

# Sava River Basin Management Plan

## Background Paper No. 10 **Climate change and RBM planning**

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# 1 Introduction

The primary purpose of this paper is to summarise activities in the Sava RB countries related to climate change. In the document are proposed guiding principles that should be of assistance to the decision makers at the developing a strategy for building adaptive capacity for management of the Sava RB under climate change. The text provides an overview of the National Climate Change policies and legislation of the Sava countries, information on future trends based on the results of available studies, summary of major projects concerning climate change in the Sava RB and suggestions for further steps regarding climate change in the second planning cycle of the Sava RBMP.

## 2 Relevant EU and National Climate Change policies and legislation

Several existing EU policies and initiatives contribute to efforts for adaptation to climate change with regard to water issues. The most important ones are the WFD, EU Floods Directive, Water Scarcity and Droughts EU Policy as well as the EC's White Paper on Adaptation.

Although climate change is not explicitly included in the text of the WFD, the step-wise and cyclical approach of the WFD river basin management process makes it well suited to handle climate change issues.

The Floods Directive (2007/60/EC) with its core elements of the flood risk management cycle (preliminary flood risk assessment, flood hazard, risk maps and flood risk management plans) explicitly includes climate change issue. EU Member States are clearly expected to take into account the likely impacts of climate change on the occurrence of floods.

On 29 June 2007 the European Commission adopted a Green Paper „Adapting to climate change in Europe – options for EU action“(COM/2007/354), which defines priority options for action in order to reduce the effects of climate change:

- Early action to develop adaptation strategies in areas where current knowledge is sufficient;
- Integrating global adaptation needs into the EU's external relations policy and building a new alliance with partners around the world;
- Filling knowledge gaps on adaptation through EU-level research and exchange of information;
- Setting up a European advisory group on adaptation to climate change to analyze coordinated strategies and actions.

The White Paper of the European Commission “Adapting to climate change: Towards a European framework for action” (COM/2009/147) was issued in April 2009 and sets out a framework to reduce the EU's vulnerability to the impact of climate change.

In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted as the basis for a global response to the problem of climate change. The ultimate objective of the Convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system. Under the Convention, governments:

- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries;
- Cooperate in preparing for adaptation to the impacts of climate change.

The Convention entered into force on 21 March 1994 and currently, there are 194 Parties. An overview of dates of signing the UNFCCC by the Sava River Basin countries can be found in Table 1. The First National Communication under UNFCCC was issued by Slovenia in July 2002, Bosnia and Herzegovina in May 2010 and Croatia in December 2010. There is a currently on-going project „Assistance for preparation of the First National Communication for the implementation of the UNFCCC” in Montenegro, whereas 31 December 2010 was the closing date of the project „Enabling Activity for the Preparation of Serbia and Montenegro's Initial National Communication to UNFCCC” in Serbia.

**Table 1: United Nations Framework Convention on Climate Change, Chapter XXVII, Environment, status as of 29/08/2010 for the Sava River Basin countries**

Country	Ratification/Acceptance Accession /Approval/Succession	Entry into force
Slovenia	1 December 1995	29 February 1996
Croatia	8 April 1996	7 July 1996
Bosnia and Herzegovina	7 September 2000	6 December 2000
Serbia	12 March 2001	10 June 2001
Montenegro	23 October 2006	

The Kyoto Protocol, which was agreed in 1997 as a voluntary effort to reduce greenhouse gas emissions under the UNFCCC had proved inadequate. The protocol came into force on 16 February 2005. As of October 2006, the Kyoto Protocol has been ratified by 162 countries and international organisations and is widely seen as a first step in deeper and broader action to cut greenhouse gas emissions in this century.

**Table 2: Status of the Sava River Basin countries as signatories to the Kyoto Protocol**

Country	UNFCCC	Reduction commitment for 2012	Signed Ratification/ Acceptance Notes
Slovenia	Member	-8%	21 October 1998 August 2002
Croatia	Member	-5%	11 March 1999 27 April 2007
Bosnia and Herzegovina	Member		16 April 2007
Serbia	Member		24 September 2007
Montenegro	Member		4 June 2007

At the European level the Commission responded in June 2000 by launching a comprehensive package of policy measures to reduce greenhouse gas emissions through the European Climate Change Programme (ECCP).

The goal of the ECCP is to identify and develop all the necessary elements of an EU strategy to implement the Kyoto Protocol. The development of the first ECCP involved all the relevant groups of stakeholders working together, including representatives from the Commission's different departments (DGs), the Member States, industry and environmental groups. The second European Climate Change Programme was launched in October 2005.

The Sava countries are at different stages of preparing, developing and implementing national adaptation strategies (for an overview, see Table 3). The development depends on the magnitude and nature of the observed impacts, assessment of current and future vulnerability and the capacity to adapt.

**Table 3: Status of national adaptation strategies to climate change as of November 2011**

Country	UNFCCC	Status
Slovenia	Member	No
Croatia	Member	No
Bosnia and Herzegovina	Member	No
Serbia	Member	No
Montenegro	Member	No

### 3 Overview of the Sava River Basin climate circumstances

The Sava River Basin is a major drainage basin of the South Eastern Europe covering the total area of approximately 97,713 km<sup>2</sup>. Geographically, it spreads between 13.67°E and 20.58 ° E longitudes and between 42.43°N and 46.52°N latitude.

Average annual air temperature for the whole Sava River Basin was estimated to about 9.5°C. An average annual rainfall over the Sava RB was estimated at about P = 1,100 mm. The Sava River length is 990 km. Its average discharge at the confluence to Danube (Belgrade - Serbia) is about 1,700 m<sup>3</sup>/s which results in a long term average unit-area-runoff for the complete catchment of about 18 l/s km<sup>2</sup>. This is equivalent to an effective rainfall of about 570 mm/year. Accordingly, it can be concluded that the average evapotranspiration for the whole catchment is about 530 mm/year (SRBA Report, 2009).

The Sava River Basin floods have seasonal character, usually appearing in the spring and in the autumn. Spring floods are the result of snow melting, while autumn floods are caused by a heavy rainfall.

A significant difference can be noticed in the flood travelling time on the Sava River between the floods in 1930s and 1960s. The earlier floods had routing periods of 8-9 days, while those on 1960s had considerably shorter travel time - only 4-5 days (flash floods). Droughts distribution over the Sava River catchment is inhomogeneous. They

were not comprehensively analyzed since 1974. Keeping in mind that 35 years passed since the last data was analyzed, it is clear that a new hydrological study of historical droughts should be undertaken. It should use longer time series, including recent years.

### 3.1 Overview of available future trends

The latest report of the IPCC (IPCC, AR4, 2007) included the region of southern Europe in global regions that are highly sensitive to climate change. In further text the data on future trends were taken from the First Communication under the UNFCCC that Sava Basin countries have contributed to.

#### 3.1.1 Slovenia

Observations in Slovenia point to the great spatial diversity of trends in air temperature and rainfall. Due to the relatively short period of measurements and extensive natural variability of the climate, the trends have only a low statistical significance.

##### *Temperature*

The first systematic measurements of temperature in the territory of Slovenia were carried out in 1851 in Ljubljana. The trend of results of temperature measurements shows a noticeable increase. For medium term (ca. 2025) incremental climate change scenarios used for Slovenia prediction show increase of  $+1^{\circ}\text{C}$   $\pm 0.5^{\circ}\text{C}$ . For the long term (ca. 2075) incremental climate change scenarios used for Slovenia prediction shows increase of  $+2.5^{\circ}\text{C}$   $\pm 1^{\circ}\text{C}$ .

##### *Precipitation*

Measurements of the annual quantity of rainfall show a slight decrease. Increased evapotranspiration and the possible change in rainfall quantity will have an impact on ground and surface waters. For medium term (ca. 2025) as well as long term (ca. 2075) incremental climate change scenarios used for Slovenia prediction shows increase of 0%  $\pm 10\%$  in annual quantity of rainfall.

##### *Runoff and water levels*

In general, it can be expected that average annual outflow will decrease. Model calculations show a decrease in outflow even with a 10% increase in the rainfall and a temperature increase of  $2.5^{\circ}\text{C}$  across the entire territory of Slovenia.

The reduction in low flows will also affect the self-cleaning capability of waters due to the smaller dilution of emissions and, in the summer months, also due to lower oxygen levels, which results from higher watercourse temperatures. It can be expected that the pressure on watercourses from which water is captured for the needs of water supply will intensify.

It is estimated that vulnerability to floods will increase in the future due to the combined impact of direct anthropogenic factors (change in the outflow properties of watercourses, settlement of border flood regions) and climate change.

Due to the temperature increases and potential greater frequency of droughts, water consumption by the end users is expected to increase, while the conditions for water supply are likely to deteriorate. The quality of water from watercourses has a tendency to deteriorate, which together with the effects of climate change is worsening the capacities for the supply of quality drinking water.

#### 3.1.2 Croatia

##### *Temperature*



Regional models of air temperature variations show a temperature increase over the territory of Croatia ranging from 2.4°C to 3.2°C in the lowland areas of the country. The greatest changes are likely to be seen during the summer months, with an anticipated temperature increase ranging from 3.2°C to 3.6°C in the lowland part. The daily temperature range (MAX-MIN) is decreasing (statistically significant change). The temperature rise causes significant overall increases in potential evapotranspiration (e.g. Osijek - 15 %).

#### *Precipitation*

The annual precipitation shows a decreasing trend. Decreases in precipitation cannot meet the water needs of plants (due to increased evapotranspiration), the result of which is a significant decline in runoffs and soil moisture in Slavonia.

#### *Runoff and water levels*

Significant decreases in runoffs can have a negative effect on water management, while the decline in soil moisture can have an adverse impact on vegetation. In the past two decades there is a decreasing trend in median and minimum annual water levels. Based on the existing climate change forecasts for Croatia, runoffs in the typical catchment areas of western Croatia and in the region of Dinaric karst could be reduced by 10 to 20 percent in relation to the present situation. In the eastern part of Croatia, these changes are expected to be below 10 percent. Demand for water will increase in Croatia during the summer and vegetation season (from April to September).

### **3.1.3 Bosnia and Herzegovina**

Projections of future climate change were made using the EH50M global model developed at the Max Planck Institute for Meteorology (Hamburg, Germany), which includes dynamic interaction of atmosphere/ocean/precipitation.

#### *Temperature*

The temperature is projected to increase from 0.7 to 1.6°C per 1°C of global increase. The largest temperature increases would occur in summer, and in inland areas. The second largest increase would occur in the autumn (2-3°C everywhere). Spring temperatures could rise by approximately 2°C and winter and spring temperatures could rise by less than 2°C. Average maximal daily temperature is expected to raise more than average minimal daily temperature.

#### *Precipitation*

During the winter period (December-February), precipitation will increase. The rainfall may also be heavier. In summer the climate will be noticeably drier.

Reduction in rainfall will be especially noticeable in summer (June-August) during the period 2031-2060 when already small amounts of rainfall could be halved. This means that the part of BA will be affected by the reduction of the precipitation.

Potential evapotranspiration (PET) is a more stable parameter than precipitation. The annual average PET in BA is about 725 mm.

#### *Runoff and water levels*

As no specific research has been carried out in Bosnia and Herzegovina regarding the impact of climate change on hydrology and water resources, projections on the runoff and water levels cannot be obtained.

### 3.1.4 Serbia

#### *Temperature*

General projection covering all country, except the south-eastern part, shows increase of the average yearly temperature in a level of 0.04°C per year. Results of the general projection for entire territory of Serbia shows clearly trend of temperature rise for period 1951-2004.

As for future trends, by implementation of the A1B regional climate models for Serbia, for the period 2001 – 2030 it is possible to observe the raise of the temperature from 0.8 to 1.1 °C for the analysed period. By implementation of harsher scenario A2 for the period 2071 -2100 the raise of the temperature would be from 3.4 to 3.8°C for the observed period.

#### *Precipitation*

For the period of 1950–2004, excluding the eastern and southern part of the country, it is possible to conclude that there is a rise of yearly precipitation. Number of the days with precipitation larger than 1 mm was in decrease since 1976 for the whole territory of Serbia, while the percentage of the yearly sum of precipitation increased due to the precipitation larger than 95-percentile calculated for the period of 1961-1990. In summary, in these three analysed decades the total amount of precipitation was decreasing, but the number of days with intensive rainfall increased.

For the period up to 2020 various climate models show the decrease of the average precipitation level in average by 15% (16.9% in the vegetation period and 13.9% in the non vegetation period), and up to 2100 the estimated decrease is 25.1% (in vegetation period 13.4% and in non vegetation 39.6%).

#### *Runoff and water levels*

Preliminary estimations of the climate change impacts on the water resources conclude that until 2100 it is possible to expect a decrease of water discharge on the national level. Results of the various climate models such as NCAR, MPI or RegCM, are that the expected decrease in water discharges until year 2020 will be 12.5% (for the vegetation period 11.1%) and until 2100, up to 19% (for the vegetation period 5.4% but 32% for the non vegetation period) of today's average levels.

Average yearly sum for evapotranspiration until 2020 will decrease for 16.5% (in vegetation period 18.5% and for non vegetation period 13.9%) and until 2100 for 27.2% (in vegetation period 15.7% and for non vegetation period 43.6%).

### 3.1.5 Montenegro

The intensity and frequency of climatic extremes such as droughts, floods, landslides, erosions, heat waves, extremely high and low temperature, heavy precipitation with short duration, forest fires, conditions appropriate for spreading epidemics, pests and diseases, etc., show the trend of changes. There is a reasonable amount of information on national climate change projections.

#### *Temperature*

The trend of increase in temperature from the second half of the 20<sup>th</sup> century has been recorded in most parts of Montenegro. Projected changes are:

- An increase in temperature of 2°C in the winter season;
- An increase in temperature of 2–3°C in the summer season (with projected 0.2°C per decade, the most rapid increase in the last 10,000 years).

#### *Precipitation*

A reduction of precipitation of 5–15%, especially in the warmer part of the year cases, consequently to a reduction of soil humidity of 15–25%.

#### *Runoff and water levels*

National statistics record a significant increase in the capture of water for water supplies from 95,133,000 m<sup>3</sup> in 2002 to 101,866,000 m<sup>3</sup> in 2006.

## **3.2 Summary of approach dealing with climate change in the Sava RB**

The priority for dealing with climate change in the first cycle of implementing the WFD in the Sava RB will be to propose a set of guiding principles that should help those in charge of the Sava RB management in setting up a strategy for building adaptive capacity in the basin to respond to climate change, such as:

- Consideration of the increased risk, due to climate change, of not achieving the WFD objectives (e.g. good status of water bodies) as a consequence of the identified WFD pressures (e.g. organic pollution);
- Looking for opportunities in the monitoring programmes, on-going and future project to improve understanding of climate change trends in a way allowing for decision making in the second cycle of the Sava RBMP.

It should be emphasized that in the first RBM planning cycle the objective is not to incorporate climate change into typologies, description of reference conditions or objective settings for determination of status of water bodies.

## **3.3 Major projects concerning climate change in the Sava RB**

### **3.3.1 Climate Change and Impacts on Water Supply (CC-WaterS)**

Project start date: May 2009

End date: April 2012

Climate change (CC) affects fresh water resources and may have significant influence on public drinking water supply. Land use activities exert pressure on water resources and will change according to CC. It is crucial for safeguarding future water supply to anticipate this climate and land use changes and to assess their impacts on water resources. Transnational action is needed to prepare SEE for the challenge of ensuring water supply for society for several decades. Policy makers and water suppliers are required to develop sustainable management practices for water resources, considering existing and future CC influences. Therefore CC-WaterS will identify and evaluate resulting impacts on availability and safety of public drinking water supply for several future decades. Elaborated measures to adapt to those changes build the ground for a Water Supply Management System regarding optimization of water extraction, land use restrictions, and socio-economic consequences under climate change scenarios for water suppliers in SEE. The joint actions to produce this technical system will be performed on a transnational level in the Alps, Danube Middle and Lower Plains and coastal areas representing different SEE-characteristic climates and topography. In CC-WaterS, SEE governmental bodies, water suppliers and research institutions work together and implement jointly developed solutions, hence to be applied on a regional or local level in SEE. The complementary knowledge of the partners, enhanced by further

applicable results of past projects, will provide a strong background. Capitalising already existing knowledge and data from EU-funded scientific projects and eliminating parallel investigations, CC-WaterS will make information applicable for concrete solutions, develop tools and instruments for public water supply and implement safeguarding measures. An accessory dissemination strategy will ensure that CC-WaterS durable results are transferred to the relevant users.

### **3.3.2 Drought Management Centre for South East Europe (DMCSEE)**

Project start date: April 2009

End date: March 2012

Droughts have dramatically increased in number and intensity in some parts of Europe. The vulnerability to drought impacts in South East Europe (SEE) is higher in comparison to neighbouring regions. Ineffective water management is seen as the fundamental problem and can induce additional problems when drought occurs. Droughts have become a strategic issue in SEE. National focal points of the UN Convention to Combat Desertification (UNCCD) (national authorities in the field of drought and desertification) and national permanent representatives with World Meteorological Organization decided to address a threat of drought and desertification and to establish a Drought Management Centre for SEE (DMCSEE). Environmental Agency of Slovenia was selected by agreement of all parties to organise sustainable, long term work of DMCSEE once its functions will be established through the execution of this kick-off project. DMCSEE will coordinate development and application of drought risk management tools and policies with the goal of improving preparedness and reducing drought impacts. It will introduce and continue to provide now missing regional information on drought situation. Since definitions and thresholds for drought differ on country/region levels today, the partnership will agree upon an integrated approach combining outputs of meteorological services and information from agricultural institutions. Using common methodology in drought analysis and impact assessment the project will obtain regionally comparable results enabling better overview of drought situation for sectors economically dependant on water availability, such as agriculture, energy and tourism. Quality assessments of drought occurrence risk and possible drought impacts provided by DMCSEE and disseminated to decisions makers and general public will allow effective and timely decisions to reduce drought related damages.

### **3.3.3 Impacts of climate change in South-East Europe**

The project started on 24 September 2007 and finished on 1 December 2008.

The project was set out to assist and increase the capacity of the South-East European (SEE) countries in transition, including Albania, Bosnia-Herzegovina, Montenegro, Serbia and Turkey in taking the necessary measures to maintain the quality of their biodiversity and to avoid, where possible, further damage to ecosystem services on which local communities are dependent. The results could also feed into the discussions on climate change and biodiversity in the framework of the EU, the Environment for Europe process and the Convention on Biological Diversity (CBD).

Partners on the project were ECNC-European Centre for Nature Conservation (coordination) and REC-Regional Environmental Centre for Central and Eastern Europe.

### 3.3.4 Pilot project on water and climate change adaptation in the Sava River

The project aims to support further expansion and strengthening of collaboration in the Sava River basin, to address transboundary management floods, specifically taking into account impacts of climate change on flood risk management.

## 3.4 Suggestions of further steps regarding climate change in the Sava RBMP

According to the recommendations from the EU CIS on Climate change the issue of climate change is recognized on the basin scale. With the outcomes of the listed on-going projects more detailed analysis of the effects of the climate changes on the Sava River Basin and water management will be available. Upon those outcomes it will be possible to climate proof the next cycles of the Sava RBMP.

Accomplishing of following activities should be considered in the frame of the WFD climate check:

- Assessment of the vulnerability of groundwater resources to climate change focussing on water quantity and quality, and the recharge of aquifers.
- Assessment of resilience to climate change of water management practices planned by the institutions for transboundary, national and regional/local water management.
- Estimation of the scale of impacts of climate change on the assessment of pressures and risks according to WFD - both primary and secondary (arising from human responses to climate change) pressures should be taken into account.
- Review of the robustness of the WFD programme of measures to future projected climate conditions
  - Taking account of likely or possible future changes in climate when planning measures today, especially when these measures have a long lifetime and are cost intensive, and assess whether these measures are still effective under the likely or possible future climate changes.
  - Designing measures on the basis of the pressures assessment carried out previously including climate projections.
  - Selecting sustainable adaptation measures, especially those with cross-sectoral benefits, and which have the least environmental impact, including greenhouse gas emissions.
- Necessary revisions of monitoring programmes to detect climate change impacts.
- Analysis of water scarcity probability on a river basin scale based on past and current water demands and on future trends incorporating climate change projections. Assessment of how the potential negative changes will affect the socioeconomic system behind the water resources system.





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INTERNATIONAL SAVA RIVER BASIN COMMISSION

Kneza Branimira  
29 10 000 Zagreb  
Republic of Croatia

Tel.: +385 1 4886 960

E-mail: [isrbc@savacommission.org](mailto:isrbc@savacommission.org)

Web: [www.savacommission.org](http://www.savacommission.org)