis of vulnerability;
- mapping of zones of great vulnerability;
- setting up comprehensive and detailed records;
- Participation and communication: creation of scenarios;
- setting of long-term goals;
- participation in initiatives relating to spatial planning;
- communication and regular panels regarding climate change adaptation;
- presentation of good practice in spatial planning with a special focus on adaptation measures;
- regular exchange of information;
- participation in international activities and research programmes;
- Policy of integrated approach and setting up of adaptation plans integration of adaptation action plans within the existing system of planning and spatial plans;
- creation of action plans for future action regarding space, particularly at a local level;
- harmonization of spatial plans with adaptation strategies,
- transposition of climate change adaptation principles to national policy;
- Setting up standards and rules adjusting national legislation and secondary legislation to achieve quality analyses of climate change issues;
- Setting up standards in the area of planning and building construction as a response to climate change challenges.

Systemic measures as a response to climate change adaptation needs

- Raising awareness with the general public and decision makers regarding the role, benefits and limitations of spatial planning within the context of climate change adaptation;
- Setting up a broader planning horizon to offer a quality response to the threat of long-term climate changes;
- Establishing stronger institutional and practical links between the need to mitigate the impact of climate change and to adapt to climate change, all within the frame of spatial planning;
- Promoting and developing regional plans that could provide a comprehensive and integrated response;
- Promoting the planning, development and protection of regions;

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- Encouraging joint participation in the planning of all sectors and policies that may contribute to quality insight into climate change issues,
- Encouraging joint participation and cooperation at both state and local levels;
- Ensuring adequate financial support for programmes encouraging strategic planning in adaptation measures,
- Creating political support for adaptation activities at both local and regional levels
- Setting up methods and practices that illustrate manifold positive effects resulting from adaptation measures;
- Setting up national level guidelines that illustrate objectives, principles and methods for all the concerned with spatial planning;
- Collection of reliable and accessible spatial data on climate change, scenario, impact and vulnerability;
- Strengthening international exchange in order to convey and apply good practice
- Strengthening mechanisms to assist in setting up responses to market and capital impacts, the effects of which could be opposed to climate change adaptation objectives;
- Strengthening and elaboration of cause-effect links between climate change and future economic prosperity, emphasizing that sustainable development agendas do not mean economic stagnation, quite the opposite;
- Development of national legislation and policies that emphasize the themes of adaption to climate change and links to spatial planning;
- Strengthening the role of educational and research institutions and providing education on the importance of spatial planning and climate change.

Limitations, gaps and needs

Financial Resources

A problem for most developing countries, Montenegro included, are financial matters for efficient climate change adaptation, and ways of adapting depend on the financial resources. It is about the countries which are least responsible for climate change, but are most vulnerable to their influence.

Financial resources are essential in order to adequately address climate change issues. The national funds that are available for activities linked to climate change are limited, so there is a need for fundraising, the involvement of the private sector, and the raising of awareness of policy makers. The budget of relevant ministry does not allocate funds for climate change issues, so projects are mainly financed by international institutions (UNDP, GEF). Even in the future, funding from international financial institutions such as the World Bank, the UNFCCC Adaptation Fund, and the Green Climate Fund along with bilateral assistance obtained through initiatives related to climate change will remain the main sources of funding. Through active participation in EU research programs such as the 'Framework Program' and 'Horizon 2020', additional funding for activities linked to climate change can be secured.

In order to adequately implement the UNFCCC Convention, it is necessary to secure significant financial resources in the following areas:

- strengthening institutional and human resources for addressing climate change;
- scientific research in area of climate change;
- setting up of an efficient system for monitoring GHG emissions and for periodical reporting;
- implementation of mitigation measures per sector in Montenegro;
- implementation of adaptation measures per sector in Montenegro;
- stimulating initiatives in the areas of energy efficiency and renewable;
- creating incentives for the development of forms of transport which represent the best solutions in terms of GHG emissions, and the improvement of energy efficiency in transport;
- Incentive measures (such as, for example, tax relief) for the import of cars and technologies which have low GHG emissions.

The Secretariat of the UN Framework Convention on Climate Change (UNFCCC), based in Bonn, provides organizational and technical support for the implementation of its convention, as well as for related agreements and institutions. In the framework of the UNFCCC, in 2010, a Technology Mechanism was established; its aim was to encourage a transfer of technology through public-private partnerships, to promote innovation, to promote the use of a technology roadmap along with action plans, and to work with developing countries on the issues of technology transfer, joint research and development activities. The Technology Mechanism comprises the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The TEC adopts policy and oversees the UNFCCC framework for technology transfer, while the CTCN, located within UNEP, is responsible for implementing the Technology Mechanism, responding to the demands of developing countries (parties to the UNFCCC), and for relating to the development and transfer of technology. Finally, the institution in charge of providing information on technology (TT: CLEAR) provides information on the activities concerning technology transfer within the UNFCCC and improves the flow of information regarding the development and transfer of environment friendly technologies.

At the end of 2013, the Secretariat of the UNFCCC launched a major global inventory of all international initiatives that support climate change mitigation and adaptation to climate change. This inventory mostly includes energy technologies, but also some which are outside the energy sector. The so-called International Cooperation Initiatives Database (ICID) contains 60 such initiatives presented in the following manner: the name of the initiative, description and year of establishment, type of initiative, thematic focus, regional presence and participation. The inventory includes more than twenty initiatives, all of which are directly related to low-carbon energy technologies. Among them are a considerable number which target local cities and regions as well as the private sector. Most initiatives are global, while some focus on specific regions.

The Green Climate Fund (GCF) is the operating entity of the financial mechanism of UNFCCC, in accordance with Article 11 of the Convention. Given the urgency and seriousness of climate change, the purpose of the fund is to provide a significant and ambitious contribution towards global efforts to achieve the goals set by the international community in the fight against climate change. GCF contributes to achieving the ultimate goal of the UNFCCC. In the context of sustainable development, GCF encourages the achievement of low-emissions by supporting developing countries to limit or reduce GHG emissions, and to adapt to the impact of climate changes whilst taking into account the needs of developing countries which are particularly vulnerable to the adverse effects of climate change. GCF plays a key role as a catalyst in terms of providing finances related to climate change, both in public and private areas and at both international and national levels

Ongoing Projects Addressing Climate Change in Montenegro

Table 1. Ongoing projects

NAME OF PROJECT	PROJECT OUTCOME	DURATION	BUDGET AND DONOR(S)	IMPLEMENTING ORGANISATION AND PARTNERS
Adaptation to climate change in the Western Balkans	Improved adaptation to climate change in the Western Balkans (Albania, Montenegro, Macedonia, Serbia), particularly in flood and drought risk management.	2012-2018	3,500,000 € (for entire region) German International Cooperation (GIZ)	Ministry of Sustainable Development and Tourism (MSDT) Ministry of Agriculture and Rural Development (MARD), Institute of Hydrometeorology and Seismology of Montenegro (IHSM), Ministry of Internal Affairs (MIA) – Directorate for Emergency Situations, Municipal protection and rescue services, Institute of Public Health (IPH), World Health Organization (WHO), Red Cross of Montenegro (RCM), Capital of Podgorica
Building resistance to natural disasters in the Western Balkans and Turkey	Strengthening resistance of IPA beneficiary countries (Albania, Bosnia and Herzegovina, Croatia, Macedonia, Serbia, Kosovo, Turkey and Montenegro) to natural disasters in line with the priorities set by Hyogo	2012−2014.	2.200.000 EUR European Commission (IPA)	World Meteorological Organization (WMO) and United Nations International Strategy for Disaster Reduction (UNISDR, Institute of Hydrometeorology and Seismology of Montenegro (IHSM) and MIA–

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	Framework for Action (2005-2015).			Directorate for Emergency Situations
Cross-border flood protection and rescue	Building flood resistance of cross-border zone and target municipalities by developing technical and human capacity, through cross-border cooperation and awareness raising of prevention and combat against this natural disaster.	2012−2014	230.000 EUR IPA, II component, cross-border cooperation Montenegro-Serbia	MIA – Directorate for Emergency Situations FORS Montenegro (Foundation for Development of the North)
Optimum use of energy and natural resources and mitigation of natural disaster effects	Improving sustainable use of natural resources at national and local level and strengthening disaster response system.	2013−2015	2.750.000 EUR EU contribution (IPA) 445,000 € National contribution	MIA – Directorate for Emergency Situations, Ministry of Economy and Ministry of Health
Holistic model of integrated forest fire protection	Prevention and mitigation of damage caused by natural disasters focusing on fire and earthquake risk, in order to improve, promote and strengthen institutional capacity in implementing activities to mitigate disaster impact faced by the Adriatic region.	2013−2016	Budget total: 9,363,801 € Budget for Montenegro: 564,158 € IPA ADRIATIC	Project leader: Split-Dalmatian region Partners: 19 partners from Albania, Bosnia and Herzegovina, Montenegro, Greece, Croatia, Italy, Slovenia and Serbia Project leader in Montenegro is the Montenegrin Academy of Arts and Sciences (MASA). Partner: Ministry of Internal Affairs – Directorate for Emergency Situations

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NAME OF PROJECT	PROJECT OUTCOME	DURATION	BUDGET AND DONOR(S)	IMPLEMENTING ORGANISATION AND PARTNERS
Civil protection for candidate countries and potential candidate countries	Project objective is two-fold and should: (1) Contribute to further development of civil protection capacity of partner countries and (2) Support gradual inclusion and cooperation of partner countries in EU civil protection instruments, particularly the EU civil protection mechanism. Participating countries: Albania, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Kosovo and Turkey.	2013−2015	2.000.000 EUR Multi-beneficiary IPA programme, Stage II (2013- 2015)	Activities in Montenegro are led by the Ministry of Internal Affairs – Directorate for Emergency Situations Project is implemented under the auspices of the Directorate General for Humanitarian Aid and Civil Protection of the European Commission (DG ECHO)
CAMP "Integrated management of coastal zone of Montenegro", and development of National Strategy of Coastal Area Integrated Management for the Mediterranean		2011−2016	147.000 EUR Government of Montenegro 204.000 EUR i 81.000 USD – UNEP/MAP	MSDT IHMS

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Programme of EE in public buildings	Improving EE and conditions in target buildings Under the authority of the Ministry of Education and Sport (primary, secondary and special schools, kindergartens and student dormitories).		13.000.000 EUR German Development Bank (KfW)	Ministry of Economy
MONTESOL	Setting up a financial tool to ensure favourable loans to households for the installation of solar water heating collectors.		1.000.000 USD	Ministry of Economy United Nations Environment Protection Programme (UNEP) and Italian Ministry of Environment Protection, Land and Sea (IMELS)
Solar Summer Pasture Settlements	Creating better conditions for life and work by providing solutions to electricity supply - installation of photovoltaic systems in summer pasture settlements.		MMMMM	Ministry of Economy, MPRR, Local government units
Regional energy efficiency programmes in the Western Balkans	Developing a legal framework for the establishment of ESCO concept in Montenegro.		European Bank for Reconstruction and Development (EBRD)	Ministry of Economy

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NAME OF PROJECT	PROJECT OUTCOME	DURATION	BUDGET AND DONOR(S)	IMPLEMENTING ORGANISATION AND PARTNERS
LocSEE (Low Carbon South East Europe)	Project intends to develop capacity of public and other climate change institutions and strengthen participation of key stakeholders in policy design for the entire region of South-Eastern Europe. The project is co-funded by South-East Europe interstate cooperation programme, which intends to improve territorial, economic and social integration in South-East Europe. The project is led by the Bolzano European Academy (EURAC).	2012−2014		Project involves 17 partners from South-East region (11 active partners and 6 observes) and includes key actors addressing climate change, including national ministries, government services, universities and research organizational and international organization. 11 active partners include institutions from old EU member states (Austria, Italy, Greece, new EU member states (Slovenia, Hungary, Croatia), candidate countries (Macedonia, Montenegro, Serbia) and potential candidates (Albania). Project leader in Montenegro: Ministry of Sustainable Development and Tourism
Harmonization of seismic hazard maps for the Western Balkans	Development of new seismic hazard of the region, promotion of the national seismology network among all participating countries, training of young researchers in seismic hazard assessment	2007−2011	Budget for Montenegro 105,000.00 EUR	Project leader: Institute of Hydrometeorology and Seismology of Montenegro (IHSM); Partner states: Albania, Bosnia and Herzegovina,

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				Croatia, Macedonia, Serbia and Turkey.
Improvement of harmonized seismic hazard maps for the Western Balkans	Improvement of seismic hazard maps of the region and development of a harmonized regional data base of accelerometric data.	2012−2015	Budget for Montenegro: 52,000.00 EUR	Project leader: Institute of Hydrometeorology and Seismology of Montenegro (IHSM); Partner countries: Albania, Bosnia and Herzegovina, Croatia, Macedonia, Serbia and Turkey.
GEPSUS	Design and development of software system for computer simulation and monitoring of natural disasters as well as of disasters caused by the human factor, with a focus on air pollutants	2011−2014	Budget for Montenegro, 148,200 EUR	Project leader in Montenegro: Faculty of Electrical Engineering (University of Montenegro) Partner countries: Italy, Israel and Slovenia
Developing capacity for the cleansing of unexploded lethal devices in Montenegro	Promoting Montenegrin capacity for detection, transport and destruction of unexploded devices	2013−2016	Budget for Montenegro: 260,000 EUR	Project leader for Montenegro: Directorate for Emergency Situations of the Ministry of Internal Affairs Partner country: the Netherlands

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NAME OF PROJECT	PROJECT OUTCOME	DURATION	BUDGET AND DONOR(S)	IMPLEMENTING ORGANISATION AND PARTNERS
MVP project (Platform for integrated monitoring and verification of action plan implementation)	Setting up a platform for integrated monitoring and verification of implementation of national energy efficiency action plans	Regional fund opened for EE in South-East Europe by the German International Cooperation (GIZ ORF EE)		Ministry of Economy
Open regional fund for South-East Europe - Energy efficiency	-Support to capitals of SE Europe in implementing sustainable energy action plans -Starting a public dialogue on sustainable use of energy in SE Europe -Monitoring and evaluation of implemented measures from national energy efficiency action plans in SE Europe	2012−2015	2.500.000 EUR For the entire region German International Cooperation (GIZ)	Capital of Podgorica NGO Civic Alliance (School of Democratic Governance) Ministry of Economy (Directorate for Energy Efficiency)
Energy Wood within the framework of FODEMO projects (Development of Forestry in Montenegro - II stage)	Setting up an attractive and sustainable financial mechanism for providing interest-free credits for households to install heating systems using modern forms of biomass (pellet, briquettes).	2013−	130,000 € Government of Grand Duchy of Luxembourg	Ministry of Economy MPRR Lux-Development – Luxembourg Agency for Development Cooperation
Solar energy in the tourism sector of Montenegro	Developing information base for investing in solar thermal systems for tourism sector of Montenegro in order		German International Cooperation – GIZ	Montenegro Centre for Energy Efficiency (CCEE)

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	to support greater use of solar thermal systems for heating and/or cooling.			Ministry of Economy
Beautiful Cetinje	Economic revival of the Montenegrin royal capital by reviving its cultural heritage using energy efficient solutions, expert training, support to small entrepreneurs and by encouraging ideas and innovations in green design and overall urban development.	2011–2015	5.162.750 USD Royal Capital Cetinje and UNDP	UNDP Royal Capital of Cetinje, Ministry of Culture, Ministry of Economy
Cadaster of small watercourses	Developing a Cadastre of small watercourses with a potential for small hydro-power plants up to 1MW in the territory of 13 municipalities across Montenegro: Kolasin, Mojkovac, Andrijevica, Berane, Bijelo Polje, Plav, Rozaje, Pljevlja, Zabljak, Savnik, Pluzine, Niksic and Danilovgrad. Cadastre includes over 70 watercourses.		European Bank for Reconstruction and Development (EBRD)	Ministry of Economy
Sustainable energy development in Kolasin municipality	Preparation of plans for the design of technical studies necessary for planning energy development of Kolasin municipality as well as creating possibilities for the implementation of projects of small hydro-power plants.	2012–2014		Ministry of Economy Company Gaudal from Norway

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Future Projects – Project Ideas Relating to Climate Change in Montenegro

Table 2. Future project ideas

PROJECT OUTCOMES	PROJECT ACTIVITIES
Improving GHG inventory	Continued education in area of human resources Procurement of IT equipment
Adaptation to climate change in the area of water resources management	Detailed analysis of present climate change impact and of prospects of future climate change impact, with one of the key activities being the creation of a climate-hydrological model
Monitoring of surface and ground waters	Continued implementation of Hydrological Stations Master Plan in Montenegro, Development of projects based on the Montenegro Ground Water Monitoring Study Procurement of modern measurement equipment for field work
Ensuring efficient hydrology data management	Upgrade of a modern hydrology database, in line with WMO standards Education of staff to work on database Necessary IT support
Putting conditions in place for implementation of modern hydrology models in water resources management	Defining model software for typical hydrological conditions in basins Recruiting and educating staff to work on hydrological models
Continued work on delineation and characterization of water bodies in line with the Framework Water Directive ((2000/60/ EC)	Delineation and characterization of water bodies in the Adriatic Sea Basin Delineation and characterization of water bodies in the Danube Basin (Black Sea Basin)
Improving the conditions for the management of catchment areas used for public water supply	Detailed information in the cadastre regarding wells for public water supply

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	Conditions for the protection of water quality at wells Protection of future potential wells
Improving the protection of surface and ground water field monitoring system	Consistency in the implementation of legislation – hydrotechnical facility of water body Defining a framework to enable cooperation between hydrometeoro-logical services and the relevant authorities at a local government level
National Drought Management Policy	National policy design based on drought risk management
Strengthening the meteorological monitoring network	Restoration of meteorological precipitation stations
Development of Climate Change Adaptation Strategy in the health sector together with the action plan and of the Action Plan for Heat Waves	Expert and scientific research implemented in order to assess the vul-nerability of the health sector to the impact of climate change
Harmonization and implementation of EU energy and climate legislation	EU package for energy and climate; Privatization of the electricity market.
Ensuring stability in energy supplies by investing in the development of new large hydro-power plants	HE Moraca HE Komarnica
Increasing the share of renewable energy sources in the energy sector	mHE VE FE biomass power plants
Improving energy efficiency in industry	Cogeneration Solar thermal energy Energy management
Improving energy efficiency in transport	Fuel replacement

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	Hybrid and electric vehicles More extensive use of public transport Improving rail cargo transport
Improving energy efficiency in households and in the service sector	Better thermal insulation Implementation of regulatory framework for energy efficiency of buildings Implementation of regular energy check-ups for heating and air-conditioning systems Certification of energy saving characteristics Labelling of household appliances regarding energy saving Financial support given for investment in renewable energy sources in consumption areas

Sources:

- The Second National communication on climate change of Montenegro to the UNFCCC;
- “Assessment of technology needs for climate change mitigation and adaptation for Montenegro” with a related action plan;
- Other relevant documents

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Serbia

Task 2 – Vulnerability Assessment

Assessing risks and vulnerabilities to climate change

Analysis of past weather events

The South East European (SEE) region is highly vulnerable to floods, landslides, droughts, forest fires, extreme temperatures, windstorms, earthquakes and technology related hazards. On average, climate related disasters account for the major share of total disaster events in SEE countries (about 70 %). The available economic loss data show the SEE countries' economic vulnerability, particularly to climate related hazards. It was found that the total annual economic losses from hydrometeorological hazards and unfavourable weather/climate conditions (floods, droughts, hail, frost, heavy rain, snow, strong winds, extreme low temperatures, etc.) in the SEE countries are about 200 million USD on average (Table 1).

Table 2. The average annual incidence of major perils and vulnerability of SEE countries.

Country (period taken for the average)	Annual average incidence of major perils					Annual average number of deaths due to perils	Annual average economic loss due to all perils (million USD)	Economic loss in comparison to GDP in SEE countries
	Drought	Earthquake	Flood related	Wind storm	Technology related			
Albania (1974-2006)	0.12	0.09	0.24	0.06	0.06	7.82	68.67	2.49
Bosnia and Herzegovina (1989-2006)	0.17	NA	0.28	0.11	0.17	3.72	22.94	0.96
Macedonia (1974-2006)	0.17	NA	0.22	NA	0.11	13.39	24.59	
Serbia and Montenegro* (1989-2006)	0.17	0.06	0.50	0.06	0.56	10.00	82.0	1.66

*Available combined data for Serbia and Montenegro are presented here to understand the risk in the region.

NA – data not available on the website

Different economic sectors in Serbia show various levels of vulnerability to natural disaster and extreme hydrometeorological events. One of the most vulnerable sectors is agriculture, followed by energy, water

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management and air traffic. The share of sectors that depend on weather conditions in the gross national product of Serbia is considerably substantial and amounted to 47.18 % in the year of 2005. An overview of the loss estimates by sector caused by natural disasters is presented in Table 2.

Table 2. Loss estimates by sectors caused by natural disasters

Sector/ Dangerous or extreme hydrometeorological events	Damage assessment by sector	
	Average annual economic loss in millions of RSD	Average annual loss in human lives
Agriculture/ floods	3.100 - 8.500	several to tens
Water management/ floods	approx. 1.960	-
Agriculture/ hail, heavy precipitation, strong winds	approx. 7316	several to tens from thunder stroke
Agriculture/ drought, frost	approx. 40.000	no losses
Energy production (heating energy)/ extremely low air temperatures	approx. 716	several to tens
Road maintenance/ snowfall, ice, freezing	approx. 3.500	-
Human losses on highways, regional and local roads caused by bad weather conditions vary annually from 105 to 131		
Commercial air transport	54 - 72	-
TOTAL	16.648 - 48.572	several to 160

Droughts also represent a major risk to many economic sectors. Forest fires, as a drought consequence, represent a significant threat factor in Serbia and cause enormous damage. It is estimated that the total damage caused by fires in public forest estates in the period from 2000-2009 exceeded 36 billion dinars (Table 3).

Table 3. Damage caused by fires in public forest estates in the period of 2000-2009

Activity	RSD
Firefighting costs	44.498.395
Damage caused by fire	34.199.158.808
The costs of remediation, breeding and protection of forests	2.211.105.203
TOTAL	36.454.762.406

Climate change risks and vulnerability assessment

Climate change poses a real and growing problem for south-eastern Europe. In this region, already vulnerable to climate variability and climate extremes, climate change are projected (IPCCAR4) to worsen the conditions. In particular, climate change may enhance the existing problems of desertification, water scarcity and food production, while at the same time introducing new threats to human health, ecosystems and national economies of the countries.

The potential effects of climate change are very diverse and are likely to alter the basic necessities of life, such as food, water, health, land usage and the environment, and will be more damaging with increased warming and significantly decreased precipitation. As the United Nations Framework Convention on Climate Change (UNFCCC) indicated, "countries in arid and semi-arid areas or areas liable to floods, drought and desertification are particularly vulnerable to the adverse effects of climate change". As the consequence of the projected regional climate change, the frequency and severity of droughts could increase across the region. The analysis showed that several months of summer drought every year is to be expected in most SEE countries. In some parts, droughts could occasionally persist throughout the year. Hotter and drier conditions would extend the areas prone to desertification to encompass areas not currently at risk. In addition, the rate of desertification would increase due to increases in erosion, salinization, fire hazard and reductions in soil quality. The IPCC project revealed that rainfall is expected to decline throughout the year in southern Europe, particularly in the summer but, paradoxically, intense events of rainfall are expected to increase in the region. River flood hazards, especially flash floods, across much of south-eastern Europe will increase even further, endangering settlements, infrastructures and waterways.

Climate change will affect many sectors, including water resources, agriculture and food security, forestry, ecosystems and biodiversity, human health, coastal zones, energy and tourism, infrastructure. Many environmental and developmental problems in the SEE region will be exacerbated by climate change.

Water resources

It is likely that the first impacts of climate change will be felt in the water resource systems of SEE. Reductions in water availability would hit SEE countries the hardest. The overall water availability in the SEE countries for the 2070s is expected to be reduced by –10 to –50 %.

The SEE region could suffer increasingly frequent regional water shortages due to the twin problems of reduced water resources in terms of their quantity and quality and rising demand. Economic activities depending on water availability, such as agriculture, tourism, industry and energy, will be particularly adversely affected, since increased climate variability will threaten, among other things, infrastructure, waterways, hydropower, crop yields and timber harvests as well as recreational areas.

Agriculture and food security

Agricultural production is very climate-sensitive. The increased intensity and frequency of storms, drought and flooding, altered hydrological cycles and precipitation variance have implications for future food availability due to their physiological effects on crops, pastures, forests and livestock (quantity, quality). A 2 °C global temperature rise could lead to a 20 % reduction in water availability for crop yields in southern Europe. Extreme weather events, such as spells of high temperature, heavy storms or droughts, can severely disrupt crop production. As far as live-stock is concerned, the impact of climate change is twofold: direct through alteration of the physiology of farm animals and indirect through changes in the food supply. Thus, the projected increases in temperature and precipitation variability across south-eastern Europe may have severe impacts on agricultural production in the region.

Forestry

A temperature increase combined with a precipitation decrease during the summer boosts the risk of fires, which represents a major concern in the SEE region. In summer, high temperatures, low air humidity and fuel moisture represent favourable conditions for forest fires. The changing climate conditions could thus affect the frequency and magnitude of forest fires. In addition, extreme climate events, such as spring temperature backslashes and summer drought, are expected to increase in frequency and duration. These impacts might negatively precondition trees to other challenges, such as new pests and diseases. Insect and fungal attacks could also be enhanced by climate change.

Energy

In all SEE countries that are heavily dependent on hydropower for the supply of energy and electricity, a decrease in precipitation and hence in river flow and runoff will provide further challenges to already stress national and regional energy security. In the SEE region, the hydropower potential is expected to decline by –34 to –40 % on average by the 2070s.

Climate change impacts on water resources

The total multi–annual average quantity of available waters on the territory of Serbia is 5648.34 m^3/s or 178–125.4 million m^3/year. Of the total available waters, 184 mm/year (16234.3 million m^3/year) originates in the state territory. The remaining 1832 mm/year (161–891.1 million m^3/year) are transit waters, flowing through Serbia via the Danube, the Sava, the Tisa and other waterways. From the territory of Serbia, the waters gravitate towards the Black Sea (the rivers of the Danube basin), the Adriatic Sea (the Drim and the Plavska Rivers) and towards the Aegean Sea (the Pcinja, the Dragovistica and the Lepenac Rivers). Southern, south–western and western parts of the country are richer in water than the northern, central and eastern regions. As mountainous areas receive more precipitation, there are specific runoffs above 15 litres per second/km^2 from these areas. In the lowlands and highlands, in the north and central parts, the specific runoff is below 6 litres per second/km^2. The basins of the Rivers Bistrica, Gradac, Lopatnica and Studenica have the most abundant runoffs in Serbia, ranging from 15 to 17 litres per second/km^2. Vojvodina has the lowest water abundance in the basins of the left tributaries to the Great Morava and the Kolubara Rivers (from 2 to 5 litres per second/km^2).

A preliminary assessment of climate change effects on the water resources indicate that a decrease of water flow on the national level, is to be expected in the forthcoming period (up to 2100). The results of numerical models indicate that the average annual discharge in Serbia will drop by 12.5 % until 2020 and by 19 % until 2100. Since these assessments are preliminary, need for further research on the impacts of climate change on the water resources is necessary, as is the adoption of a detailed programme of adaptation measures.

All studies and analyses on the climate change impact are summarized in Second National Communication and will be available during 2015. This document examines the public possibilities for how to respond to the growing pressures in relation to this natural resource, i.e. to predict certain “limits” (for the next 100 years) of country’s water management, further to check on available water resources and ways of their exploitation and to provide specific guidelines for a rational “closure” of the water balance, all under the circumstances of possible climate change effects.

According to the newest hydrological and climate model results, we will face with the reduction of water resources in this region as result of an increase of average temperatures and decrease of precipitation quantity. This is especially related to the summer months, when a substantial reduction of available water resources could be expected. A higher water demand in the whole Danube River Basin could have significant consequences of available water resources in Serbia, bearing in mind that of all available water resources in the territory of Serbia over 90 % comes from the upriver territories.

In the field of water defence, there are no explicit trends, but a substantial number of studies predict an increase in intensity and frequency of flooding, particularly in the winter season. On the other side, there are studies that do not foresee such a trend, so that a low level of reliability must also be taken into account when it comes to projection of adaptive measures. In addition, certain studies indicate a potential increase in frequency of torrent floods in smaller basins, but the reliability of these predictions is also quite low, primarily because of the shift from global models to regional ones and the accuracy of this process when smaller basins are concerned.

The projected increase of water demands due to climate change, as well as decrease in precipitation amounts resulting in lower runoffs in rivers, will lead, especially in the summer, in low flow periods, to a higher pressure on surface waters in regard to their quality. These pressures are most significant for water bodies which are then, because of natural characteristics, extremely poor in water in the low flow periods, mainly in the summer. This is mainly valid for rivers in the south of Serbia (South Morava Basin), but also rivers in some other parts of Serbia (Central Serbia – Sumadija, eastern Serbia, etc.).

Climate change impacts on agriculture

Agriculture is a very important economic sector in Serbia. Agricultural production made up 9 % of the total gross national income in 2011. This is a very high percentage in comparison to the 27 EU countries, where the percentage of agricultural production lies below 3 % of the gross national product. Since the crisis period in the early 1990s, when agricultural production suddenly dropped, this sector has recovered gradually. In 2000, the income from agriculture increased to 21.9 % of the GDP. After this period, the share of agriculture in the GDP has fallen again, but more as a result of the development of other sectors than because of a decline in agricultural production itself. Projections about the agricultural development are that the share of agriculture will continue to drop and that by 2020 it will fall under 8 %. Agricultural products make up a substantial component of exports with more than 20 %. Apart from this, the number of persons employed in this sector amounts to 21 %. In some regions in Serbia, agriculture represents the core activity and a large number of households depend on it.

The natural potential for the development of agricultural production is extraordinarily large. Climatic conditions are favourable; there is a good quality of soil which mostly has not yet been notably polluted. Serbia also owns considerable water resources that could be used for the development of agricultural production. More than half of the country's territory is agricultural land (4867000 ha), which explains such a high share of agriculture in the overall production and positively defines Serbia as an agrarian country. In addition, Serbia has a long tradition of agricultural production, which indisputably represents an important capacity.

Agriculture is by nature highly dependent on climate change. Different technological solutions are being developed and implemented with the aim to reduce the dependence of agricultural production on unpredictable climate conditions, primarily in terms of protective measures from adverse weather conditions (greenhouses, hail suppression, anti-hail net), irrigation, development of animal breeds and plant varieties more resistant to unsteady conditions, use of artificial fertilizers and chemical protective agents. Despite all this, agriculture is still very vulnerable to unsteady weather conditions, and thus to long-term climate changes.

The predictions of climate change impacts to agriculture in Serbia are not promising. Several models project a decrease in yields for almost all arable cultures. A slight increase is expected only for maize, but only in case of an intensified irrigation. For the territory of Vojvodina it is projected that the rising temperature and summer droughts will generally more affect the yields of spring sowing than winter crop. In case of winter sowing, more favourable effects are expected to exceed the indirect negative ones, due to prolonged vegetation season. Of course, climate change impacts will have a variety of manifestations in different areas in Serbia, but there is still no reliable information on different regional scenarios. Nevertheless, it should be mentioned that the most important arable land in Serbia lies in Vojvodina and in the valleys of large rivers, just in that lower part of the country where drier climate conditions are expected.

The assumed higher frequency of natural disasters and extreme weather conditions will also affect agricultural production, primarily the plant production. Apart from the direct climate change impact that will be reflected in temperature and precipitation regime changes, production can be also endangered by various types of diseases and parasites whose incidence and spread may alter due to climate change. The prolonged vegetation seasons due to increased winter or early spring temperatures would lead to a higher possibility of disease or insect occurrence. According to the survey results among farmers that were carried out within the project ADAGIO a larger incidence of fungal diseases has been observed with grain and fruit products over the past years. On the other hand, it is to be expected that in case of some types of insects, particularly those that depend on the soil moisture, it will come to decreased incidence and population due to prolonged dry periods.

Another adverse phenomenon that might be enhanced by climate change is erosion of soil. The expected higher frequency of floods and high waters will certainly influence intensity of water erosion in some areas. Besides, large part of Vojvodina is most susceptible to the wind erosion that could be significantly increased due to prolonged periods of drought and high temperatures.

Task 3 – Adaptation needs

Climate change impacts on water sector

Potential climate change adverse effects on water sector in Serbia are following:

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- Increase in water scarcity in general;
- Enlarge of intensities and areas affected by droughts;
- Increase in duration of low flow conditions in rivers;
- Increase in intensity of low flow condition in rivers without upstream reservoirs;
- Increase in water quality problems directly / indirectly;
- Enlarge of the erosion processes, torrential and small rivers floods;
- Increase in medium size rivers floods;
- Increase in large areas and large rivers floods.

Adaptation measures

Changes in hydrological variables, various water resources issues, and measures to decrease water sector vulnerability require evaluation of socioeconomic changes and changes in land use practices. Many of the proposed measures in this chapter are fundamental even if the adverse effects of climate change are disregarded. However, their implementation will reduce water sector vulnerability significantly. The measures needed to address relevant issues and constrains are divided into three categories: basic measures (planning documents), specific measures (for various water sector segments and multi-purpose measures) and other measures (research, monitoring, etc.).

The basic adaptation measures pertain to the development of the main planning documents in the water sector. The Law on Water of the Republic of Serbia calls for the development of a Water Management Strategy and River Basin Management Plans. The *Water Management Strategy* is a planning document that needs to set forth the long-term direction of water management. This document has to be harmonized with other strategic documents at the national level, such as those relating to spatial planning, sustainable development, use of natural heritage and resources, and environmental protection. The planning period for the Water Management Strategy is 20 years. The Water Management Strategy is currently in its final stages of preparation and formal adoption is expected in 2015. According to the Law on Water, *River Basin Management Plans* are to be developed for a period of six years and need to be adopted, in compliance with the above Strategy, for the Danube River Basin and water districts. It is essential that all these planning documents, primarily the Water Management Strategy, anticipate developments, define possible solutions for all water sector segments, and consider climate and other changes.

With respect to water use**,** it is very likely that precipitation decline and increase in average temperatures, in areas with high population density and those suitable for irrigation, will increase water scarcity in the future, particularly in low-flow conditions. In addition to big cities, the most vulnerable are the south-eastern, eastern, central and northern parts of the country. Climate change is expected to have an additional adverse effect to the water use segment. At present, water losses in water supply systems are considerable in a large number of towns, amounting to 20-30%, and even as much as 50% in some places. With respect to droughts, more attention should be paid to drought prediction and monitoring system upgrades, the development of drought mitigation plans and the distribution of available water recourses.

Also, cooperation with other countries needs to be improved with the goal of exchanging experiences in combating droughts.

Although water quality improvement is commonly associated with the development of wastewater treatment plants, other aspects of water quality vulnerability should not be disregarded. Special attention during low-flow conditions is critical for water quality, e.g., the Morava and the Tisa rivers, as well as some smaller rivers in eastern Serbia, the Nišava, Timok, Mlava. Also, a greater demand, especially in the summer season, has adverse effects on water quality and might be a significant risk to achieving good status of water bodies in Serbia. The same applies to water bodies' status when it comes to excess water. Namely, fluvial erosion and resulting sediments put pressure on water quality. Heavy precipitation causes floods in both rural and urban areas and threatens water quality in many ways, e.g., pollutant particles attached to sediments.

Regarding protection against the adverse effects of water, efforts aimed at improving protection in upstream countries along major rivers (the Danube, Tisa, Sava, etc.) call for a higher level of protection in Serbia as well. Also, sedimentation in some major river reservoirs (Iron Gate I, Potpeć, etc.) will affect the flow regimes of the respective rivers in the future, and there will be the need to reassess protection systems. Maintenance and retrofit of already present flood protection infrastructure and drainage systems are crucial for protection against the adverse effects of water and measures for adaptation, along with the development of flood protection plans and improved flood safety, especially in high-value areas, the largest industrial centres, the biggest thermal power plants, etc. Harmonization of activities among institutions and organizations in charge is needed.

Given that an increase in water demand is expected, the currently unfavourable spatial and temporal distribution of water resources within the territory of Serbia needs to be improved. This can primarily be accomplished by building river reservoirs, where water could be stored in high-flow periods and used later, as needed, for various purposes: public water supply, irrigation, industrial needs, and improvement of the low-water flow regime, hydropower facilities and the like. Also, the feasibility of transferring water from water-abundant to water-deficient areas should be considered. The main problem is that all these regional schemes require substantial funding and detailed long-term planning.

Given the scope of this report, the majority of the proposed measures in Table 1 refer to the national level. Different measures might be appropriate within the same river basin, due to the dissimilarities in its upper and lower parts. With respect to adaptation to climate change, all measures contribute significantly to national efforts to combat climate change. The proposed adaptation measures for the identified problems would reduce water sector vulnerability. The adaptation measure class (no regrets - NR, low regrets - LR, and techno-economic analyses required - TEAR) and the approximate length of time needed for implementation (short term - ST, medium term - MT, long term - LT, and continuous long term - CLT) are assigned to each measure.

Table 3 Proposed adaptation measures. The adaptation measure classes are: no regrets - NR, low regrets - LR, and techno-economic analyses required – TEAR. In relation to the time required for implementing the measure, short term-ST, medium term-MT, long term-LT, and continuous long term – CLT are given in parenthesis

Strategic segments		Adaptation measures
Risk reduction	Water use	- Increase in efficiency of water supply systems (NR, MT) including: o Decrease in losses to optimal level o Economic pricing of drinking water o Organizational optimization of waterworks. - Application of best available techniques in irrigation and cooperation with upstream countries (bilateral commissions, ICPDR, ISRBC), with respect to water quantity (LR, CLT); - Reduction in specific water use by industry and irrigation, especially for new industrial and irrigation systems (NR, MT); - Transferring water from water-abundant regions to water-deficient areas (TEAR, LT)
	Water quality	- Wastewater treatment plants for all settlements with more than 2000 inhabitants and industrial centres (NR/LR, CLT), many of them based on priorities (NR, ST); - Best available techniques applied for diffuse sources of pollution that mainly originate from agriculture (LR, CLT); - Increase in wastewater tariffs (LR, MT).
	Protection against the adverse effects of water	- Development of flood protection plans for international rivers and large river basins (Danube, Sava, Tisa, etc.) (LR, ST); - Regular maintenance and retrofit of flood protection infrastructure and drainage systems (LR, CLT); - Increase in water storage capacity within river basins by constructing flood cells and retentions in flood-prone areas (TEAR, LT); - Restricting building and infrastructure development in flood-prone areas (NR, MT); - Improved flood safety, especially for high-value areas, largest industrial centres, biggest thermal power plants, etc. (LR, CLT); - Integrated approach and harmonized activities of institutions and organizations in charge at local, regional and national levels (LR, ST/MT).
	Multi-purpose	- Increase in water storage capacity (TEAR, CLT); - Transferring water from water-abundant regions to water-deficient areas (TEAR, LT)
Policy and legal framework		- Water Management Strategy (NR, LT); (adoption ST) - River Basin Management Plans (NR, MT); - Other planning documents according to the Law on Water, e.g., Water Pollution Protection Plan, Flood Protection Plans, etc. (NR, MT).

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Monitoring and research	- Improving monitoring and other non-structural measures to combat droughts (LR, CLT) - Hydrological monitoring network improvement (NR, CLT) - Improvement of the early warning systems for extreme climate and hydrological events (NR, CLT) - Establishment of database on extreme meteorological and hydrological events and disasters (NR, ST) - Research improvement in the field of numerical modelling of hydrological processes (LR, CLT) - Reinforcing research of climate change impacts on water resources (NR, CLT) - Reinforcing multidisciplinary research of climate change impacts (LR, CLT)
Capacity building and public awareness	- Improvement of coordination/harmonized activities of institutions and organizations in charge at local, regional and national levels (NR, CLT) - Strengthening capacities of government institutions (NR, CLT) - Strengthening local community capacities (LR, CLT) - Strengthening capacities of research and educational institutions (LR, CLT) - Improved inter-sectoral cooperation and ongoing international cooperation (NR, CLT) - Public awareness raising and better information dissemination on climate change impacts and possible adaptation measures (LR, CLT)

Constrains, gaps and needs

In the upcoming period it is necessary to make additional efforts to achieve goals and complete activities on the implementation of adaptation measures in the framework of water management. For major deficiencies and future needs with respect to the legal framework, funding, technical issues, and capacity building please refer to Table 2 (proposed adaptation measures).

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Table 4 Legal framework

Constraints and gaps	Comments	Corresponding needs
Water legislation The Law on Water (Official Gazette of RS, No. 30/10, 93/12) does not explicitly address climate change impacts and adaptation measures.	Although current research projects and other documents on adaptation to climate change are not finalized, it is necessary to consider and include climate change impacts and adaptation measures at different stages of implementation of the Law on Water.	Climate change aspects should be included in the Law on Water, as follows: • Article 30: Contents of Water Management Strategy. Climate change issues should be included in the formulation of objectives and guidelines for water management, for measures and for the future development. • Article 33: Content of water management plan and • Article 41: Separate water management plan Impacts of climate change, monitoring network, environmental objectives in relation to surface water and groundwater and protected areas, program of measures, and economic analysis of water resources management. • Article 49: Flood Risk Management Plans Flood risk management should be periodically reviewed and updated as necessary. • Article 81: Ensuring minimum sustainable flow Take into account future climate change impacts.
Environmental and planning legislation Aspects of climate change were not considered in the legislation and regulation in the field of environmental protection, spatial planning and construction in respect of water use, protection of water from pollution and protection against the adverse water effects.	Competent authorities should incorporate climate change impacts and adaptation measures in the environmental and spatial planning legislation, taking into account climate change issues that will be defined in the amended Law on Water and bylaws	Incorporate climate change adaptation measures in: 1. Environmental Protection Law 2. Law on Strategic Environmental Impact Assessment 3. Law on Environmental Impact Assessment 4. Law on Planning and Construction 5. Regulation on the contents, method and procedure for the development of planning documents

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Legal framework and financial needs

Insufficient funds for the development of the water sector in general, as well as for the implementation of climate change adaptation measures. Development and improvement in the water sector require significant spending in all water management segments, namely in water use, water protection and protection against the adverse effects of water. Funding of capital projects in the water sector requires approximately 9 to 10 billion Euros over the next 20 years.

Climate change impacts on agriculture

Potential climate change adverse effects on agriculture in Serbia are following:

- Climate warming will increase length of vegetation period and shift beginning of growing season to earlier dates (i.e. up to 20-30 days in average towards 2100) affecting timing of crop management. Spatial shifts of agro-climatological conditions will strongly affect crop growing conditions and crop selection in the future;
- Warming will affect crop phenology, leading to faster crop development rate. This can reduce crop yields, if crop cultivars used will not be adapted to higher temperature demand (changing ripening groups);
- Climate change will lead to decreasing rainfalls during summer and higher potential evapotranspiration leading to more severe summer drought conditions. These will especially reduce the yields of summer crops that are not irrigated in some regions of Serbia. Soils with low soil water storage capacity will be affected more negatively in their yield potential;
- More severe and frequent EWE under climate change (especially heat and drought related ones) may further reduce yield potentials and increase inter-annual yield variability, especially for rainfed conditions and for summer crops;
- More severe and frequent heat waves will increase production risks and reduce crop and animal production. Heat stress affects negatively fertility of some crops (i.e. maize) and health conditions and production of animals (i.e. milk and meat production). Further, sanitary conditions can be affected (i.e. milk and meat) as well as related risks can be increased (i.e. ozone effects on yields);
- Long term effects of impacts of EWE may reduce yield potentials of soils and damage important soil functions. Especially soil water erosion due to heavy precipitation in combination with bare soils at hill slopes needs specific consideration;
- Several shifts and changes in disease and pest occurrences are observed and expected under climate change conditions. Especially fungal diseases and pest occurrence (and related virus diseases) will be a challenge for future crop protection measures.

Vulnerability and specific hot spots for Serbia under climate change scenarios:

- Climate change impact in agriculture sector will cause:
- Increased stress for crop growth and faster phenological development because of higher air temperatures;

- Extreme weather events such as drought, dry winds, wet spells, intensive precipitation, frosts, heat and cold waves as a typical feature of continental climate;
- Occurrence of new pest and diseases;
- Water soil erosion;
- All regions will be affected by a shift of agroclimatic conditions, especially increasing temperatures and less summer precipitation which will reduce crop yield potentials without adaptations.

Significant vulnerability due to summer drought is expected for rain fed crops. Similarly, all crops (winter and summer crops) will be affected in all regions by changing pest and disease pressure due to warming and changes in precipitation, with increasing the overall vulnerability especially related to pests (thermopile insects). These risks are crop specific and are strongly influenced by relevant crop acreage in a region, crop management and crop rotation. Vulnerabilities due to increasing heat stress for summer crops and animals are expected in the lowland and warmest regions of Serbia. Significant soil water erosion is also expected highest in the mountain regions.

Adaptation measures

Adaptation options at the policy level are crucial for support, feasibility and success of implementation of adaptation options at the stakeholder (farmer) level. Related measures at the policy level should optimize the framework of conditions under which stakeholders can be motivated to implement adaptation and mitigation options. Although the “cost-benefit value” of measures at the policy level can hardly be measured in financial terms, the legislative frameworks, regulations as well as related financial subsidies are preconditions for a successful implementation of any adaptation strategy.

Analysis of adaptation options under climate change scenarios in crop management related to: sowing time, type of soil cultivations, pest and disease management, soil cultivation, irrigation options, land use options, etc. are presented in Table 3.

Adaptation measures listed by crop type:

- **Small grains** Crop cultivation in an area influenced by climate implies development of new genotypes with adaptability to abiotic and biotic factors or adaptation of existing genotypes to said changes. To obtain these traits, germplasm from geographically distant areas in which such desirable traits are dominant needs to be used. This germplasm contains undesirable traits as well, most often susceptibility to pathogens. The newly developed crop species or cultivar is then adapted to the growing conditions resulting from the climate change and begins to interact with the pathogen population. Because of this, a detailed risk assessment based on meteorological and biological observations in wider region must be made to prevent disease outbreaks in a given area.
- **Maize** Specific measures which can reduce sensitivity of maize production to expected climate change are: changing the sowing dates (earlier planting time), selection of tolerant hybrids and production of crops under irrigation in order to reduce overall stress. The possibility for irrigation will reduce risk for crop failure in maize production and thus be required more often and at more sites than in the past. According to longer growing periods a change to later ripening cultivars can be recommended. Due to increasing heat stress, heat tolerant cultivars should be breaded or introduced. Changing pest and disease pressures can be reduced by sound crop rotations. Pest

and disease monitoring and forecasting can strengthen effective crop protection measures and reduce risk for crop failure.

- **Sugar beet** Germination process hindered due to the lack of rainfall in March can be alleviated by changing the sowing dates to February. In support of an earlier planting time, apart from winter precipitations still available at that moment and early high temperatures in March are the decreasing trends of the number of freezing or frost days during January-April period. The negative impact of increasing trends of tropical nights during the sugar synthesis can be alleviated by delaying the root disposal, which means the extension of production and exposure to outdoor conditions at least for another month. Probably this measure will have just limited impact on sugar beet production and the additional measures will be needed. On the first place is irrigation. Bringing water to the sugar beet fields, eliminating the problems with germination and seedling growth until the end of the growing season is necessary. However, irrigation with the assumed temperatures, may cause plant pathogenic fungi, primarily causal agent of leaf spot (Cercospora beticola Sacc) but also the causal agent of root rot (Rhizoctonia solani). The most effective measures with the aim of protecting sugar beet crops from leaf spot are chemical measures, fungicidal treatment of seeds and use of tolerant hybrids. Also great problems in sugar beet production are associated with root rot during the month of June. Infections have been associated with May-July precipitation. Sugar beet production without the effects of root rot is possible only if sugar beet is sown in fields without soil inoculum. This is very difficult to achieve due to the limited areas suitable for sugar beet production with inoculum already present in the soil.
- Selecting tolerant hybrids and testing favourable growing conditions, which include all thresholds still avoiding yield losses, for our country is the most important measure to be taken. The process of testing tolerant hybrids started in our conditions four years ago and it still continues.
- **Grape and fruits** Expected changes of climate in Serbia will have different impact on regional level but common characteristic of these changes supposed to be exerted in increased temperature variations and regional heterogeneity of distribution of precipitation on all time scales. Additionally it is expected that some new pests will appear, while other will become less important in some regions. In case of downy mildew of vine grape, for example, expected meteorological conditions in upcoming growing seasons supposed to be less favourable, even first symptoms can appear earlier during the year. If it happens it can decrease regional vulnerability of production regions in Serbia. However, there is a secondary impact of climate change on vulnerability to certain plant disease - stress effect. Namely, according to all climate change scenarios, increased number of extreme weather events supposes to be most pronounced feature of climate effects in Serbia. It will tremendously affect stress conditions of plants and therefore their vulnerability to diseases. Hence, short-term adjustments and long-term adaptation measures in plant protection, regarding climate change, supposed to be directed in two ways. One way is related to increase of "physiological conditions" of plant as a whole through fertilization, irrigation, use of hail nets, weeds control, and permanent shoots cutting. Since oospores can overwinter in debris, its removal will reduce inoculums presence in vineyard. It will lead to reduced potential of disease appearance in forthcoming growing season. Another one should be focused on actions with prime aim to avoid or at least reduce negative effects of extreme weather events. In case of new orchards and vineyards it is important to take into account expected agroclimatic conditions and to reduce potentially favourable environment for intensive development of some harmful organisms.

Since the publishing of Initial National Communication (INC) certain measures proposed in INC have started to be implemented. Some of them are related to the changes in field operations and optimization of plant density per unit area. Also introduction and breeding of drought and heat resistant cultivars and earlier ripening cultivars are reported. Especially greater percentage of early ripening spring crops cultivars (varieties/hybrids) and early growing varieties and hybrids in order to avoid crop stress and damage from foreseen longer period with summer and tropical days during the critical part of crop phenology. Warmer winters with reduced number of frost days in March and April allow earlier start of vegetation and sowing of earlier varieties of i.e. sugar beet and spring crops. Change in practices concerning the use of fertilizers and chemicals are also one of the measures mentioned in INC whose application started in recent years.

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Table 5. Proposed adaptation measures. In relation to the time required for implementing the measure, short term-ST, medium term-MT and long term-LT are given in parenthesis.

Strategic area	Adaptation measure
isk reduction	- Change timings of field operations (ST) - Optimal soil cultivation time and sowing time, especially for Backa and northern Banat (ST) - Optimize plant density per area unit, especially for Backa, northern Banat and Srem (ST) - Introducing minimum tillage or reduced soil cultivation (ST) - Introducing and breeding of drought and heat resistant cultivars (MT) - Earlier ripening cultivars in summer drought prone areas without irrigation, particularly in surroundings of Vranje, Nis, Zajecar, Cuprija, Kragujevac and Novi Sad (MT) - More productive cultivars (like C-4 plant types) (MT) - Increasing percentage of winter crops (MT) - Wide use of grasses varieties in crop rotation system, including alfalfa (MT) - More crops per crop rotation due to increasing length of vegetation period (MT) - Rational and effective use of fertilizers, optimized fertilizing (ST) - Enhancement of organic contents in soils, especially northern parts of Vojvodina, Suboticko-horgoski (ST) - Optimized alternative use of residues by partial introduction of crop residues, particularly for the region Backa and northern Banat (ST) - Plant residues incorporation combined with nitrogen application to provide better and faster decomposition of crop residues, especially for southern Vojvodina (ST) - Improve effective water management including water harvesting methods (MT) - Improving irrigation water use efficiency and crop water productivity by optimizing irrigation techniques and methods (MT) o Improving bench border irrigation (MT) o Irrigation on sandy soils (MT) o Implement/extend local irrigation systems (MT) o Improving basin check irrigation, fertilizer irrigation, channel irrigation (MT) - Use more heil nets (MT) - Adaptation to integrated fruits production, particularly for region of Fruska gora and Bela crkva (MT) - Alternative, earlier species and table cultivars, particularly for western Serbia (MT) - More effective application of the techniques for protection grape vine against early autumn and later spring frosts (MT) - Introduce protective belt systems in the crop areas improving snow arresting tree belts, especially in areas influenced by Kosava wind (MT) - Effective snow hedge application especially in areas influenced by Kosava wind (MT) - Slope terracing (MT) - Improving practice for water erosion protection particularly in mountainous regions, improving practice for water accumulation into soil (MT) - Improving afforestation for soil erosion protection (MT)

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Strategic area	Adaptation measure
Policy	- Providing legislative framework for implementation of adaptation and mitigation options in agriculture and harmonizing national legislative with related EU (LT) - Strengthening institutional measures for a successful information chain between stakeholders and experts i.e. providing necessary capacities in agricultural research and extension services, establish monitoring and warning systems for agriculture (MT) - Providing subsidies where these can force implementation of adaptation/mitigation measures, i.e. in the framework of environmental programs such as timing of fertilization (MT) - Implementing adapted legislative measures for specific environmental problems i.e. protection of quality of surface and drinking water resources through limitations in fertilizing or land use restrictions (MT) - Supporting training and education of farmers (ST)
Monitoring and Research	- Monitoring: adaptation capacity building, cost effectiveness of applied adaptation measures, changes of insurance policy, farmers awareness, education of people involved in realization of adaptation measures, time and place of appearance of harmful organisms, work of agricultural operational advisory services. - Development of monitoring system for extreme weather (drought, heat waves, hail, storm, flood, frost) and diseases and pests. - Research: Development of varieties more resistant to stress and drought, development of procedures for minimization of evapotranspiration and soil water savings, more efficient use of numerical weather prediction of different scales and advanced agricultural tools in providing crucial piece of information for farmers.
Capacity building and public awareness	- Training and education of farmers related to production technologies and farm management options - Support and advices for direct marketing options for farmers - Ensure extension services available for all farmers/farming systems - Providing attractive education possibilities for young generation of farmers - Aggregation of too small farms in medium and large ones; building cooperatives where applicable - Permanent care about a balance between crop and livestock productions in farming system in order to avoid an increase of GHG emissions

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Constrains, gaps and needs

All suggested measures of adaptation should not increase production costs and application of them should tend to increase production stability.

Potential limitations for farm-level adaptation options to climate change in Serbia are:

- Unreliable farmers' incomes,
- A great number of small farms, insignificant production efficiency,
- Old machinery, with low investments in farming techniques,
- High costs for modern farm technology,
- Legislation barriers,
- Unfavorable bank credits are increasing costs and risks for farm investments,
- Investments in irrigation often not economic (subsidies needed),
- Chaotic market conditions,
- Unfinished privatization of food industry,
- Great number of farms is out of advisory service programs,
- Soil acidification,
- Undeveloped refining industry,
- Insufficient production of manure for arable cropping use,
- Farmers behavior and Know-How,
- Farmers need specific training and information for using minimum and conservation tillage and other soil cultivation options to ensure success of implementation,
- Topographical limitations, forest-clad relief.

Turkey

Task 2 – Vulnerability Assessment

Vulnerability Assessment in Agricultural Sector

Introduction

Pursuant to decision 26/CP.7 of the United Nations Framework Convention on Climate Change (UNFCCC) at the 7th Session of the Conference of Parties held at Marrakesh, Morocco in 2001, Turkey's name was deleted from Annex II of the UNFCCC, and the Parties were invited to recognize the special circumstances of Turkey. And Turkey became a Party to the Kyoto Protocol as of 26 August 2009. Turkey does not have emission reduction commitment under the Kyoto Protocol. However it has been conducting intensive emission reduction activities in areas such as energy efficiency, promotion of renewable energy, transportation, and waste management.

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Turkey's total surface area is 785.347 km^2; it decreases to 769.604 km^2 after excluding natural lakes and dam lakes (TUIK_a, 2013). According to the distribution of land use classification, agriculture has the biggest part with 31.1%. 27.6% of country land is forest, 18.6% is rangeland, 1.4% is wetland and 21.3% is for other purposes (OGM_a, 2012). Turkey has 7 geographical regions. From biggest to smallest in terms of surface area are Eastern Anatolian Region, Central Anatolian Region, Black sea Region, Mediterranean Region, Aegean Region, Marmara Region and south-eastern Region.

Turkey being between middle latitude and subtropical climate belts has various climatical regions due to different topographical features but it is mostly located in Mediterranean macro-climatical belt (İyigün, et al., 2013).

Black sea climate, in which temperature difference between summer and winter is low, affects Black sea coastal region, northward parts of Black sea Region mountains and northern coasts of Marmara Region. Mediterranean climate, on the other hand, affects Aegean, western part of Central Anatolian and Mediterranean regions. Continental climate of which characteristics are hot and dry summer and cold and snowy winter can be analysed in four sub-types such as south-eastern Anatolian, Eastern Anatolian, Central Anatolian and Thrace Continental climates. In Marmara climate which affects Marmara and Northern Aegean regions, summers are hot and rainy and winters are colder compared to Mediterranean climate. (Şensoy, Demircan, Ulupınar, & Balta, 2008).

Turkey, during summer, is under the impact of Azores High Pressure Centre generally which causes rainy and chilly weather in summer and Basra Low Pressure Centre which causes hot and dry season. During winter, due to impact of İcelandic Low Pressure Centre and Mediterranean Low Pressure Centre systems, season is wet and during the times when Siberian HPC is effective, season is cold and dry.

According to the temperature data between 1970-2013, average temperature of 12.7°C for 1970-1978 period has risen to 13.7°C for 2006-2013. When temperature distribution is analysed, it is Southern Mediterranean that has the highest average temperature and Northeast the lowest (MGM_a, 2014).

Turkey's average annual precipitation for 2006-2013 period is 634,8 mm. Black sea Region has the highest precipitation with 2060-2240 mm and Central Anatolia the lowest with 250-400 mm (MGM_a, 2014).

Agriculture

According to statistics, total agricultural area is 24.3 million ha including perennial crop area. In 2011, there was a significant decrease in agricultural area but for the last 3 years there has not been a significant change.

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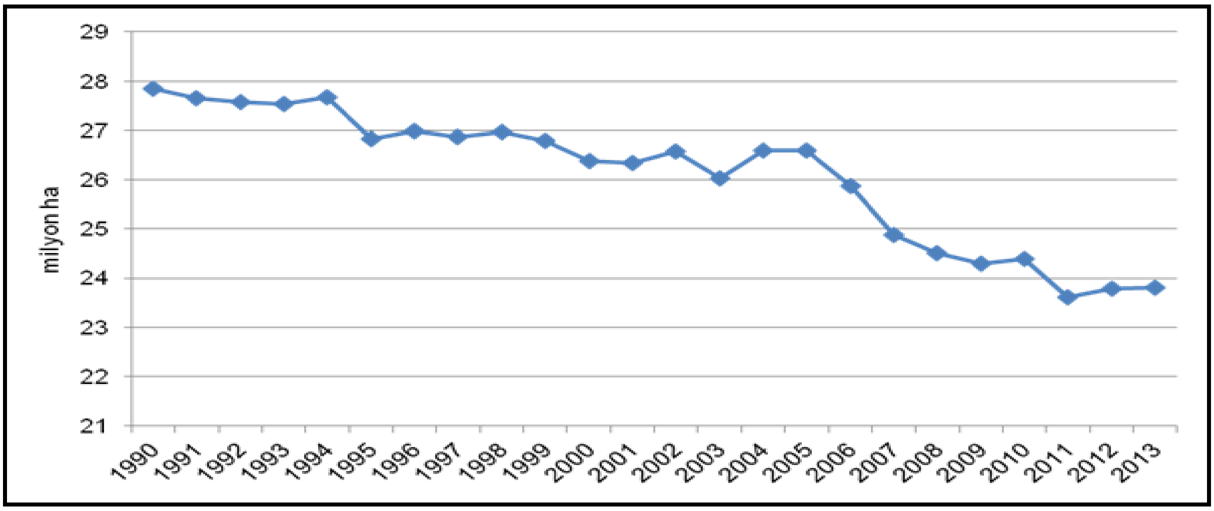
Table1. Change in Agricultural Land (1990-2013)



Source: TÜİK- 2014

For 1990-2009 period, it is seen that the total number of ovine and bovine animals continuously decreases and there is a continuous increase for 2009-2013 period. As of 2013, there are totally 53.4 million ovine and bovine animals in Turkey, 29.3 million of which is sheep, 14.4 million cattle, 923 thousand goats and 482 thousand other animals (TÜİK_i, 2014).

According to 2013 year statistics, there are 88.7 million layer hens, 177.4 million broiler hens, 2.9 million turkeys, 0.8 million gooses and 0.4 million ducks, in total 270 million poultry animal in Turkey (TÜİK_i, 2014).

Turkey is rich in terms of biodiversity and 2% of all of the identified species in the world is deployed in Turkey. 8 thousand (4 thousand plant and 4 thousand animal) of all the identified species in Turkey are endemic. And 50 animal and 1284 plant species are endangered species. Furthermore, it is estimated that 8 animal and 11 plant species are extricated.

Expected Impacts in Agriculture Sector

Turkey's being surrounded on three sides by sea, mountains' run and diversification in landforms cause different types of climate to occur. It is located between temperate zone and subtropical zone (Atalay, 1997).

Thus it is not only rich in terms of diversity in agricultural products but also of natural vegetation. Although areas affected by Mediterranean climate which causes hot and dry summers and wet and temperate winters, constitute only 2% of the total area of the world, they host 20% of all the known plant species (Shaw, 2010).

Turkey hosts 75% of all the plant species in Europe and approximately one third of these plants are endemic. Mediterranean Region has the highest number of species with 862 out of the total 2282 endemic plant species (BAKA, 2012).

Mediterranean Region is also important for agricultural production. According to 2011 statistics, the share of agriculture sector in gross value added for provinces in Mediterranean region such as Antalya,

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Isparta, Burdur in total is 16.6 %, for Adana and Mersin is 14.7% and for Hatay, Kahramanmaraş and Osmaniye is 14.4% (TÜİK_g, 2014).

It is expected that these regions will be affected more socio-economically from climate change due to their share in gross value added.

It is estimated that future climate change will affect food production in Mediterranean region in many ways. Direct impacts could emerge as increase in the amount of carbon dioxide in the atmosphere and as increase in the sea level. But food production in many areas will be affected more due to factors such as desertification, increased risk of fire, disease and pest and changes in world market. However it is not determined certainly that how climate change will affect food production. Because comprehensive and integrated studies that reveal the impacts of climate change in different levels have not been conducted. Most of the conducted studies have focused on restricted number of food products and they have only taken current tillage methods and doubled carbon dioxide level at most into consideration. Nevertheless, current indications show that climate change will have adverse effects on food production, thus food prices will increase and food security will be under threat in the region (Karas, 2006).

As of 2013 total agricultural area in Turkey is 23.8 ha and one fourth of it is irrigated land and major part is used for rainfed agriculture. Therefore, agricultural production depends directly on precipitation. Animal breeding is in a close relation with crop production. Parallel to the increase in number of livestock, the need for fodder crop increases. Hence every possible adverse effect of global warming on crop production has a potential to affect animal breeding sector as well.

There are very limited number of studies addressing impacts of climate change, multiple factors and future scenarios.

One of these studies on climate impacts on agriculture was conducted by Dellal, McCarl, & Butt in 2011 in seven geographic regions of Turkey and at a national scale. Five fundamental products (wheat, barley, corn, sunflower and cotton) comprising 85% of Turkey's cultivated areas were assessed. Precipitation and temperature changes were generated based on HADCM projections for the year 2050. Effects of climate change were estimated on Turkey's agricultural production, interregional product pattern, prices of agricultural products, the amount of import and export, as well as consumer, manufacturer and social welfare. The study results estimate a decrease in the yield in all regions of Turkey (Table 6.5). Decrease of production is estimated to be 8.2%, 2.2%, 9.1%, 4.5%, 12.9% on wheat, barley, corn, sunflower and sunflower, respectively. The study also estimated changes in production patterns, with decreases expected in export of wheat and sunflower, increases of export of corn and cotton, and increases in the prices of products by 6.3%, 7.1%, 12.6% and 0.1% respectively for wheat, barley, corn and sunflower. Manufacturer welfare is expected to increase by 8.3%, while consumer welfare and total welfare are expected to decrease by 1.7% and 0.7%, respectively.

The Impact of Climatic Change on Agricultural System in Arid Areas (ICCAP) project was conducted by TUBITAK and Japanese Research Institute for Humanity and Nature-RIHN between 2002 and 2007 with the goal of determining the effects of climate change on agricultural production systems in arid areas (Kanber 2008).

It is estimated that precipitation will decrease significantly; the amount of snowfall and melting time change; planting times of main crops such as wheat and corn times and more importantly places change. According to Project results, water resources will be affected most and monthly precipitation distribution, amount and temperature values will change significantly. The project estimates that by 2070, average temperatures will increase 3°C, annual precipitation will decrease 25%, water surface sources, snow storage and underground water potential will decrease by up to 30% in the Seyhan Basin. According to the results, natural and agricultural water needs of plants may increase, and irrigation management is going to be important responses to the decrease in water availability. In the study it is suggested that issues such as inter-sectoral water distribution, water saving, water demand management, control of water usage, expansion of observation networks, and the increase of large volume storage buildings should primarily be assessed (Kanber, 2008).

In the simulation conducted under ICCAP project (Yano, Koriyama, Haraguchi, & Aydın, 2007), it is indicated how biomass, grain yield, rise time and evapotranspiration of wheat and corn which are widely cultivated in Adana Region change in case of doubled carbon dioxide concentration and increased maximum and minimum temperatures by 1, 3 and 5 degrees (Table 2). It is seen that in case of doubled carbon dioxide concentration, biomass and grain yield increased both in wheat and corn, but in case of temperature increase, they decrese. Therefore, it should be taken into consideration that temperature increase could cause problems in animal breeding; at best it could increase the cost of feeding.

Table2. Impact of double CO^2 concentration and increased temperature on plant development and evaporation in wheat and corn

	Wheat				**Corn**			
Factor	Biomass (ton/ha)	Grain yield (ton/ha)	Number of days for developing	ET (mm)	Biomass (ton/ha)	Grain yield (ton/ha)	Number of days for developing	ET (mm)
Control	17,74	4,71	164	370	27,14	17,29	120	378
2xCO_2	21,67	5,74	162	371	28,85	17,98	120	359
+1 °C	16,41	4,14	155	350	25,13	15,83	116	362
+3 °C	13,21	3,96	141	310	21,71	13,14	110	335
+5 °C	10,37	4,01	128	254	18,62	10,79	107	314

ET: Evapotranspiration

Source: Yano ve ark., 2007.

In a study on olive which has a special importance for Turkey (Varol & Ayaz, 2012), it is stated that olive stops cap growth and continues to do photosynthesis and transpiration activities thus builds a resistance mechanism for drought in case of water scarcity. It is a drought-tolerant plant but it comes as one of the first agricultural products that will be affected most from climate change. Therefore urgent measures need to be taken in olive growing. Water stress causes significant changes in fruit set, ripening and oil capacity in olive trees.

In the study upon impacts of climate change on agricultural products (Soylu & Sade, 2012), impacts of climate change in Konya plateau have been researched in a multi-dimensional way and the relations among climate and soil preparedness, planting time, disease, weed, irrigation, pollination and harvest for barley, corn, sunflower and sugar beet have been stated. İt is also examined in the study interaction between climate change and ecological balance and the following outcomes are reached:

- The most important issue related to climate change in recent years in Konya and Karapınar is irrigation and water sources. The only key for agriculture in Karapınar region is water because

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most of the time the annual precipitation is not enough for economical production of any cultivated plant;

- It is said that in Konya 60% and in Karapınar %40 change of underground water is due to climate change and the rest is caused by overdrawn water;
- Drought in the region and drawing of water above annual harvest make it harder for the farmers to reach water every passing year;
- One of the impacts of climate change is potholes in Karapınar. There have been around 20 potholes in the region due to collapses since 1977;
- Most of the reed field in Karapınar and Hotamış has lost its wet area property. And water level in Meke, Acıgöl, Çıralı and Meyil lakes has decreased significantly compared to previous years;
- The arid climate of Karapınar area causes soil salinity. Due to lack of proper amount of precipitation combined with overdrawing of water, salinity causes important environmental problems;
- Some diseases which are not local were seen in some areas in 2010 and 2011 due to climatical changes.

Another study (Demir İ., 2013), for the region of Kırıkkale, Kırşehir, Aksaray, Niğde and Nevşehir provinces, includes assessment of cultivation areas of oily seed plants and yields and also impacts of climate change to oily seed plant according to 30 year climate projections until 2041. According to ECHAM5-A2 scenario of RegCM3 regional climate model, it is estimated that annual average temperature increase until 2041 will be between 0.2 and 0.6°C compared to 1961-1990 average and the minimum temperature change will be in spring and maximum temperature increase will be in summer and autumn (0.6-0.8°C). Annual total precipitation is estimated to increase by 5-25% compared to 1961-1990 average, especially this increase is expected to be around 30% in winter in South of Kırıkkale province, Kırıkkale and Aksaray province besides Niğde province. It is estimated a decrease (5%) in autumn in southwest of Kırıkkale and Kırıkkale and Aksaray and an increase (20%) in Niğde. According to the study result, when future climate change impacts for the next 30 years is taken into consideration, the region is in a better condition in terms of agricultural production compared to other areas in Turkey, however this change will significantly affect agricultural potential of the region. Annual temperature increase will intensify temperature stress of the plants; increased evaporation will have an adverse effect on yield and will increase the pressure on restricted irrigation potential. Particularly temperature increase during grain production time in sunflower, will adversely affect the development of table and it will cause grains to be thin in the table.

In a study (Ustaoglu & Karaca, 2014) that searches the impacts of climate change in hazelnut cultivation areas in Black sea Region, various estimation have been realized by using Reg CM3 regional model in order to propound whether current hazelnut cultivation areas will be affected. According to A2 worst case scenario, in the next 90 years regional temperature will increase by 6 ºC and this increase will have an adverse effect on hazelnut production however there will not be a change in the level production in terms of precipitation effect. This temperature increase could cause vertical and horizontal changes in location of olive cultivation areas. It is expected that lands in coastal area up to 250 m will be adversely affected from climate change and lands up to 1500 which are not proper for hazelnut growing could become suitable for hazelnut cultivation.

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In the study that analyses 2010-2011 agriculture drought (Şimşek, Gördebil, & Yıldırım, 2012), it is stated that there is a humid period in the country in general. Annual precipitation average which was 640 mm has risen to 709 mm and there has been a 11% increase compared to normal average. Considering the last 51 years, most arid agricultural season is 1972-73 with 477 mm and most wet season is 1962-63 with 840 mm. Turkey has an irregular precipitation regime. Variation in precipitation does not follow a significant path. And this shows that the country is a risk of drought with different level of severity. Agricultural drought in that agricultural year affected only south-eastern Anatolian Region with a decrease of 7% in precipitation. Other regions had normal or above normal precipitation.

Expected Impacts on Animal Breeding Sector

Impacts of global warming on animals occur as physical environment, biological environment, Physical environment conditions are felt through the impacts in maintenance and nutrition conditions.

Due to extreme climate conditions (too hot or too cold), animal housing becomes more costly and some decreases could occur in performance in reproduction, milk and meat yield. Furthermore because of the decrease in crop production areas, rangeland and fodder crop production could be adversely affected. Crop production could decrease due to rising sea level, drought and salinity thus it is expected that there will be a tendency to produce primarily for human consumption in existing areas. It is also expected that there will be adverse effects on animal health due to increasing vectors of some diseases and increasing temperature of atmosphere (Görgülü, Darcan, & Göncü, 2009).

Conclusion

Agriculture is a vulnerable sector all over the world since it depends on natural conditions. It is important for countries in terms of nutrition, employment and development. Turkey continues its effort in agricultural productivity and technology intensive production models to achieve its agricultural production goals. However in addition to that, natural disasters of which frequency and severity have increased should be taken into consideration. There happen losses in agricultural production (crop, animal and aquaculture production) thus this cause sustainability of agriculture to be at risk. Since agriculture is one of the most affected sectors by climate, the impact will increase in years, it can be concluded that serious measures need to be taken in this regard.

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Vulnerability Assessment in Water Sector

Since climate change impacts and water usage activities can vary from one region to another region, one of the most vulnerable river basins was selected.

General Information:

Distribution of Water Usage

Drinking Water Supply	%75
Irrigation	%15
Industry	%9

Climate Model Projections:

Data Sets of Global Model	Regional Model	Data Sets of Sensitiveness Analysis Test	Period
HadGEM2-ES MPI-ESM-MR	RegCM4.3.4	• CRU (1971-2000) • UDEL (1971-2000)	1971-2000 (RF) 2013-2099

Results of the Climate Modelling Study

HadGEM2-ES

Temperatures raises may reach 2-3 °C according to RCP 4,5. There is no trend in annual precipitation. But precipitation is wetter till 2050, unlikely a more arid climate can be expected after 2050.

Temperatures raises may reach and 5 °C according to RCP 8,5, precipitation is similar to the RCP 4,5 but negative anomalies are more frequent and severe.

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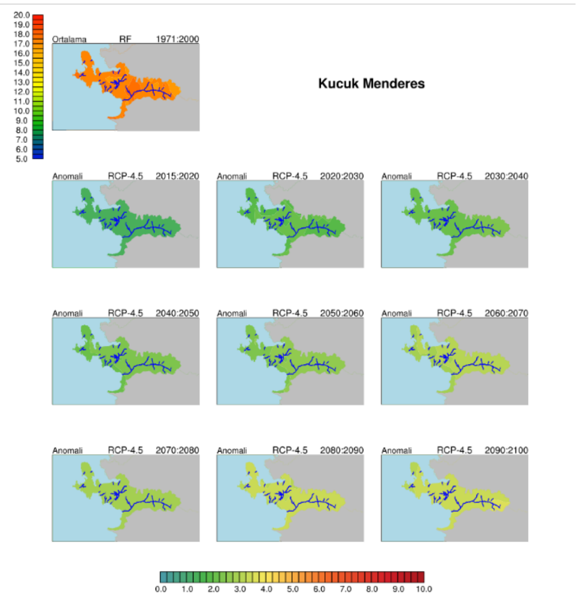
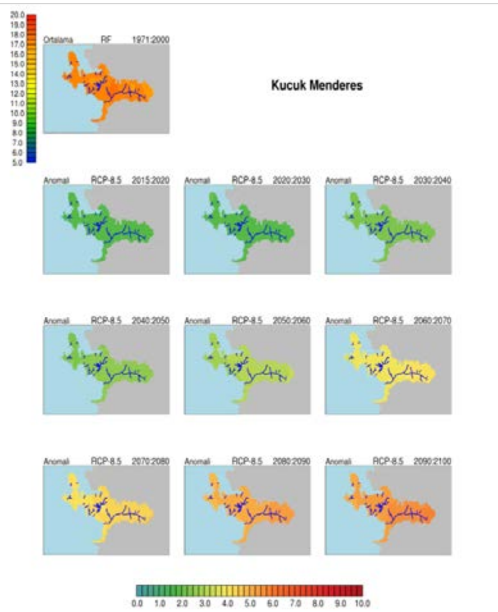
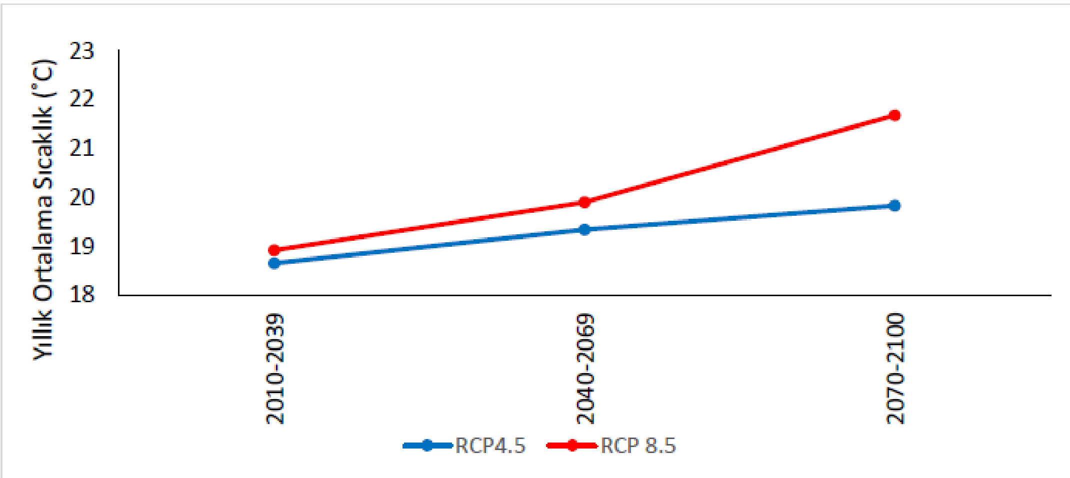
Average Temperature *HadGEM2-ES*

RCP 4,5 **RCP 8,5**







Precipitation HadGEM2-ES

RCP 4,5 **RCP 8,5**

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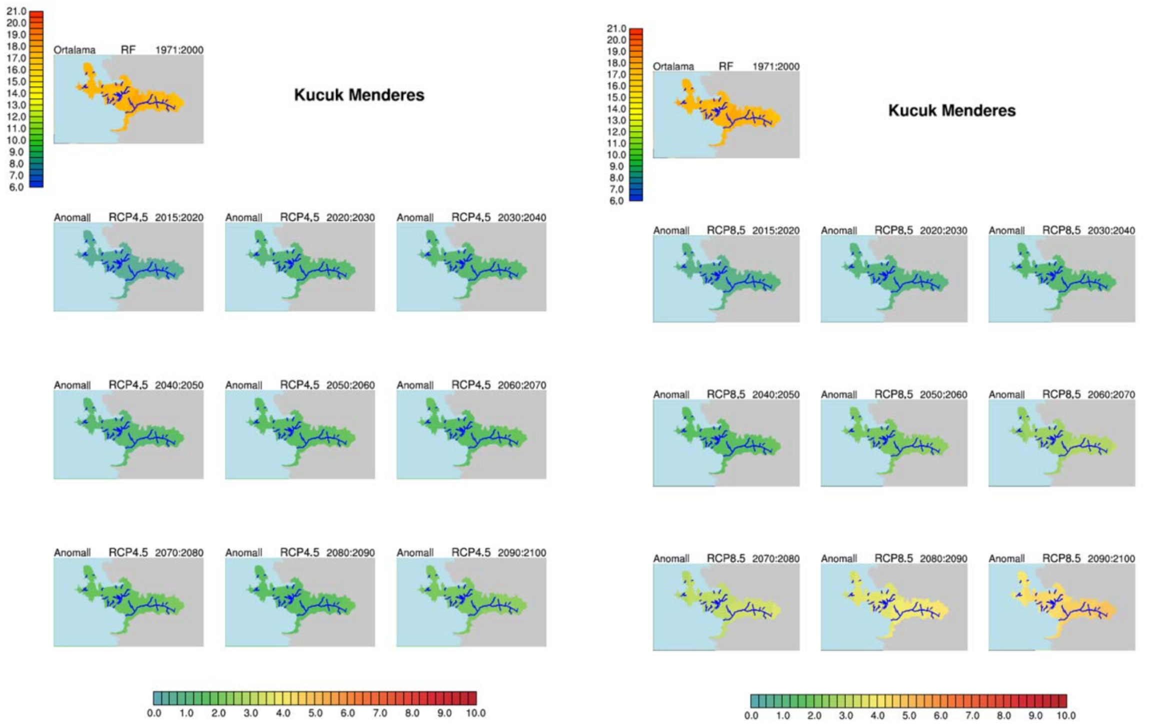

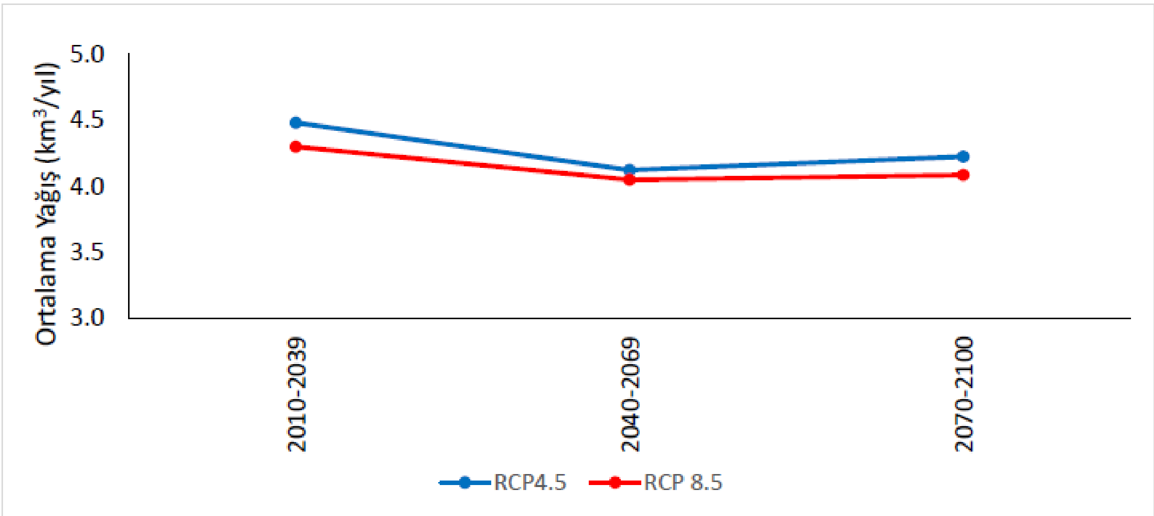

MPI ESM-MR

Temperatures raises may reach 2°C according to RCP 4,5 and annual precipitation is expected to decrease especially in the period of 2020-2030.

Temperatures raises may reach and 4 °C according to RCP 8,5, precipitation decrease is more than RCP 4,5.

Average Temperature *MPI ESM-MR*

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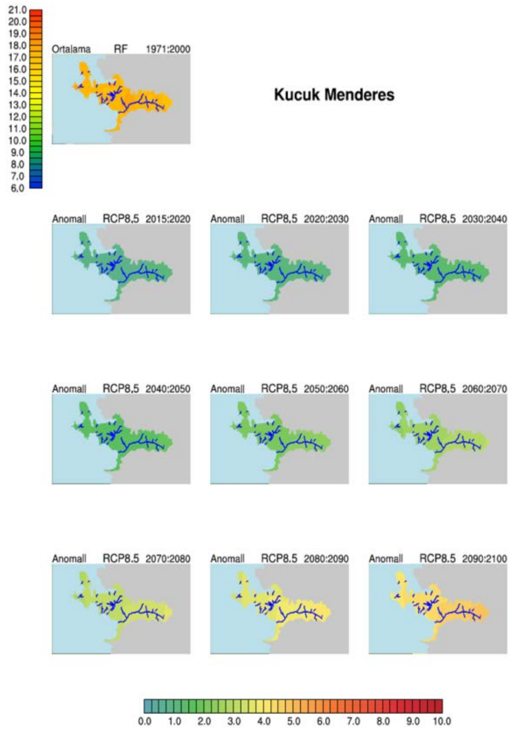
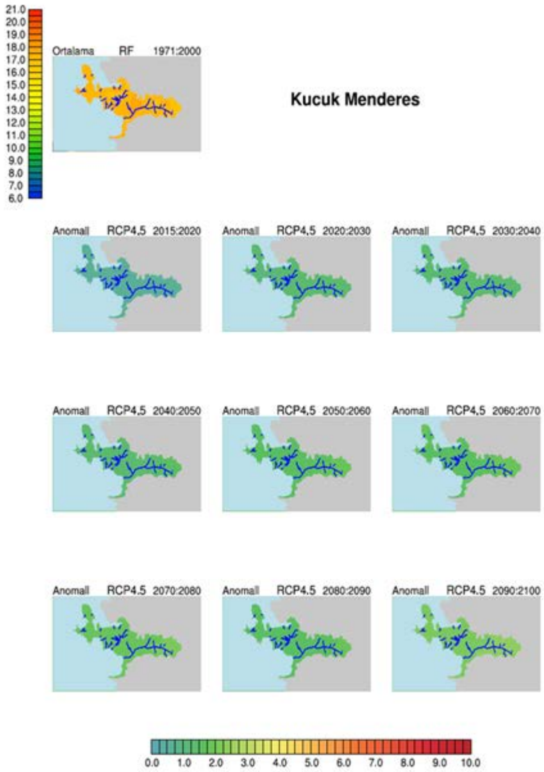
RCP 4,5



RCP 8,5



Precipitation *MPI ESM-MR*

RCP 4,5

RCP 8,5

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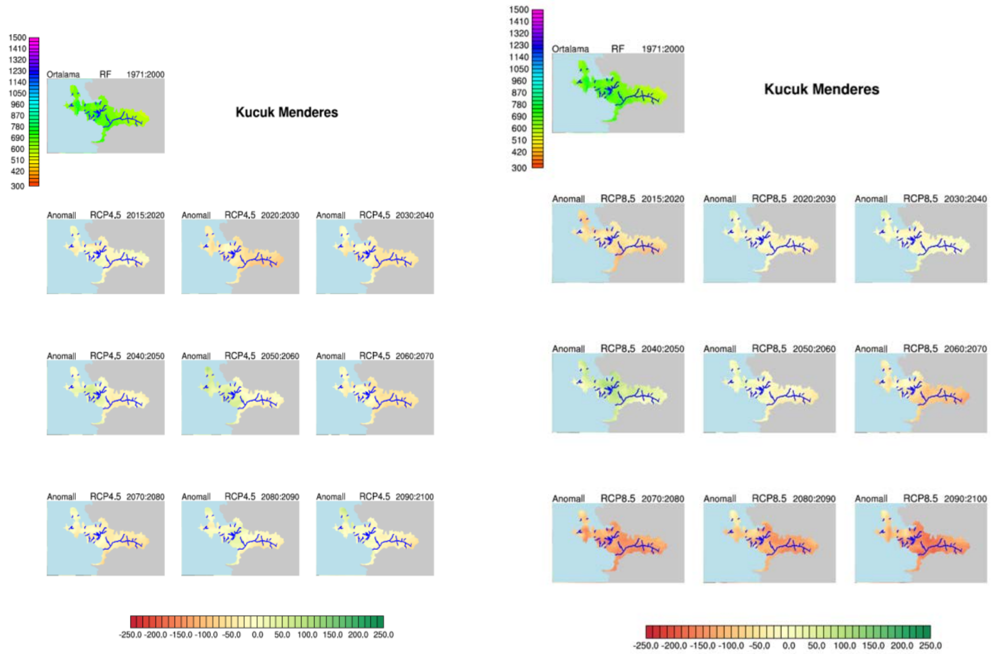
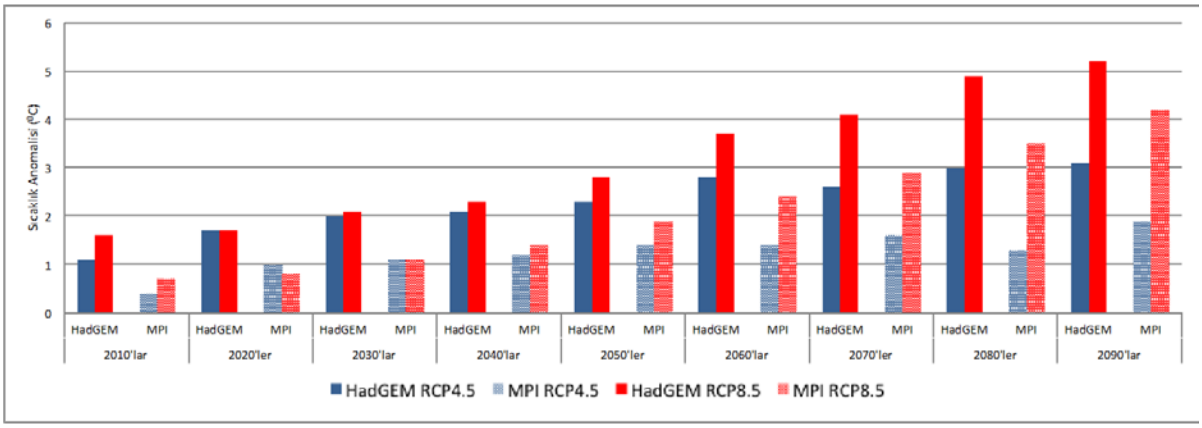
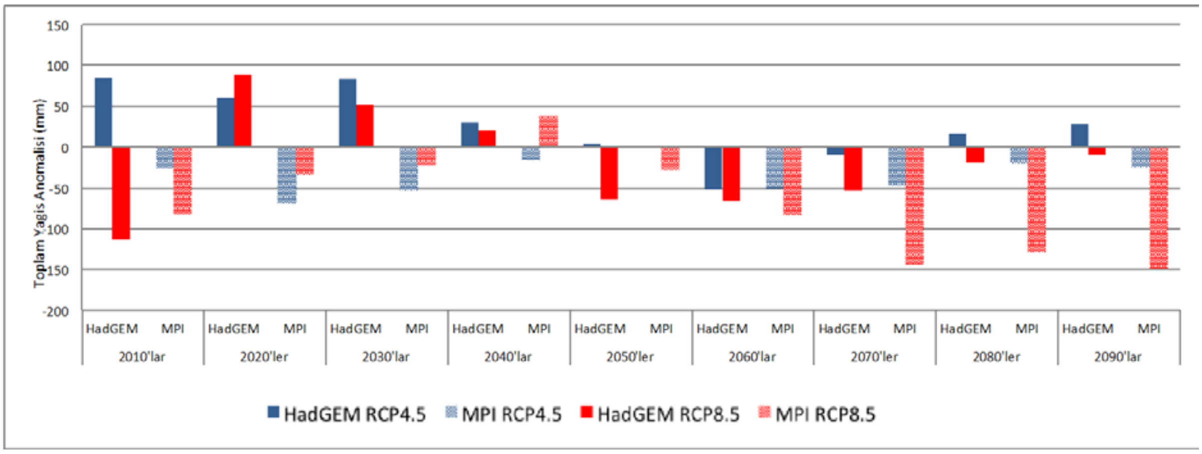


Temperature and Precipitation Anomalies Figure (2 models together)





Vulnerability Assessment:

Exposure Chart on Water Resources

Sector	2015-2040	2040-2070	2070-2100
Drinking Water Supply	**2**	**3**	**4**
Irrigation	**1**	**2**	**3**
Industry	**1**	**2**	**2**

1 to 5

1: no change

2: unlikely to be adversely affected

3: yes, will be affected

4: yes, will be severally affected

5: yes, will become unmanageable

Adaptation Capacity Chart on Water Resources

Sector	2015-2040	2040-2070	2070-2100
Drinking Water Supply	**1**	**3**	**4**
Irrigation	**1**	**2**	**3**
Industry	**1**	**2**	**2**

1 to 5

1: able to adapt with no problem

2: able to adapt with fare minor challenges

3: should be able to adapt, but will face

4: may be unable to adapt without increased support and resources

5: unable to adapt without substantially increased support and resources

Vulnerability Assessment Chart on Water Resources

Vulnerability = Exposure x Adaptation Capacity

Sector	2015-2040	2040-2070	2070-2100

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Drinking Water Supply	**2**	**9**	**16**
Irrigation	**1**	**4**	**9**
Industry	**1**	**4**	**4**

Task 3 – Adaptation Needs

Existing Studies and Adaptation Needs in Agriculture Sector

Prepared by Ministry of Food, Agriculture and Livestock, General Directorate of Agricultural Reform

Agriculture is a vulnerable sector all over the world since it depends on natural conditions. It is important for countries in terms of nutrition, employment and development. Turkey continues its effort in agricultural productivity and technology intensive production models to achieve its agricultural production goals. However in addition to that, natural disasters of which frequency and severity have increased should be taken into consideration.

There happen losses in agricultural production (crop, animal and aquaculture production) thus this cause sustainability of agriculture to be at risk. The impact of climate change will increase in years, therefore adaptation measures need to be taken. Some of the adaptation actions that are being conducted:

- As an addition to technical measures, producers suffering from disasters should be supported financially as well to maintain sustainability. From this point of view agricultural insurance is the most important tool for agricultural risk management. Hail, storm, landslide, earthquake, flood, frost, death and disease (for ovine, bovine and poultry animals, beekeeping, and aquaculture) are in the scope agricultural insurance system. There is state premium support (mainly %50, for some cases e.g. frost in open area orchards %66,7). And it is planning to extend the scope of agricultural insurance with extreme and timeless precipitation and drought after the completion of its project.
- As a measure to increase carbon sinks, rehabilitation of rangelands activities are being executed. An area of 4,7 million da in total has been rehabilitated.
- In 2010-2015 period, land consolidation in an area of approximately 5 million ha has been completed. By land consolidation, parcels get bigger and it becomes easier to implement new agricultural techniques and irrigation methods; the distance between the centre of enterprise and parcel shortens; the ratio and efficiency of irrigation increase; saving from machines and labour increases.
- In Environmentally Based Agricultural Land Protection (ÇATAK) Program, it is aimed to protect areas for soil and water quality, sustainability of natural resources, prevention of erosion and decreasing adverse effects of agriculture. As of 2013, in 30 provinces grant of 98 million TL has been given in this regard. Furthermore, it is planning to increase income of agricultural producers through taking “minimum tillage” into program and decreasing input costs.
- Drought Test Centre has been opened. In this centre for combatting drought, the water utilization capacity and efficiency and water stress tolerance levels are being identified for all the field crop species that are cultivated in Turkey. As a start, scanning studies have been initiated taking into consideration of drought tolerance parameters of rehabilitation materials

of bread/durum wheat and barley under greenhouse, laboratory and field conditions.

It is known that drought, as one of the biggest problems on the global scale, will affect all levels of our lives, namely physical and natural environment, urban life, development and economy, technology, agriculture and food, clear water and health as of current situation. For taking the necessary measures in terms of adaptation, Strategy and Action Plan for Combatting Agricultural Drought in Turkey has been prepared.

Main objective in combatting agricultural drought is to take all necessary measures when there is no drought with sustainable agricultural water usage planning in terms of environment by taking supply – demand management into consideration through including all shareholders to the process and increasing public awareness; to ensure minimization of drought effects by applying an effective combatting program during crisis.

For coordinated conduction of Strategy and Action Plan for Combatting Agricultural Drought, management consists two parts, central and provincial. Activities of central and provincial units have been determined.

a) Central Management; (Agricultural Drought Management Coordination Board)
    1. Monitoring Early Warning and Estimation Committee,
    2. Risk Assessment Committee,
    3. Data Flow Unit have been established.

Provincial Management; Agricultural Drought Provincial Crisis Centres have been established under the presidency of Governors.

It is planning to develop institutional capacity to ensure that combatting is realized under an integrated and comprehensive approach and to provide a structure where drought affects agriculture sector at minimum level.

Adaptation Needs – Water Sector

Prepared by Ministry of Forestry and Water Affairs, General Directorate of Water Management

The water sector is a primary sensitive sector for climate change. This counts for water management and irrigation, water quality management, drinking water supply and sanitation, as well as planning and protection of coastal zones.

Climate change leads to the following trends or step changes that change groundwater and surface water quality and quantity:

1. Increase in average air temperature, leading to higher water temperature of fresh water bodies, seas and oceans, and increased evapotranspiration. This leads to changes in chemical and ecological water quality and may change the fish stock. Increased evapotranspiration increases water scarcity and changes vegetation, with possible increase of erosion, land degradation and increased sediment loads in rivers, lakes and coastal zones;
2. Sea level rise with increased risks of floods and salt intrusion. It also obstructs drainage in delta rivers;

3. Melting of glaciers and ice, leading to changes in discharge regimes of rivers and streams e.g. the dry season minimal flow;
4. Changes in global and regional precipitation averages, intensities and/or distribution. On global scale, it is expected that the hydrological cycle will intensify and average rainfall will increase, but this differs for parts of the earth, some become wetter, and others dryer. Climate models disagree on which parts become wetter or dryer, so one should reckon with uncertainties;
5. Changes in weather: frequency, intensity and timing of rainfall, storms and droughts. This is the least known and least predictable part of climate change, as it happens at regional and local scale, not well described by global models. It is expected that weather becomes rougher with more and more intense rainstorms and longer and more intense droughts. Changing weather influences frequency, timing and intensity of peak flows, dry season minimal flow and water availability. It may also change the recharge of shallow groundwater and the groundwater level, with consequences for vegetation, agriculture and water availability in wells.

As it is known that climate modelling studies have been executed in Turkey and a sample vulnerability analysis report for Küçük Menderes River Basin have been shared with the ECRAN Project participants. The Vulnerability Assessment Chart on Water Resources can be seen in the Table 1 below.

Table 6. Vulnerability Assessment Chart on Water Resources

Sector	2015-2040	2040-2070	2070-2100
Drinking Water Supply	**2**	**9**	**16**
Irrigation	**1**	**4**	**9**
Industry	**1**	**4**	**4**

A shift to winter rains will potentially lead to more runoff, flooding, greater storm damage, scour, and erosion during a time when there is reduced vegetative cover and low evapotranspiration during the winter months. Higher summer temperatures, less summer precipitation, and an increase in drought frequency and duration will affect both water quantity and quality. Some intermittent streams may cease flowing earlier in the season and more frequently and some perennial streams may become intermittent.

Water is also critical in relation to climate change mitigation, as many mitigation actions rely on water availability for their long-term success.

Additionally, aquatic ecosystems are vulnerable to climate change. Predicted changes in timing, frequency, and duration of precipitation events, more intense storms, a shift from winter snow to rain, more frequent and longer summer droughts, and increases in temperature trends and extreme high temperatures will affect both lotic (flowing water) and lentic (still water) habitats. Water quality and quantity are expected to be adversely affected by predicted increased temperature, drought, an increase in the number of extreme heat days, and a decrease in summer precipitation. Higher temperatures, along with changes in stream flow, will degrade water quality. Warmer, drier conditions will lead to deeper and stronger thermal stratification in lakes which will decrease the volume of the deeper, cooler, well oxygenated water that is critical summer habitat to a number of species.

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Taking into account the negative effects of climate change and the results of vulnerability analysis, the related bodies for water management should take the necessary steps given below:

- Raising awareness of the need for climate change adaptation;
- Increasing resilience to current climate extremes;
- Taking timely action for long-lead time measures;
- Addressing major evidence gaps;
- Combining Mitigation and Adaptation Strategies;
- Advance Risk and Vulnerability Assessments;
- Evaluating and Prioritizing Adaptation Strategies for Implementation;
- Supporting Local Communities;
- Improving Planning and Land Use Practices;
- Enhancing Emergency Preparedness;
- Encouraging Ecosystem-Based Adaptation;
- Seeking Expert Advice and Stakeholder Input;
- Ensuring Agency and Regional Coordination;
- Promoting Communication and Outreach.

As it is seen in Table 1, drinking water-related issues play a pivotal role among the key regional and sectoral vulnerabilities in all three period. So, seepage losses may be the first and the main measurement in the short, medium and long term. Therefore, the relationship between climate change and freshwater resources is of primary concern and interest. Then, some necessary measures may be taken in medium and long term to diminish the water demand, like reprising the water usage. Finally technological development and water reuse and recycling should be taken into consideration, especially in the long term due to the expected negative effects of climate change on water resources. Please see Table 2 for the projected total water demand; see Table 3 for the water demand in industry; and see Table 4 for the water demand in irrigation between the periods 2015-2100 in Küçük Menderes River Basin.

Table 7. Total Water Demand Projection based on years in Küçük Menderes

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Years	Küçük Menderes River Basin	
	Population	Water Demand (million m^3/year)
2015	4.208.289	559,61
2020	4.534.072	604,24
2030	5.110.456	626,19
2040	5.523.576	671,10
2050	5.678.896	637,27
2060	5.678.896	637,27
2070	5.678.896	591,75
2080	5.678.896	591,75
2090	5.678.896	552,30
2100	5.678.896	552,30

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Table 8. Water Demand Projections based on years for Industry in Küçük Menderes

Years	Water demand change due to industrial development (million m^3/year)
2015	70,45
2020	79,06
2030	98,08
2040	111,38
2050	120,62
2060	130,62
2070	141,45
2080	150,92
2090	158,64
2100	166,75

Table 9. Water Demand Projections based on time periods for Irrigation in Küçük Menderes

Years	Water demand for irrigation (million m^3/year)
2015	112,40
2020	134,88
2030	146,12
2040	157,36
2050	168,60
2060	168,60
2070	168,60
2080	168,60
2090	168,60
2100	168,60

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Within this scope some adaptation measures can be counted below for Küçük Menderes River Basin:

- Improvement of water-use efficiency by recycling water or water saving Technologies;
- Reduction in water demand for irrigation by changing the cropping calendar, crop mix, irrigation method and area planted;
- Reduction in water demand for irrigation by promoting agricultural products;
- Promotion of indigenous practices for sustainable water use;
- Expanded use of water markets to reallocate water to highly valued uses;
- Improved efficiency of waste water treatment;
- Importing water intensive products;
- Importing water intensive products;
- Greater use of water markets (price incentives to use less);
- Reduced leakage and discharges;
- Curb floodplain development and early warning.

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