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Outline of the Climate Adaptation Strategy and basin-wide priority measures for the Sava River Basin

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Outline of the Climate Adaptation Strategy for the Sava River Basin

This document has been prepared by Thomas Dworak as international expert, on the basis of data and information provided by local experts from Bosnia and Herzegovina, Croatia, Serbia, Slovenia and Montenegro, the Sava Commission`s permanent expert groups for river basin management and for hydrological and meteorological issues and the participants of the workshop held in October 2017 in Belgrade (RS). The process of the development of the Outline has been supported by the Ministry of Ecological and Inclusive Transition (Republic of France), International Office for Water and United Nations Economic Commission for Europe.

This document is an annotated outline. It should be considered as a step towards the full Sava adaptation strategy to climate change. The data presented has not been officially approved by the Sava Countries and should therefore be considered as non-official.

Foreword

Planning climate adaptation activities at the river basin level is an extremely relevant and important tool for the water resources community at large, as well as for those stakeholders working on more mainstream climate considerations and their planning and management decision making. Recognising this importance, the parties to the Framework agreement on the Sava River Basin agreed in their sixth meeting:

“Recognizing the likely consequences of climate change on the water regime in the Sava River Basin and the need for effective adaptation measures, as well as the importance of the „Paris Agreement“ agreed on December 12, 2015 under the UN „Framework Convention on Climate Change“, we appreciate great efforts and work of the ISRBC and the Parties related to the assessment of climate change impacts and elaboration of potential adaptation measures in the basin, and encourage the ISRBC to undertake further activities toward a strategy and an action plan for the climate change adaptation in the basin”

The International Sava River Basin Commission as a signatory of the Paris Pact on water and climate has requested the International Office for Water to support developing the *Outline of the Climate Change Adaptation Strategy and priority measures for the Sava River Basin* in the framework of the Global alliance for water and climate incubator platform. The process was also supported by the French Ministry of Ecological and Inclusive Transition and the UNECE.

As a results this *Outlines* has been developed which is an important step towards the full strategy and an action plan for the climate change adaptation in the Sava river basin.

Table of content

Foreword	3
Table of content	4
1. Introduction.....	6
1.1. Basic information about the basin	7
1.2. The Sava Strategy in a wider context	10
1.3. What is the added value of a Sava Basin wide strategy?	11
2. Climate change scenarios for the Sava.....	12
2.1. Projected changes for Air temperature	13
2.2. Projected changes for Precipitation	15
2.3. Extreme weather events	17
3. Projected impacts on water resources, economic sectors, nature conservations and other sectors	17
3.1. Expected impacts on water resources	17
3.2. Expected impacts on extreme hydrological events	18
3.3. Expected impacts on water quality (surface and groundwater)	19
4. Expected impacts on economic sectors, settlements, disaster risk reduction and nature conservation	19
4.1. Agriculture and forestry	21
4.2. Hydropower.....	24
4.3. Industry	25
4.4. Navigation	25
4.5. Tourism.....	26
4.6. Settlements	26
4.7. Nature & ecosystems	27
4.8. Disaster Risk Reduction	28
4.9. Health	28
5. Vulnerability in the Sava Basin	29
5.1. Methodological approach	29
5.2. Basin wide vulnerability identified	30
6. Framework Conditions for adaptation	30

Outline of the Climate Adaptation Strategy for the Sava River Basin

- 7. Guiding principles on adaptation to climate change 31
- 8. Adaptation objectives and targets 32
- 9. Measures for adaptation 33
 - 9.1. National adaptation measures planed/started..... 33
 - 9.2. Transboundary measures..... 34
 - 9.2.1. Type of measures considered 35
 - 9.2.2. Cost and benefits of measures..... 36
 - 9.2.3. Priorities of actions 36
 - 9.3. Principles when implementing of measures..... 37
 - 9.4. Financing Implementation 37
 - 9.4.1. Adaptation financing mechanism in place 37
 - 9.4.2. Funding for transboundary measures..... 38
- 10. Public participation..... 38
- 11. Monitoring and evaluation of adaptation approach..... 39
- Annexes 40
 - Annex 1: List of legislative Acts that address climate change and in particular adaptation . 40
 - Annex 2: Competent authorities in the country related to climate change adaptation 40
 - Annex 3: Climate change scenarios..... 40
 - Annex 4: Ongoing Transboundary projects..... 40
 - Annex 5: Measure fact sheets 45

1. Introduction

The *Sava* is a river in Central and South-eastern Europe, a right tributary of the Danube. The four riparian countries of the Sava River Basin (Slovenia, Croatia, Bosnia and Herzegovina and Serbia) ratified the Framework Agreement on the Sava River Basin (FASRB) as a unique international agreement which integrated many aspects of water resources management and established the International Sava River Basin Commission (ISRBC) for its implementation.

According to the FASRB, Article 12, “The Parties agree to develop the joint and/or integrated Plan on the management of the water resources of the Sava River Basin and to cooperate on its preparatory activities”. In the last 10 years the Parties have cooperated in development of many plans and programmes covering navigation, water management, flood protection etc.

Climate change poses significant and complex challenges for transboundary water basins worldwide. As climate change increases over the coming decades, transboundary cooperation on adaptation and resilience-building strategies is essential to advancing sustainable development and ensuring social and political stability for basin countries and their people. The impacts of climate change in the transboundary context extend beyond direct and immediate impacts on communities, ecosystems, infrastructure, and local or national economies¹.

Initiated through a request by the Danube Ministerial Conference 2010, the International Commission for the Protection of the Danube River (ICPDR) developed a climate adaptation strategy addressing also the sub-basin of the Sava. Based on a scientific study on Climate Change in the Danube Basin, the adaptation strategy was adopted in 2012². In 2015 the Water and Climate Adaptation Plan (WATCAP) was developed for the Sava River Basin as result of a study undertaken by the World Bank³. The WATCAP is intended to help to bridge the gap between the climate change predictions for the Sava River Basin and the decision makers in current and planned water management investment projects that will be affected by changing climate trends.

Climate change has also been addressed in the 1st Sava River Basin Management Plan⁴ where it was noted that the Sava countries are at different stages of preparing, developing and implementing national climate change adaptation strategies.

¹ Background Paper: Training on how to prepare bankable projects for financing climate change adaptation in transboundary basins
Dakar, Senegal, 21-23 June 2017

² ICPDR (2012): ICPDR Climate Change Adaptation Strategy, available at <https://www.icpdr.org/main/activities-projects/climate-change-adaptation>

³ World Bank (2015): Water & Climate Adaptation Plan for the Sava River Basin

⁴ International Sava River Basin Commission (2014): Sava River Basin Management Plan, available at http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/srbmp_approved/sava_river_basin_management_plan_approved_eng.pdf, endorsed on 5th meeting of the Parties to FASRB on December 2, 2014

Outline of the Climate Adaptation Strategy for the Sava River Basin

This draft outline summarises the state of knowledge on climate change adaptation efforts in the Sava countries and is based on international and national assessments and discussions in the:

- 34th meeting of Permanent Expert Group for River Basin Management (September 25-26, 2017);
- 14th meeting of Permanent Expert Group for Hydrological and Meteorological Issues (October 12, 2017); and
- Workshop on “Outline of the Climate Adaptation Strategy and basin-wide priority measures for the Sava River Basin” in October 23-24, 2017.

The Sava countries, Parties to the FASRB and Montenegro⁵, have already entered in the process of 2nd Sava River Basin Management Plan development. As a first step a 2nd Sava River Basin Analysis⁶ and the interim overview on significant management issues have already been developed.

1.1. Basic information about the basin

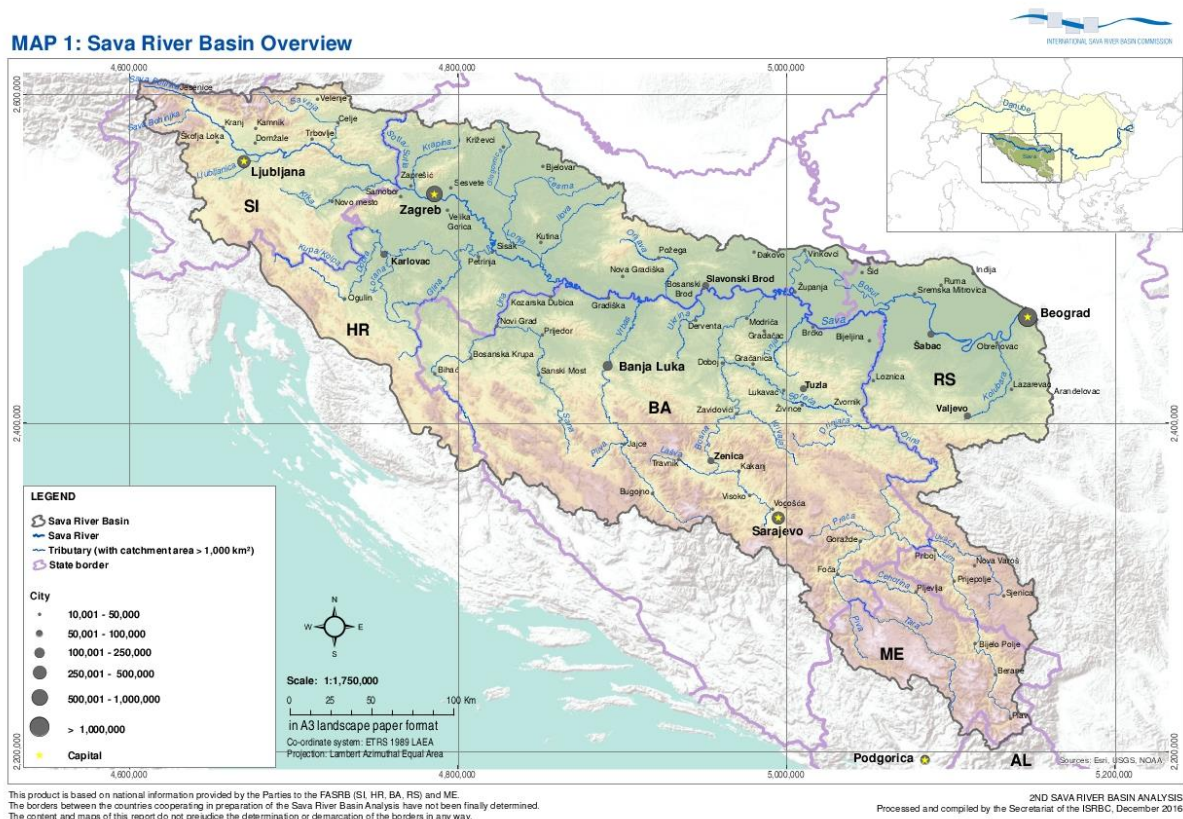
The Sava River basin covers a total area of 97,713.2 square kilometres and is the second largest Danube tributary catchment by area size. It encompasses 12% of the Danube basin, draining into the Black Sea. The Sava represents the third longest tributary of the Danube and its largest tributary by discharge. The catchment area borders the remainder of the Danube basin to the north and east, and the Adriatic Sea basin to the west and south. The river basin generally consists of parts of Slovenia (SI), Croatia (HR), Bosnia and Herzegovina (BA), Serbia (RS) and Montenegro (ME), with a very small part of the catchment area belonging to Albania (AL).

⁵ Montenegro is not the Party to the FASRB and cooperation in the fields covered by the FASRB on the basis of the Memorandum of understanding on cooperation between the ISRBC and Montenegro, signed on December 9, 2013 in Belgrade

⁶ 2nd Sava River Basin Analysis Report available on http://www.savacommission.org/dms/docs/dokumenti/documents_publications/publications/other_publications/2nd_sava_river_basin_analysis_report.pdf

Outline of the Climate Adaptation Strategy for the Sava River Basin

Map 1: Location of the Sava River Basin



Topography of the basin varies significantly. Upstream portion of the basin is more rugged than downstream one, but asymmetry of the basin topography is particularly apparent when comparing right and left bank areas—the former dominated by the Alps and the Dinarides reaching elevations in excess of 2,000 metres, while the latter is dominated by the Pannonian Plain.

The Sava River catchment is situated within a region characterized by the dominant moderate climate of the northern hemisphere, which is modified by the influence of relief. Thus, mountainous zonal climate characteristics are present especially in the eastern and southern part of the area. Cold and hot seasons are clearly defined. The winter can be severe with abundant snowfalls, while the summer is hot and long. Climate conditions within the basin can be classified into three general types⁷:

- An alpine climate prevails in the upper Sava Basin in Slovenia;
- A moderate continental climate dominates in the right tributaries' catchment areas within Croatia, Bosnia and Herzegovina and Montenegro;
- A moderate continental (mid-European) climate primarily features in the left tributaries' catchment areas that belong to the Pannonian Basin.

⁷ International Sava River Basin Commission (2014): Sava River Basin Management Plan, available at http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/srbmp_approved/sava_river_basin_management_plan_approved_eng.pdf

Outline of the Climate Adaptation Strategy for the Sava River Basin

Average annual air temperature for the whole Sava River Basin was estimated to be approx. 9.5°C. Mean monthly temperature in January falls to approx. -1.5°C, whilst in July it can reach almost 20°C. The precipitation amount and its annual distribution are fairly variable within the basin. The average annual rainfall over the Sava River Basin is estimated to be approximately 1,100 mm. The average evapotranspiration for the whole catchment area is approx. 530mm/year⁸.

In the Sava River basin several reservoirs are located; most of them are used primarily, or even exclusively, for electricity generation, but they are also used as supply of drinking water, industrial water source, for irrigation and food production. There are 18 hydroelectric power plants with power generation capacity exceeding 10 Megawatts in the Sava River basin. In Slovenia, most of them are located on the Sava itself. In other countries, the hydroelectric power plants are situated on its tributaries. They are an important source for electricity generation in all countries and several plans for further development of hydropower exists⁹

The total consumptive and non-consumptive water use in the Sava River Basin is 4.1 billion m³ and approximately two-thirds of this is used by thermal and nuclear power plants (2.5 billion m³; 62%). The public drinking water supply uses 760 million m³ (19%). The agricultural water use, including irrigation, amounts to 600 million m³ (12%). Water used for irrigation in the Sava countries has the lowest share of 30 million m³ (0.70%) annually. Industrial water use is less than 300 million m³ (7%)¹⁰.

Groundwater is a very important resource in the Sava River basin, generally used for public water supply of potable water, as a source of water for industrial use, but also as the mainstay of aquatic ecosystems. There are 41 identified significant groundwater bodies of basin-wide importance, ranging in area size from 97 to 5,186 square kilometres, as well as numerous minor ground water bodies. Even though most of them are transboundary waters, eleven are considered to be largely located in Slovenia, fourteen in Croatia, seven in Bosnia and Herzegovina, five in Serbia and four in Montenegro¹¹.

The current resource use in the basin still does not causing water stress (according to the Sava RBM Plan and Water exploitation index (WEI) data). This might change because of the climate change in the future.

⁸ International Sava River Basin Commission (2014): Sava River Basin Management Plan, available at http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/srbmp_approved/sava_river_basin_management_plan_approved_eng.pdf

⁹ Dworak, T., Romanovska, L (2013): Study for the identification of the state, challenges and issues of water and energy nexus in transboundary basins of Southeastern Europe. Prepared as background document for the International Roundtable on Water and Energy Nexus in transboundary basins in Southeastern Europe, 6 - 8 November 2013, Sarajevo, Bosnia and Herzegovina

¹⁰ International Sava River Basin Commission (2014): Sava River Basin Management Plan, available at http://www.savacommission.org/dms/docs/dokumenti/srbmp_micro_web/srbmp_approved/sava_river_basin_management_plan_approved_eng.pdf

¹¹ ibid

1.2. The Sava Strategy in a wider context

Slovenia and Croatia are already members of the EU, while the other countries are in different stages of the accession process. So, the EU policy framework plays an important role. As such several existing policies and EU Directives contribute to efforts for adaptation to climate change with regard to water issues. The most important ones are:

- Water Framework Directive 2000/60/EC (WFD) establishes a legal framework to protect and restore the water environment and to ensure the long-term sustainable use of water. Climate change adaptation is not explicitly addressed, but Member States agreed to consider the impact from Climate change in the implementation process.
- The EU Floods Directive 2007/60/EC (EFD) establishes a legal framework for the assessment and management of flood risks, aiming at reducing the adverse consequences of floods to human health, the environment, cultural heritage and economic activity. Climate change needs to be considered in the second Flood risk management plan that needs to be developed for each River Basin or Unit of Management.
- In April 2013 the European Commission adopted an EU strategy on adaptation¹² to climate change which has been welcomed by the EU Member States. The strategy aims to make Europe more climate-resilient. By taking a coherent approach and providing improved coordination, it will enhance the preparedness and capacity of all governance levels to respond to the impacts of climate change. The strategy is currently under evaluation with results expected in early 2018.

Besides the EU legislation, several national (see chapter 6) and international activities are as well of relevance for climate adaptation in the Sava River Basin. At the international level the most important are:

- The Paris Agreement was adopted on 12 December 2015 by the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC)¹³. It is widening the normative framing around adaptation, calling for stronger adaptation commitments from states, being explicit about the multilevel nature of adaptation governance, and outlining stronger transparency mechanisms for assessing adaptation progress.
- The ICPDR activities on climate change: In order to take the required steps on adaptation, the ICPDR was asked in the Danube Declaration to develop until 2012 a Climate Adaptation Strategy for the Danube River Basin¹⁴. This strategy should be based on a step-by-step approach and encompass an overview of relevant research

¹² https://ec.europa.eu/clima/policies/adaptation/what_en

¹³ See http://unfccc.int/paris_agreement/items/9485.php

¹⁴ ICPDR (2013): ICPDR Strategy on Adaptation to Climate Change

Outline of the Climate Adaptation Strategy for the Sava River Basin

and data collection, a vulnerability assessment, ensure that measures and projects are climate proof respectively “no regret measures” and ensure that climate adaptation issues are fully integrated in the 2nd Danube River Basin Management Plan in 2015.

- The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) developed Guidance on Water and adaptation to Climate Change¹⁵ that aims to support decision makers from the local to the transboundary and international level by offering advice on the challenges caused by climate change to water management and water-related activities and for developing adaptation strategies.

Specific studies addressing the Sava adaptation efforts have been carried out as well, namely:

- Project Water – Food – Energy – Ecosystems Nexus Assessment in the Sava River Basin, implemented within the Programme of Work for 2013–2015 under the UNECE Water Convention (finalized in 2015)¹⁶;
- Danube Water Nexus Project – Sava Case Study, implemented by the EC Joint Research Centre¹⁷ (finalized in 2016);
- Project Water and Climate Adaptation Plan for the Sava River Basin (WATCAP), implemented by World Bank (finalized in 2015)¹⁸.

1.3. What is the added value of a Sava Basin wide strategy?

Overall, the benefits of a basin approach to adaptation allow the sharing of the costs and benefits of adaptation measures, ensure their optimal location in a river basin and preventing of possible negative effects of unilateral adaptation measures. Further transboundary cooperation on adaptation can also bring additional benefits in terms of conflict prevention, socioeconomic development and human well-being, and can even motivate transboundary cooperation in other areas¹⁹. Moreover, flood forecasting and disaster management are highly dependent on early information sharing and requires forecasting data from the river basin as a whole.

In addition to the issues mentioned above, taking a river basin approach offers the advantages of:

¹⁵ UNECE (2009): Guidance on Water and Adaptation to Climate Change, available at https://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf

¹⁶ <http://www.unece.org/index.php?id=45241>

¹⁷ See <https://ec.europa.eu/jrc/sites/jrcsh/files/jrc-danube-water-nexus.pdf>

¹⁸ See https://www.savacommission.org/project_detail/18/1

¹⁹ UNECE (2015): Water and Climate Change Adaptation in Transboundary Basins: Lessons Learned and Good Practices

Outline of the Climate Adaptation Strategy for the Sava River Basin

- broadening the knowledge/information base;
- common understanding and consistency of national programs of action and agendas;
- enlarging the set of available adaptation approaches;
- lessons learnt and experience sharing between EU and non-EU countries;
- avoiding “unilateral” adaptation to the detriment of other countries and parts of the basin;
- enabling better and more cost-effective solutions;
- strengthening the Sava Commission transboundary coordination role;
- support to participatory approach and sharing of common knowledge and tools
- methodological support to the definition of priority measures at transboundary level;
- contributing to the implementation of the Danube adaptation Strategy;
- giving international visibility for the on-going regional adaptation process.

At the same time, failure to address the negative impacts of climate change cooperatively in a river basin can threaten socio-economic development and create conflicts between riparian states²⁰.

2. Climate change scenarios for the Sava

For the assessment of future climate parameters, various global and regional climate models and scenarios are used. Over the course of time, the models have been further developed in regard to coupled processes between different land surfaces, the atmosphere and oceans. Nevertheless, models are based on simplifications and assumptions. Despite careful validation, climate models sometimes over- or underestimate the investigated parameter compared to observed data. To determine climate change information from a global to a regional or local scale, different downscaling techniques are used (see annex 3). For the Danube basin the adaptation strategy is based on the IPCC AR 4 SRES scenarios A1B and A2²¹.

It is important to note that Slovenia, Croatia and partly BiH are already using newer IPCC scenarios from AR5, while the other countries have scenarios from older models (see table below). These newer models do not represent a different approach but are more detailed and accurate and further in line with already observed changes.

Country	Scenario used
Slovenia	IPCC AR 5: RCP2.6, RCP4.5 and RCP8.5
Croatia	IPCC AR 5: RCP4.5 and RCP8.5

²⁰ UNECE, et al (2017): Background Paper - Training on how to prepare bankable projects for financing climate change adaptation in transboundary basins, Dakar, Senegal, 21-23 June 2017

²¹ See <https://ipcc.ch/pdf/special-reports/spm/sres-en.pdf>

Country	Scenario used
Bosnia and Herzegovina	A variety of scenarios from IPCC AR 4 and IPCC AR 5:
Serbia	IPCC AR 4: A1B and A2
Montenegro	IPCC AR 4: A1B and A2

Table 1: Climate change scenarios used in the Sava Basin.

The uncertainties reported by all countries related to the scenarios are primarily connected with the used global and regional climate models, which are still somewhat limited when it comes to the representation of all atmospheric processes and interactions within the climate system. Another aspect is downscaling, which is still a challenge. Additional sources of uncertainties are the projections of the socio-economic development used in the assessment of potential climate change impacts.

However, even if the scenarios and models used to estimate the climate change impacts in the Sava region are not harmonised and uncertainties exist, there are some common trends that have been identified and summarised below. The information available is also sufficient in most cases to take adaptation action.

Nevertheless, as recommended by experts in the Workshop on “Outline of the Climate Adaptation Strategy and basin-wide priority measures for the Sava River Basin” in October 2017 a system that allows to permanently update the knowledge base should be established providing the Sava Commission with newer information on climate change and the related impacts.

2.1. Projected changes for Air temperature

The climate in **all countries** has already changed noticeably and increases in temperatures in all countries are reported. For example, in Slovenia in the period 1961–2011, the average annual air temperature increased by 1.7 degrees Celsius. For Croatia, in the period 1961–2010 the average annual air temperature increased by 1.5 degrees Celsius.

For the future, a further increase in air temperature is expected within the Sava basin by around +1 °C in the next 30 years. However, there are quite some variations expected among the riparian states.

Climate change scenarios show that the air temperature in **Slovenia** will continue to rise, increasing on average by +1 °C Celsius all over the country in the period till 2040, and for additional +1 °C Celsius by 2070 (according to the RCP4.5 emission scenario).

In **Croatia** in the period 2011–2040 the rise in ground air temperature is expected in all seasons in according to scenario RCP4.5. In winter and summer, the highest projected temperature rise is between 1.1 and 1.2°C in the coastal regions. In spring, it could rise

from 0.7°C in the Adriatic to slightly over 1°C in the north, and in the fall the temperature rise would be between 0.9°C in the east and from 1.2°C to 1.4°C in the far west. Until 2070, the highest increase in mean air temperature, up to 2.2°C, is expected in the coastal area in summer and autumn, and a slightly lower temperature increase is projected for winter and spring. The maximum and minimum air temperature follows the trends of the average daily temperature - relative to the reference period, their growth is expected in both future climatic periods. Until 2040, the maximum temperature rise would be 1.5°C. The highest increase in the minimum temperature of about 1.4°C is expected in the winter in Gorski Kotar, where it is otherwise colder. Between 2041 and 2070 the trend of increasing the maximum temperature to about 2.2°C would continue, while an increase in temperature of up to 2.3°C in the continental parts of the winter is expected.

In the period 2011-2040 there is no big difference between the RCP8.5 and RCP4.5 scenarios - the seasonal increase in temperature for RCP8.5 is on average higher only by about 0.3°C compared to RCP4.5. However, in the period from 2041-2070 a more prominent temperature rise for the RCP8.5 scenario is projected: between 2.6 and 2.9°C in the summer and in other seasons from 2.2 to 2.5°C. The highest increase in temperature, up to about 3.0°C, is expected in the summer around the middle of the century. And the minimum temperature would have increased considerably in the period 2041-2070: from 2.2 to 2.8°C in the winter, and from 2.6 to 2.8°C in the summer.

For **Bosnia and Herzegovina** by the end of the XXI century all three scenarios (A2, A1B, RCP8.5) indicate a continuous increase in temperature. According to the scenario RCP8.5 the increase in temperature in the first thirty-year period is in the range from +1.6 to +2°C, whereas in the last thirty-year period, this range is from +5.4 to +5.6°C. The temperature increase is somewhat lower under scenarios A2 and A1B. In the first two thirty-year periods the temperature anomaly is higher based on the scenario A1B and for the period from 2011 to 2040 it is approximately +1°C, while for the period from 2041 to 2070 the anomaly is around +2.4°C. For the last thirty-year period based on the A2 scenario, the extent of the anomaly ranges from +3.8 to +4.2°C²². For the remaining two periods from 2041 to 2070 and from 2071 to 2100, the difference between the change in temperature for the seasons DJF and SON, and JJA is smaller, so that for the period from 2071 to 2100 the changes are in the range from 5.2 to 6°C. Change for the season MAM for the period from 2071 to 2100 is smaller than compared to the other seasons and it ranges from 4.6 to 5°C.

The mean annual temperature during the first 30 years of the 21st century, compared to the period 1961 – 1990, is expected to increase within the entire territory of **Serbia**, according to the A1B scenario of climate model projections. An increase of 1°C in most

²² These results are consistent with the concentrations of greenhouse gases that are foreseen in some of the scenarios, given that the greatest concentrations at the end of the century are defined within the scenario RCP8.5, then A2 and finally based on the scenario A1B the concentrations of greenhouse gases by the end of this century would be the lowest compared to RCP8.5 and A2. For the period 2011–2040, changes in seasonal mean temperatures for the seasons DJF and SON are around 2.2°C while the change for the seasons MAM and JJA is in the range from 1.2 to 1.6 (Scenario RCP8.5).

parts of Serbia is expected, except in the most eastern Banat and the most southern parts, where it is 0.9°C, and in the northeast part of the Timok Valley, where it is 1.1°C.

In **Montenegro** for the periods 2001-2030 and 2011-2040 a slowly increase of the average annual temperature by + 0.5 °C is expected. For the period 2040 – 2071 a faster increase of the average annual temperature than in the previous periods is expected leading to an increase of > + 2 °C; These changes are expected to be are higher in central part than in the coastal areas.

2.2. Projected changes for Precipitation

All countries are expecting changes in precipitation. However, these changes are very variable.

In **Slovenia** the climate scenarios for precipitation show great uncertainty. However, the annual time scale, the changes are only visible in the second thirty-year period (2041-2070) with an increase in precipitation in the Eastern half of Slovenia. At the seasonal time scale, the changes are already evident in the first thirty-year period (2011-2040). In winter the amount of precipitation is expected to increase and in summer to decrease, which becomes even more pronounced moving towards 2070.

For **Croatia** results from two climate scenarios are available: the RCP4.5 and the RCP8.5 scenario. The RCP4.5 scenario shows a decrease in annual precipitation by a less than 5% for the period 2011-2040 and a maximum of up to 5% for the period 2041-2070 in most of the country. For both periods this change will not be uniform throughout the year with an increase in precipitation in winter and a decrease for the rest of the season especially during the summer period. In the RCP8.5 scenario the decrease in annual precipitation for the period 2011-2040 is limited to central and southern Dalmatia, while in other regions a slight increase is expected, up to a maximum of 5%. In the second period (2041-2070) the decrease in precipitation is limited to Croatia's mountain and coastal hinterland. Thus, for both scenarios changes in the annual mean will not exceed $\pm 5\%$ in relation to the reference climate (1971-2000), but the spatial distribution of these changes depends on the scenario and the observed future climatic period.

For **Bosnia and Herzegovina**, the RCP8.5 scenario predicts an increase of +5% in mean annual precipitation for the period 2011-2040, while for the periods 2041-2070 and 2071-2100 a decrease is expected, with a maximum decrease of -10% between 2041-2070 and a range of -10% to -20% between 2071 - 2100 for most of the territory. Seasonal changes are very variable. In the winter and autumn season changes range from -10 to +10% for all three periods, while for the spring and summer season a decrease in precipitation is expected, especially for the summer season in 2071-2100 with a decrease larger than -40%. A second scenario (scenario A2) predicts the same changes in mean annual precipitation,

but different ones for seasonal precipitation. For the winter, autumn and spring season an increase in precipitation is expected from 2011-2040, while summer precipitation is expected to decrease for all three future periods with a very large decrease of more than -40% for the period 2071-2100 (which is in accordance with the scenario RCP8.5). However, unlike the RCP8.5 scenario all seasons on almost the entire territory show a decrease in precipitation for the period from 2071 to 2100.

For **Serbia** a slight increase in precipitation (0%-5%) is expected over most parts of Serbia (A1B 2001-2030), as well as for the central parts of Bačka (5-10%). A decrease in precipitation up to -5% might occur in the east of Serbia, in the Danube Valley, on the mountains bordering with Montenegro and south parts of Kosovo and Metohija.

According to the A1B scenario for period 2071-2100 a decrease in precipitation is expected ranging from -10% to -15% for most parts of the country and from -5% to -10% for the southern parts of Vojvodina and over smaller areas on the east and southeast of the country. For scenario A2B (2071-2100) there is a decrease in precipitation expected in most part of Serbia with increase from 5% to 10% in Vojvodina.

For **Montenegro** a change in average annual precipitation change is evident in the first half of the 21st century with a contrast between northern and southern regions with parts of the Sava River Basin expecting increases between 7% and 9%. In the middle of the century the expected decreases in precipitation spread towards the north. In the periods 2061-2090 and 2071-2100 a decrease in precipitation is expected for 90% of the territory. The most vulnerable part in regard to the total annual precipitation is the coastal region because of its continuous deficit in precipitation.

The WATCAP project of the World Bank provides, beside the country information, as well an analysis of potential future changes in precipitation (and other climate variables) that directly relate only to the Sava river basin. For the 21st century the A1B IPCC/SRES greenhouse gas (GHG) emission scenario was assumed which is considered a mid-level intensity scenario and is commonly used for future projection of GHG emission in many climate change studies. The applied approach was based on downscaling of General Circulation Models (GCM) outputs by using the regional climate models (RCMs) in order to derive locally adjusted time series of future precipitation. The projections of five GCM/RCM models of the ENSEMBLES project²³ were used.

The results show that the projected precipitation change differs from model to model. For the period 2011-2040, three models show a similar tendency of precipitation change, with an increase during the winter and a decrease during the spring and summer. However, the size of the changes and its spatial distribution differs among the models. Model 4 simulates an increase of winter precipitation in the upstream part of the basin, while in the middle

²³ See <http://ensembles-eu.metoffice.com/>

and downstream part this increase is shifted to the autumn months. During the summer, this model also predicts a precipitation decrease for all stations. Model 5 differs most from the other models. It generally predicts the smallest change, but is generally positive (a precipitation increase) in all seasons, with an exception for the upstream stations, where it shows a decrease during the spring and winter, and a few stations across the basin that show a negative summer change. For the period 2041-2070, the first four models generally show the same tendency – precipitation increase during winter and, at some stations, during autumn, and the decrease during the summer months. Model 5 has slightly different results showing a general summer precipitation deficit at many stations, whilst some stations in the upstream part of the basin show a precipitation increase during the summer months. In these areas, a winter decrease is more pronounced than at the rest of the stations, while for the majority of the stations, a spring or autumn increase on precipitation is more dominant than the winter.

So, to conclude, the precipitation change is complex and expected changes are very variable. In general, an increase during the winter and a decrease for the summer months is expected. Summer precipitation deficit is more pronounced in 2041-2070 period.

2.3. Extreme weather events

As for many places in Europe it is expected more frequent and more intense extreme weather events will take place more often in the region. There are longer periods of drought and shorter and locally distributed periods of intense precipitation in the future predicted in all countries with an increasing risk of flooding.

In **Montenegro** there is also an increase of warm days expected (6 times more very warm days than in the period 1961-1990). The same applies to **Croatia** for the period of 2011-2040 where an increase between 6 and 8 warm days is expected. In eastern Croatia and some parts of the Adriatic in increase of more than 8 days is expected. For mountain areas, the rise of hot days under a future climate would be the same as in most parts of the country.

3. Projected impacts on water resources, economic sectors, nature conservations and other sectors

3.1. Expected impacts on water resources

Water resources in the Sava River basin are directly impacted by climate change which is expected to lead to major changes. So, water management in particular in the

transboundary context is expected to play an increasingly central role for adaptation. Climate change is projected to lead to major changes in water availability across the Sava Basin with more extreme events occurring.

Impacts on the water regime have been analysed in the WATCAP World Bank project based on hydrologic modelling and the projections of five different GCM/RCMs predications. The results show that the overall change in the annual runoff is small, but strong changes in the seasonal regime and for extreme events are expected. On a seasonal timescale, the most notable change is an increase in runoff in the winter season. This change results from an increase in precipitation and a significant rise in temperatures that either lead to a smaller amount of snow in winter or more snowmelt. Furthermore, a substantial decrease in river flows is expected in the spring and summer seasons. In terms of high and low annual flows, the results indicate that low annual flows are projected to decline somewhat, meaning that the proportion of very dry years would slightly increase. On the other hand, high annual flows show a greater reduction, indicating that the proportion of very wet years would decrease. This is confirmed by national reports where **Croatia, BiH, Montenegro and Serbia** are predicting a reduction of the annual flow in surface waters. For Slovenia no information is currently available. As a consequence of these results a reduction of groundwater levels and water levels in lakes and reservoirs in spring time can be expected.

3.2. Expected impacts on extreme hydrological events

Regarding extreme events, the results of the WATCAP World Bank project show potential changes for both, floods and low flows. The projections indicate that floods will increase in the future due to climate change. The increase was shown to be greater for 100-year floods than for the 20-year events, thus suggesting an overall increase of the flood risk. The greatest increase in floods is expected in the upper part of the Sava River Basin, that is, in Slovenia (the Catež hydrologic station) and in the main right tributaries (Kupa, Una, and Bosna). The results were again confirmed by national reports for **all countries** which state that the occurrence of flood will increase in the future.

Results for changes in low flows, which are an important factor for navigation and water supply, reveal great variation among the climate models. On average, low flows are not likely to change much in the near future, while a significant decrease could be expected in the distant future downstream of Sisak in Croatia (i.e., downstream of the confluence of the Kupa and Sava Rivers).

3.3. Expected impacts on water quality (surface and groundwater)

Impacts on water quality are only assessed in Croatia and Serbia, while **Slovenia** provided information with regard to water temperature changes scenarios that will be available in the future from which a detailed Impact assessment for water quality will be possible. In **Croatia** the extreme hydrological conditions that are expected will cause difficult conditions for securing sufficient quantities of drinking water for the needs of the population. There is also the risk caused by flooding that can lead to the occurrence of water related epidemics. An increase in water temperature will result in increased eutrophication risks. For **Serbia** the effects of land use changes and changes in human use of water on water quality usually exceed the impact of climate change. Water temperature increases, and particularly during low flow periods, can have adverse effects on water quality, in particular in combination with the large amount of small number of wastewater treatment plants in place.

4. Expected impacts on economic sectors, settlements, disaster risk reduction and nature conservation

The following section describes expected potential impacts on economic sectors, settlements, disaster risk reduction and nature conservation. In summary the following picture can be drawn (see table below).

Sector	Overall positive and negative impact on the SRB
Agriculture	<ul style="list-style-type: none"> – increased need for water due to more frequent and longer-lasting droughts – projected water stress as evapotranspiration increases in summer, with significant yield reductions as a result – More frequent storms and floods – More frequent diseases of plants and animals in combination with new diseases – impacts on animals such as heat – cultivation of some new cultures and varieties in areas where it has not been possible so far
Forestry	<ul style="list-style-type: none"> – phenological²⁴ phenomena of forest trees, decreasing or increasing the productivity of individual forest ecosystems, – more frequent occurrence of pests and diseases – more invasive species – Change of species composition

²⁴ e.g. dates of last appearance of a species.

Outline of the Climate Adaptation Strategy for the Sava River Basin

Sector	Overall positive and negative impact on the SRB
	<ul style="list-style-type: none"> – increased need of sanitary cuts – loss of biodiversity (varietal choice) – increase in incidence of forest fires and an extended season – reduce the productivity of forestry in the region.
Hydropower	<ul style="list-style-type: none"> – Decrease in river runoff affects all hydro power plants, particularly run-of-the-river schemes – Increase in floods in the autumn/winter and droughts in the spring/summer season mostly affect run-of-the-river hydro power plants and small reservoirs – Increase in evaporation due to future rising temperatures are expected to cause decrease in hydropower production for reservoir and pumped storage–type facilities – Indirect effects: increased demand for energy for heating and cooling due to the projected higher and lower temperatures
Navigation	<ul style="list-style-type: none"> – no change in the low flows expected in the near future, but a modest decrease in the distant future – number of days with low flows likely to increase very little in the near future, but a significant increase in the later future – High flows do not exhibit significant changes in the future – reduced potential for ice formation due to rising temperatures
Industry	<ul style="list-style-type: none"> – reduced precipitation will affect energy production in thermal power plants due to insufficient cooling of the plant – more frequent damage on and increasing losses due to floods – The expected rise in temperature in all seasons may cause increase cooling energy consumption during the summer period but it reduces the energy required for heating in the winter
Tourism	<ul style="list-style-type: none"> – Negative impacts on winter skiing tourism due to decrease of snow fall caused by rising temperatures – Negative impacts in the summer to tourism in inland cities due to expected higher summer temperatures – positive impacts for the upper part of the Basin close to the coast as there might be reduced seasonality and extending tourism season into the sub-season and the pre-season
Settlements	<ul style="list-style-type: none"> – increased risks to flooding caused by a) short-term high intensity rainfall (flash floods) and b) pluvial floods – increased possibility of landslides and erosion – more heat waves in big settlements – negative impacts on water supply (quality and quantity) and waste water treatment
Nature and	<ul style="list-style-type: none"> – spread and invasion of alien invasive species – lower water levels and reduced flows of rivers

Sector	Overall positive and negative impact on the SRB
Ecosystems	<ul style="list-style-type: none"> – increased levels of threats and habitat changes – consequences of extreme phenomena and – loss of biodiversity

Table 2: Observed and expected negative impacts of climate change on forestry

A more detailed description is provided in the subsequent sections. Please note that the order of the headings does not indicate any priority given to economic sectors in the paragraph.

4.1. Agriculture and forestry

Climate change has complex effects on the bio-physical processes that underpin agricultural and forestry systems, with both negative and positive consequences in different regions. Rising atmospheric CO₂ concentration, higher temperatures, changes in precipitation patterns and in frequency of extreme events both affect the natural environment as well as the quantity, quality and stability of food production²⁵.

In relation to **agriculture** the following impacts have already been observed:

- Drought is the most common problem in **Slovenian** agriculture. After 2000 drought appeared nine times (in 2000, 2001, 2003, 2006, 2007, 2009, 2012, 2013 and 2015). At least four times it had consequences with the dimensions of a natural disaster. The highest estimated drought damage in 2003 amounted to 130 million €. In 2013 drought caused damage of 100 million €, in 2006 of 50 million €, in 2007 - 17 million € and in 2012 - 60 million €. Of the estimated total damage, 29 percent was covered via state aid in 2003, 25 percent in 2006, 27 percent in 2007, ten percent in 2012, and only 5 percent in 2013.
- In **Croatia** the drought in the summer months specially in years 2011 and 2012 was the largest single cause of damage caused to Croatian agriculture by climate variability in the period from 1980 to 2014. It has been observed that climatic changes already affect phenological phases of apple, grapevine, olive and corn - vegetation begins earlier, lasts longer, but yields drop. The lack of groundwater (drought) and elevated air temperatures in the upcoming time will be two key issues in combating agriculture with climate change.
- In **BiH** the year 2012 represented the fourth consecutive year when agriculture suffered significant losses due to bad weather. The drought and high temperatures in the summer of 2012 have been estimated to cost approximately US\$1 billion in lost

²⁵ <http://climate-adapt.eea.europa.eu/eu-adaptation-policy/sector-policies/agriculture>

Outline of the Climate Adaptation Strategy for the Sava River Basin

agricultural production, and are estimated to have destroyed almost 70% of vegetables and corn in inland areas of the country.

- In **Serbia** increasingly frequent and intensive droughts in the past two decades have caused great damage to Serbian agriculture. According to the evaluation of drought impacts on the crop yield the average drop was 40.9% in comparison to the average annual yield in the years without drought. In Vojvodina climate change in the past decade has caused a variation intensity of the following diseases in crops and vegetables: powdery mildew in wheat, Fusarium class, leaf spot in sugar beet, and downy mildew in sunflower and potato and tomato blight.
- **Montenegro**'s agriculture suffered from droughts in 2003, 2007 and most heavily 2011 where meteorological and hydrological conditions also contributed to the forest fires (3% of the total area) that affected whole country and taking away human lives. The damage to the crop production is estimated to 30% to 60% of expected yield in 2011. This also effected the milk production.

Negative impacts are expected in all Sava Countries to be increasing causing the following vulnerabilities for agriculture:

- increased need for water; more frequent and longer-lasting droughts;
- More frequent storms (e.g. hail, storms with strong winds) and floods;
- More frequent diseases of plants and animals in combination with new diseases;
- choice of species / varieties of agricultural plants and / and breeds of agricultural animals;
- change in timing of agricultural practices (such as time of sowing / planting, fertilizing, harvesting, trimming, etc.); and
- impacts on animals such as heat stress.

These changes are expected to lead to a yield reduction of 3-8% in Croatia by 2050, 10% reduction in Serbia in second half of this century.

However, climate change will also have some positive effects on the agriculture sector in the region. It will enable the cultivation of some new cultures and varieties in areas where it has not been possible so far.

In the WATCAP World Bank project the impacts of climate change on the agricultural sector were also analysed. The report of the project states that the food sector in the Sava river basin generally lags behind the rest of the economy in growth terms largely because it is undercapitalized, fragmented, and dominated by small producers. Irrigation accounts for less than 1 percent of total water withdrawals, but is expected to increase according national information.

Outline of the Climate Adaptation Strategy for the Sava River Basin

A vulnerability analysis was undertaken to assess the impact of a changing climate on crop water status and crop yields using the crop water balance to determine the water stress and subsequent crop yield changes (with the CROPWAT model). The model projections indicate that surplus rainfall in winter gets stored in the root zone that suits winter wheat, so there is some storage buffer, but toward the end of the growing season, the summer crops are likely to experience water stress. Some water stress is already being experienced by the potato and sugar beet crops as a result of their relatively shallow root zone. Water stress is projected to become more pronounced as the evapotranspiration increases in summer, with significant yield reductions as a result. However, due to high uncertainty in future precipitation, the crop modelling results need to be viewed with caution, especially for the distant future. On a positive note, the predicted temperature rises might expand the growing season across the basin, with longer summers and warmer winters that might potentially provide an increase in agricultural production for selected crops that require less watering.

A preliminary economic evaluation was carried out in WATCAP, combining crop modelling with an economy-wide analysis, to measure the expected economic costs of climate change impacts on selected crops and adaptation options under alternative water regime scenarios at the sector and economy-wide levels. Results indicate yields may change from -6 to +3.5 percent for each crop and producing country through time.

Among the Sava River Basin countries, the agriculture sectors of Serbia and Bosnia and Herzegovina are estimated to be the most vulnerable to climate change. Grape, tomato, and potato yields are predicted to decline by around 6 percent by 2070 compared to a baseline scenario in which climate impacts are not taken into account. For sugar beets, sunflowers, and maize, loss estimates are -2 to -3.5 percent from the baseline. The predicted impact on winter wheat is lower and varies from +0.5 to -1 percent. Simulated results for crop prices show a rise with respect to the baseline scenario except for winter wheat. Again, Serbia and Bosnia and Herzegovina are the most vulnerable, where price hikes are predicted to be the highest. The lowest and highest values are predicted as 8–18 percent for winter wheat; 15–80 percent for potatoes, grapes, tomatoes, maize, and sunflowers; and 5–100 percent for sugar beets. For a majority of the crops, the price changes vary between 15 and 80 percent compared to their 2010 prices.

Also, the **forests** in the Sava basin will experience impacts from climate change namely:

- phenological phenomena (i.e. the timing of the phenophases²⁶) of forest trees;
- decreasing the productivity of individual forest ecosystems;

²⁶ A phenophase is a distinct event in the annual life cycle of a plant or animal in relation to changes in seasons and climate. In plants, examples of these observable events include budburst, first flower, first ripe fruit, and color change.

Outline of the Climate Adaptation Strategy for the Sava River Basin

- more frequent occurrence of pests and diseases;
- more invasive species;
- change of species composition;
- increased need of sanitary cuts;
- loss of biodiversity;
- increase in incidence of forest fires and an extended fire season (Serbia, BiH, Montenegro).

It is expected that these changes will reduce the productivity of forestry in the region, but also that the damage from forest fires will increase. For example, in Montenegro the forest fires in 2012 affected already 7% of the country causing already damages estimated around 4,288,000.00 Euro and there is evidence that this will increase in the future.

4.2. Hydropower

All countries are reporting that they are expecting an increased vulnerability of the hydropower sector. The expected reduction of precipitation in the summer period likely to causes a lower energy production of hydro power plants while the electricity demand will raise in the same time. In addition, extreme climatic events may have a negative impact on energy generation and might disrupt transmission and distribution.

The World Bank WATCAP project report states that the impact of climate change on hydropower in the Sava river basin is principally associated with direct effects on the power generating potential. There will also be indirect effects, involving an increased demand for energy for heating and cooling due to the projected higher and lower temperatures.

A decrease in river runoff would affect power generation through a reduction in the amount of water available at all hydro power plants, but would particularly affect run-of-the-river schemes that are solely dependent on river runoff. Floods in the autumn/winter and droughts in the spring/summer season would also mostly affect run-of-the-river hydro power plants, as well as those with small reservoirs.

With increasing evaporation due to future rising temperatures, hydropower production is expected to decrease in the reservoir and pumped storage–type facilities. Other types of hydro power plants would face smaller effects but still experience a decrease in hydropower generation. Hence, it is expected that power generation from the hydropower sector in the Sava river basin will be lower in the future.

It should be noted that currently, power companies in the region generally fail to carefully optimize the operation of reservoir-type power plants, and the projected magnitude of decrease in power production might be compensated for by an increase in production under well-optimized operational rules.

4.3. Industry

Climate change is also expected to have impacts on industry and the related production. The expected impacts reported from **Slovenia**, **Croatia** and **Montenegro** are as follows.

- reduced precipitation will affect energy production in thermal power plants due to insufficient cooling of the plant;
- more frequent damage and increasing losses due to floods;
- the expected rise in temperature in all seasons may cause increase cooling energy consumption during the summer period but it reduces the energy required for heating in the winter;
- reduced productivity due to less water availability;

For **BiH** and **Serbia** and, no assessment was available.

4.4. Navigation

For **Serbia** and **BiH** the effects of climate change are projected to have change of river discharges (increased flooding and low waters). This will lead to higher temporary interruption of navigation.

For **Croatia**, **Slovenia**, **Montenegro**, no vulnerability assessment was available for transport sector nor impact assessment was made on river transport development.

In the World Bank WATCAP project the impacts of climate change on navigation were considered by evaluating the changes in three indicators: low flows, high flows, and river ice.

Low-flow thresholds for the Sava River are associated with two target water depths that facilitate navigation with a maximum and a reduced draft; a maximum draft must be possible for 65 percent of the time and a reduced draft for 95 percent. The modelling results indicate that no change in the low flows corresponding to these two water depths (Q65 and Q95) is likely to occur in the near future, while a modest decrease can be expected in the distant future, which will be more significant downstream of the city of Sisak. In addition, the number of days with flows below the current Q65 and Q95 is likely to increase very little in the near future (on average for three days and two days, respectively), but a significant increase can be expected in the distant future downstream of Sisak (on average for 13 and 8 days, respectively). Therefore, restrictions on the number of navigable days could be much more pronounced in the distant future.

High flows, which were assessed as the flows exceeded for 1 and 3 percent of time during a year, do not exhibit significant changes in the future. They are therefore not likely to have

additional implications on the navigation sector in terms of the number of days that navigation would be restricted or suspended due to high flows compared to current conditions.

Given the general trend in rising temperatures that all climate models predict, a reduced potential for ice formation along the whole navigable part of the Sava River can be expected. This, of course, would have a beneficial impact on inland navigation, since the number of days per year that navigation would be suspended due to ice is expected to decrease.

4.5. Tourism

Tourism plays in some parts of the basins an important economic role. Croatia, Slovenia, Montenegro and BiH have already prepared some limited vulnerability assessments for the tourism sector which will be impacted by climate change in a negative and positive way.

Negative impacts are expected in **BiH** and **Slovenia** for winter tourism. In both countries ski slopes are low lying compared to the Alps and with less snow fall the resorts will be particularly vulnerable. Negative impacts are also expected in the summer tourism. City tourism may also be adversely impacted: An increase in summer temperatures, coupled with reduced rainfall and/or increased flooding, are likely to make cultural heritage sites, such as Sarajevo, less attractive during the summer months (during the summer of 2012 there were reports in western European media of the 'sweltering' Balkans). In **Montenegro** the expected summer water shortage and higher risk of forest fires are expected to have negative impact on summer tourism.

At the same time positive impacts are expected for the upper part of the Basin which is close to the coast. Favourable climatic conditions on the coastal part of Croatia in the sub-season and the pre-season can positively affect tourism by reducing seasonality through extended tourism season.

Available estimations of climate change damages for Montenegrin economy show that substantial decrease of revenues (in the range of € 33 to 68 million per year) from tourism loss could be expected in the far future.

4.6. Settlements

Since the modern era, there has been a general migration of people from rural to urban areas in the Sava river basin countries, which is a global tendency for countries in transition. This urbanization trend can be expected to continue in the future, thus increasing the vulnerability of the capitals built along the Sava River (Ljubljana, Zagreb, and

Belgrade) and also to the smaller towns, such as Sisak, Slavonski Brod, Brcko, etc., that are all prone to flooding when the river and its tributaries rise.

The main increasing vulnerability for settlements (urban and rural) is increased risks to flooding caused by a) short-term high intensity rainfall (flash floods) and b) pluvial floods. This might also lead to increased possibility of landslides and erosion. The May 2014 flood proved that the urban areas are at greatest risk; flood protection for these areas should therefore be prioritized. This implies that outlays for flood protection will need to increase in the future, possibly at the expense of protection for agriculture areas, which should be reduced if it is deemed necessary. Clearly, carefully designed adaptation measures for long-term flood planning must be developed.

In addition, more heat waves in big settlements can be expected. When people are exposed to such extreme heat, they can suffer from potentially deadly illnesses, such as heat exhaustion and heat stroke. Older adults, young children, low-income populations, people who work outdoors, and people in poor health are the most vulnerable to these impacts. There is also evidence that labour productivity is reduced by such heat waves.

Another impact that might occur is the lack of sufficient water supply for drinking. This relates to droughts where a higher demand faces a lower availability, but also to flooding where a damaged infrastructure or pollution might cause interrupts in the service. Droughts and floods might also have negative impacts on the sewage systems capacities by either reducing the dilution capacity or by flooding the treatment plant. However, no detailed assessments on these impacts are available in the countries.

4.7. Nature & ecosystems

The expected impacts on ecology are hardly investigated in the countries (except Croatia). It is expected that with a reduction in the mean annual and minimum annual flows, an increase in maximum annual flow and changes in water temperature both the aquatic ecosystems, their diversity and reception capacity, and their utilization for other purposes will be negatively affected. Natural ecosystems and biodiversity also affected by decline of precipitation and changes in rainfall patterns and the occurrence of climatic extremes (droughts, floods). All Countries except Montenegro (no information provided) report quite similar impacts and vulnerabilities for nature and ecosystems, namely:

- spread and invasion of alien species;
- lower water levels and reduced flows of rivers;
- increased levels of threats and habitat changes;
- consequences of extreme events; and
- loss of biodiversity.

These impacts might increase the vulnerabilities of other sectors. Therefore, **ecosystems adaptation and nature based adaptation solutions must lay at the centre of any adaptation policy. Such an approach** can help mitigate climate change impacts, by absorbing excess flood water or buffering us against coastal erosion or extreme weather events.

4.8. Disaster Risk Reduction

Climate change and disaster risk reduction are closely linked. More extreme weather events in future are likely to increase the number and scale of disasters, while at the same time, the existing methods and tools of disaster risk reduction provide powerful capacities for adaptation to climate change.

In order to guide efforts on disaster-risk reduction in the period between 2015 and 2030 the Sendai Framework for Disaster Risk Reduction (DDR) was developed²⁷. It outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction and should be applied in all Sava countries.

A national Disaster Risk Assessment Plan exists for **Croatia**. For **Serbia** several laws have been passed including "The National Strategy in the field of emergency management and disaster risk reduction". A National Strategy for Emergency Situation was adopted by the Government of **Montenegro** in 2006. It gives authority to the Ministry of Internal Affairs through its Directorate for Emergency Situation and Civil Protection. The National Strategy analyses all the risks affecting the territory of Montenegro, providing a survey on the actual capacity of the Montenegrin structures to cope with them. It highlights the operational capabilities with reference to the major risks on its territory and emphasizes importance of constant monitoring and the need of an integrated approach to disaster risk reduction.

In the case of disaster previous practice and experience has shown that public funds have been used to repair the damage caused from extreme events. This money mainly is coming from assistance from international organizations and from insurance companies.

4.9. Health

Health as another sector of relevance in terms of vulnerability has been reported by **Croatia, Serbia and Slovenia**. The following impacts are expected

²⁷ <http://www.unisdr.org/we/inform/publications/43291>

Outline of the Climate Adaptation Strategy for the Sava River Basin

- increased heat stress and temperature-related death toll (long-lasting heat waves);
- increased number of allergies, respiratory diseases, cardiovascular diseases;
- Increased number of injured and deaths in extreme weather events. This is further leveraged by increased air pollution in cities;
- an increase in the number of people and animals migrating and thus the emergence of new diseases and the transmission of infectious diseases;
- an increase in the number and expansion of ticks, mosquitoes, snails, rodents, viruses etc. and thus an increase in vector diseases.

Some of these impacts are already observed. For example, in Serbia since the beginning of the millennium, more introductions have been registered, the latest one being the African virus (Chikungunya) transmitted by the Asian tiger mosquito (*Aedes albopictus*) registered in Serbia in 2009.

Existing approximate data indicate an increase of the number of heat strokes and mortalities during periods with extremely high daily air temperatures in the last few years. Available data indicate the possible spread of vectors and exotic diseases that can be transmitted from tropical regions to Serbia.

5. Vulnerability in the Sava Basin

5.1. Methodological approach

Vulnerability assessment is the analysis of the expected impacts, risks and the adaptive capacity of a region or sector to the effects of climate change. Vulnerability assessment encompasses more than simple measurement of the potential harm caused by events resulting from climate change: it includes an assessment of the region's or sector's ability to adapt.

In other words vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

[The vulnerability assessment is an exercise that is strongly recommended to do on a basin level but has not been finalized yet in the Sava countries. Currently exposure and sensitive (impacts) of the systems are known, but the adaptive capacity remains a step to be performed as it is driven by adaptation measures. As some countries have started to do such assessment it is recommended that: i) a stocktaking exercise on available vulnerability assessment is done and based on this exercise, ii) a common methodology for all countries is agreed and iii) a basin wide vulnerability assessment should be carried out. A potential

approach to assess vulnerabilities can be obtained from the project CC-WARE, which aims at developing an integrated transnational strategy for water protection and mitigating water resources vulnerability²⁸.]

5.2. Basin wide vulnerability identified

[Results to be included in the full version of the strategy]

6. Framework Conditions for adaptation

Adaptation is legally framed in different ways in all of the countries and mainstreaming has taken place in various degrees. All countries ratified the UNFCCC Kyoto Protocol and ratified the Paris Agreement.

Parties to the United Nation Framework Convention on Climate Change (UNFCCC) must submit periodically national reports on implementation of the Convention to the Conference of the Parties (COP). In the context of National Communication on Climate Change should address also the issue of adaptation. All Sava countries except Montenegro have done so.

The framework for adaptation in the Sava Countries is quite diverse. Croatia and Slovenia are part of the EU, Bosnia and Herzegovina, Serbia and Montenegro are candidate countries to the EU. This leads to different legal frameworks (even if all non-EU countries are working towards the EU legislation) but also to different financial possibilities for adaptation. The biggest challenges in the non EU Countries relate to the lack of financial resources for implementing adaptation measures and also to the lack of knowledge on procedures and insufficient knowledge about climate change impacts.

Besides the EU Water Framework Directive and the EU Floods Directive, several international activities such as the ICPDR adaptation strategy²⁹ are as well of relevance for climate adaptation in the Sava River Basin. National Adaptation Strategies and action plans focus on the assessment of the present situation, on the requirements for adaptation to climate change and contain measures for adaptation in the Sava basin. Adaptation strategies or draft and action plans exist all countries, except BiH where no plan exists.

	Legal acts	Strategy on climate change adaptation	Action plan
Slovenia	y	y	n
Croatia	y	y	y
Bosnia and	y	y	n

²⁸ See <http://www.ccware.eu/>

²⁹ https://www.icpdr.org/flowpaper/app/services/view.php?doc=icpdr_climate-adaptation-strategy.pdf&format=pdf&page={page}&subfolder=default/files/nodes/documents/

Outline of the Climate Adaptation Strategy for the Sava River Basin

	Legal acts	Strategy on climate change adaptation	Action plan
Herzegovina			
Serbia	y	draft	draft
Montenegro	y	n	n

Table 3: Overview on adaptation mainstreaming, strategies and plans (y=yes, n=no)

The sectors addressed in the strategies with relevance to the Sava are shown in the table below.

	Water resources	Public Health	Agriculture	Forestry	Bio diversity	DRR	Other
Slovenia	x	x	x	x	x	x	x
Croatia	x	x	x	x	x	x	x
Bosnia and Herzegovina	x	x	x				x
Serbia	x	x	x	x	x	x	x
Montenegro	-	-	-	-	-	-	-

Table 4: Sectors covered in the strategies

Except for Slovenia³⁰ these strategies include suggested adaptation measures with regard to water-related issues and built the basis for the Sava adaptation strategy

7. Guiding principles on adaptation to climate change

Climate Change Adaptation applies to policies, practices and projects which can either reduce risks and / or realise opportunities associated with climate change. Adaptation affects all levels of decision-making, all regions as well as most sectors. Adaptation needs to be structured as a cross-sectoral, multi-level and inter-regional activity bringing together actors with different knowledge, interests and values. Adaptation is not simply about doing more, it is about new ways of thinking and dealing with risk and hazards, uncertainty and complexity. The guiding principles for adaptation in the Sava Basin could be:

[The list of guiding principles below is a draft proposal based on international guidance documents such as from EUNECE, EEA and will be expand during the development of the full strategy in the future.]

Strengthen the Knowledge base and agree on basin wide approaches

- There should be continuous process of updating knowledge while implementing the strategy and revising the strategy on a regular basis.
- Agree on definitions (nature-based or ecosystem based solutions, vulnerability, adaptive capacities, etc.) and develop a common understanding on methodologies used to ensure constancy across the basin.

³⁰ The Slovenian strategic framework provides steps to address guidelines, not a list of measures

Outline of the Climate Adaptation Strategy for the Sava River Basin

- Share tools, exchanging information to achieve a common understanding of CC issues etc. at transboundary level.
- Learn from the experiences made in the past.

Use of synergies

- Work in partnership – identify and engage with affected actors (e.g. from public authorities, NGOs, business) at all relevant levels and ensure they are well informed and encouraged to work on adaptation.
- Create win-win solution with other strategies and implementation actions (e.g. WFD, by integration of regional interest adaptation measures into programs of measures of River Basin Management Plans).
- Ensure coherence (consistency of actions and agendas) with other basin wider plans such as the Danube Strategy.

Adaptation planning

- Data will always be imperfect, but there is enough knowledge to adapt.
- Adaptation needs to be sustainable – adaptation responses should not add to climate change or limit the mitigation efforts. In addition, it should not cut the ability of other parts of the natural environment, society or business to carry out adaptation elsewhere.
- When adapt avoid new, unacceptable risks and maladaptation.
- Ecosystems adaptation and nature based adaptation solutions must lie at the centre of any adaptation policy.
- Aim for the implementation of “No regret” measures. Such measures can be justified under all plausible future climate change scenarios, including the absence of manmade climate change.
- Seek for opportunities for benefits from adaptation.

8. Adaptation objectives and targets

[Objectives and targets need to be discussed and agreed on Sava Basin level and will be approved during the development of full Strategy. The objectives should set the overall direction of the adaptation process and a timeframe.

Targets should be linked to specific objectives beforehand. The targets should be measurable and precise, also because the subsequent monitoring and evaluation of the implementation of the adaptation strategy and/or plan is directly linked to the targets.

Targets may range from numerical (e.g. area of natural water retention measure created) or process based (e.g. see scoreboard of the European Commission on adaptation³¹).

Examples from the workshop in October 2017 are:

- Sustainable development of the Sava basin;
- Safety and damage reduction, increasing resilience to climate change;
- Definition of social and physical vulnerabilities;
- Promotion of nature based solutions and their implementation;
- Sectoral studies that will address vulnerabilities (e.g. pilot studies, pilot sites);
- Continuing communication and education (e.g. create a specific task force).

Targets should be set for the short term (2027) and long term (2050)]

9. Measures for adaptation

9.1. National adaptation measures planned/started

[to be updated when full strategy is developed]

The table below provides an overview of the planned national adaptation measures in the area of risk forecasting and analysis. In summary it can be concluded that all countries are aiming to improve risk forecasting and analysis.

	SI	HR	BA	RS	ME
Establishment of an early warning (floods)	x	x	x		x
Establishment of an early warning (Droughts)	x		x		
Water management plans	x	x	x	x	x
Development of a model for extreme precipitation and flooding	x	x			x
Monitoring of water quality	x	x		x	
Increase research		x		x	x

Table 5: Planned measures related to risk forecasting and analysis

The table below shows potential measures related to risk prevention and reduction applied in the Sava Basin.

	SI	HR	BA	RS	ME
Reconstruction and new construction of irrigation systems	x		x		
Reconstruction of draining systems in flat		x	x		

³¹ Currently under development.

	SI	HR	BA	RS	ME
lands and flood plains					
Afforestation			X		
Artificial snow	X		X		
Establishment of flood risk zones in spatial plans	X	X		X	X
Structural flood defence measures	X	X		X	
Measures to reduce the risks from pollution in the case of an extreme event	X	X		X	
Increase efficiency of water supply	X			X	
Reduce water consumptions	X				
Water transfers				X	
Better cooperation and coordination among institutions	X	X	X	X	
Capacity Building			X		

Table 6: Planned measures related to risk prevention and reduction

In all countries (except ME) the plans and actions required by the WFD and the EFD built the basis for adaptation. However as one can see some of these measures need to be reviewed critically, as they might pose maladaptation measures (e.g. artificial snow, water transfers, increasing irrigation). For a final judgment the details of the possible application need to be analysed.

Through the establishment of the Southeast Europe Forum³², a platform for regional cooperation among civil service organisations and public officials has been created. This allows beside others to exchange experience among DRR issues.

Remediation measures are only reported for Slovenia. There is for example the possibility to use state aid in case of an extreme event (e.g. flood, drought) that cause estimated direct damage of more than 0,003% of projected state GDP. Also, Insurance system for farmers are in place.

Beside several national adaptation projects in the water sector, there are also some transboundary projects in place (see Annex 4) supporting the basin wider adaptation process.

9.2. Transboundary measures

[To be finalised when transboundary measures are agreed]

Following the UNECE Guidance³³, climate change impacts on water resources should always be considered together with other pressures or stressors, such as population growth or

³² <http://www.seclimateforum.org/CCA-Forum/1/Home.shtml>

³³ UNECE (2009): Guidance on water and adaptation to climate change. United Nations Publication, Geneva.

changing consumption patterns, when planning adaptation measures. As a result, adaptation measures with respect to climate change can often build on planned or already implemented water management measures in the framework of RBMPs. Adaptation planning in general should consider and prevent, possible conflicts and provide adequate trade-offs.

9.2.1. Type of measures considered

Based on the Danube adaptation strategy developed by the ICPDR³⁴ the following categories of measures should be further considered (without any hierarchy in their order) and discussed at the Sava basin scale. The list of measures will be further identified in the full strategy and action plan in the future.

Preparation measures for adaptation: Such measures aim to support planning processes. At transboundary level, this includes coordination and consistency for data exchange and water information systems, monitoring devices and networks, warning systems and emergency plans, evaluations of middle term changes, identification of risk areas and the support of further research where needed. However, one measure should also cover the continuous process of updating the knowledge on climate change and the related impacts while implementing the strategy. Also, educational measures are part of this category.

Ecosystem - based measures: measures based on “the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change” should be differentiated from measures targeting conservation or restoration of ecosystems. Healthy ecosystems can contribute to increase resilience to slow changes such as increasing summer temperatures or sudden impacts such as floods. Ecosystems also contain direct indicators of climate change (variation in species and population, migration of bioclimatic layers, ...) which will have to be developed in further steps.

Behavioural changes measures: Such measures aim to raise awareness about possible future conditions, to modify behaviours and practices and to support sustainable management with a focus on the efficient use of water and conservation of good water quality. Voluntary actions, at individual or territorial levels, and regulatory measures are complementary and cover the full spectrum from bottom-up to top-down approaches for a better adaptation, taking into consideration the diversity of local situations.

This includes, inter alia, the propagation of best practices, where the education to risk prevention and the exchange of knowledge plays an important role but also the elaboration of risk management plans. Also, educational measures are part of this category.

Policy measures: These measures aim to support the national, international and basin-wide coordination of activities. They cover a better implementation of existing instruments such

³⁴ ICPDR (2013): ICPDR Strategy on Adaptation to Climate Change

as environmental impact assessment or SEIA which are compulsory in the EU countries and could be beneficial for others, but also the updating of existing RBMP. Common transnational threshold values, limits, restrictions, expansions (e.g. for protection areas or nature reserves), etc. should be considered.

Technological measures: Technological measures focus is on infrastructure which has to be built or improved, such as dykes, reservoirs, water networks and transfers. It is an attribute of water supply policies and the demonstration of their link to climate change may be difficult to establish.

Disaster Risk reduction measures: Disaster risk reduction measures can be defined as actions taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, improved preparedness for adverse events and emergency measures. These measures are often combined with measures mentioned above.

9.2.2. Cost and benefits of measures

[In order to assess feasible adaptation options, the analysis of costs and benefits is crucial. An assessment on the Sava level can raise awareness of the issue and the scale of adaptation. It can also provide input to the discussion on the likely resources, sources of finance and funds needed. However, it should be noted that the estimation of costs and benefits can vary substantially with the objectives of the study, and the aggregation level and sector.

For further guidance (which is updated by the EEA continuously) please see <http://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool/step-4-2>]

9.2.3. Priorities of actions

[Based on an assessment of possible adaptation options, a selection of the most suitable ones should be carried out. Most often a multi-criteria analysis can prove useful for ranking and selecting preferred options. This analysis should include a set of criteria, such as³⁵:

- urgency with respect to already existing threats;
- early preparatory action (to avoid future damage costs);
- range of effect (options covering multiple risks might be favoured);
- cost-benefit ratio;
- time-effectiveness;
- robustness under a broad range of likely future impacts;
- flexibility for adjustments or reversibility in case of diverging developments;
- political and cultural acceptability;

³⁵ See <http://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool/step-4/prioritise-and-select> for further details

- enhancement of learning and autonomous adaptive capacity, etc.]

9.3. Principles when implementing of measures

The States in the Sava catchment are in charge of implementing adaptation measures to climate change and apply the principles of subsidiarity and solidarity. In order to respect these provisions, the Sava Countries have agreed to effectively coordinate measures with transboundary effects.

[This could be done along with the following principles:

1. Regional or local measures which are known not to have any transboundary effects will be planned and implemented regionally/locally.
2. For regional measures with transboundary effects there will at first be an exchange of information at a bilateral level or within the Sava basin commission. Eventually, these measures must be coordinated on a bilateral or multilateral level in order to find joint solutions.
3. The measures with regional effects mentioned under second might also cause supra-regional effects. Therefore, such measures must at the same time be included in the mutual exchange of information within the ICPDR.

To be discussed when measures are agreed]

9.4. Financing Implementation

9.4.1. Adaptation financing mechanism in place

Funding of adaptation remains a challenge in the region. In **BiH** the financing mechanism for adaptation are only in the initial phase. It is encouraging that policymakers and decision makers are ready to implement measures and projects in the area of adaptation to climate change as soon as possible. Some projects have already been implemented or are being implemented, but for large capital projects, which are related to water resources management, financial resources have still not been provided.

In **Croatia** three main financing mechanism are in place: a) a Water Fund, b) the EU Operational Programme - Competitiveness and cohesion for the EU financial period 2014 – 2020, and c) the national Environmental Protection and Energy Efficiency Fund that transfers funds collected from emission trading to adaptation. The latter two are also applied in **Slovenia**. Further, Slovenia has also other dedicated state funds (such as a ECO fund, and target research program fund, a Water Fund, intended for funding water infrastructure) and other state resources devoted under different laws (e.g. laws on

remediation measures after a natural disaster or extreme weather event). In **Montenegro** and **Serbia** only very, limited funding for adaptation exists. Projects are mainly financed by international institutions (UNDP, GEF, World Bank, the UNFCCC Adaptation Fund, the Green Climate Fund).

9.4.2. Funding for transboundary measures

[To be discussed when measures are agreed. However, the financing of measures will require discussion with donors, strong ownership and visibility]

10. Public participation

The Sava Commission supports the active involvement of stakeholders and civil society on all levels of its work. Consolidation processes are part of the normally procedure in all Sava Countries as all countries are parties to the Aarhus convention³⁶ and are obliged to perform practice of environmental democracy.

[The approach to public participation needs to be discussed as early as possible to ensure active involvement during the strategy development process but should be similar as for the as for adoption of Sava RBM Plan.

The public participation process should cover the following aspects³⁷:

- Inform –to provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.
- Consult –to obtain public feedback on analysis, alternatives and/or decisions.
- Involve –to work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered
- Collaborate –to partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.

The chapter should cover the following aspects:

- Description of the public information and participation process. Distinguish between stakeholders, NGOs and general public;
- Information on data and information access- How is it organized.

It is suggested that the public participation last at least 6 Month.]

³⁶ <https://www.unece.org/env/pp/ratification.html>

³⁷ International Association for Public Participation (IAP2). 2007. 'Spectrum of Public Participation'. Available online: [<http://www.iap2.org>].

11. Monitoring and evaluation of adaptation approach

[Issue for discussion as most Sava Countries do not have a monitoring or reporting process for adaptation measures in place, which would be the basis for a Sava wide process. A compilation and summary of approaches that could trigger the discussion can be found in the report “Monitoring and Evaluating Adaptation at Aggregated Levels: A Comparative Analysis of Ten Systems”³⁸]

³⁸ See https://gc21.giz.de/ibt/var/app/wp342deP/1443/wp-content/uploads/filebase/me/me-guides-manuals-reports/GIZ_2014-Comparative_analysis_of_national_adaptation_M&E.pdf

Annexes

Annex 1: List of legislative Acts that address climate change and in particular adaptation

To be completed in the full strategy.

Annex 2: Competent authorities in the country related to climate change adaptation

To be completed in the full strategy.

Annex 3: Climate change scenarios

Please see https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexI_FINAL.pdf

Annex 4: Ongoing Transboundary projects

The list below only shows transboundary projects, fully acknowledging that also several national projects are under implementation that aim to support the adaptation to climate change.

Outline of the Climate Adaptation Strategy for the Sava River Basin

Project	Partners	Content	Funding	Timeframe	Costs
DriDanube – Drought Risk in the Danube Region³⁹	Lead by the Slovenian Environment Agency Republic Hydro-meteorological Service of Republic of Srpska	Increase the capacity to manage drought related risks through establishing a Drought User Service, harmonizing methodologies for risk and impact assessments and improve decision-making process	Danube Transnational Programme	01/2017-07/2019	1,974,750 €
Project JENTRAP - Joint Contribution to Enhanced Transnational Emergency Preparedness in the Sava Basin	The Brodsko-Posavska County from Croatia with partners from Šabac city from Serbia.	The overall goal of the project is to achieve transnational readiness to protect against floods and to reduce flood damage in the Sava River Basin. Of the total amount of the project, about 70 percent of the funds are intended for the purchase of flood protection and rescue equipment.	IPA II Cross-border Program Croatia-Serbia 2007-2013.	2016	889.656,92€
Flood Risk Slovenia-Croatia Operations – Strategic Project 1 – Nonstructural Measures (FRISCO1)	Croatian waters leading consortium of 8 partners	This Project will serve two key purposes: to improve coordinated flood risk management and reduce flood risks through implementation of non-structural measures, and to prepare documentation (studies and design) for the optimal structural measures that will be implemented in subsequent strategic project or projects. The main outputs will be sets of joint models, maps and	Slovenia-Croatia INTERREG Program	04/2016-04/2019	3.460.307,50 €

³⁹ www.interreg-danube.eu/approved-projects/dridanube

Outline of the Climate Adaptation Strategy for the Sava River Basin

		tools for each of the six target transboundary river basins (Kupa/Kolpa, Sutla/Sotla, Drava, Mura, Dragonja and Bregana) with the associated design documentation for optimal structural measures, improved physical alert systems, and the outputs of awareness rising/capacity building activities. The Project will address the needs of a wide range of target groups, and the ultimate beneficiary of the Project is the affected population. The Project's objectives can only be achieved through cross-border cooperation because, in line with the Floods Directive, the flood risk management planning should be done following the river basin approach in order to determine the optimal measures. The Project is original because of its comprehensiveness, both in terms of the spatial coverage (all transboundary river basins) and in terms of the scope of the measures (all key non-structural measures covering preparedness, prevention and response).			
CAMARO-D⁴⁰	Public Water Utility of Ljubljana, University of	developing recommendations towards a strategic policy for the implementation of an innovative transnational	Danube Transnational Programme	01/2017 – 07/2019	2,588,138.36 €

⁴⁰ <http://www.interreg-danube.eu/approved-projects/camaro-d>

Outline of the Climate Adaptation Strategy for the Sava River Basin

	Ljubljana, 14 partners in total	catchment-based “Land Use Development Plan” for the Danube River Basin, to strengthen transnational water management and flood risk prevention			
AMIIGA⁴¹	Public Water Utility of Ljubljana, Geological Survey of Slovenia, 12 partners in total	aims to improve planning, management and decision-making capacity of the public sector for the groundwater management and mitigation of pollution through pilot action	Central Europe Transnational programme	09/2016 – 08/2019	7 794 852,79€
PROLINE-CE⁴²	Public Water Utility of Ljubljana, University of Ljubljana, 13 partners in total	Efficient Practices of Land Use Management Integrating Water Resources Protection and Non-structural Flood Mitigation Experience	Central Europe Transnational programme	07/2016- 07/2019	2.750.209,47€
Improvement of joint flood management actions in the Sava river basin Component 1: Joint Flood Risk Management Plan for the Sava River Basin (Sava FRMP)	EPTISA Servicios de Ingenieria S.L	Project will provide technical support and assistance to the ISRBC and the beneficiary countries in flood management in the Sava River Basin. The following results should be achieved: Prepared Flood Risk Management Plan, including Summary of Measures with all its related components and accompanying documents; Carried out public participation process and development of a follow-strategy which would set out proposals for priority activities (draft work program) for the Sava River Basin	WBIF	03/2017- 07/2018	

⁴¹ <http://www.interreg-central.eu/Content.Node/AMIIGA.html>

⁴² <http://www.interreg-central.eu/Content.Node/PROLINE-CE.html>

Outline of the Climate Adaptation Strategy for the Sava River Basin

		to guide the work of ISRBC and FASRB Parties from the first to the second Sava FRMP, including data collection activities and implementation of the measures.			
Improvement of joint flood management actions in the Sava river basin Component 2: Joint Flood Forecasting and Warning System for the Sava Basin (Sava FFWS).	Deltares, NL; Royal Haskoning DHV; Eptisa; HEIS, Mihailo Anđelić	Technical Assistance for the implementation of an integrated flood and drought forecasting system and a system for the dissemination of warnings, covering the complete Sava River Basin. The three major expected outcomes of the project are: Operational flood forecasting and early warning system with installations in the riparian Sava River Basin countries Bosnia and Herzegovina, Montenegro, Serbia, Slovenia and Croatia; Well trained staff in each of Riparian Countries and Recommendations on future improvements of the forecasting system.	WBIF	06/2016-09/2018	

Annex 5: Measure fact sheets

[The fact sheet template below should be filled for each measure agreed and listed in the full strategy (e.g. Annex)]

Measure name	
Measure Number	
Vulnerabilities addressed	
Type of measures	See categories above
Description of the measure	
Costs	
Benefits/co- benefits	
Funding	
Responsible authorities in each Country	
Timeframe for implementation	
Indicator to measure progress	