External Action of the European Union:
"Support to the International Sava River Basin Commission
in preparation and implementation of the
Sava River Basin Management Plan"

Sava River Basin Analysis Summary

Funded by
the Europen Union

Implemented by
the International Sava River Basin Commission

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December 2010

The *Sava River Basin Analysis Summary* has been prepared and edited by the International Sava River Basin Commission (ISRBC).

The *Sava River Basin Analysis Summary* has been produced with the financial assistance of the European Union, within the Instrument for Pre-Accession Assistance (IPA) for the Action "Support to the International Sava River Basin Commission in preparation and implementation of the Sava River Basin Management Plan" (Ref.: 22.020701/2009/547132/SUB/D1). The contents of this document are the sole responsibility of the ISRBC and can under no circumstances be regarded as reflecting the position of the European Union.

The *Sava River Basin Analysis Summary* is available at the website of the ISRBC.

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Publisher: International Sava River Basin Commission
Design and print: ITG d.o.o. za izdavačku i grafičku djelatnost

Foreword

According to the *Framework Agreement on the Sava River Basin* (*FASRB*), the establishment of sustainable water management in the Sava River Basin is one of the principal objectives of the cooperation of the Parties to the Agreement. Development of the *Sava River Basin Management Plan*, in line with the EU *Water Framework Directive* (EU *WFD*) and under the coordinating role of the International Sava River Basin Commission (ISRBC), certainly presents a key activity in this context.

As the first step toward the *Sava River Basin Management Plan*, substantial effort has been made during the past years in order to perform the Sava River Basin Analysis, as recognized at the 2nd Meeting of the Parties to the *FASRB* (Belgrade, June 1, 2009).

The Sava River Basin Analysis provides the characterization and assessment of water resources in the Sava River Basin in accordance with Article 5 of the EU *WFD*, including an additional consideration of the important issues such as flood management and development of navigation in the basin. Accordingly, the Analysis has been accepted by the ISRBC "as a good basis for further activities on development of the *Sava River Basin Management Plan*".

The commitment of the Parties to respect the EU *WFD*, although not all of them are legally bound to do so, as well as a good cooperation of the Parties in development of the Sava River Basin Analysis, have granted a positive perception of the European Commission, which finally resulted in a decision of the EC to provide support for remaining steps in development of the first *Sava River Basin Management Plan*, including filling-up the gaps identified in the Analysis.

The *Sava River Basin Analysis Report* has been approved at the 13th Special Session of the ISRBC, held in September 2009, and subesequently published and made available on the ISRBC web-site in the beginning of 2010 (http://www.savacommission.org/publication).

This publication provides an extract of the *Sava River Basin Analysis Report*. It presents the most important findings of the Analysis, and outlines the identified gaps, to a level of detail appropriate for a wider audience, aiming to attract attention of readers to the *Sava River Basin Analysis Report* itself, as a source of detailed information.

I hope that this publication will contribute to raising the awareness of the present situation in the basin with respect to the requirements of the EU *WFD*, and thus facilitate further efforts to be invested in development and implementation of the *Sava River Basin Management Plan*.

Dejan Komatina, Ph.D.
Secretary of the ISRBC

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1. INTRODUCTION

After the political changes in the region in the early 1990-ies, the Sava River, which was the biggest national river in the former country, has become an international river of recognized importance. The arising need for cooperation in management of the shared waters of the Sava River Basin led to beginning of the negotiation process known as the Sava Initiative, which resulted in signing of the *Framework Agreement on the Sava River Basin* (*FASRB*) at Kranjska Gora (Slovenia), on December 3, 2002. The *FASRB*, which is the first multilateral agreement in the region after the agreement on succession, is being implemented by the four Parties - Bosnia and Herzegovina, Republic of Croatia, Republic of Serbia, and Republic of Slovenia.

The *FASRB* emphasizes the importance of transboundary cooperation of governments, institutions and individuals for sustainable development of the Sava River Basin.

One of the main goals of the process of transboundary cooperation is the establishment of sustainable water management, including the cooperation on management of the Sava River Basin water resources in a sustainable way, in a manner that would provide:

- water in sufficient quantity and of appropriate quality for the preservation, protection and improvement of aquatic eco-systems;
- waters in sufficient quantity and of appropriate quality for all kinds of water utilization;
- protection against detrimental effects of water (flooding, excessive groundwater, erosion and ice hazards);
- resolution of conflicts of interest caused by different uses and utilizations, and
- effective control of the water regime.

The cooperation is based on the following principles:

- Sovereign equality, territorial integrity, mutual benefit, and good faith;
- Mutual respect of national legislation, institutions and organizations;
- Cooperation in line with the EU *WFD* and other related Community legislation;
- Regular exchange of information within the basin on: water regime, navigation regime, legislation, organizational structures, administrative and technical practices;
- Securing the integrity of the water regime in the basin,
- Reduction of transboundary impacts caused by economic and other activities.

By signing of the *FASRB*, the Parties have expressed their commitment to prepare a joint *Sava River Basin Management* (RBM) *Plan*. As the first step in development of the *Sava RBM Plan*, the *Sava River Basin Analysis* was performed, providing the characterization of the Sava River Basin in terms of the general characteristics of the basin (surface area, country share, relief and topography, land cover, climate, water balance), water quality, water quantity and economic issues. The flood protection and navigation issues were elaborated within the Analysis, as well.

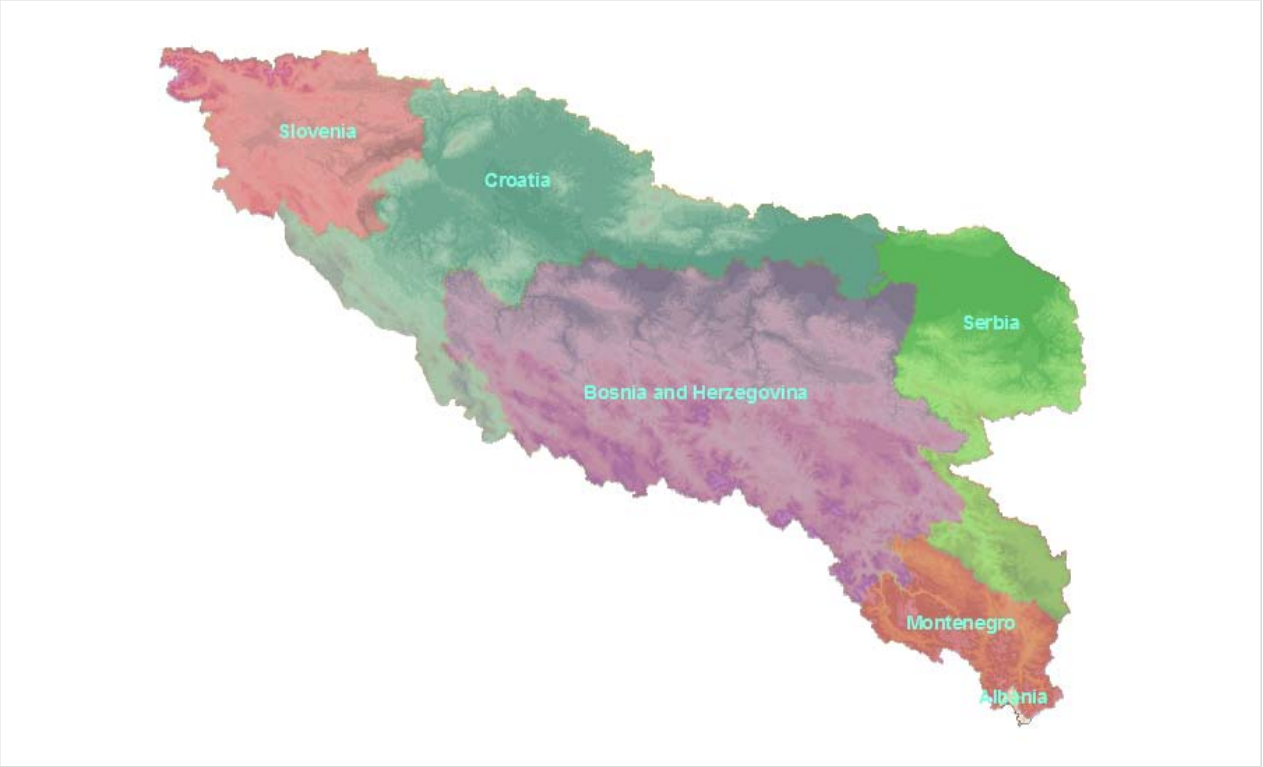
This publication provides a summary of the *Sava River Basin Analysis Report*, outlining the main findings and indicating the gaps identified in the Analysis.

2. BASIC FACTS ON THE SAVA RIVER BASIN

The Sava River Basin is a major drainage basin of the South Eastern Europe, covering the total area of approximately 97,713.20 km² and represents one of the most significant sub-basins of the Danube River Basin, with the share of 12%.

The basin area is shared between five countries: Republic of Slovenia (SI), Republic of Croatia (HR), Bosnia and Herzegovina (BA), Republic of Montenegro (ME) and Republic of Serbia (RS), while a negligible part of the basin area also extends to Republic of Albania (AL).

Population in the Sava River Basin is approximated to 8,176,000, which represents 46% of the total population of all countries (excluding AL and ME).



Country share of the Sava River Basin

Share of the Sava countries territory belonging to the Sava River Basin

	SI	HR	BA	RS	ME	AL
Total country area [km²]	20,273	56,542	51,129	88,361	13,812	27,398
Share of national territory in the Sava River Basin [%]	52.8	45.2	75.8	17.4	49.6	0.59
Area of the country in the Sava River Basin [km²]	11,734.8	25,373.5	38,349.1	15,147.0	6,929.8	179.0
Share of Sava River Basin [%]	12.01	25.97	39.25	15.50	7.09	0.18

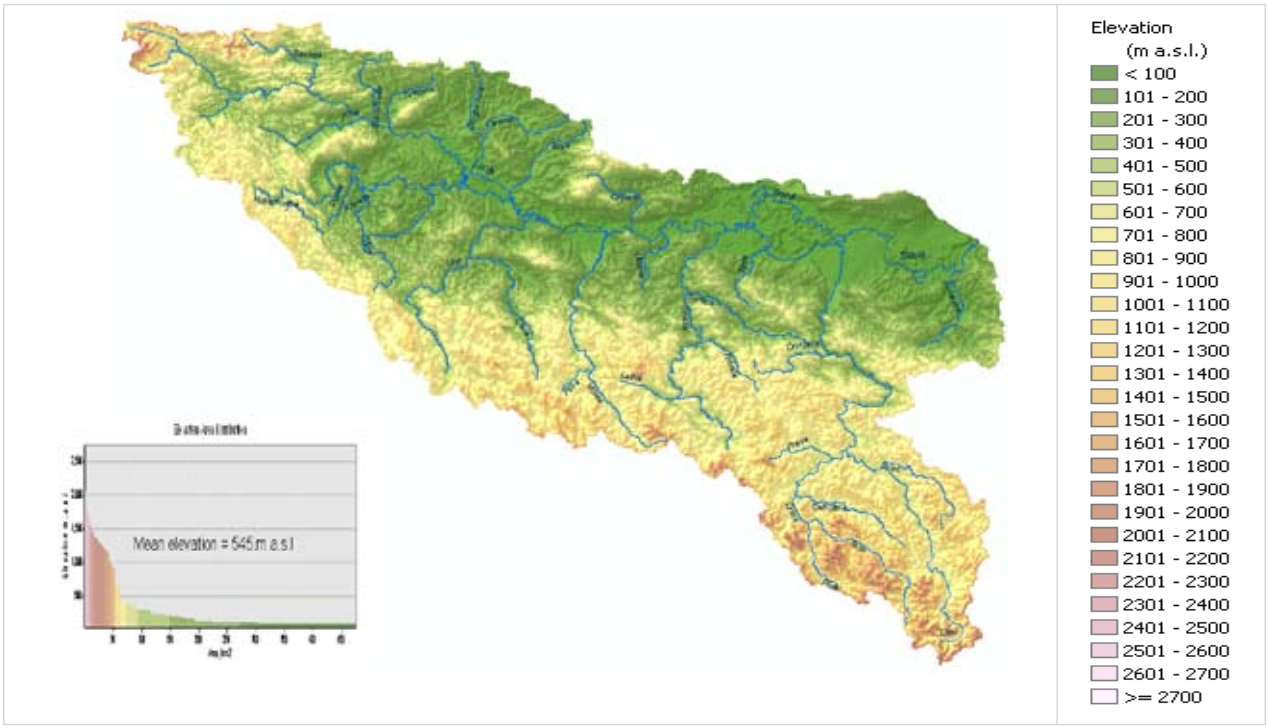
2.1 Relief and topography

Terrain in the Sava River Basin is very variable. It significantly changes from the source on the west to its confluence with the Danube River on the east.

Rugged mountains (the Alps and the Dinarides) dominate in the upper part of the basin. In the downstream parts, the areas drained by right tributaries in the middle section of the Sava watercourse are also rugged, while the middle and lower part of the Sava watercourse is characterized by flat plains and low mountains as a part of Pannonian Plain, a low-lying, fertile, agricultural region.

Generally, elevation of the Sava River Basin varies between approx. 71 m above sea level (m a.s.l.) at the mouth of the Sava River in Belgrade (Serbia) and 2,864 m a.s.l. (Triglav, Slovenian Alps). Mean elevation of the basin is 545 m a.s.l.

According to FAO classification, the dominant slope in the basin is moderately steep, and the mean value of slope is 15.8%.



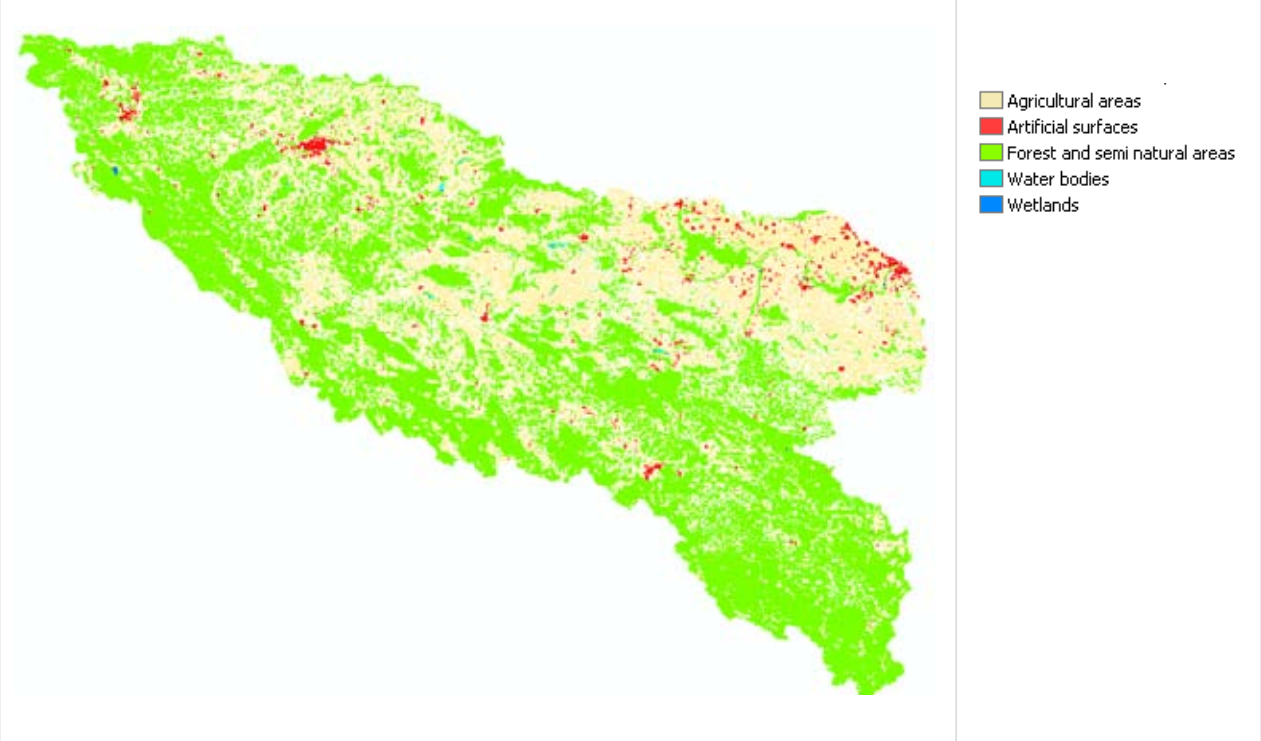
Sava River Basin relief characteristics

2.2 Soils

According to Harmonized World Soil database, the soils with the largest extent are the Cambisols (weakly to moderately developed soils) that cover 46.4% of the basin. Other important soil groups are the Luvisols (soils with subsurface accumulation of high activity clays and high base saturation), Leptosols (very shallow soils over hard rock or in unconsolidated very gravelly material), Podzoluvisols (leached soils) and Fluvisols (young soils in alluvial deposits).

2.3 Land cover/land use in the basin

An overview of the land cover/land shows that most of the basin is covered by the forest and semi-natural areas (54.71%) and agricultural surfaces (42.36%).



Distribution of the main land cover classes in the Sava River Basin (According to the CLC 2000)

2.4 Climate conditions

The Sava River catchment is situated within a wide region where the moderate climate of the northern hemisphere prevails. The cold and hot seasons are clearly distinctive. The winter can be severe with abundant snowfalls, while summer is hot and long.

Climate conditions within the basin can be classified into three general types:

- Alpine climate (upper part of the Sava River Basin);
- Moderate continental climate (right tributaries' catchments);
- Moderate continental (mid-European) climate (left tributaries' catchments that belong to the Pannonian Basin).

Average annual air temperature for the whole Sava Basin is estimated to about 9.5°C. Mean monthly temperature in January falls to about -1.5°C, whilst in July it can reach almost 20°C.

Precipitation amount and its annual distribution are very variable within the basin. Average annual rainfall over the Sava River Basin was estimated at about 1,100 mm.

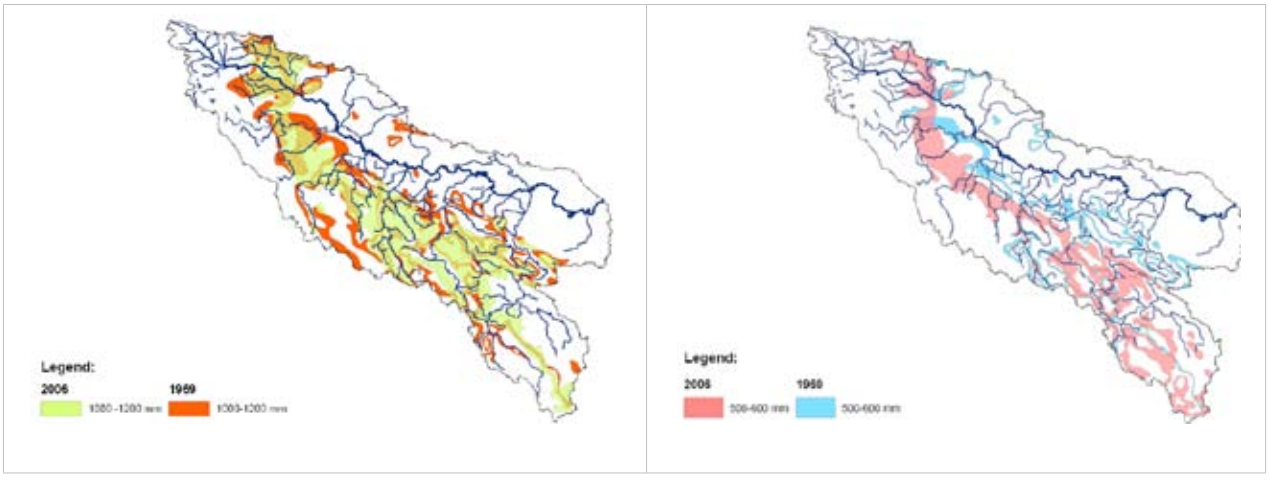
The average evapo-transpiration for the whole catchment is about 530 mm/year.

2.5 Water balance

Hydrologic balance, i.e. input and output of water over a given area, depends primarily on climatic conditions and physical features of the catchments. Spatial distribution of hydrologic balance is heterogeneous. Long-term average annual precipitation ranges between 600 mm and 2,300 mm. The largest precipitations take place at the upper parts of the Kupa, Piva, Tara, Una, Vrbas and Drina River catchment. Areas with lowest precipitation, in addition to the mentioned regions, are found in Slavonia and Semberia.

Spatial distribution of unit-area-runoff largely follows the pattern of precipitation spatial distribution. It varies from 150 mm/year (under 5 l/s/km^2) up to 1,200 mm/year (almost 40 l/s/km^2). The lowest water yields take place within catchments of the Bosut and Kolubara River, as well as along lower parts of catchments of the Sava River tributaries (Posavina, Semberija, and Mačva). Upper catchments of the Sava River in Slovenia, as well as of its tributaries (Kupa, Una, Vrbas, Bosna, Piva and Tara River), are characterized by high water yield.

Spatial distribution of evapotranspiration is heterogeneous, too. Long term evapo-transpiration ranges between 320 and 620 mm/year. The highest values appear in the Central Posavina and catchments of Lonja, Ilova and Kupa River. The lowest value of evapo-transpiration is present in upper parts of catchments of Drina, Bosna and Vrbas River. Areas with relatively small evapo-transpiration are in Slovenia, as well as the upper catchments of the Kupa and Una River.



Comparative maps of mean annual precipitation and runoff (study 1969 – 2006)

2.6 Description of the Sava River and its main tributaries

The Sava River is formed by two mountainous streams: Sava Dolinka River and Sava Bohinjka. From their confluence near Radovljica until it joins the Danube River in Belgrade (Serbia), the Sava River is 945 km long while together with its longer headwater, the Sava Dolinka River, it measures 990 km.

Its average discharge at the confluence at Belgrade, Serbia is 1,700 m^3/s.

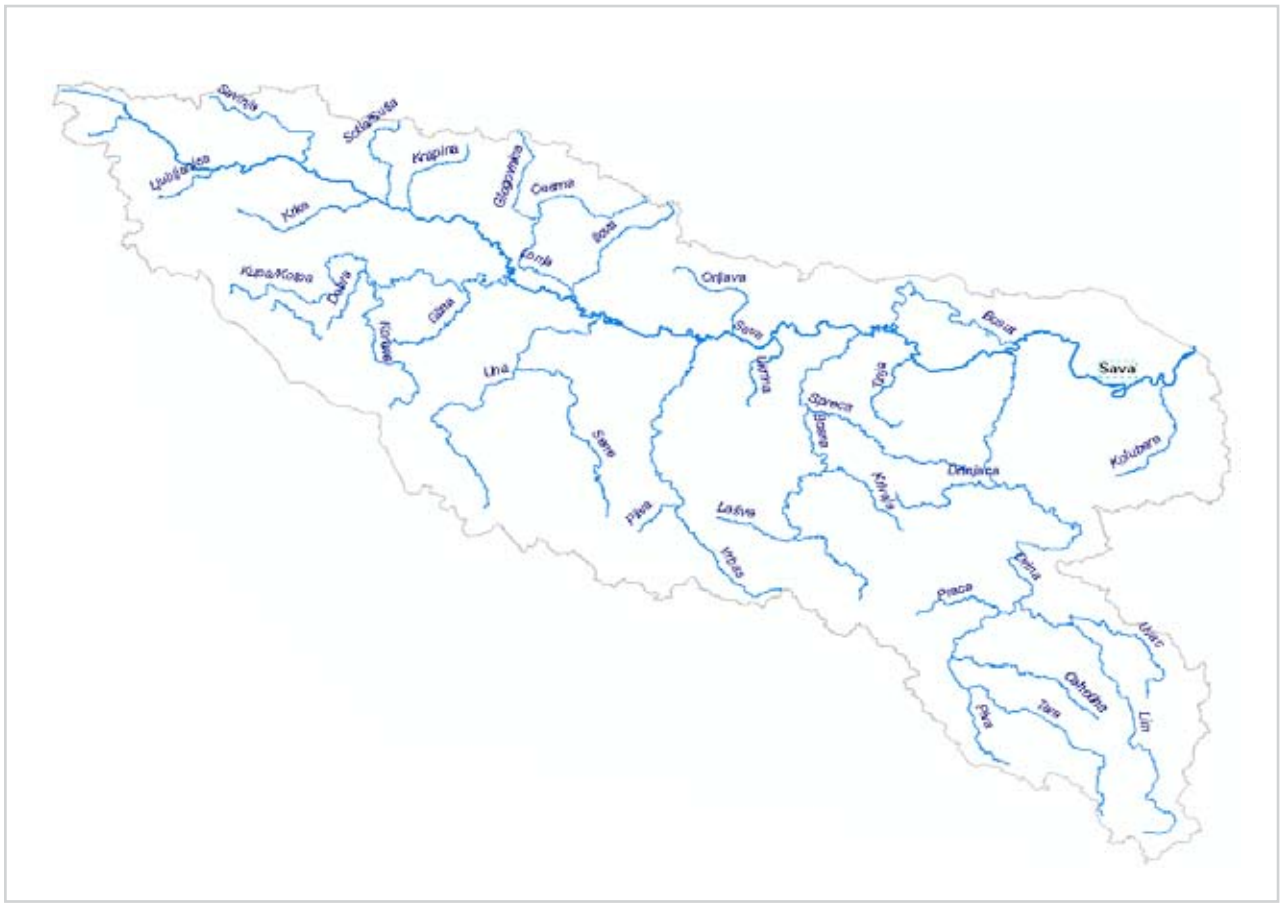
Hydrographic network in the basin is well developed. Most important tributaries in the upper Sava River Basin are: Kokra, Kamniška Bistrica and Savinja River (from the left side) and Sora, Ljubljanica and Krka River (from the right).

At its middle and lower course, the Sava River begins to meander and together with the lower parts of the Bosnian watercourses creates huge floodplains.

Common feature of almost all right tributaries of the Sava River is their torrential behaviour, particularly in their upper sections (Una and Drina River). The Una River is famous by several water falls. As it approaches the confluence, the Una River becomes mild and slowly moving. Further downstream, the Sava River receives several right tributaries that drain central and northern part of Bosnia and Herzegovina. Most significant among them are Vrbas, Ukrina, Bosna, Brka and Tinja River. Vrbas and Bosna River are medium size rivers whose catchments are deeply penetrating into the central part of Bosnia and Herzegovina. They receive several mountainous tributaries each.

Drina River is the largest and most important of all tributaries of the Sava River. Its drainage basin extends into four countries: Montenegro, Bosnia and Herzegovina, Serbia and a very small part extends to Albania.

Flowing further downstream, the Sava River receives, near Belgrade, two important tributaries from the right: Kolubara and Topčider River.



The Sava River Basin hydrographic network – rivers included in the analysis

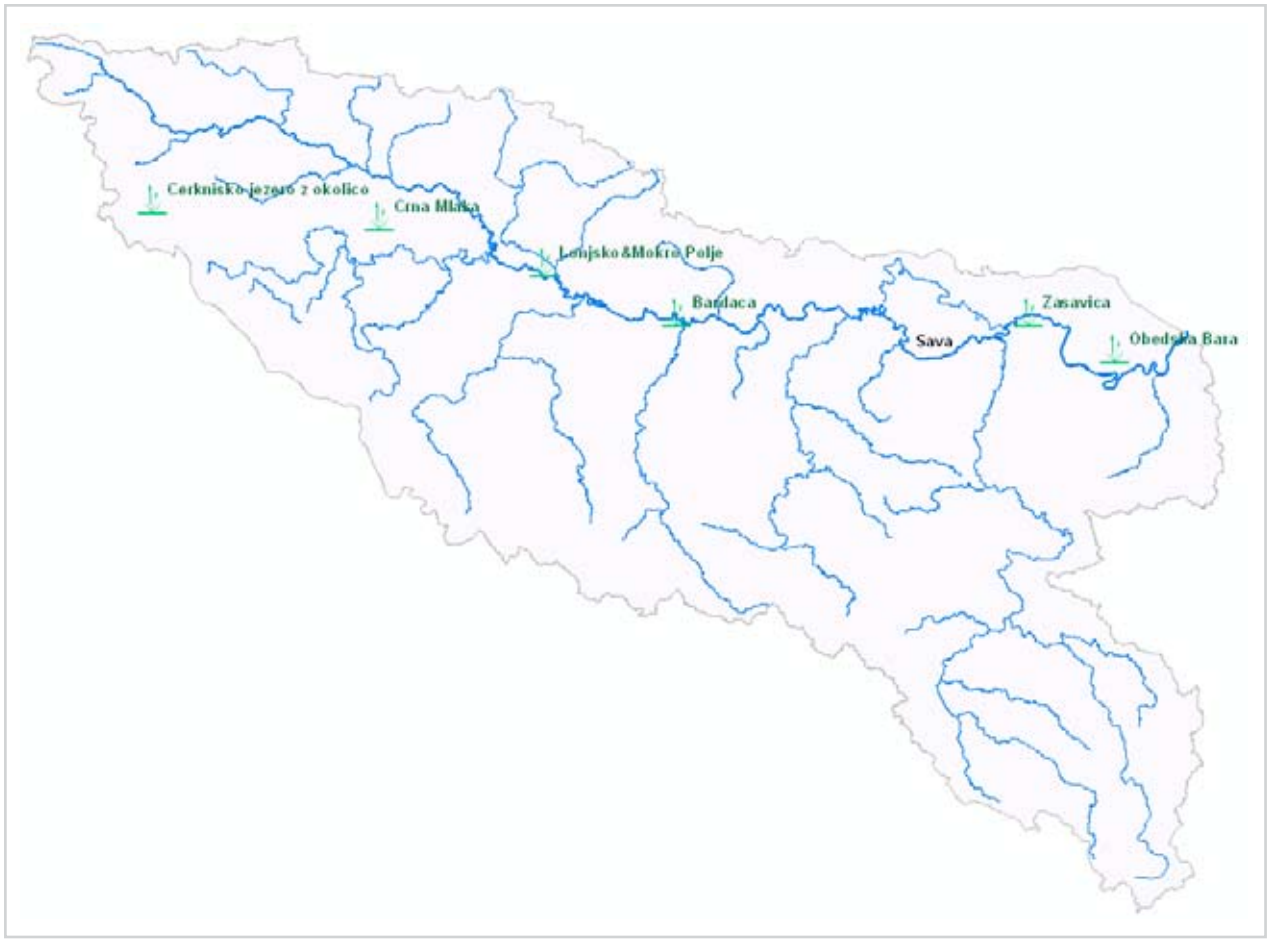
Agreed list of the Sava River Basin rivers considered in the Sava River Basin Analysis Report

River	Con-fluence (l-left; r-right)	Trib. order	River basin size [km²]	River length [km]	Countries sharing the (sub-)basins
Sava			**97,713.2**	**944.7**	**SI, HR, BA, RS, ME, AL**
Ljubljanica	r	1st	1,860.0	41.0	SI
Savinja	l	1st	1,849.0	93.9	SI
Krka	r	1st	2,247.0	94.6	SI
Sotla/Sutla	l	1st	584.3	88.6	SI, HR
Krapina	l	1st	1,237.0	66.9	HR
Kupa/Kolpa	r	1st	10,225.6	297.4	HR, SI, BA
Dobra	r	2nd	1,428.0	104.2	HR
Korana	r	2nd	2,301.5	138.6	HR, BA
Glina	r	2nd	1,427.1	112.2	HR, BA
Lonja	l	1st	4,259.0	49.1	HR
Česma	l	2nd	3,253.0	105.7	HR
Glogovnica	r	3rd	1,302.0	64.5	HR
Ilova (Trebež)	l	1st	1,796.0	104.6	HR
Una	r	1st	9,828.9	214.6	BA, HR
Sana	r	2nd	4,252.7	141.9	BA
Vrbas	r	1st	6,273.8	249.7	BA
Pliva	l	2nd	1,325.7	26.8	BA
Orljava	l	1st	1,618.0	87.6	HR
Ukrina	r	1st	1,504.0	80.7	BA
Bosna	r	1st	10,809.8	281.6	BA
Lašva	l	2nd	958.1	56.6	BA
Krivaja	r	2nd	1,494.5	73.5	BA
Spreča	r	2nd	1,948.0	138.8	BA
Tinja	r	1st	904,0	99.4	BA
Drina	r	1st	20,319.9	346.0	ME, AL, BA, RS
Piva	l	2nd	1,784.0		ME
Tara	r	2nd	2,006.0		ME, BA
Ćehotina	r	2nd	1,237.0	125.0	ME, BA
Prača	l	2nd	1,018.5	55.0	BA
Lim	r	2nd	5,967.7	193.0	AL, ME, RS, BA
Uvac	r	3rd	1,596.3	114.5	RS, BA
Drinjača	l	1st	1,090.6	87.5	BA
Bosut	l	1st	2,943.1	186.0	HR, RS
Kolubara	r	1st	3,638.4	86.6	RS

2.7 Ramsar sites

The Sava River Basin is of high significance due to its outstanding biological and landscape diversity. It hosts the largest complex of alluvial wetlands and large lowlands forest complexes. Some of these floodplains are still intact and support flood alleviation and biodiversity.

Because of the ecological and cultural value of the wetlands, the Sava riparian countries have designated six sites in the Sava River Basin according to *The Convention on Wetlands of International Importance especially as Waterfowl Habitat*, or so-called *Ramsar Convention*. Those important sites are: Bardača Wetland (BA), Lonjsko polje and Crna Mlaka (HR), Obedska Bara and Zasavica (RS) and Cerknica Lake (SI).



Locations of the Ramsar sites in the Sava River Basin

3. CHARACTERIZATION OF THE SURFACE WATER BODIES

3.1 Typology and reference conditions of the surface water bodies

According to the provisions of the EU *WFD*, the countries differentiated the relevant surface water bodies within the river basin district according to the type. All Sava riparian countries cover the obligatory factors (altitude, latitude, longitude, geology, size) given for System B in the EU *WFD* Annex II, 1.2.1. As an optional factor for river typology, the countries have introduced the mean substratum composition. As additional optional factors, HR has introduced discharge, while SI has introduced some other specific factors as hydrology, karst spring influence, lake outflow influence, limnocrene spring influence. In total, this, so far resulted in 60 different river types in the Sava River Basin (excluding ME).

The types of the Sava River Basin water bodies are distributed mainly in eco-region 5 (Dinaric Western Balkans), only small number is distributed in eco-region 11 (Hungarian lowland) and eco-region 4 (Alps). The altitudes vary between 200-800 m a.s.l. Most of the tributaries are large rivers. Most of the main tributaries are siliceous and calcareous, and only a few are mixed and organic.

3.2 Identification of River Water Bodies

According to the provisions of the EU *WFD* the Sava countries have identified 26 water bodies for the Sava River and 118 water bodies for the tributaries.

3.3 Reservoirs in the Sava River Basin

The countries have identified 21 reservoirs with the volume above 5 million m^3. The largest reservoir in the basin is Mratinje, located on the Piva River in ME. Most of the reservoirs are used for the purpose of the electricity production, some of them are used for flood protection, drinking and industrial water supply, and irrigation.

3.4 Identification of significant pressures

The necessity to analyze pressures and impacts is stated in Article 5 of the EU *WFD*. In this context, a pressure stands for any anthropogenic influence on natural conditions of a river, lake and groundwater, whereas a significant pressure means 'having the potential to cause a more than marginal, at least locally (measurable) effect on a river, lake or groundwater body, irrespective of the detailed properties, size and typology of the respective water body'.

Sum of effects of pressures is a result of simultaneous activity of different categories of pressures and intensities of their impact to changes in the water body, which are also dependent of dynamics in the water body.

Driving forces related to the settlements, industry, agriculture and waste management have been considered as key elements that exert or may exert significant pressure on surface water bodies.

The significant sources of point pollution are settlements agglomeration larger than 2,000 PE and the industry without waste water treatment.

According to the inventory based on the population equivalent (PE) the total waste water load from the municipal sources is almost 5,450,000 PE. It represents the total of almost 72,000 t/year of BOD, 156,000 t/year of COD, 13,000 t/year of N-tot and more than 3,000 t/year of P-tot.

Unfortunately, no or only few data on hazardous substance pollution and nutrient pollution, especially from the diffuse sources of pollution (e.g. agriculture), have been available.

Identification of significant hydromorphological alterations

Three hydromorphological pressure components have been identified in the Sava River Basin:

- Interruption of river and habitat continuity (longitunal and lateral);
- Disconnection of adjacent wetland/floodplains,
- Hydrological alterations.

Longitudinal continuity and habitat interruption

The course of the Sava River is interrupted by 5 existing hydropower dams in Slovenia (Moste, Mavčiče, Medvode, Vrhovo, and Boštanj). Significant number of hydropower dams is also present in the Drina River sub-basin (Višegrad (BA), Bajina Bašta and Zvornik (RS)) and on the Lim and Uvac River in RS, as well as on the Piva River (Mratinje) and Ćehotina River (Otilovići) in Montenegro. 13 structures are located on tributaries in SI. In HR, one hydropower dam is located on the Kupa River (Ozalj). Two dams on the Vrbas River are located in BA. One sill on the Kolubara River also represents the interruption of river connectivity, and one weir is located on the Bosut River.

Lateral connectivity interruption

The lateral connectivity interruptions are presented by disconnected wetlands and former floodplains.

The main causes of reduction of wetland areas have been the expansion of agriculture uses and river engineering works mainly for flood control. In the large plains of the lower-middle and lower Sava, extensive flood protection systems and drainage networks were built up, and have caused a loss of wetlands.

Hydrological alterations

Hydropower generation, agriculture and industry can be identified as the main drivers causing hydrological alterations in the Sava River Basin. Water abstraction from rivers corresponds with many anthropogenic purposes and uses. Slovenia reported 18 hydrological alterations affecting 14 water bodies on the Sava River and tributaries. There are 8 hydrological alterations in RS - one on the Sava River (impoundment by the Iron Gate I reservoir), and others on the tributaries.

Future infrastructure projects

In addition to the present degradation of the Sava River and its tributaries caused by existing hydromorpological alterations, a number of future infrastructure projects are at different stages of planning and preparation which may provoke significant hydromorphological pressures on water status.

Two dams with the main purpose of hydropower production on the Sava River (Brežice and Mokrice), and also flood protection, are planned in SI.

There are no official plans for future infrastructure projects in HR at the moment.

There is a decision on building 4 hydropower plants on the Bosna, Drina, Unac and Vrbas River in BA in the next 5 – 6 years. About 10 future hydropower plants are also under consideration as the ”A” priority (Sana, Bosna, Vrbas, Drina, Una, Bioštica – Krivaja and Ugar River) and also 7 projects as the ”B”. At the same time, concession for 202 small hydropower plants is already issued in BA Federation.

In the Republika Srpska, design for 3 hydropower plants on the upper part of the Drina River and one on the Lim River are planned. The planning documents comprise two hydropower plants in the middle flow of the Vrbas River. Concessions are issued for 7 planned hydropower plants on the Bosna River.

Although there is none official information on future infrastructure projects in RS, remarkable but unexploited hydro-potential of the Drina River was demonstrated together with the fact that future development depends on harmonization of interests of different stakeholders.

The navigation issues comprise rehabilitation of the Sava River waterway. This activity is recognized by the ISRBC as a priority and a feasibility study was performed in 2008. A multifunctional approach was used taking into account not only transport but also leisure, water management and environment. Basic documents (reviews) for the environmental impact assessment report were carried out, including proposal of environment protection measures, environmental monitoring program and evaluation of costs for environmental protection.

3.5 Identification of artificial water bodies (AWBs)

According to Article 2(8) of the EU *WFD*, „'Artificial water body' means a body of surface water created by human activity".

Only BA and SI have reported on the AWBs. In BA, the AWBs are Drina-Dasnica, intake tunnel from reservoir to the Jajce HPP, and the Channel system in the downstream part of the Vrbas River. In SI, the AWBs are Gruber Canal and Velenje Lake.

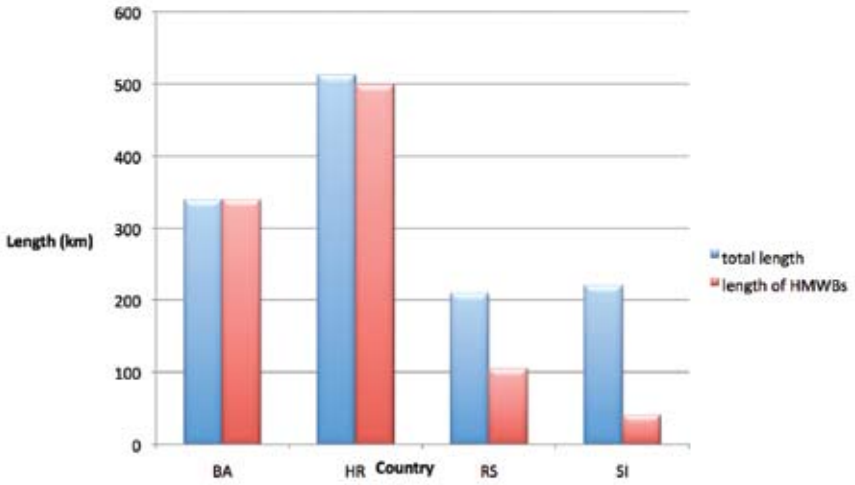
3.6 Identification of heavily modified water bodies (HMWBs)

According to Article 2(9) of the EU *WFD*, „'Heavily modified water body' means a body of surface water which, as a result of physical alterations by human activity, is substantially changed in character, as designated by the Member State in accordance with the provisions of the Annex II".

The HMWBs have been identified by the Sava countries provisionally. The total length and number of the HMWBs on the Sava River is presented in the following tables and figures:

Length and number of the HMWBs on the Sava River

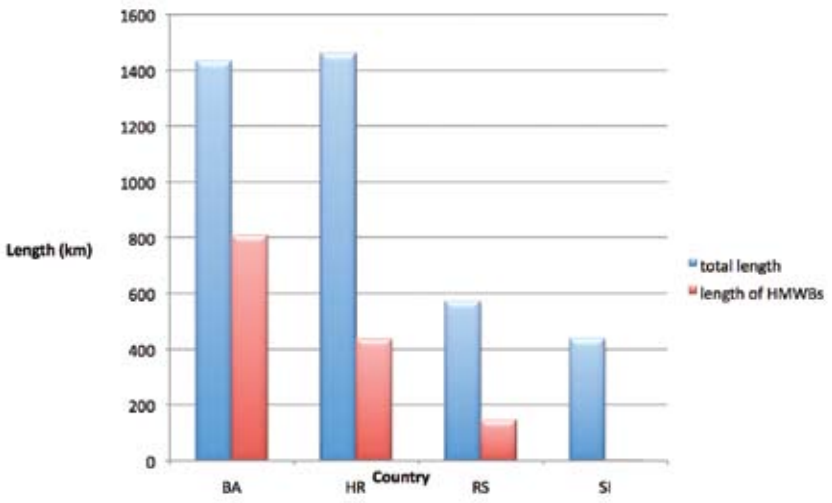
Country	total length	length of HMWBs	Perc. of total length	total No of WBs	No of HMWBs	Perc. of total WBs
	km	km	%			%
BA	338.8	338.8	100.00	3	3	100.00
HR	512	498	97.27	8	7	87.50
RS	210	104.4	49.71	3	1	33.33
SI	220.76	40.93	18.54	12	3	25.00



Ratio between the total WBs length and the HMWBs length on the Sava River

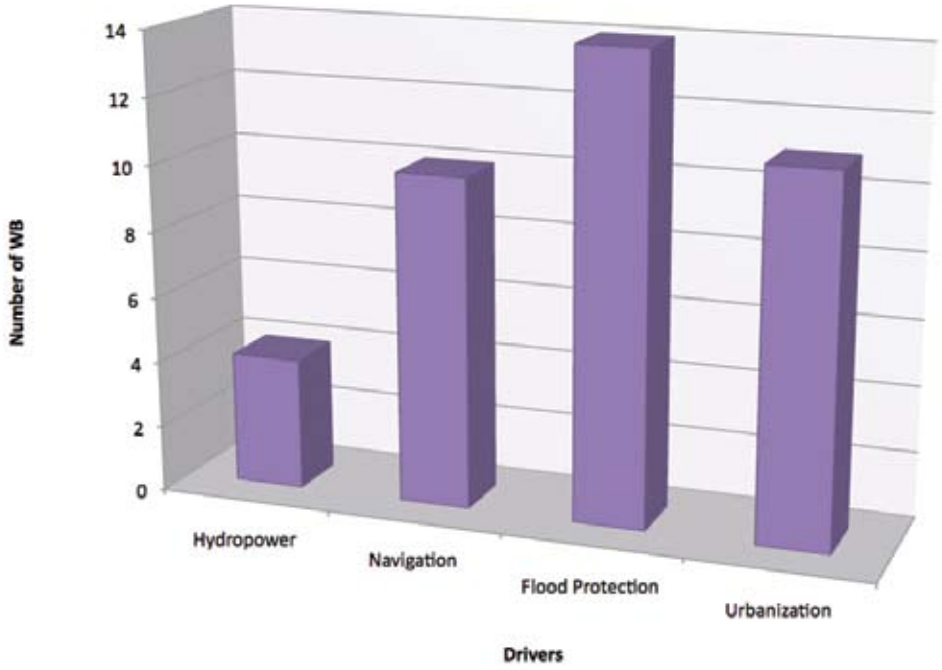
Length and number of provisional HMWBs on the Sava tributaries

Country	total length	length of HMWBs	Perc. of total length	total No of WBs	No of HMWBs	Perc. of total WBs
	km	km	%			%
BA	1432	807	56.38	38	19	50.00
HR	1460	436.4	29.89	43	10	23.26
RS	570.8	146.3	25.63	22	7	31.82
SI	437.1	4.60	1.05	14	1	7.14

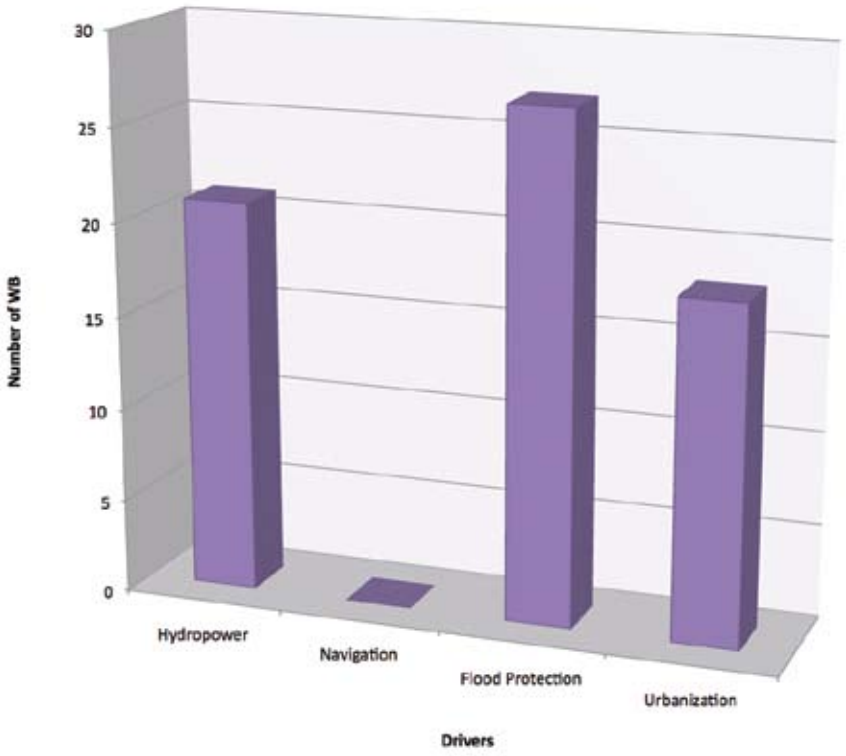


Ratio between the total WBs length and the HMWBs length on the Sava tributaries

The main users/drivers affecting the provisional HMWBs in the Sava River Basin are hydropower, navigation, flood protection and urbanization, and are presented in the following figures:

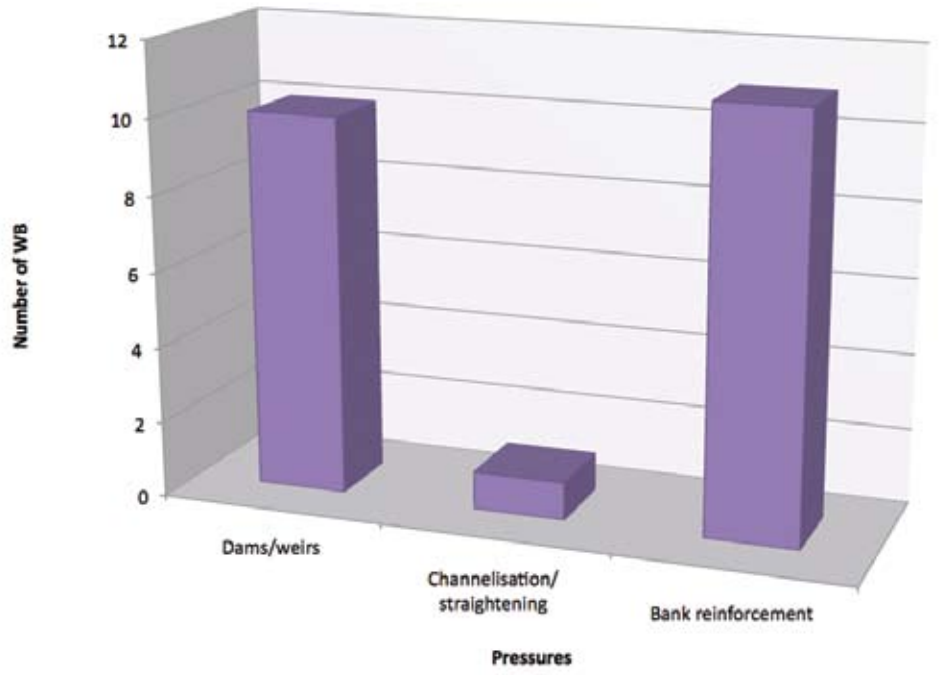


Main users/drivers affecting the HMWBs on the Sava River

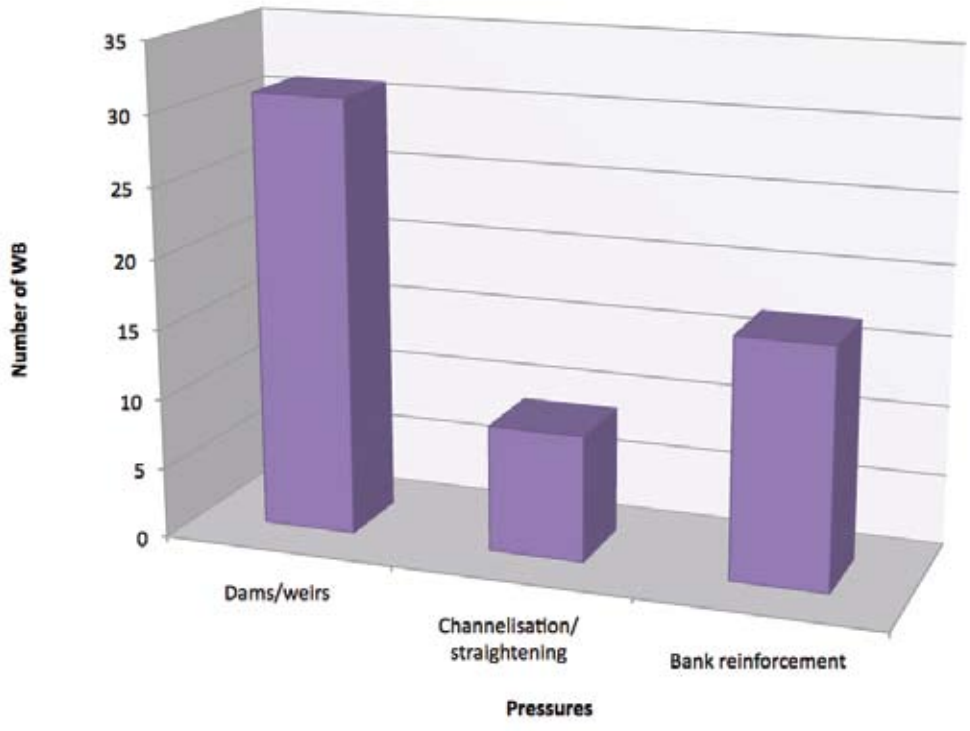


Main users/drivers affecting the HMWBs on the Sava tributaries

Significant physical alterations affecting the provisional HMWBs in the Sava River Basin are dams/wires/dikes, channelisation/straightening and bank reinforcement. They are presented in the following figures:

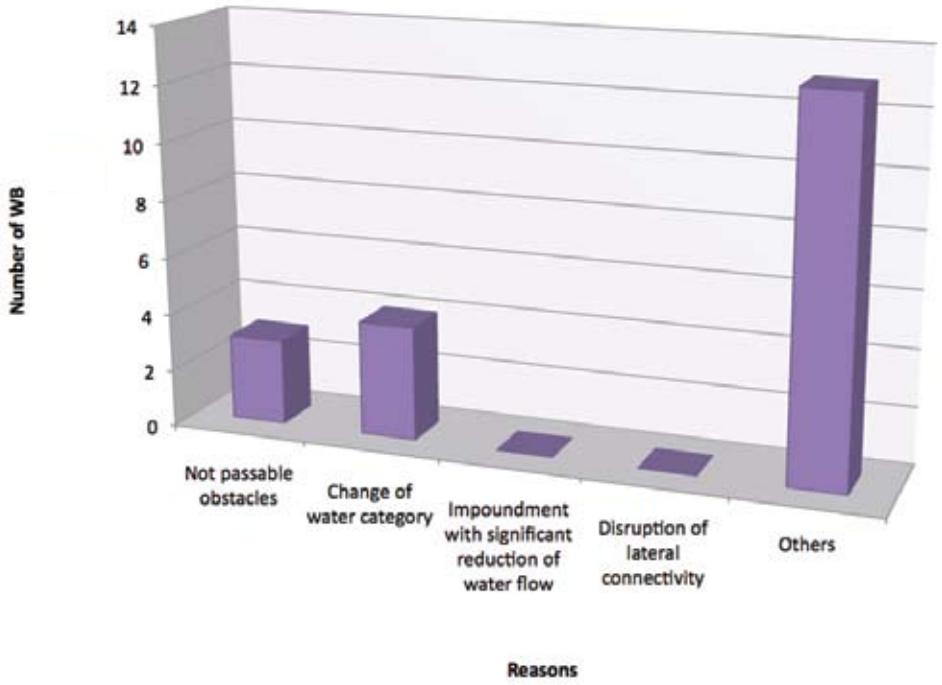


Physical alterations affecting the HMWBs on the Sava River

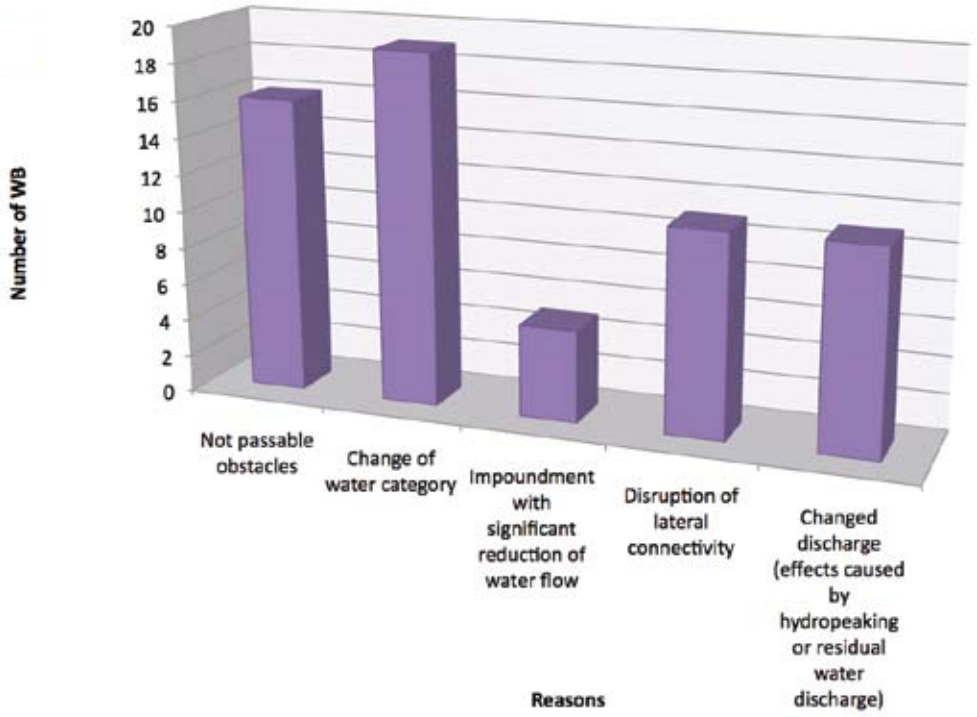


Physical alterations affecting the HMWBs on the Sava tributaries

The main reasons for assessing the risks on the HMWBs considered on the basis of expert judgment are not passable obstacles, change of water category, impoundement with significant reduction of water flow, disruption of lateral connectivity and others.



Reasons for assessing the risk on the HMWBs on the Sava River

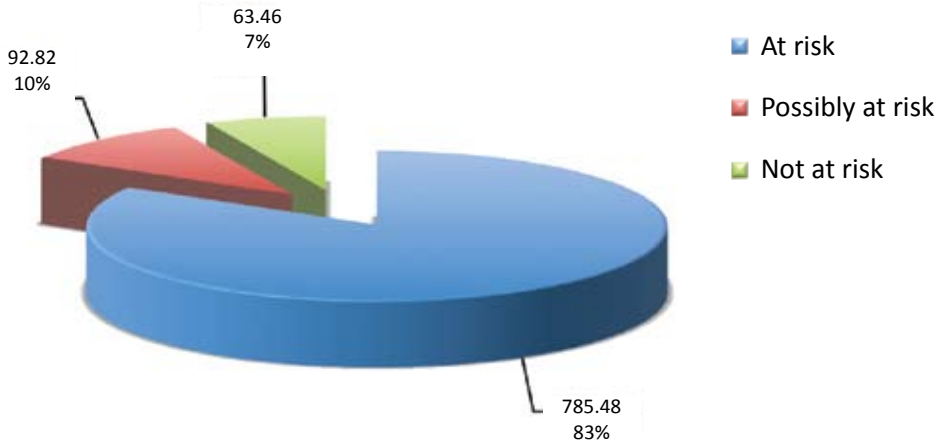


Reasons for assessing the risk on the HMWBs on the Sava tributaries

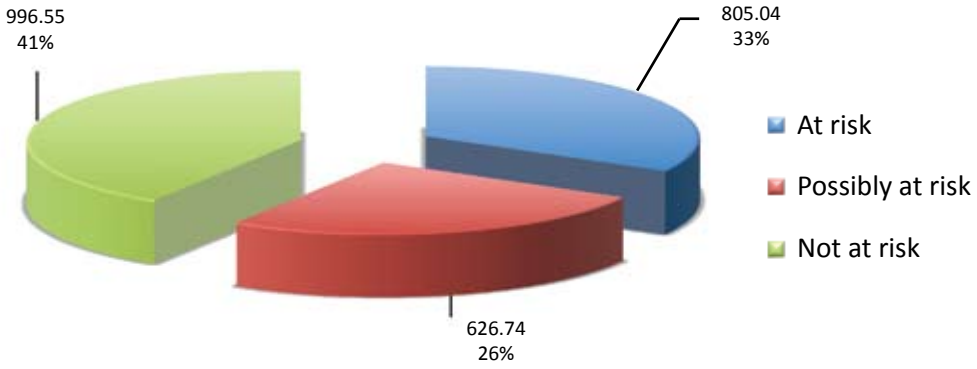
3.7 Risk assessment of the surface water bodies

The risk assessment of the likelihood that surface water bodies will fail to meet the environmental quality objectives set for the water bodies defined in Article 4 of the EU *WFD* for the Sava River and its tributaries has been provided for HR, RS and SI on the basis of the data collected. The risk assessment for BA has not been provided yet.

The results of the risk assessment for the surface water bodies are presented in the following figures:



Risk assessment status of the Sava WBs

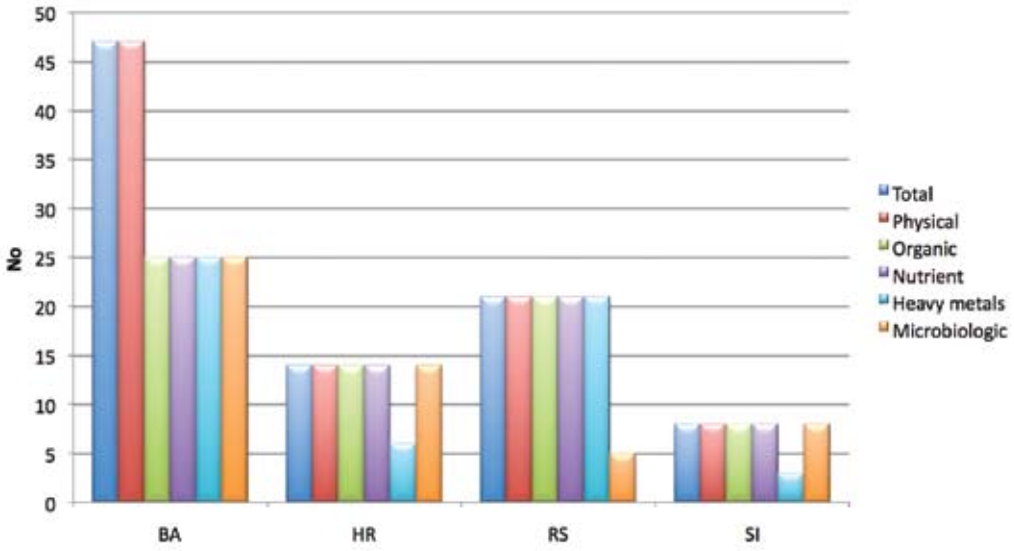


Risk assessment status of the Sava tributaries WBs

3.8 Water quality monitoring in surface waters

Total number of quality monitoring stations in the Sava River Basin, where physical, organic, nutrients, heavy metallic and microbiologic parameters are measured, is 90.

The distribution of water quality monitoring stations and water quality parameters is indicated in the following figure:



Measured parameters at the water quality monitoring stations in the Sava River Basin

To contribute to the implementation of the *Convention on cooperation for the protection and sustainable use of the Danube River* (*DRPC*), the Parties to the *FASRB* cooperate in the field of monitoring and assessment to:

- harmonise or make comparable their monitoring and assessment methods,
- develop concerted or joint monitoring systems
- elaborate and implement joint programmes for monitoring.

For implementation of the *DRPC*, the Trans-National Monitoring Network (TNMN) has been established building on the national surface water monitoring networks.

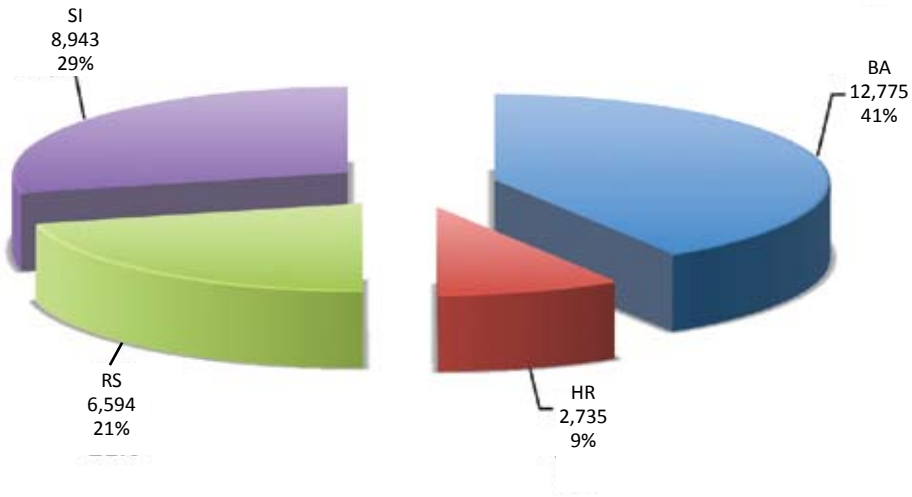
Twelve (12) TNMN stations are operating in the Sava River Basin, among them 9 stations on the Sava River (Jesenice-SI, Jesenice-HR, Jasenovac-HR, Jasenovac-BA, Županja-HR, Jamena-RS, Sremska Mitrovica-RS, Šabac-RS, Ostružnica-RS) and 3 stations on the main Sava tributaries (Modriča-BA-Bosna River, Kozarska Dubica-BA-Una River, Razboj-BA-Vrbas River, Badovinci-RS-Drina River).

Location of the TNMN monitoring stations on the Sava River

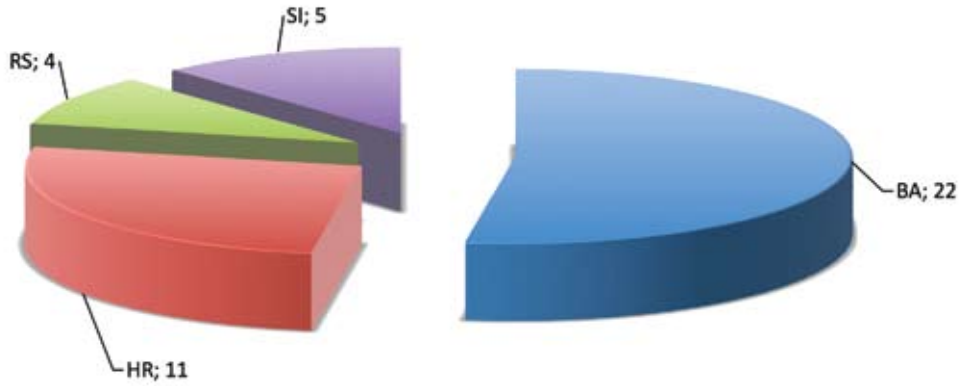
4. CHARACTERIZATION OF GROUNDWATER BODIES

According to the Article 2 of the EU *WFD*, 'groundwater' means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. The Parties to the *FASRB* carry out an initial characterisation of the groundwater bodies to assess their uses and the degree to which they are at risk of failing to meet the objectives for each groundwater body under Article 4. In the Sava River Basin, 42 important groundwater bodies have been reported.

The national breakdown of the groundwater bodies (GWBs) related to size and number is indicated in the following figures:



Country repatriation of the GWBs related to size in km²

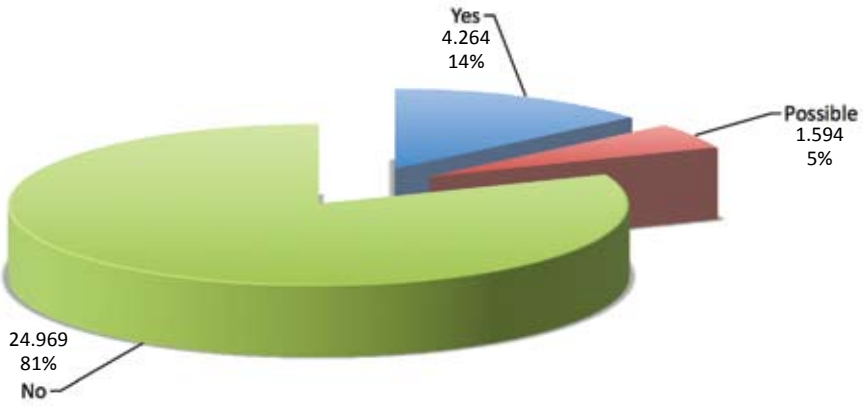


Country repatriation of the GWBs related to number of GWBs

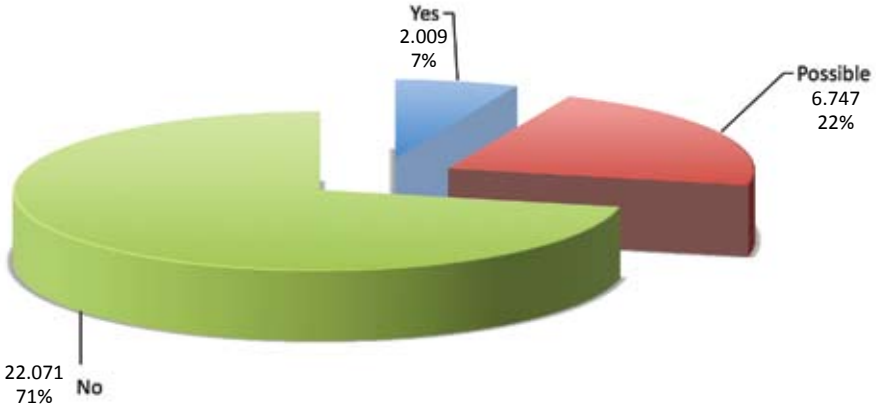
4.1 Risk assessment of groundwater bodies

The countries have implemented the risk assessment concerning the quality (chemical) status and quantity status of all important GWBs in the Sava River Basin except BA.

The following figures present the status of the risk assessment of the GWBs in the Sava River Basin concerning the quantity and quality.



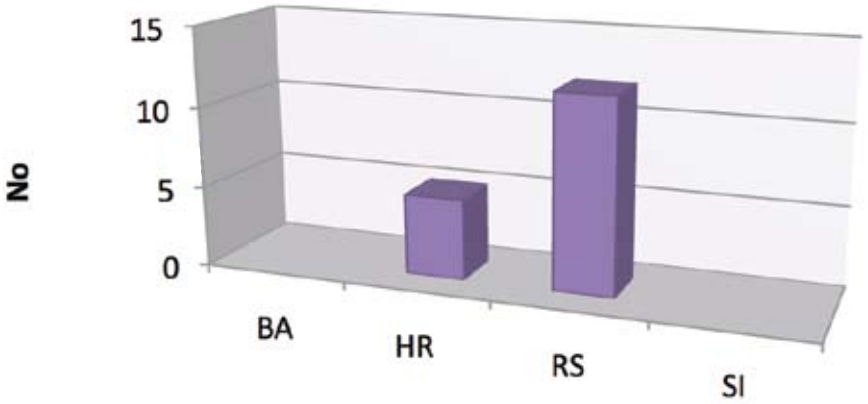
Risk assessment of the quality (chemical) status of important GWBs in the Sava River Basin



Risk assessment of the quantity status of important GWBs in the Sava River Basin

4.2 Monitoring of groundwater

Regarding the national monitoring network, there are 17 groundwater stations (only data from HR and RS are available) on the main groundwater bodies in the Sava River Basin.

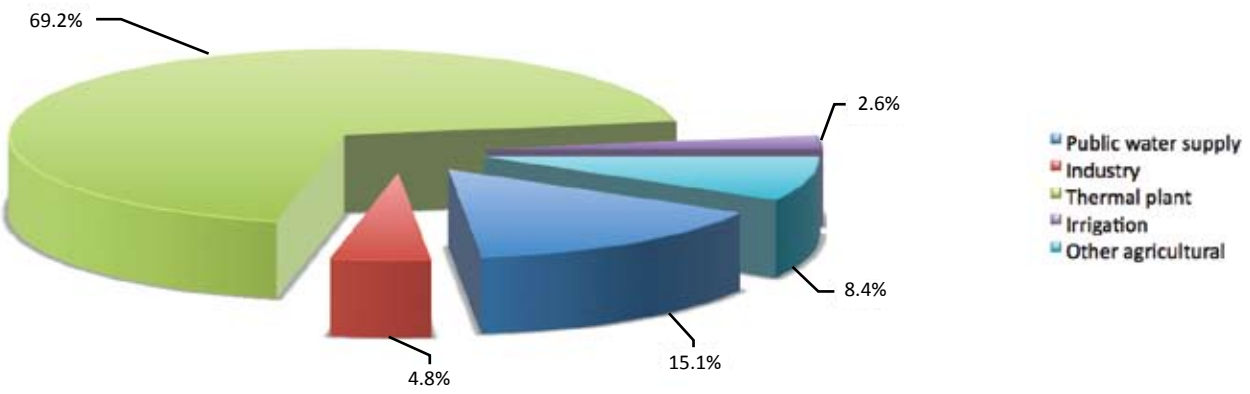


Groundwater monitoring stations on main groundwater bodies in the Sava River Basin

5. WATER USE AND DEMAND

Generally, water use refers to the use of water by households, industry, agriculture, for energy production, environmental protection, etc. including so-called in-stream uses such as fishing, recreation, transportation, etc.

The overview of various types of water uses in the Sava River Basin is given in the following fugure.



Estimation of total water use in the Sava River Basin

The total annual water use in the Sava River Basin is estimated at about 4.8 billion m^3/year. The total annual use of water for public water supply is about 783 million m^3/year. The total annual use of water for industry with separate water sources is about 289 million m^3/year.

Power plant cooling represents the major use of water in the Sava River Basin – about 3.3 billion m^3/year. Major plants in the Sava River Basin are: Krško NPP, Obrenovac 1 and 2 TPP, Nikola Tesla A TPP, etc.

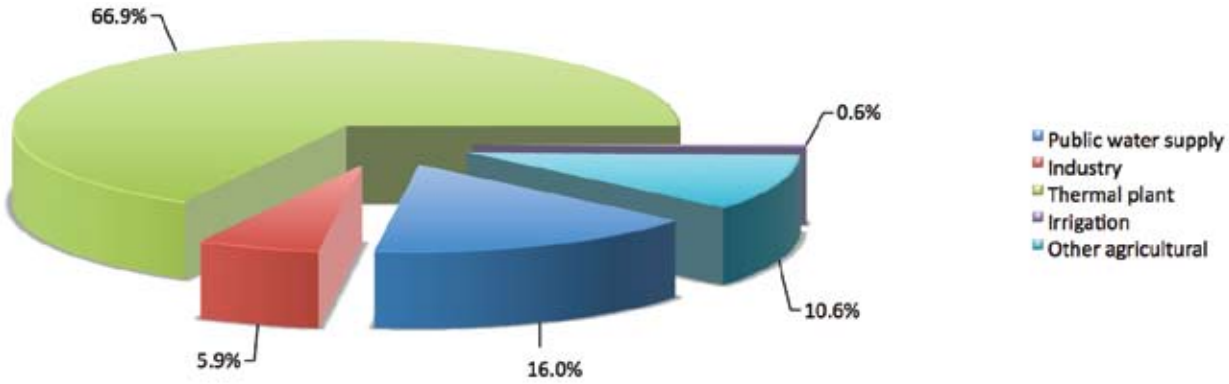
The total annual use of water for irrigation in the Sava River Basin is less than 30 million m^3 because of an inadequate status of agriculture in the Basin.

Use of water for other agricultural uses (i.e. fish production, livestock farms, or other uses) is relatively high, but most of the water is used for fish production and does not represent the consumptive use.

There are 18 hydropower plants in the Sava River Basin with installed capacity higher than 10 MW. In Slovenia, most of the plants are located on the Sava River, while in other riparian countries, on the major tributaries (Drina, Vrbas River, etc.). There is a large number of small and micro hydropower plants in Slovenia. The total installed capacity of the these plants is 41,542 MW, with a yearly production of 2.497 GWh/year.

Use of water for navigation could be seen from the perspective of minimum flows required for navigational purposes in different cross sections of the Sava River.

On the basis of the existing national plans, an attempt to estimate future water demand for 2015 was made for all important water uses in the Sava River Basin. The estimated demand for water is given in following figure.



Estimation of total water demand between water users for 2015 in the Sava River Basin

It has to be noticed that the confidence of such analysis is low, due to the fact already specified in the previous chapter, but also for the fact that such predictions in rapidly changing political and economic conditions are very problematic. Some of the countries, or parts of them, were not able to perform such analysis.

In conclusion of the analysis of water demand in the Sava River Basin, in spite of the fact that very little data were available for such analysis, it can be noted that it is to expect that the water use could not be considered as significant water management issue in the Sava River Basin until 2015.

New hydropower plants are planned in Slovenia on the Sava River, and in Bosnia and Herzegovina, on the Sava tributaries. The planned future increase of hydropower capacities is nearly 450 MW, with planned yearly production of more than 1,500 GWh/year.

6. ECONOMIC ANALYSIS OF WATER USE IN THE SAVA RIVER BASIN

The EU *Water Framework Directive* (*WFD*) under Article 5 and Annex III stipulates an economic analysis of water use by demonstrating the main economic characteristics and importance of the water therein and demonstrating the economic capacity of different economic sectors.

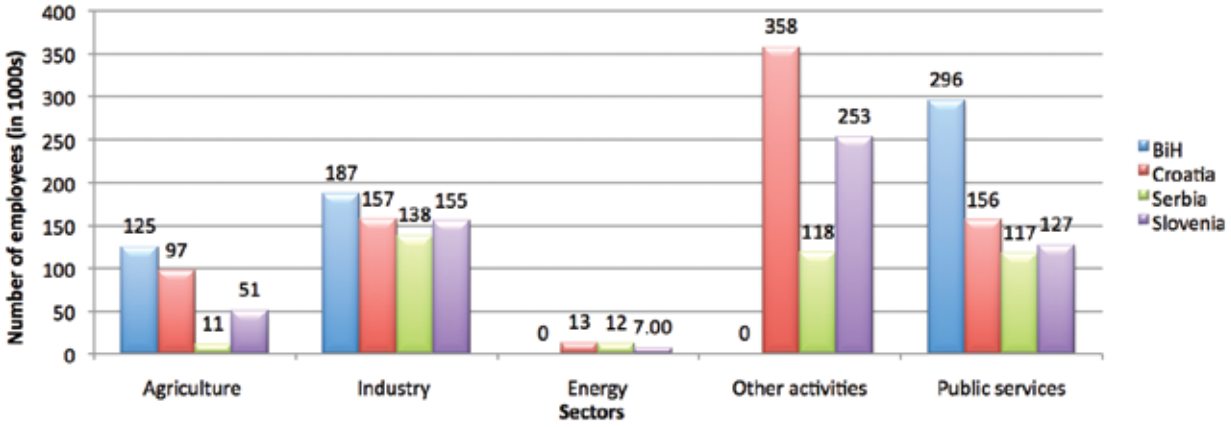
The population of the Sava River Basin is 8,176,000, which represents 46% of the total population of all countries. Particularly, the population of the Sava River Basin in BA is 75% of the total population in that country, in HR 50%, in RS 25% and in SI 61%.

Economic activities developed in the Sava River Basin, generate more than 2,379,000 employed people. That is 29% of all inhabitants in the Sava River Basin and 45% of all employed people in the countries.

Population and number of employees in the Sava River Basin per country (in 1,000s)

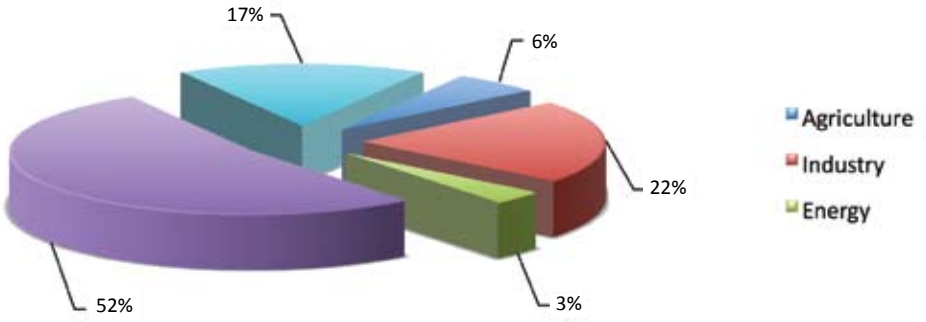
Country	Total population whole country	Population in the Sava River Basin	Share of total population (%)	Emloyees in whole country	Employees in the Sava River Basin	Share of emloyees in whole country (%)
BA	3,843	2,882	75	811	608	75
HR	4,442	2,210	50	1,496	781	52
RS	7,441	1,854	25	2,069	397	19
SI	2,003	1,230	61	921	593	64
Total	**17,729**	**8,176**	**46**	**5,297**	**2,379**	**45**

As for employment, the industry and other activities sector (construction, wholesale and retail trade, hotels and restaurants, transport, storage and communication, financial intermediation, real estate, renting and business activities) remain the greatest producers of jobs. 31% of all employed people in the Sava River Basin work in the other activities sector, 27% work in the industry sector, 29% work in the public sector, 12% work in the agriculture and 1% work in the energy sector.



Number of employees in the Sava River Basin by sector and country (in 1,000s)

The total gross value added (GVA) of the Sava River Basin is 40,039 million euros. The contribution of the economic sectors to the GVA is presented in the following figure:



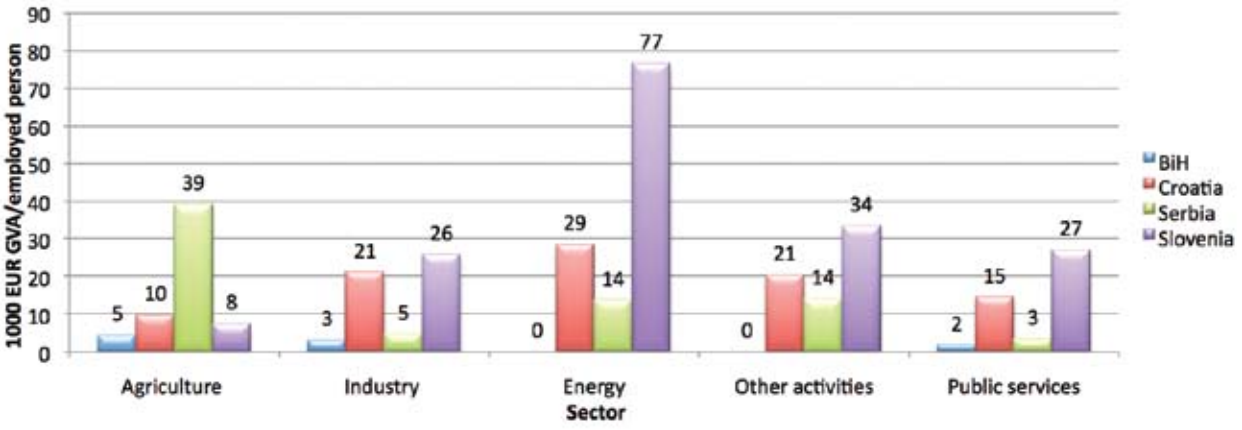
Main economic activities in the Sava River Basin - GVA (2005)

Share of the gross domestic product (GDP) in the Sava River Basin reaches a very significant 53% of the GDP of all countries. The following table shows the GDP of each country separately.

GDP and GDP per capita for the Sava River Basin and each country

Country	GDP for the whole country	GDP in the Sava River Basin	Share of whole countries GDP	GDP per capita for the whole country	GDP per capita in the Sava River Basin
	(million EUR)	(million EUR)	(%)	(EUR/capita)	(EUR/capita)
BA	8,654	6,490	75	2,252	2,252
HR	31,255	17,212	55	7,036	7,788
RS	20,358	3,913	19	2,736	2,110
SI	28,704	19,331	67	14,328	15,711
Total	**88,971**	**46,946**	**53**	**5,018**	**5,742**

As a measure for the general productivity of each of the analyzed sectors, the GVA/employed person variable has been calculated and shown in following figure. It gains a much greater value in the energy sector (especially in Slovenia), far away from the one gained in the public service and the agriculture sector.



Productivity according to the economic activities in the Sava River Basin

7. NAVIGATION ISSUES

The Sava River is centrally located in the east-west and north-south Core Transportation Network for South East Europe (SEE) and could complement the road and rail corridors, as well as the European waterway corridor focusing the Danube River. Economic decline in the 1990's caused a strong decrease of transport and navigation on the Sava River and the Sava River is hardly used for river transport in present.

In accordance with the *FASRB*, the Sava River and tributaries are open for international navigation as follows:

- Sava River, from rkm 0 (Belgrade) to rkm 594 (Sisak),
- Kolubara River, from rkm 0 to rkm 5,
- Drina River, from rkm 0 to rkm 15,
- Bosna River, from rkm 0 to rkm 5,
- Vrbas River, from rkm 0 to rkm 3,
- Una River, from rkm 0 to rkm 15,
- Kupa River, from rkm 0 to rkm 5.

Detailed surveys indicated that there is at present a navigable fairway of modest quality on the Sava River between Sisak and Belgrade and on the 5 rkm of the Kupa River, but overall navigation conditions are poor and unfavourable mostly related to:

- Limited draft during large periods;
- Limited width of the fairway;
- Sharp river bends limiting the length and width of vessels and convoys.

General conclusion is that the navigation infrastructure suffers of aging, lack of maintenance and incompleteness. Such status has a negative impact on the safety of navigation and increases possibility for accidents with potential adverse impacts on environment.

The ISRBC and the Sava countries aim at rehabilitation and development of the waterway, improving the Sava river waterway between Belgrade and Sisak, along the stretch rkm 0 to rkm rkm 594). The extension of the navigability upstream of Sisak is planed for a later phase in accordance with the development of the economic and transport activities.

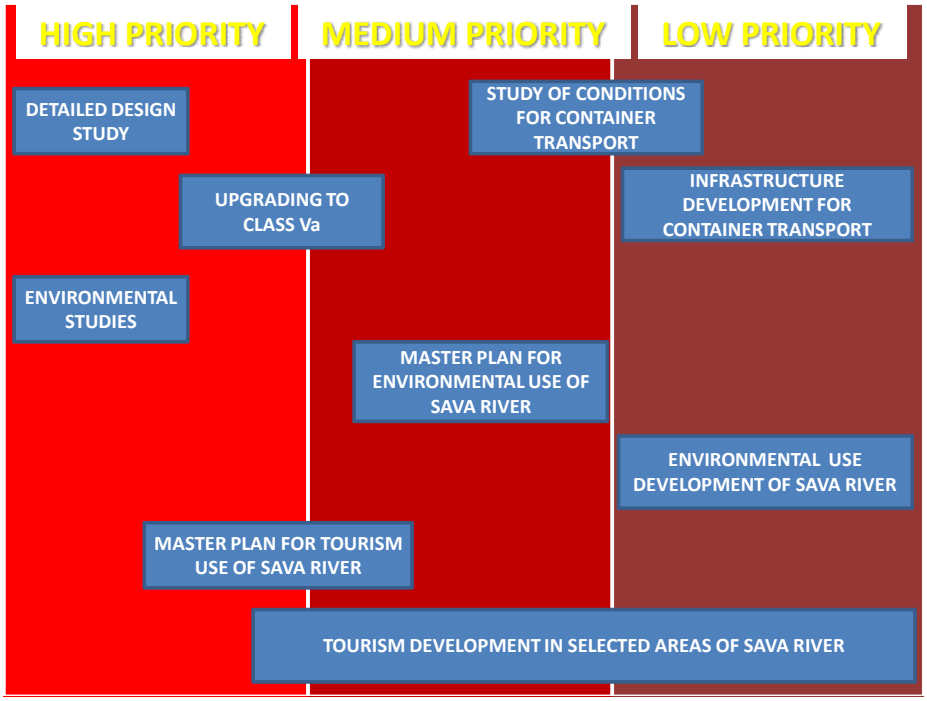
In this regard, the ISRBC finished the *Feasibility Study and Project Documentation for the Rehabilitation and Development of the Transport and Navigation on the Sava River Waterway*.

The Feasibility Study recognized that 21 stretches required dredging and training works, 20 stretches required bends improvement, 3 bridges have to be reconstructed in order to meet the Class Va requirements according to the ISRBC waterway classification.

Beside of these "basic" requirements, the following miscellaneous works can significantly improve the state of fairway conditions:

- Removal of ship wrecks or obstacles (total of 3 ship wrecks have to be removed);
- Cleaning of areas from unexploded ordnances;
- Implementation of River Information Services;
- Upgrading of winter ports.

It is concluded that the rehabilitation and development of the waterway of the Sava River seems to be a project with clear positive socio-economic effects and the future activities should therefore focus on an efficient completion of the studies and design, and the execution of works on the waterway rehabilitation.



General Action Plan implementation lines

The infrastructure rehabilitation is only a first step in the establishment of a modern river transport sector and in this regard, the next actions are of particular importance:

- The transposition of all EU rules and regulations for inland waterway transport is realized as quickly as possible with full transparency and following the principles of good governance;
- Further work on the harmonization of the rules and regulations on the European level;
- The necessary strategies are developed for the realization of a public support program for the restoration/creation of a competitive river transport sector, within the limitations of the EU rules and regulations on state aid;
- In time, river transport and Sava River become part of the region's transport systems and attention is paid to the introduction of modern techniques and technologies and to container transport;
- The development of the sector and the modernization of IWT should be strengthened by a sustainable and modern marketing campaign, on the one hand to attract private investments and on the other hand to increase the demand for and use of IWT, and
- The creation of a comprehensive expertise building program will be required and should be developed following a benchmark of existing knowledge levels with best practices.

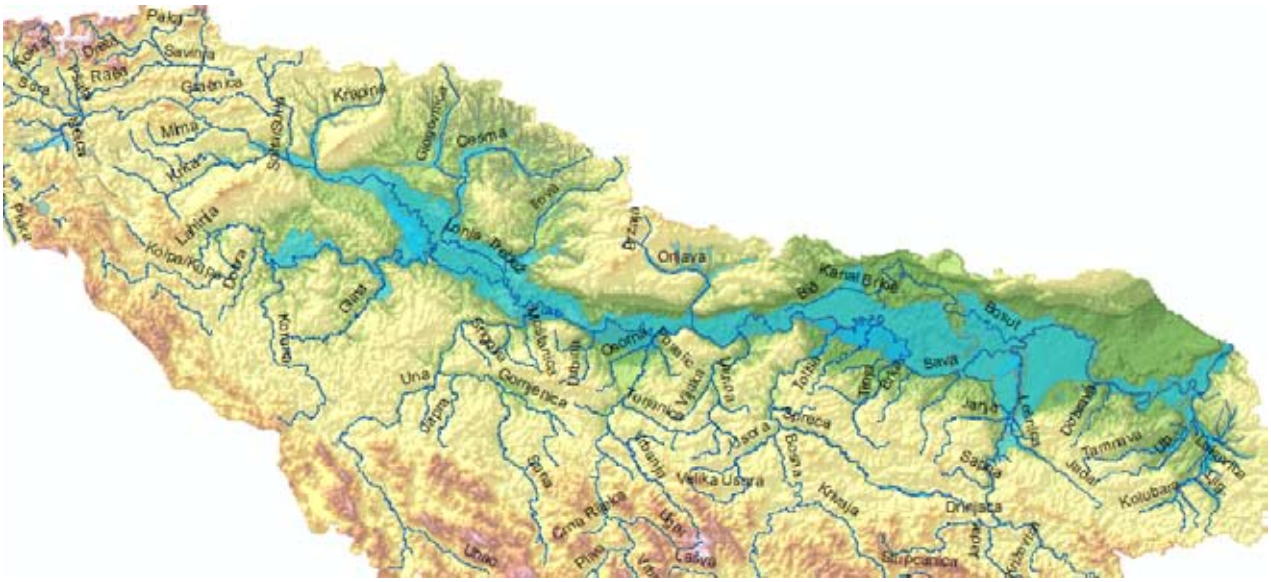
All the required ecological and planning regulations and guidelines such as EU directives and *Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin,*which aims to provide guidance to decision makers dealing with inland waterway transport and environmental sustainability as well as to water managers preparing relevant riverine environmental and navigation plans, programme and projects, shall be met during the following steps of the rehabilitation and development of the waterway.

8. FLOOD MANAGEMENT ISSUES

The Sava River valley, especially its middle part (from Zagreb to Županja), and the lower part (downstream of Županja), as well as the downstream sections of the Sava tributaries, are prone to flooding. The floods occur generally in spring, after the snow melt, and in autumn, after the heavy rainfall. The wide floodplanes and the natural lowland areas act as detentions and retentions of the flood waves.

The flood protection system in the Central and the Lower Sava River Basin relies mostly on the natural retention areas and the flood protection levees. Generally, the main levees are designed for the 100-year return period floods, while in urban settlements for the 1000-year flood. The Sava River flood protection system is significant for the rarely preserved large natural retentions (Lonjsko polje, Mokro polje, Kupčina, Zelenik and Jantak) which have, together with the system of relief canals, a large positive impact on the flood regime as in Croatia, so in the downstream countries. At the same time, the Nature Park and Ramsar site Lonjsko Polje, covering some 500 km^2 presents a great ecological value, while Obedska Bara in the Lower Posavina is one of the biggest wild bird nature reserves.

Droughts are non-homogeneous over the Sava River catchment, since they cover only certain sub-regions. Nevertheless, as compared to floods, the droughts have larger spatial coverage, which implies that they are governed by global causes and have multidimensional character giving them a larger scale. Most severe historical droughts in the Sava River Basin occurred in 1946, 1947, 1949 and 1950. Last significant drought happened in 1971, in the upper part of the Sava catchment. This does not imply that there has been no droughts eversince. Actually, there is a strong feeling that very severe droughts have taken place in last twenty years although they have not been comprehensively analyzed since 1974.



Indicative map of important flood prone areas along Sava River

After disintegration of the former country in early 90-ties, where efforts have been made to treat the flood management in the Sava River Basin in an integrated manner[1], the flood management has been led only on a national level. The hydraulic structures have not been maintained, some have been damaged and monitoring processes have been interrupted. Many reconstruction works are still to be done.

The Parties to the *FASRB* are promoting a common approach to the flood risk management, coordinated planning and action within the Sava River Basin, and consideration of all the Parties involved. The common long-term flood protection strategy in the Sava River Basin has a clear goal - to minimize the risk from flooding. The crucial document is the *Protocol on Flood Protection to the FASRB*, signed in 2010, which will serve as a basis for all common activities in the Sava River Basin. By adoption of this Protocol, the riparian countries agree, while taking into account the *FASRB*, the *Directive 2007/60/EC* and the *Action Programme for Sustainable Flood Protection in the Danube River Basin*, on cooperation in development of the *Flood Risk Management Plan for the Sava River Basin*. In the process of undertaking of preliminary flood risk assessment and preparation of the flood hazard and flood risk maps, the ISRBC will be the coordinating body for data exchange between the countries. The cooperation will be based on a joint or harmonized flood forecasting, warning and alarm system, and information exchange. Measures for flood defense emergency situations, for establishment of preparedness and measures for mitigation of transboundary impacts are foreseen. Interested public should be actively involved in the process of the development of the *Flood Risk Management Plan* and its up-date.

[1] *Study for the Regulation and Management of the Sava River in Yugoslavia,* Polytechna-Hydroprojekt - Carlo Lotti & C., Prague-Roma, 1972.

9. DATA GAPS AND UNCERTAINTIES

In the process of developing the Sava River Basin Analysis, some data gaps and uncertainities have been identified. Gaps and uncertainities have been notified mainly in determination of the typology and reference conditions, in identification of significant pressures and within the assessment of impact, as well as in cross-cuting issues. They will be resolved for the subsequent RBM cycles.

The summary tables of the gaps identified are given below:

Summary table of data gaps and uncertainties for the surface waters

Gap	BA	HR	RS	SI	Remarks
Lack of water quality monitoring data	x	x	x	x	
Lack of biological monitoring data	x	x	x	x	
Lack of data on hydromorphology and hydromorphology changes	x	x			
Lack of data on interaction between hydromorphology and eco-system	x	x			
Not identified WBs delineation		x			For example: Karst areas - underground runoff not defined
No harmonization on typology and WBs delineation	x	x	x	x	For example: BA-HR: Sava River BA-RS: Drina River RS-HR: Bosut River
Late start of typology process and defining reference conditions	x				
Lack of data for assessment of impacts	x			x	It is based on current evaluation of the chemical water status and biota which is not harmonized with *WFD*. It is result of current knowledge and available data
Synergistic effects of different pressures not evaluated yet				x	

Summary table of data gaps and uncertainties for the groundwater

Gap	BA	HR	RS	SI	Remarks
Lack of groundwater quality and quantity data	x	x			
Lack of data on drinking water supply systems and protection zones	x				Especially for small settlements
Lack of data on water balance groundwater	x	x	x		
Lack of data on GWBs connections	x		x		
Lack of data on influence of different pressures to the GWBs	x		x		Especially diffuse pollution

The European Union is made up of 27 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years,they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.