INTERNATIONAL SAVA RIVER BASIN COMMISSION

FLOOD HAZARD AND RISK MAPS IN THE SAVA RIVER BASIN

UPDATE 2024

Prepared by: International Sava River Basin Commission (ISRBC) in cooperation with the Parties to the Framework Agreement on the Sava River Basin (Bosnia and Herzegovina, Croatia, Serbia and Slovenia) and Montenegro.

Overall coordination and editing: Secretariat of ISRBC.

Contact:

International Sava River Basin Commission

Kneza Branimira 29

10 000 Zagreb, Croatia

Phone: + 385 1 488 6960

Fax: + 385 1 488 6986

E-mail: isrbc@savacommission.org

Web: www.savacommission.org

Edition: English

The document was accepted at the 68th Session of ISRBC, held in Zagreb on March 25-26, 2025. The document is available at the ISRBC website: https://www.savacommission.org/documents-and-publications/water-management-1957/1957

Ref. No. IR-68-O-25-2/4-2

FLOOD HAZARD AND RISK MAPS IN THE SAVA RIVER BASIN

UPDATE 2024

March 2025

Date	Document Revision History	Document Author/Reviser
February 27, 2024	Initial draft – reviewed at the 49th PEG FP meeting	Secretariat/PEG FP
Sept./Nov., 2024	Draft – updated based on delivered data	Secretariat
February 19, 2025	Draft – sent to PEG FP for approval	Secretariat/PEG FP
March 6, 2025	Draft – approved by PEG FP	Secretariat/PEG FP
March 17, 2025	Final Draft – sent to ISRBC	Secretariat/ISRBC
March 25, 2025	ISRBC accepted and approved publishing on web	ISRBC

International Sava River Basin Commission
Kneza Branimira 29
10 000 Zagreb, Croatia
T: + 385 1 488 69 60
isrbc@savacommission.org
www.savacommission.org

Acknowledgements

Many institutions and individuals contributed to the preparation of the Sava Flood Maps – Update 2024, and therefore this report represents a true collective effort that reflects cooperation in flood management in the Sava River Basin and beyond.

Special acknowledgments should be given to:

- Members of the Permanent Expert Group for Flood Prevention (PEG FP) of the International Sava River Basin Commission, in alphabetical order: Bajramlić Almir, Barbalić Darko, Biondić Danko, Borota Merita, Kavazović Amer, Latinović David, Milutin Igor, Ribnikar Mateja, Sokolić Sandra, Spasić Ivana, Štravs Luka, Vukmanić Luka, national expert from Montenegro Đukić Dragana for knowledge and information sharing, facilitation of the data collection, valuable comments during drafting procedure and overall guidance.
- Members of the Permanent Expert Group for GIS (PEG GIS) for the data collection and assistance, in alphabetical order: Borota Merita, Božić Milorad, Kregar Maja, Mičivoda Hajrudin, Nikolić Nebojša, Njegomir Milan, Radić Maja, Rosandić Tijana, Šturlan Popović Sandra, Vučković Zoran, national experts from Slovenia, Rožman Davor and from Montenegro, Đukić Dragana.
- Secretariat of the International Sava River Basin Commission for facilitation, drafting the report in the course of its preparation and overall coordination.

Disclaimer

The Flood Hazard and Risk Maps in the Sava River Basin (Sava Flood Maps) – Update 2024 is based on data delivered by the Parties to the Framework Agreement on the Sava River Basin (Bosnia and Herzegovina, Republic of Croatia, Republic of Serbia and Republic of Slovenia) and Montenegro, which joined the activities of the International Sava River Basin Commission based on the Memorandum of Understanding on cooperation between the International Sava River Basin Commission and Montenegro. Some countries were not able to provide all the information needed and these data gaps are noted in the text. Where data has been made available, it has been examined and is presented to the best of available knowledge. Nevertheless, inconsistencies cannot be ruled out.

Given the complexity of all aspects of flood risk management in the Sava River Basin and various legal frameworks, this document is not fully aligned with all national documents, Directive on the Assessment and Management of Flood Risks and other valid documents. For this reason, if there are differences in this document in relation to national valid documents or if there are differences in the interpretation of this document, relevant national documents will be considered valid at that time as well as the interpretations that follow from the valid national documents. For the same reason, for all activities arising out of this document and not foreseen in the applicable national documents, it is necessary to fully align them with national legal frameworks, available flood risk management instruments and to carry out their more detailed elaboration at national and bilateral levels in accordance with the law defined by the national procedure for their acceptance.

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 EXCHANGE OF INFORMATION ACCORDING TO THE PROTOCOL, ARTICLE 7, PAR. 2 ON DRAFTING FLOOD HAZARD AND RISK MAPS 2

2 OVERALL APPROACH AND METHODOLOGY 3

2.1 METHODOLOGIES USED AT THE NATIONAL LEVEL 3

2.2 SIMPLIFIED METHODOLOGY USED AT THE SAVA RIVER BASIN LEVEL 5

3 FLOOD MAPPING IN AREAS OF MUTUAL INTEREST FOR FLOOD PROTECTION IN THE SAVA RIVER BASIN 7

3.1 HAZARDS ASSOCIATED WITH MAPPED FLOODS 7

3.1.1 Sources, mechanisms and characteristics of mapped floods 9

3.2 RISKS ASSOCIATED WITH MAPPED FLOODS 11

3.2.1 Inhabitants Affected 11

3.2.2 Economy Affected 14

3.2.3 Environment Affected 16

3.2.4 Cultural Heritage Affected 22

4 WATER CONTROL STRUCTURES WITH POTENTIAL IMPACT TO THE FLOOD PROTECTION IN AMIS 25

5 CONCLUSIONS 27

APPENDICES 29

ANNEX 1: LIST OF THE AREAS OF MUTUAL INTEREST FOR FLOOD PROTECTION 30

ANNEX 2: WORK PLAN FOR THE 2ND FLOOD RISK MANAGEMENT PLANNING CYCLE 31

ANNEX 3: INTERNET LINKS TOWARDS NATIONAL METHODOLOGIES AND THE FLOOD MAPS 33

ANNEX 4: INTERNET LINKS TOWARDS THE FLOOD MAPS IN THE AREAS OF MUTUAL INTEREST 34

TABLES

Table 1: Overview of information, scenarios, flood sources, probabilities and related elements used for modelling mapped in development of the national flood maps per country 4

Table 2: Classification of national hazard maps according to hydraulic parameters 6

Table 3: Classification of the potential adverse consequences associated with flood scenarios 6

Table 4: Number of inhabitants potentially affected across AMIs 13

Table 5: Overview of potential adverse consequences on the Water Bodies' ecological status across AMIs (with number of Water Bodies potentially affected) 17

Table 6: Overview of potential adverse consequences on the Water Bodies' chemical status across AMIs (with number of Water Bodies potentially affected) 18

Table 7: Overview of the potential adverse consequences on the Water Bodies' hydro-morphological alterations across AMIs (with number of Water Bodies potentially affected) 18

Table 8: Overview of potential adverse consequences on the Ground Water Bodies' chemical status across AMIs (with number of Water Bodies potentially affected) 19

Table 9: Overview of potential adverse consequences on the Protected Areas across AMIs 20

Table 10: Overview of potential adverse consequences on the Pollution Sources across AMIs 21

Table 11: Overview of potential adverse consequences on the cultural heritage across AMIs for the medium probability scenario 23

Table 12: Overview of potential adverse consequences on the cultural heritage across AMIs for the low probability scenario 24

Table 13: Overview of large dams, reservoirs and retention areas relevant for flood protection in AMIs 25

FIGURES

Figure 1: Illustration of the Flood Maps Development by UoM (Ctrl + Click to the Figure to open the web app) 5

Figure 2: Illustration of the Flood Hazard Maps (Ctrl + Click to the Figure to open the web app) 7

Figure 3: Flood hazard areas in AMIs (in km^2) 8

Figure 4: Flood hazard area by classes in AMIs (in km^2) 9

Figure 5: Types of the flooding in AMIs 10

Figure 6: Illustration of the Flood Risk Maps – Total risk (Ctrl + Click to the Figure to open the web app) 11

Figure 7: Illustration of the Flood Risk Maps – Inhabitants Affected (Ctrl + Click to the Figure to open the web app) 11

Figure 8: Number of inhabitants potentially affected across AMIs in countries 12

Figure 9: Illustration of the Flood Risk Maps – Economy Affected (Ctrl + Click to the Figure to open the web app) 14

Figure 10: Hazard area distribution by potential adverse consequences on the economic activities across AMIs 15

Figure 11: Illustration of the Flood Risk Maps – Environment Affected (Ctrl + Click to the Figure to open the web app) 16

Figure 12: Hazard area distribution by potential adverse consequences on the environment across AMIs 17

Figure 13: Illustration of the Flood Risk Maps – Cultural Heritage Affected (Ctrl + Click to the Figure to open the web app) 22

Figure 14: Hazard area distribution by potential adverse consequences on the cultural-historic heritage across AMIs 23

Figure 15: Illustration of the Water Control Structures map (Ctrl + Click to the Figure to open the web app) 25

ABBREVIATIONS

APSFR	Area with Potential Significant Flood Risk
AMI	Area of Mutual Interest for flood protection in the Sava River Basin
EU FD	Directive 2007/60/EC of the European Parliament and Council on 23 October 2007 on the assessment and management of flood risk (EU Floods Directive)
EU WFD	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (EU Water Framwork Directive)
FASRB	Framework Agreement on the Sava River Basin
FFWS	Flood Forecasting and Warning System
FRMP	Flood Risk Management Plan
GIS	Geographic Information System
ISRBC	International Sava River Basin Commission
PEG FP	Permanent Expert Group for Flood Prevention
PFRA	Preliminary Flood Risk Assessment
RBMP	River Basin Management Plan

1 INTRODUCTION

The *Framework Agreement on the Sava River Basin* (FASRB) [1], which implementation is coordinated by the International Sava River Basin Commission (ISRBC), has established a framework for flood risk management that has set in detail in the *Protocol on Flood Protection to the FASRB* (Protocol)[2]. Although the Protocol doesn't foresee any timeline or deadlines, the dynamic of preparation of the particular steps is in line with the EU Floods Directive[3].

The Flood Hazard and Risk Maps in the Sava River Basin (Sava Flood Maps) are regularly prepared in accordance with the Article 7 of the Protocol, which states the following:

1. *Each Party shall prepare Flood Maps for the areas identified in the Preliminary Flood Risk Assessment as referred to in Article 6 of this Protocol for the part of the Sava River Basin under its jurisdiction, taking into account the Directive 2007/60/EC.*
2. *Each Party shall, through the Sava Commission, inform other Parties on the Flood Maps prepared for its territory.*
3. *The respective Parties shall agree upon the methodology for mapping of the flood areas shared by two or more Parties, identified according to the Article 6 paragraph 4 of this Protocol, and, thereof, inform the Sava Commission.*
4. *The Parties may, for purpose of joint implementation of the activities from paragraph 1 of this Article, agree to develop a joint methodology for preparation of Flood Maps for the whole Sava River Basin.*
5. *The Sava Commission shall coordinate the development of the Methodology from paragraph 4 of this Article.*

During the first planning cycle, the countries drafted Flood Maps at the Sava River basin level as a part of the *Flood Risk Management Plan in the Sava River Basin* (Sava FRMP)[4].

The EU Floods Directive instructs that the flood hazard maps and the flood risk maps shall be reviewed, and if necessary, updated every six years. Having in mind that all preparation steps for the first planning cycle covered period from 2014 to 2019, during the second cycle the countries agreed to have reviewed and updated joint planning steps in the Sava River basin by 2021 for PFRA, by 2024 for Flood Maps and by 2026 for FRMP. In the second cycle of implementation of the Protocol and the EU Floods Directive, the joint report on *Preliminary Flood Risk Assessment in the Sava River Basin* has been already updated (Sava PFRA update 2021)[5]. In the Sava PFRA update 2021, countries updated the earlier identified area for which potential significant flood risk exists or might be considered likely to occur, which is shared by two or more countries, i.e. the *Areas of Mutual Interest for flood protection in the Sava River basin* (AMIs) and agreed that AMIs will be used as the main analytical unit in the second planning cycle. Therefore, the exchange of information on the Flood Maps was done for the AMIs that are listed in Annex 1.

The Sava Flood Maps - Update 2024 included information from the following sources:

- Sava FRMP (2019)
- Sava River Basin Management Plan – Update (2022)[6]
- Update of national report on FHR maps of Slovenia (2019)
- Update of national report on FHR maps of Croatia (2019)
- National report on FHR maps of Bosnia and Herzegovina (2020)
- Draft national report on FHR maps of Serbia (2021)
- National report on FHR maps of Montenegro (2023), as a part of the Flood Risk Management Plan for the Danube River Basin in Montenegro
- Other relevant information from the countries.

[1] https://www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/fasrb.pdf

[2] https://www.savacommission.org/UserDocsImages/05_documents_publications/basic_documents/protocol_on_flood_protection_to_the_fasrb.pdf

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN

[4] https://www.savacommission.org/UserDocsImages/05_documents_publications/water_management/eng/SavaFRMPlan//sfrmp_eng_web.pdf

[5] https://www.savacommission.org/UserDocsImages/05_documents_publications/water_management/eng/SavaFRMPlan//sava_pfra_update2021.pdf

[6] https://www.savacommission.org/UserDocsImages/05_documents_publications/water_management/eng/SavaRBMPlan//2nd%20Sava%20River%20Basin%20Management%20Plan_eng.pdf

1.1 EXCHANGE OF INFORMATION ACCORDING TO THE PROTOCOL, ARTICLE 7, PAR. 2 ON DRAFTING FLOOD HAZARD AND RISK MAPS

In its Article 7, paragraph 2 the Protocol provides that, each country shall, through the ISRBC, inform other countries on the flood maps prepared for its territory, while in paragraph 3 that the respective countries shall agree upon the methodology for mapping of the flood areas shared by two or more countries, identified according to the Article 6, paragraph 4 of the Protocol, and, thereof, inform the ISRBC.

Similarly, the EU Floods Directive in its Article 6, paragraph 2 provides that, for areas identified according to Article 5 (APSFR) and which are shared by several countries, the preparation of the maps shall be subject to prior exchange of information between the countries concerned.

The exchange of information within the ISRBC concerning the drafting of the flood risk maps is based on a continuous work of the ISRBC's permanent expert groups for Flood Prevention and GIS.

After jointly drafting the report on Sava PFRA update 2021 and the identification of area for which potential significant flood risk exists or might be considered likely to occur, which is shared by two or more countries, i.e. the Areas of Mutual Interest for flood protection in the Sava River basin (AMIs) the countries in the Sava River Basin have immediately started a regular exchange of information and coordination of the drafting of flood hazard maps and flood risk maps according to the Protocol Article 7.

The national reports contain the details on how the maps were prepared while this report elaborates an added information relevant to the flood prone areas shared by two or more countries.

The following products are available:

- List of **internet links** towards the national map portals for flood hazard maps and flood risk maps (see Annex 3).
- Results of the **Sava Flood Maps Atlas** – Update 2024 (see Annex 4) which compiles the mapping data themes that are also separately presented by corresponding chapters:
  - *Flood Maps Development – Summary*
  - *Flood Hazard Maps – Total and classified hazard*
  - *Flood Risk Maps – Total risk*
  - *Flood Risk Maps – Inhabitants Affected*
  - *Flood Risk Maps – Economy Affected*
  - *Flood Risk Maps – Environment Affected*
  - *Flood Risk Maps – Cultural Heritage Affected*
  - *Water Control Structures*.

The main purpose of this report is to present a very successful exchange of information on the flood maps between the Sava countries within the second flood risk management cycle at the basin level.
The report also integrates preliminary conclusions on the flood maps while the more comprehensive will be part of the Sava FRMP update.

2 OVERALL APPROACH AND METHODOLOGY

The Protocol on Flood Protection to the FASRB emphasizes the importance of coordination measures, works and activities aimed at decreasing the flood risk throughout the basin, and the implementation of these activities in accordance with the "no harm rule" principle. Therefore, in order to contribute to the decrease of harmful consequences of floods, in particular for human life and health, environment, cultural heritage, economic activities and infrastructure, the countries have agreed to cooperate in the implementation of above activities. The Protocol represents a firm legal foundation for the implementation of all activities agreed by the countries via ISRBC.

With the aim of fulfilling the goals of the Protocol, the countries have undertaken the obligation to cooperate in a flood risk management planning cycle on the Sava River Basin level through reporting on PFRA, preparation of Flood Maps, development of FRMP, starting with preparation of the Program for its development. The Protocol also recognises ISRBC as a body for coordination of the cooperation on activities related to the Flood Forecasting, Warning and Alarm System in the Sava River Basin (Sava FFWS), the exchange of information significant for sustainable flood protection and implementation of all other mutually agreed measures and activities.

The overall work plan with expected outcomes, responsibilities and deadlines in conducting all elements relevant for the flood risk management planning in the Sava River Basin, including development and update of Sava Flood Maps and accompanying steps is given in Annex 2.

The countries through ISRBC regularly exchange data relevant on the national Flood Maps and inform other countries on the update. For the purpose of preparation of the Sava Flood Maps – Update 2024, the countries have exchanged/updated data and information on maps for the *Areas of Mutual Interest for flood protection in the Sava River basin* (AMIs). Data and information have been exchanged through a common data sharing platform - the Sava GIS Geoportal.

2.1 METHODOLOGIES USED AT THE NATIONAL LEVEL

The maps developed per each country show at least the hazards and risks to potentially affected people, areas of economic activity, and, where present, installations which might cause accidental pollution should they be flooded, and other vulnerable features such as nature protection areas and cultural heritage assets.

Maps have been prepared covering a range of different probabilities of occurrence of flooding events (e.g. those with low, medium and high probabilities).

Even though the impact of climate change on the occurrence of floods should, where possible, be taken into account in a preliminary flood risk assessment and in the subsequent reviews of the preliminary flood risk assessment and flood risk management plans, this is not a strict requirement of at the mapping stage. However, all countries have taken climate change into account when preparing their flood maps.

One important change in the national flood maps is that Slovenia, Croatia and Bosnia and Herzegovina switched from PDF maps to exclusively GIS-based online map viewers, or to a mix of online GIS map viewers and downloadable PDF maps, while Serbia still offer the PDF only, while Montenegro still has not downloadable maps. The GIS-based approach has increased accessibility, even if the user friendliness of the map viewers varies. However, these differences in user friendliness can partly be explained by the intended use of the maps, i.e. if the map is intended for public use, expert use, or both.

Although more detailed information is available on the web sites links of responsible national institutions to relevant documents and maps listed in Annex 3, which also further addresses the methodologies and criteria used by the countries.

A summary information on development of the flood maps by the Units of Management according to national methodologies is given in Table 1 and can also be reached through the interactive web app showed at Figure 1.

Table 1: Overview of information, scenarios, flood sources, probabilities and related elements used for modelling mapped in development of the national flood maps per country

		Slovenia	Croatia	Bosnia and Herzegovina	Serbia	Montenegro
Defined methodology		✓	✓	✓	✓	✓
Considered flood defences		✓	✓	✓	✓	✓
Considered flood defence failure scenarios			✓		✓	
Considered existing buildings and infrastructure			✓			
Considered scenarios	Low probability return period (years)	500	1000 / infrastructure failure	500	1000	500
	Medium probability return period (years)	100	100	100	100	100
	High probability return period (years)	10	25	20	50	10
Approach taken to the calculation of flood return periods and probability	Statistical analysis on historical record/counts data		✓	✓		✓
	Statistical analysis on hydraulic modelling	✓		✓	✓	✓
	Statistical analysis on hydrological modelling		✓	✓		✓
	Statistical analysis on observed/gauging data		✓	✓		✓
	Statistical analysis on rainfall data					✓
	Expert judgement		✓			
	Other (e.g. uncertain)					
Considered flood sources	Fluvial	E (lp)	E/D (mp/lp)	E/D/V (-)	D (mp)	E/D/V (mp/lp)
	Pluvial				D (mp)	E/D/V (mp/lp)
	Groundwater		E/D (mp/lp)			
	Artificial Water-Bearing Infrastructure		E/D (lp)			
Considered groundwater sources and preparation of flood hazard maps limited to the low probability or extreme event scenarios (EU FD Article 6.7)				✓		
Considered effects of climate change		✓	✓(i)	✓(ii)	✓(i)	✓
Determined for each flood scenario	Indicative number of inhabitants affected (EU FD Article 6.5.a)	✓	✓	✓	✓	✓
	Type of economic activity (EU FD Article 6.5.b)	✓	✓	✓	✓	✓
	Location of the IED installation (EU FD Article 6.5.c)	✓	✓	✓	✓	✓

		Slovenia	Croatia	Bosnia and Herzegovina	Serbia	Montenegro
	Impact on the EU WFD Protected Areas (Article 6.5.c)	✓	✓	✓	✓	✓
Prior exchange of information on the preparation of flood hazard maps and flood risk maps for areas shared with other countries (EU FD Article 6.2)		✓ (ii)	✓(ii)	✓ (ii)	✓ (ii)	✓ (ii)

E – Flooding extent; D – Water depth/level; V – Water flow/velocity
mp – Medium probability (return period > 100 years); lp – Low probability or extreme event scenarios (i) Yes but not for all sources
(i) Yes but not for all maps
(ii) Prior information exchanged through ISRBC within the preparation of the Sava FRMP 2018 and the Sava PFRA update 2021

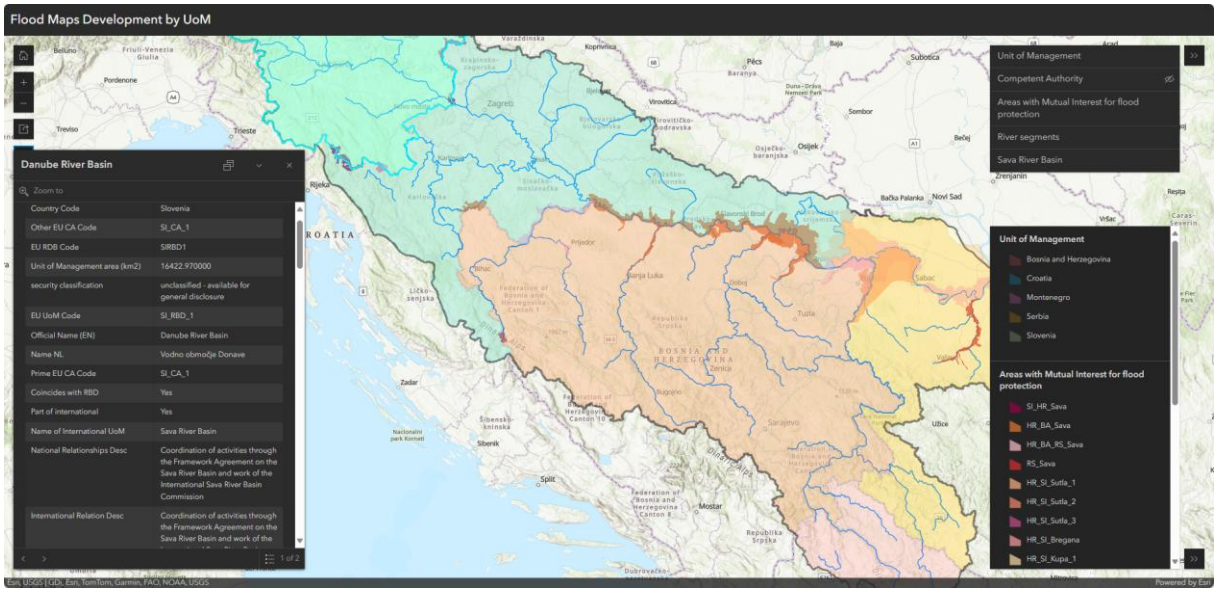


Figure 1: Illustration of the Flood Maps Development by UoM (Ctrl + Click to the Figure to open the web app)

2.2 SIMPLIFIED METHODOLOGY USED AT THE SAVA RIVER BASIN LEVEL

Elements of the simplified methodology have been prepared within the development of Sava FRMP.

The simplified methodology is primarily related to AMIs, i.e. flood areas shared by two or more countries and it considers the fact that all the countries in the Sava River Basin had already developed the national methodologies.

The hazard maps for AMIs are based on two scenarios:

- floods with a medium probability (likely return period of 100 years) and
- floods with a low probability, or extreme event scenarios (regardless of the return period).

The hazard maps are classified into five categories, based to the national methodologies and according to hydraulic parameters (depth and/or velocity) presented in Table 2.

Table 2: Classification of national hazard maps according to hydraulic parameters

Hazard classes	Slovenia	Croatia	Bosnia and Herzegovina	Serbia	Montenegro
	h or h×v	h	h × (v+0,5)	h	h
High	> 1.5	> 2.5	> 2.5	> 4	
Medium	0.5 - 1.5	1.5 - 2.5	1.5 - 2.5	1.5 - 4	> 1.5
Low	< 0.5	0.5 - 1.5	0.75 - 1.5	0.5 - 1.5	0.5 - 1.5
Very low	extraordinary causes of occurrence	< 0.5	< 0.75	< 0.5	< 0.5
No hazard	potentially significant flood risk identified by PFRA but not by flood maps				

Regarding the flood risk maps, the simplified methodology proposes the following categories of risk receptors:

- Inhabitants Affected (indicative number)
- Economy Affected (type of economic activities)
- Environment Affected
- Cultural Heritage Affected (including historic heritage).

Each of the listed category of risk receptors contains its subcategories, which can be further divided into specific groups. The degree of division and the final list of all risk receptors has been determined during the development of risk maps.

Table 3 shows all subcategories of risk receptors which were determined based on the availability of spatial data on risk receptors and the analysis of data and the obtained risk assessment results.

Table 3: Classification of the potential adverse consequences associated with flood scenarios

No	Categories of the risk receptors	Sub-categories of the risk receptors
1	Indicative number of inhabitants	Overall inhabitants affected
		Inhabitants affected during daytime
		Inhabitants affected during night
		Transitory population
		Other people potentially affected
2	Type of economic activities	Property
		Infrastructure
		Rural land use
		Economic activity
		Other activities
3	Environment	Waterbody status
		Protected areas
		Pollution sources
		Other potential adverse environmental impacts
4	Cultural-historic heritage	Cultural Assets
		Landscape
		Other

3 FLOOD MAPPING IN AREAS OF MUTUAL INTEREST FOR FLOOD PROTECTION IN THE SAVA RIVER BASIN

3.1 HAZARDS ASSOCIATED WITH MAPPED FLOODS

Flood hazard maps can be reached through the interactive web app showed at Figure 2.

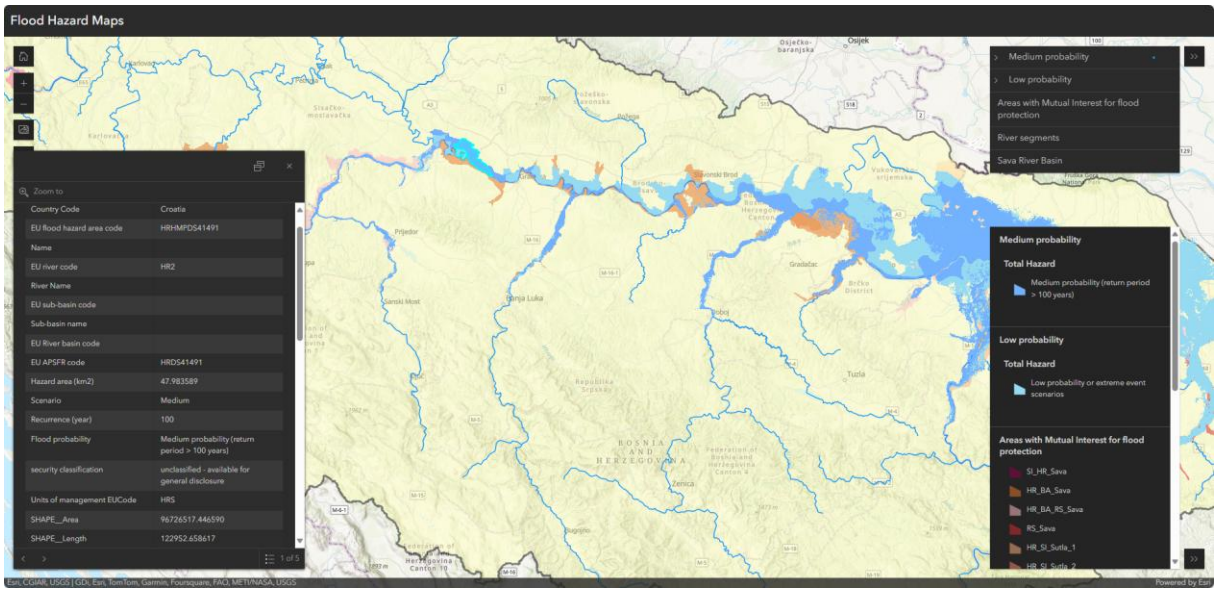


Figure 2: Illustration of the Flood Hazard Maps (Ctrl + Click to the Figure to open the web app)

Updated flood hazard maps, identified based on national flood maps in AMIs[7], cover area of 4.596,6 km² for the flood maps with the **medium probability** scenario, while for maps with the **low probability** area of 5.934,6 km². Distribution per countries is presented in Figure 3.

Maps also show flood hazard areas classified in five different classes for two scenarios. The most common for the flood maps with the **medium probability** scenario is the high hazard class with area of 1.989,9 km² and for maps with the **low probability** is the medium hazard class covering area of 1.231,1 km². Distribution per classes is presented in Figure 4.

[7] AMIs (presented in Annex 1) include a total of 255 flood prone areas, identified based mainly on national APSFRs that are grouped in 17 areas, cover area of 5.734,5 km², respectively 129 km² in Slovenia, 1.694 km² in Croatia, 1.099 km² in Bosnia and Herzegovina, 2.810 km² in Serbia and 2,5 km² in Montenegro

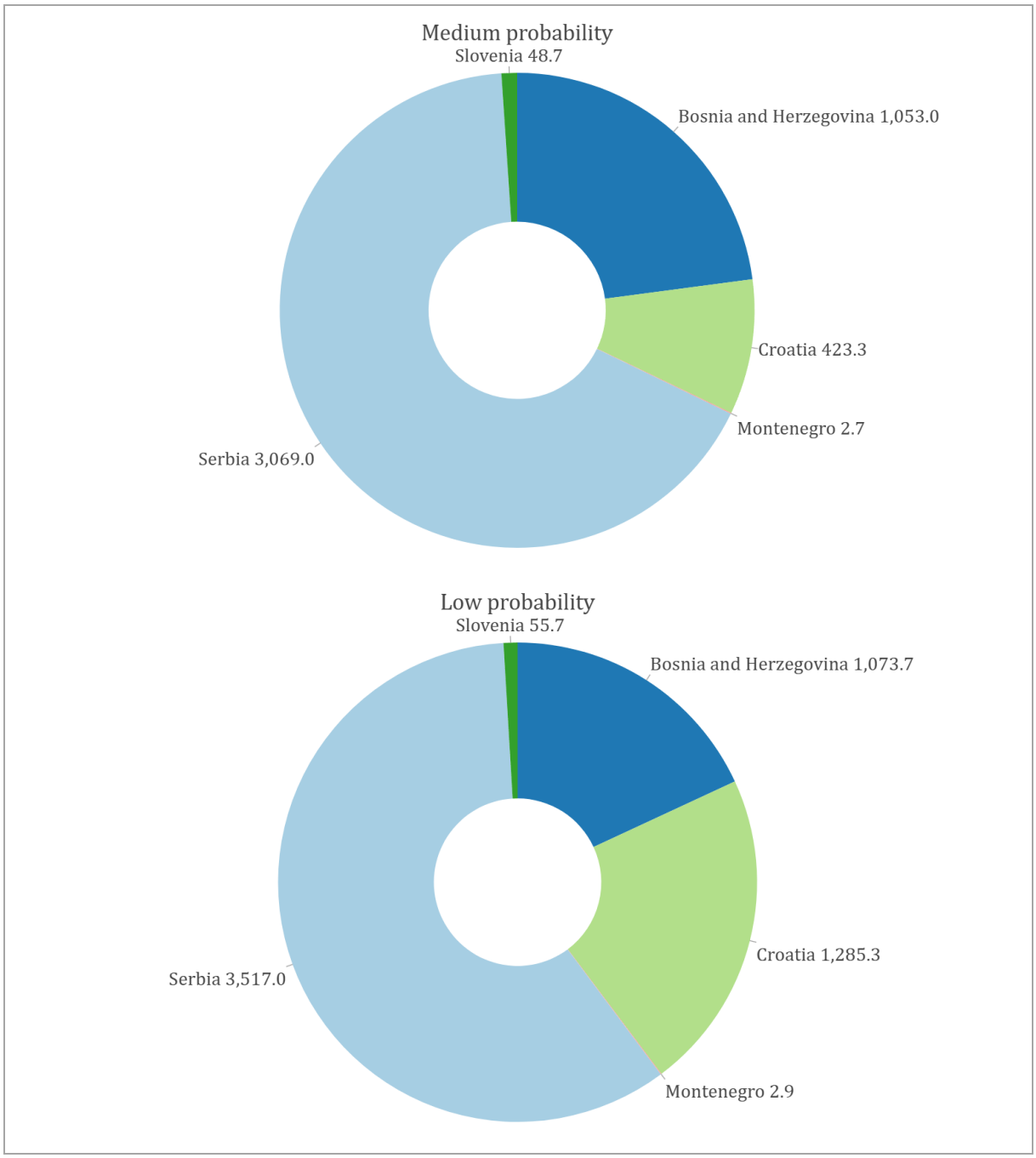


Figure 3: Flood hazard areas in AMIs (in km²)

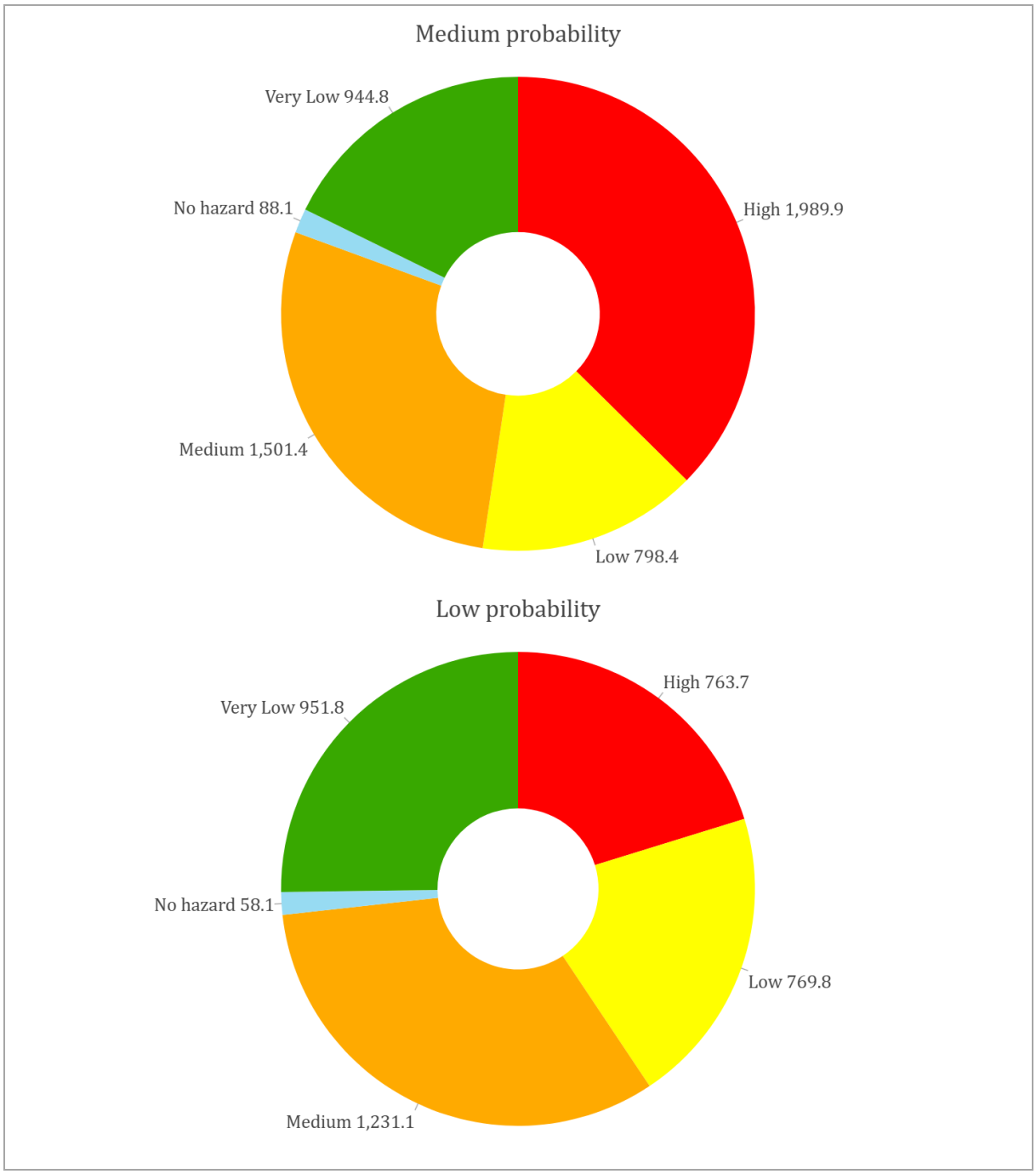


Figure 4: Flood hazard area by classes in AMIs (in km²)

3.1.1 Sources, mechanisms and characteristics of mapped floods

The types of floods associated with flood areas are based on data related to AMIs and the main source of flooding identified is fluvial. The defence exceedance and failure are the most common mechanism of flooding, different than in the Sava PFRA update where the natural exceedance was dominant. The slow onset is the most common characteristic. Data on the sources, mechanisms and characteristics of floods within AMIs are shown in Figure 5.

Some sources of flood associated with AMISs (national APSFRs) have not been included in maps of the areas (groundwater, artificial water-bearing infrastructure), given that for some only the most significant source affecting the area has been mapped and/or all sources of flood associated with an area may have been combined in the map.

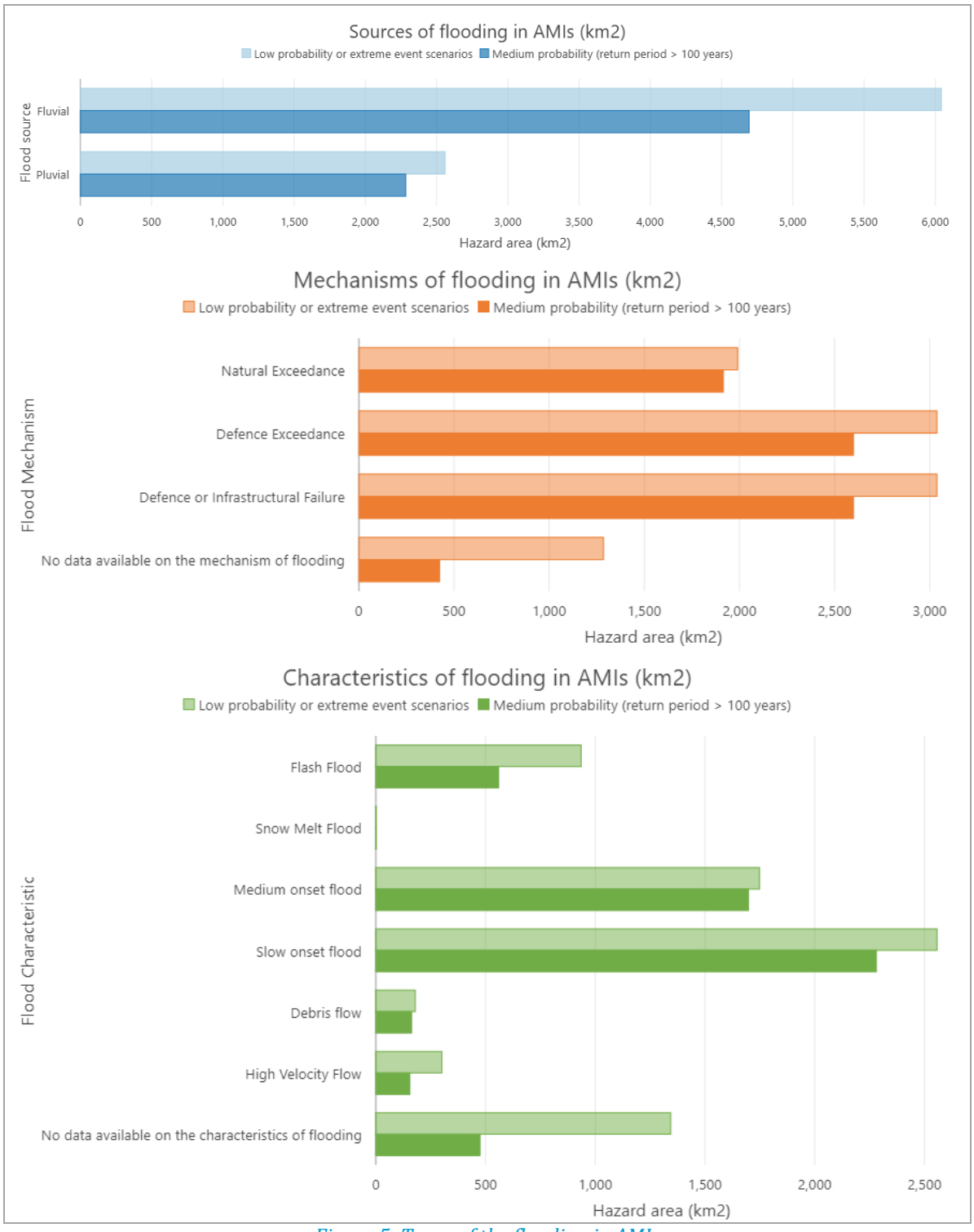


Figure 5: Types of the flooding in AMIs

Types of floods which should be considered are identified, and data delivered but whether other types had been considered did not specified at all. It is advised to clearly state if floods, especially for those occurring after completion of the initial national PFRA reports, were not considered because of their relevance, because of the absence of data or if it is to be expected that they will be included in the next reporting cycle. Also, more detailed information should be provided for floods that could occur in the future during subsequent planning cycles.

3.2 RISKS ASSOCIATED WITH MAPPED FLOODS

Article 6(5) of the EU Floods Directive says that flood risk maps shall show the potential adverse consequences associated with flood scenarios expressed in terms of (a) the indicative number of inhabitants potentially affected; (b) type of economic activity of the area potentially affected; (c) IED installations and protected areas identified in Annex IV(1)(i), (iii) and (v) to EU Water Framework Directive; and (d) other information which considers useful.

Total flood risks related to the inhabitants potentially affected can be reached through the interactive web app showed at Figure 6.

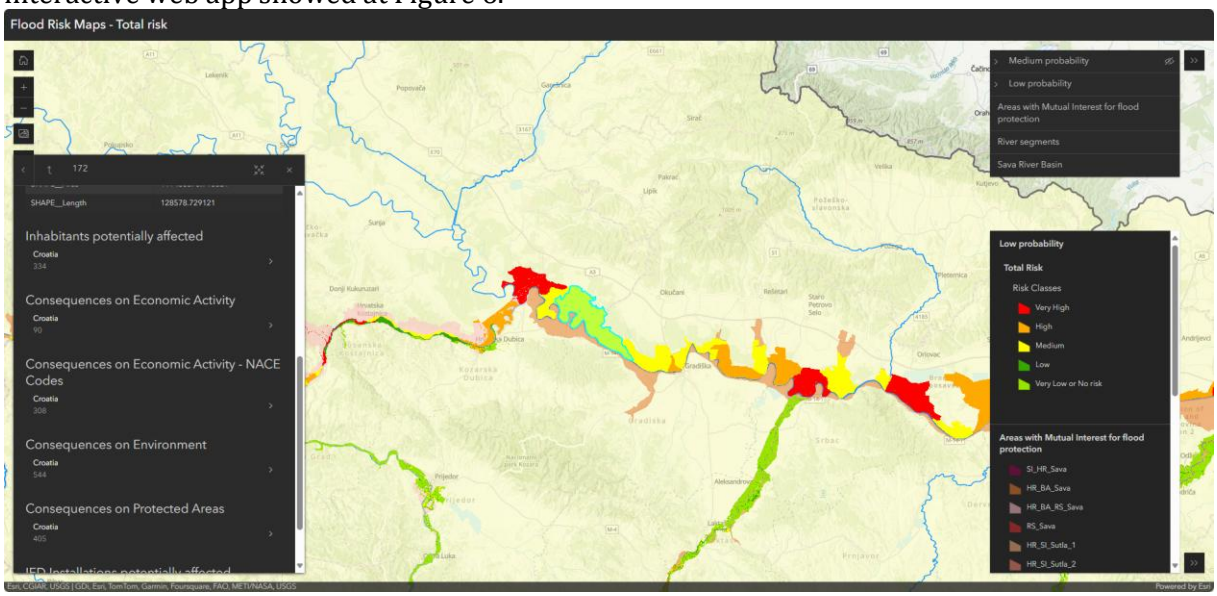


Figure 6: Illustration of the Flood Risk Maps – Total risk (Ctrl + Click to the Figure to open the web app)

3.2.1 Inhabitants Affected

Flood risk map related to the inhabitants potentially affected can be reached through the interactive web app showed at Figure 7.

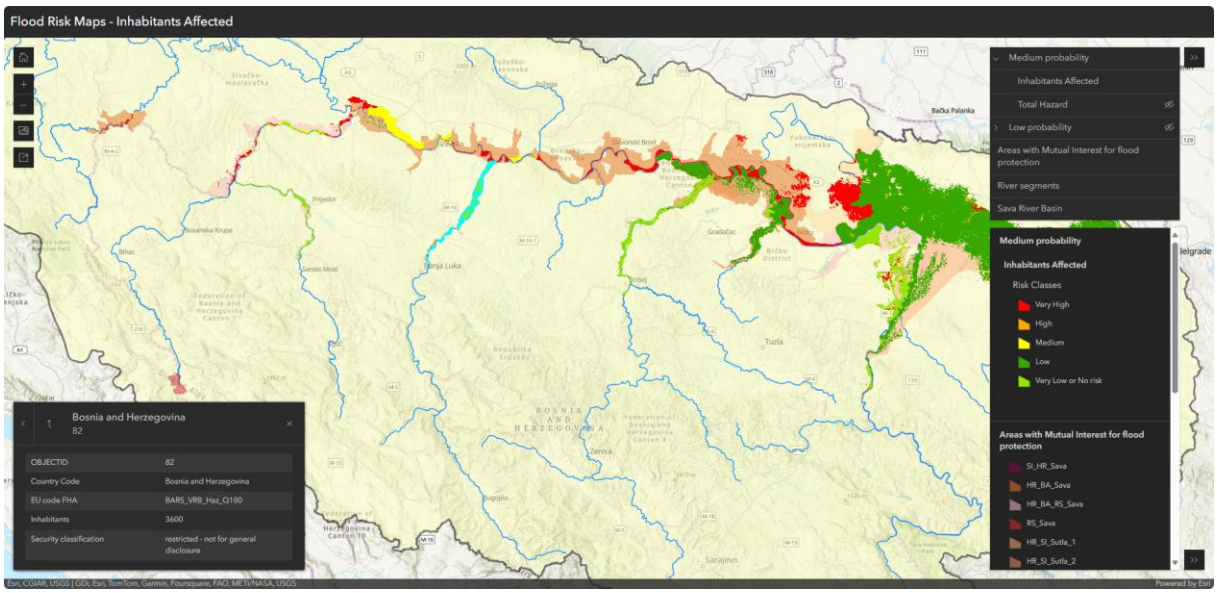


Figure 7: Illustration of the Flood Risk Maps – Inhabitants Affected (Ctrl + Click to the Figure to open the web app)

Maps showing the potential impacts of flooding most often include an indication of the number of inhabitants potentially affected for each of the probabilities and sources of flooding. Potentially more inhabitants would be affected by flooding from low probability or extreme, rare events than from medium probability (more common) events.

The information presented in Figure 8 is also summarised in Table 5 in terms of potentially affected inhabitants in the areas of mutual interest for flood protection in the Sava River Basin. There are differences within and between countries in the numbers of potentially affected inhabitants reflecting differences in the size and population densities of the flood risk areas.

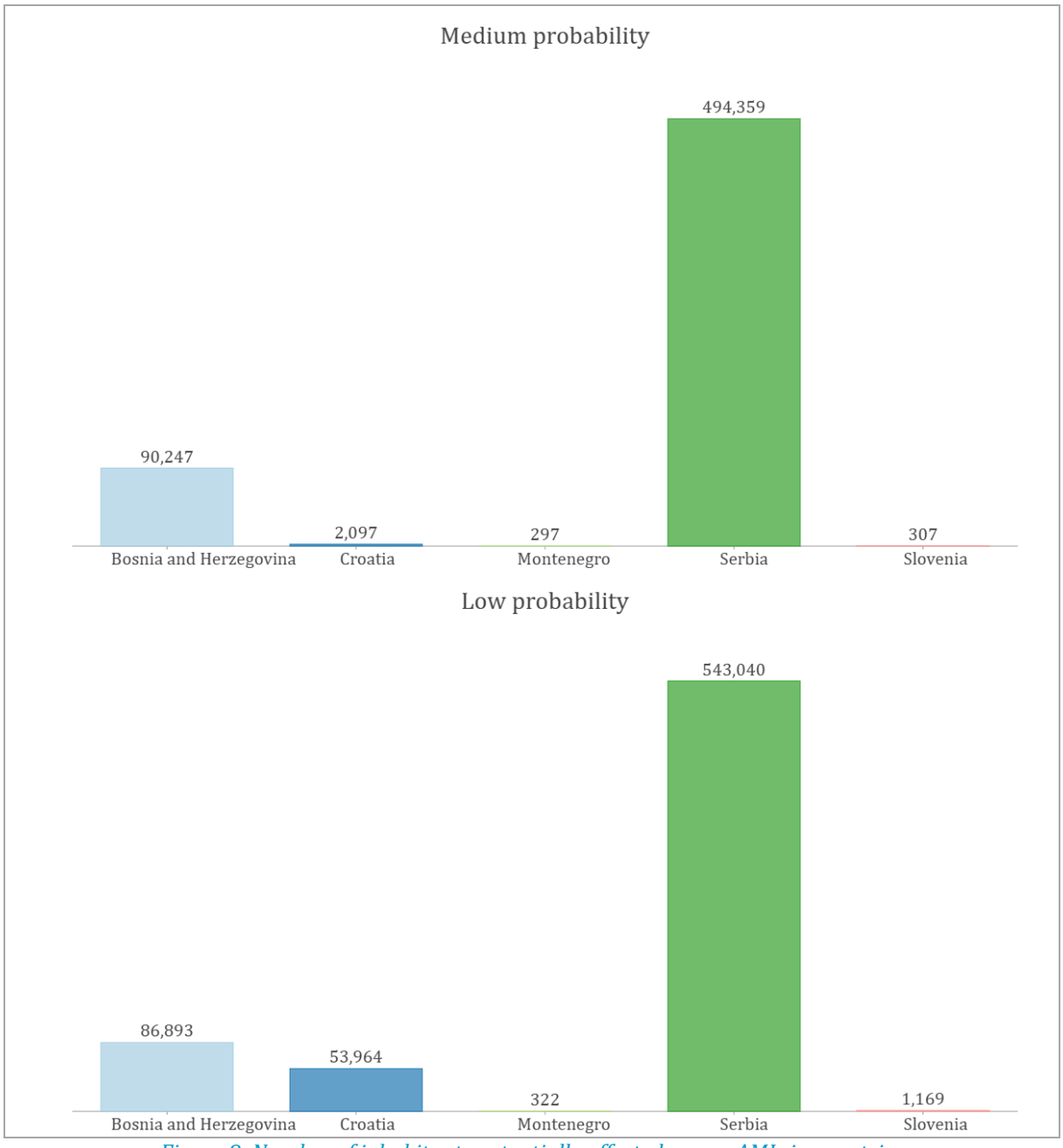


Figure 8: Number of inhabitants potentially affected across AMIs in countries

Table 4: Number of inhabitants potentially affected across AMIs

No.	River / AMI[i]		Inhabitants affected by AMIs		Country	Inhabitants affected by countries	
			Medium probability	Low probability		Medium probability	Low probability
1	Sava	SI_HR_Sava	750	1.576	Slovenia	n/a	779
					Croatia	750	797
2		HR_BA_Sava[ii]	12.742	54.652	Croatia	31	45.879
					Bosnia and Herzegovina	12.711	8.773
3		HR_BA_RS_Sava[ii]	339.428	327.557	Croatia	1	556
					Bosnia and Herzegovina	43.318	4.056
					Serbia	297.109	322.945
4		RS_Sava	72.320	77.188	Serbia	72.320	77.188
5	Sutla/ Sotla	HR_SI_Sutla_1	22	72	Slovenia	20	67
					Croatia	2	5
6		HR_SI_Sutla_2	76	123	Slovenia	3	3
					Croatia	73	120
7		HR_SI_Sutla_3	313	465	Slovenia	205	255
					Croatia	108	240
8	Bregana	HR_SI_Bregana	357	563	Slovenia	62	486
					Croatia	295	77
9	Kupa/ Kolpa	HR_SI_Kupa_1	2	5	Slovenia	n/a	n/a
					Croatia	2	5
10		HR_SI_Kupa_2	26	26	Slovenia	7	7
					Croatia	19	19
11		HR_SI_Kupa_3	227	263	Slovenia	10	11
					Croatia	217	252
12		HR_BA_Glina	44	59	Croatia	44	59
					Bosnia and Herzegovina	n/a	n/a
13	Una	HR_BA_Una_1	2.440	7.006	Croatia	536	1.260
					Bosnia and Herzegovina	988	5.746
14		HR_BA_Una_2	0	0	Croatia	0	0
					Bosnia and Herzegovina	n/a[ii]	n/a[ii]
15	Drina	BA_RS_Drina	138.720	181.488	Bosnia and Herzegovina	30.320	60.536
					Serbia	108.400	120.952
16		ME_BA_Drina	2.994	7.782	Montenegro	n/a	n/a
					Bosnia and Herzegovina	2.994	7.782
17		ME_RS_Lim	297	322	Montenegro	297	322
					Serbia	n/a[ii]	n/a[ii]
18		RS_BA_Lim	5.230	5.805	Serbia	5.230	5.805
					Bosnia and Herzegovina	n/a	n/a
19	Bosut	HR_RS_Bosut	11.319	20.436	Croatia	19	4.286
					Serbia	11.300	16.150
		TOTAL	**591.268**	**692.339**			

(i) River and/or subbasin with identified areas, shared by two or more countries, for which potential significant flood risk exists
(ii) For the noted AMIs in Bosnia and Herzegovina, number of inhabitants affected by the flood event from May 2014 is included in the medium probability scenario

Indicative numbers of inhabitants potentially affected have been identified by all countries. Compared to the first flood maps across AMIs, the number of inhabitants potentially affected by the medium probability floods as a total has increased by about 72.000 to 591.268 inhabitants, while for the low probability scenario decreased by about 157.000 to 692.339 inhabitants.

3.2.2 Economy Affected

Flood risk map related to the economic activities potentially affected can be reached through the interactive web app showed at Figure 9.

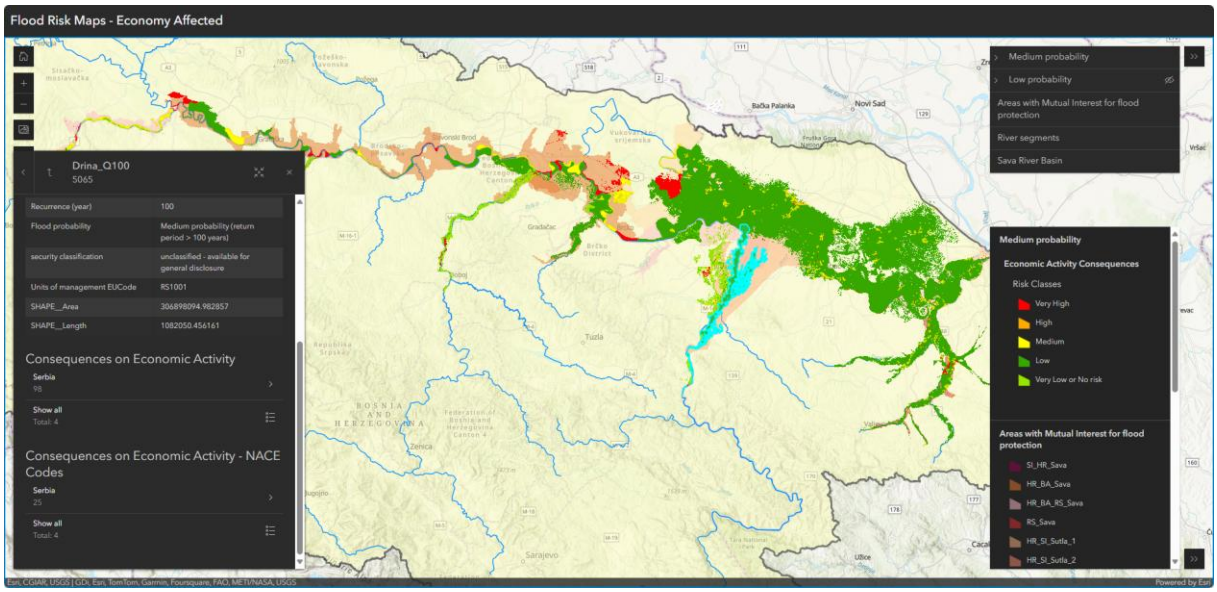


Figure 9: Illustration of the Flood Risk Maps – Economy Affected (Ctrl + Click to the Figure to open the web app)

Figure 10 summarises the potential adverse consequences on economic activity as a number of predefined "types" of economic activity. Not all types would necessarily be expected to be associated with each flood risk area and/or UoM as the potential economic features at risk may not occur within the area of potential flooding being mapped.

The type of economic activity of the area potentially affected is presented by all countries, including related NACE (Nomenclature of Economic Activities) codes[8] for some countries. The situation largely remains similar to the first flood maps in the sense that information is mainly provided by showing land use on the maps. Countries have not quantified the economic damages.

[8] Glossary: Statistical classification of economic activities in the European Community (NACE) - Statistics Explained

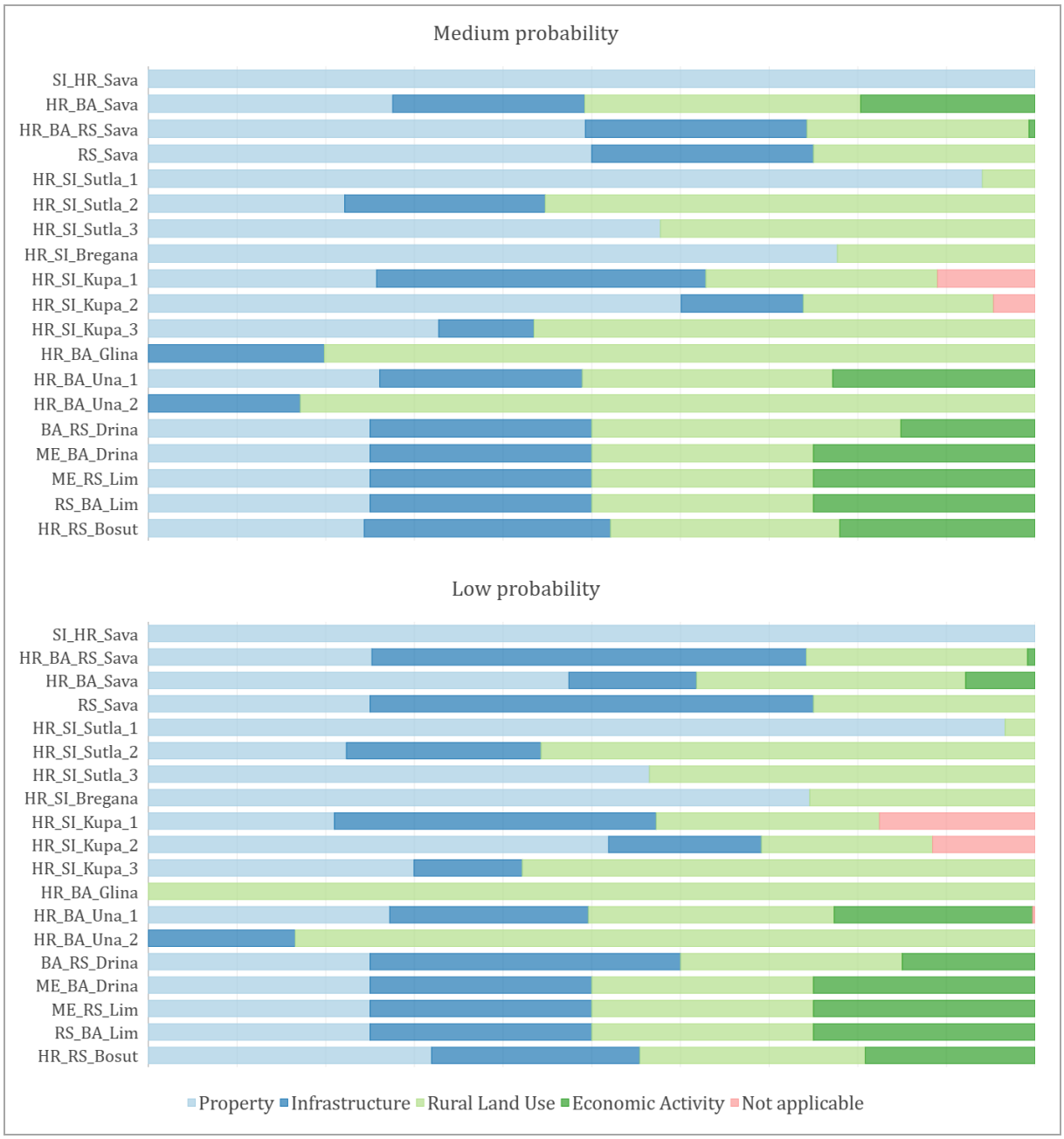


Figure 10: Hazard area distribution by potential adverse consequences on the economic activities across AMIs

3.2.3 Environment Affected

Flood risk map related to the environment potentially affected can be reached through the interactive web app showed at Figure 11.

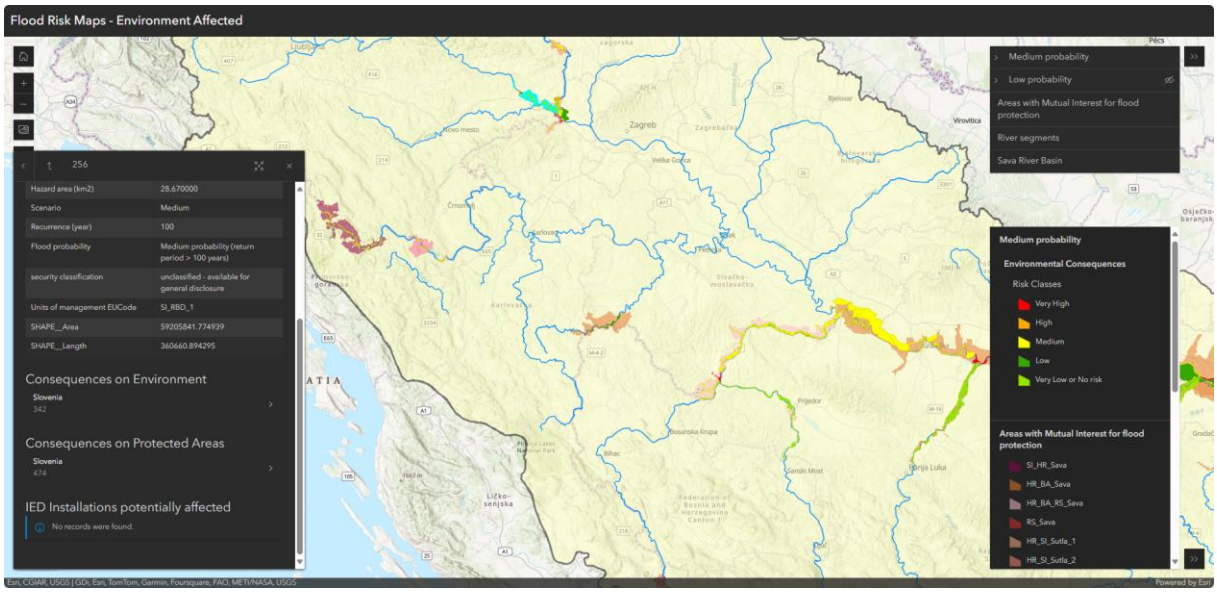


Figure 11: Illustration of the Flood Risk Maps – Environment Affected (Ctrl + Click to the Figure to open the web app)

Environmental consequences included permanent or long-term consequences on the ecological or chemical status of affected surface water bodies or chemical status of ground water bodies, as defined under the EU WFD. Such consequences may arise from pollution from various sources (point and diffuse) or due to hydro-morphological impacts of flooding. Map also included adverse consequences to protected areas such as those designated under different EU Directives as well as sources of potential pollution in the event of a flood, such as IPPC and Seveso installations, or point or diffuse sources, including IED (Industrial and Livestock Rearing Emissions Directive) codes[9].

[9] Industrial and Livestock Rearing Emissions Directive (IED 2.0) - European Commission

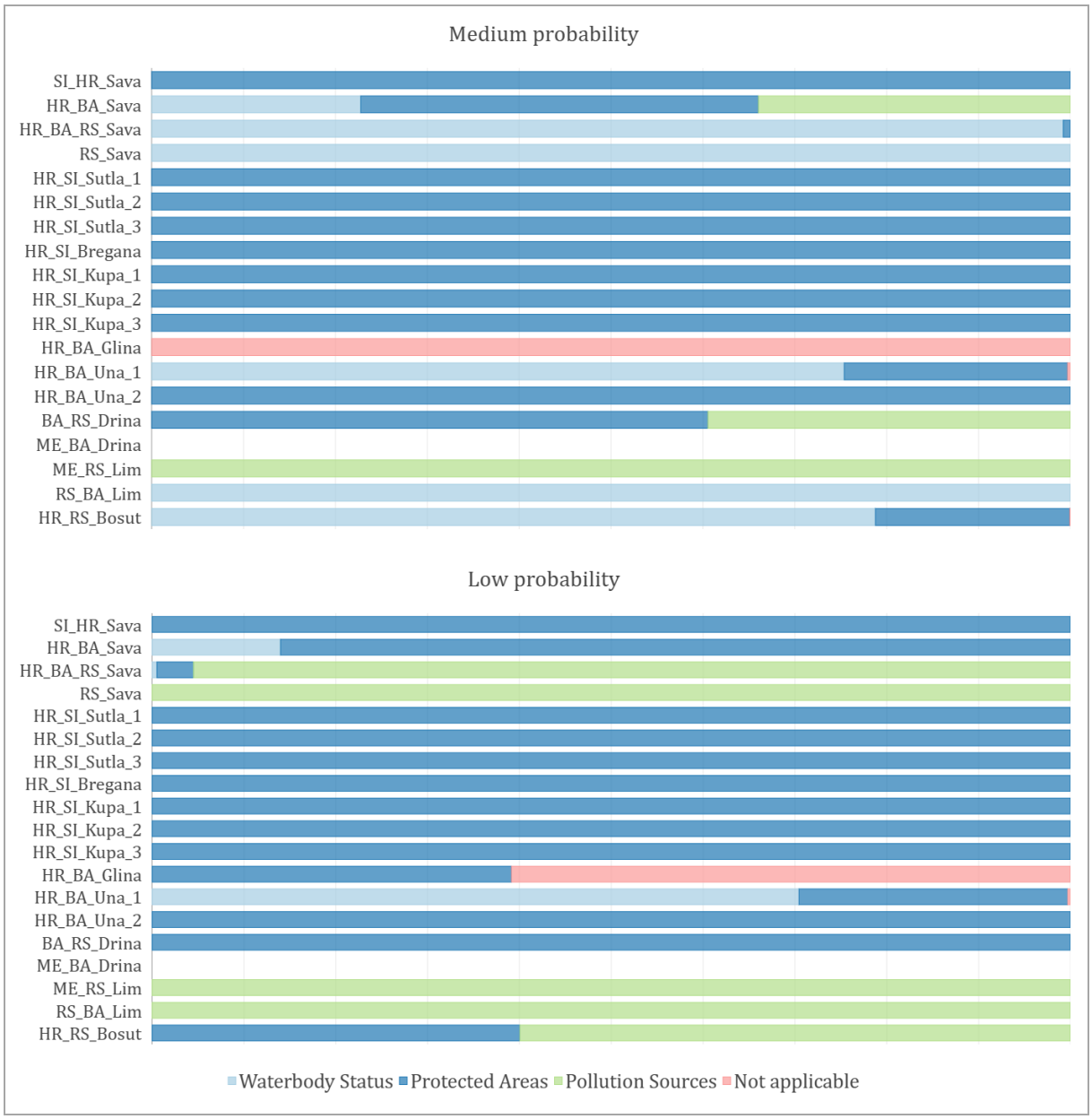


Figure 12: Hazard area distribution by potential adverse consequences on the environment across AMIs

3.3.3.1. WATER BODIES

Surface Water Bodies

In total 91 surface water bodies are located in AMIs and potentially could be affected by flood hazards. However, potential consequences on specific surface water bodies may arise due to impacts of flooding from several AMIs. Many of surface water bodies, located in the AMIs, have failing to achieve good chemical status, but more important is their moderate, poor, and bad ecological status or potential, considering that the flood protection is recognized as the one of the main drivers for heavily modify water body designation.

Table 5: Overview of potential adverse consequences on the Water Bodies' ecological status across AMIs (with number of Water Bodies potentially affected)

No.	River / AMI		High status / maximum potential		Good status		Moderate status / potential		Poor status / potential		Bad status / potential		Unknown status / potential	
1	Sava	SI_HR_Sava			SI/HR	4	HR	1						
2		HR_BA_Sava					BA	6	HR	5	HR/BA	9	BA	1
3		HR_BA_RS_Sava					HR/BA/RS	11	HR/RS	5			RS	1

No.	River / AMI		High status / maximum potential		Good status		Moderate status / potential		Poor status / potential		Bad status / potential		Unknown status / potential	
4		RS_Sava					RS	6	RS	1			RS	2
5	Sutla/ Sotla	HR_SI_Sutla_1			SI	1			HR	1				
6		HR_SI_Sutla_2			HR/SI	3								
7		HR_SI_Sutla_3			HR/SI	2	SI	1	HR	1				
8	Bregana	HR_SI_Bregana			HR/SI	2								
9	Kupa/ Kolpa	HR_SI_Kupa_1			SI	1	HR	1						
10		HR_SI_Kupa_2			SI	1	HR	2						
11		HR_SI_Kupa_3	SI	1	HR/SI	4								
12		HR_BA_Glina			HR	3								
13	Una	HR_BA_Una_1			HR/BA	3	HR/BA	6	HR	3			BA	3
14		HR_BA_Una_2			HR	2								
15	Drina	BA_RS_Drina					BA/RS	3	RS	1				
16		ME_BA_Drina			BA	1	BA	1			BA	1		
17		ME_RS_Lim											ME	1
18		RS_BA_Lim					RS	1	RS	2			BA	2
19	Bosut	HR_RS_Bosut					HR	1	HR/RS	2			RS	1
		TOTAL	**1**		**27**		**40**		**21**		**10**		**11**	

Table 6: Overview of potential adverse consequences on the Water Bodies' chemical status across AMIs (with number of Water Bodies potentially affected)

No.	River / AMI		Good status		Failing to achieve good chemical status		Unknown status	
1	Sava	SI_HR_Sava	SI/HR	5				
2		HR_BA_Sava	HR/BA	14	BA	4	BA	3
3		HR_BA_RS_Sava	HR/RS	7	BA/RS	3	BA/RS	7
4		RS_Sava	RS	2			RS	7
5	Sutla/ Sotla	HR_SI_Sutla_1	HR/SI	2				
6		HR_SI_Sutla_2	HR/SI	3				
7		HR_SI_Sutla_3	HR/SI	4				
8	Bregana	HR_SI_Bregana	HR/SI	2				
9	Kupa/ Kolpa	HR_SI_Kupa_1	HR/SI	2				
10		HR_SI_Kupa_2	HR/SI	3				
11		HR_SI_Kupa_3	HR/SI	5				
12		HR_BA_Glina	HR	3				
13	Una	HR_BA_Una_1	HR/BA	8	BA	4	BA	3
14		HR_BA_Una_2	HR	2				
15	Drina	BA_RS_Drina	RS	1	BA	1	RS	2
16		ME_BA_Drina	BA	1	BA	2		
17		ME_RS_Lim					ME	1
18		RS_BA_Lim					BA/RS	5
19	Bosut	HR_RS_Bosut	HR/RS	2	HR	1	RS	1
		TOTAL		**66**		**15**		**29**

Table 7: Overview of the potential adverse consequences on the Water Bodies' hydro-morphological alterations across AMIs (with number of Water Bodies potentially affected)

No.	River / AMI		Near natural		Slightly modified		Moderately modified		Extensively modified		Severely modified		No information	
1	Sava	SI_HR_Sava	SI/HR	3	SI	1	SI	1						
2		HR_BA_Sava			BA	2	HR/BA	17					BA	2
3		HR_BA_RS_Sava	HR/RS	2	RS	3	HR/BA/RS	6	RS	6				
4		RS_Sava	RS	4	RS	1	RS		RS	3	RA	1		
5	Sutla/ Sotla	HR_SI_Sutla_1	HR/SI	2										
6		HR_SI_Sutla_2	HR/SI	3										
7		HR_SI_Sutla_3	HR/SI	4										
8	Bregana	HR_SI_Bregana	HR	1	SI	1								
9	Kupa/ Kolpa	HR_SI_Kupa_1	SI	1	HR	1								
10		HR_SI_Kupa_2	SI	1	HR	2								
11		HR_SI_Kupa_3	HR/SI	4	HR	1								
12		HR_BA_Glina	HR	3										
13	Una	HR_BA_Una_1	HR/BA	9			HR/BA	4					BA	2
14		HR_BA_Una_2	HR	2										
15	Drina	BA_RS_Drina					BA	1	RS	3				
16		ME_BA_Drina							BA	1			BA	2

No.	River / AMI		Near natural		Slightly modified		Moderately modified		Extensively modified		Severely modified		No information	
17		ME_RS_Lim											ME	1
18		RS_BA_Lim	RS	1	BA/RS	3							RS	1
19	Bosut	HR_RS_Bosut	HR	2	RS	1	RS	1						
TOTAL			**42**		**16**		**30**		**13**		**1**		**8**	

Ground Water Bodies

Table 8: Overview of potential adverse consequences on the Ground Water Bodies' chemical status across AMIs (with number of Water Bodies potentially affected)

No.	River / AMI		Good status		Failing to achieve good chemical status		Unknown status	
1	Sava	SI_HR_Sava	SI/HR	4				
2		HR_BA_Sava	HR	3	BA	4		
3		HR_BA_RS_Sava	HR	1	BA	3	RS	5
4		RS_Sava					RS	1
5	Sutla/ Sotla	HR_SI_Sutla_1	HR/SI	4				
6		HR_SI_Sutla_2	HR/SI	2				
7		HR_SI_Sutla_3	HR/SI	3				
8	Bregana	HR_SI_Bregana	HR/SI	4				
9	Kupa/ Kolpa	HR_SI_Kupa_1	HR/SI	2				
10		HR_SI_Kupa_2	HR/SI	2				
11		HR_SI_Kupa_3	HR/SI	2				
12		HR_BA_Glina	HR	1				
13	Una	HR_BA_Una_1	HR/BA	5				
14		HR_BA_Una_2	HR/BA	2				
15	Drina	BA_RS_Drina			BA	1	RS	2
16		ME_BA_Drina(i)						
17		ME_RS_Lim					ME	1
18		RS_BA_Lim(i)						
19	Bosut	HR_RS_Bosut	HR	1			RS	2
TOTAL			**36**		**8**			**11**

(i) No information provided for potential adverse consequences on ground water body status

3.3.3.2. PROTECTED AREAS

Also, the adverse permanent or long-term consequences to protected areas or water bodies have been considered such as those designated under the following EU Directives and other legislation:

- Water Framework Directive 2000/60/EC – Article 7 Abstraction for drinking water
- Birds Directive 2009/147/EC
- Habitats Directive 92/43/EEC
- Nitrates Directive Report 91/676/EEC – Nutrient vulnerable zones and sensitive areas
- Bathing Water Directive 2006/7/EC
- Freshwater Fish Directive 2006/44/EC and Shellfish Directive 79/923/EEC – Economically significant aquatic species
- Urban Waste Water Treatment Directive 91/271/EEC
- Other EU legislation
- National legislation
- Local legislation.

The most commonly Protected Areas potentially at risk were Habitats Directive followed by other directives that were not indicated and the least commonly reported were Fish Directive.

Table 9: Overview of potential adverse consequences on the Protected Areas across AMIs

No.	River / AMI		Protected Areas									
			WFD (art.7)		Bird		Habitat		National		Other	
1	Sava	SI_HR_Sava	SI/HR	4	SI(ii)	1	SI/HR	4				
2		HR_BA_Sava	HR	9	HR	3	HR	8			HR/BA	6
3		HR_BA_RS_Sava			HR	1	HR	2	BA	1	RS	3
4		RS_Sava(i)										
5	Sutla/ Sotla	HR_SI_Sutla_1	HR	2			HR/SI	3				
6		HR_SI_Sutla_2					HR/SI	3			HR	1
7		HR_SI_Sutla_3	HR	1			HR/SI	2				
8	Bregana	HR_SI_Bregana	HR	1								
9	Kupa/ Kolpa	HR_SI_Kupa_1					HR/SI	3				
10		HR_SI_Kupa_2	SI	2			HR/SI	3				
11		HR_SI_Kupa_3	HR	4	HR	1	HR/SI	6			HR	1
12		HR_BA_Glina									HR	
13	Una	HR_BA_Una_1			HR	1	HR	4			HR/BA	2
14		HR_BA_Una_2					HR	1			BA	1
15	Drina	BA_RS_Drina							BA	1	RS	
16		ME_BA_Drina(i)										
17		ME_RS_Lim(i)										
18		RS_BA_Lim(i)										
19	Bosut	HR_RS_Bosut	HR	3	HR	1	HR	3			RS	1
TOTAL			**26**		**8**		**42**		**2**			**15**

(i) No information provided for potential adverse consequences on protected areas
(ii) For the low probability scenario only

3.3.3.3. POLLUTION SOURCES

Pollution Sources were analysed in terms of potential pollution in the event of a flood, such as IED/IPPC and Seveso installations, or other significant industrial pollution sources. However, there was very little information on how the subsequent impact on the flood-affected Protected Areas was assessed or if it was at all, while for some hazard areas or AMIs environmental consequences are not applicable.

For the most included pollution sources there were no details on types of installation, while some of the types are:

- 1 - energy industries (thermal power stations)
- 3 - mineral industry (opencast mining and quarrying)
- 3.3 - manufacture of glass including glass fibre
- 4.1.a - production of organic chemicals - simple hydrocarbons
- 4.1.b - production of organic chemicals - oxygen-containing hydrocarbons
- 4.2.e - production of inorganic chemicals - non-metals
- 4.3 - production of phosphorous-, nitrogen- or potassium-based fertilisers
- 4.5 - production of pharmaceutical products including intermediates
- 5.4 - landfills
- 6.4.c - treatment and processing of milk
- 6.4.b.ii - treatment and processing - vegetable raw materials
- 6.11 - independently operated treatment of wastewater
- 5.2.b - disposal or recovery of waste - hazardous waste
- 5.6 - underground storage of hazardous waste
- 6.1.b - production in industrial installations - paper or card board
- 6.6.c - intensive rearing of poultry or pigs
- 6.11 - independently operated treatment of waste water.

Table 10: Overview of potential adverse consequences on the Pollution Sources across AMIs

No.	River / AMI		Collecting system without UWW treatment		Operating UWW treatment		Significant industrial pollution sources	
1	Sava	SI_HR_Sava			SI	1	HR	1
2		HR_BA_Sava	HR/BA	13	HR/BA	2	HR	3
3		HR_BA_RS_Sava	RS	12	RS	2	BA/RS	11
4		RS_Sava	RS	5	RS	1	RS	2
5	Sutla/ Sotla	HR_SI_Sutla_1						
6		HR_SI_Sutla_2						
7		HR_SI_Sutla_3			HR	1		
8	Bregana	HR_SI_Bregana						
9	Kupa/ Kolpa	HR_SI_Kupa_1						
10		HR_SI_Kupa_2						
11		HR_SI_Kupa_3						
12		HR_BA_Glina						
13	Una	HR_BA_Una_1	HR/BA	4			BA	1
14		HR_BA_Una_2						
15	Drina	BA_RS_Drina					BA/RS	
16		ME_BA_Drina(i)						
17		ME_RS_Lim					ME	2
18		RS_BA_Lim	RS	3				
19	Bosut	HR_RS_Bosut	RS	2			RS	
		TOTAL		**39**		**7**		**20**

(i) No information provided for potential adverse consequences on pollution sources

3.2.4 Cultural Heritage Affected

Flood risk map related to the cultural and historic heritage potentially affected can be reached through the interactive web app showed at Figure 13.

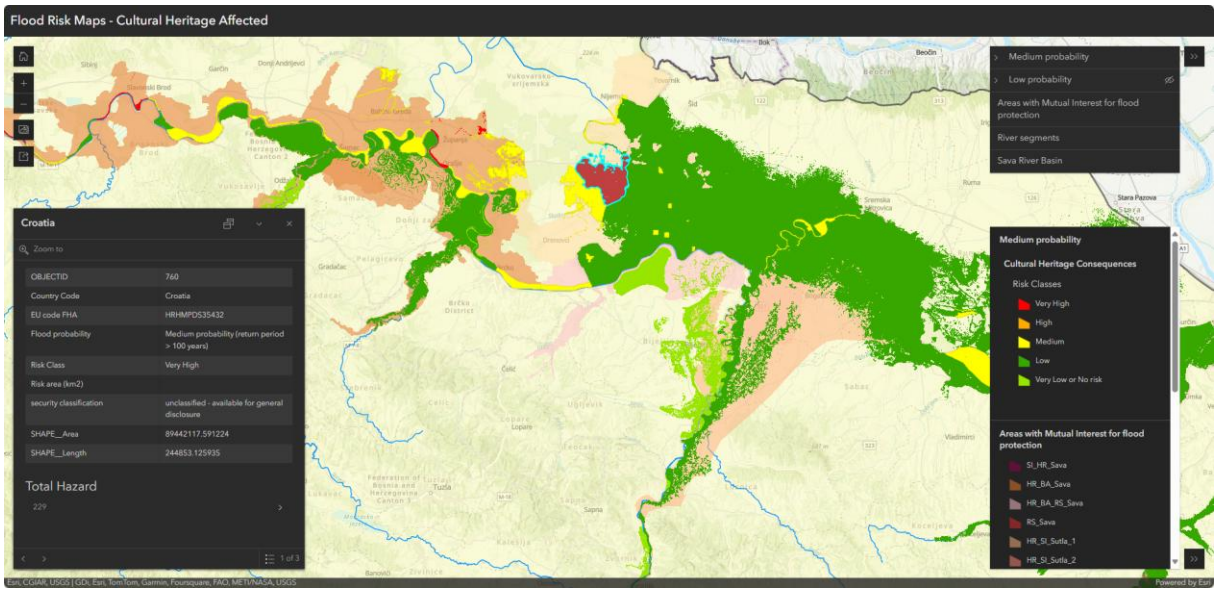


Figure 13: Illustration of the Flood Risk Maps – Cultural Heritage Affected (Ctrl + Click to the Figure to open the web app)

The potential adverse consequences on cultural heritage were also considered in the risk maps and included Cultural Assets (archaeological sites/monuments, architectural sites, museums, spiritual sites and building) as well as landscape (cultural properties which represent the combined works of nature and man, such as relics of traditional landscapes, anchor locations or zones).

Cultural heritage was disaggregated into:

- Archaeological heritage
- Secular architectural heritage
- Sacral architectural heritage
- Sacral-secular architectural heritage
- Memorial heritage
- Garden architectural heritage
- Urban heritage
- Cultural landscape
- Other cultural heritage.

Figure 14: Hazard area distribution by potential adverse consequences on the cultural-historic heritage across AMIs

Table 11: Overview of potential adverse consequences on the cultural heritage across AMIs for the medium probability scenario

No.	River / AMI[i]		Cultural Assets		Landscape and Other		Not applicable
1	Sava	SI_HR_Sava	8	SI/HR	-		
2		HR_BA_Sava	14	HR	5	BA	
3		HR_BA_RS_Sava	39	BA/RS	9	BA	
4		RS_Sava	2	RS	-		
5	Sutla/ Sotla	HR_SI_Sutla_1	5	SI	-		
6		HR_SI_Sutla_2	3	SI/HR	-		
7		HR_SI_Sutla_3	20	SI/HR	-		
8	Bregana	HR_SI_Bregana	1	SI	1	HR	
9	Kupa/ Kolpa	HR_SI_Kupa_1	4	SI	-		
10		HR_SI_Kupa_2	5	SI	-		
11		HR_SI_Kupa_3	11	HR/SI	1	HR	

No.	River / AMI(i)		Cultural Assets		Landscape and Other		Not applicable
12		HR_BA_Glina	-				HR
13	Una	HR_BA_Una_1	4	HR	4	HR/BA	
14		HR_BA_Una_2	-				HR
15	Drina	BA_RS_Drina	-		2	BA	
16		ME_BA_Drina	2	BA			
17		ME_RS_Lim	1	ME			
18		RS_BA_Lim	3	RS			
19	Bosut	HR_RS_Bosut	12	HR/RS	1	RS	
TOTAL			**134**		**23**		
(i) River and/or subbasin with identified areas, shared by two or more countries, for which potential significant flood risk exists							

Table 12: Overview of potential adverse consequences on the cultural heritage across AMIs for the low probability scenario

No.	River / AMI(i)		Cultural Assets		Landscape and Other		Not applicable
1	Sava	SI_HR_Sava	8	SI/HR	-		
2		HR_BA_Sava	50	HR	5	BA	
3		HR_BA_RS_Sava	62	HR/BA/RS	9	BA	
4		RS_Sava	2	RS	-		
5	Sutla/ Sotla	HR_SI_Sutla_1	6	SI	-		
6		HR_SI_Sutla_2	3	SI/HR	-		
7		HR_SI_Sutla_3	23	SI/HR	3	HR	
8	Bregana	HR_SI_Bregana	3	SI	1	HR	
9	Kupa/ Kolpa	HR_SI_Kupa_1	4	SI	-		
10		HR_SI_Kupa_2	5	SI	-		
11		HR_SI_Kupa_3	12	HR/SI	1	HR	
12		HR_BA_Glina	-				HR
13	Una	HR_BA_Una_1	7	HR	6	HR/BA	
14		HR_BA_Una_2	-				HR
15	Drina	BA_RS_Drina	-		3	BA	
16		ME_BA_Drina	2	BA			
17		ME_RS_Lim	1	ME			
18		RS_BA_Lim	3	RS			
19	Bosut	HR_RS_Bosut	16	HR/RS	2	RS	
TOTAL			**207**		**30**		
(i) River and/or subbasin with identified areas, shared by two or more countries, for which potential significant flood risk exists							

4 WATER CONTROL STRUCTURES WITH POTENTIAL IMPACT TO THE FLOOD PROTECTION IN AMIs

Map showing the existing water (flood) control structures along the Sava River and its tributaries in AMIs can be reached through the interactive web app at Figure 15.

Figure 15: Illustration of the Water Control Structures map (Ctrl + Click to the Figure to open the web app)

Information on the existing reservoirs and retention areas in the Sava River basin that have a multi-purpose character including a certain role in flood protection, not only on rivers they are constructed on, but also on the entire downstream basin and AMIs, are also given in Table 13.

Table 13: Overview of large dams, reservoirs and retention areas relevant for flood protection in AMIs

Country	Sub-basin	River	Dam		Reservoir/Retention area	
			Name	Dam height (m)	Name	Volume (Mm^3)
Slovenia	Sava direct	Sava	Moste	60,00	Moste	6,03
			Mavčiče	40,00	Mavčiče	10,84
			Medvode	40,00	Medvode	2,92
			Vrhovo	27,00	Vrhovo	8,65
			Boštanj	7,47	Boštanj	8,00
			Arto-Blanca	9,29	Arto-Blanca	9,95
			Krško	9,14	Krško	6,31
			Brežice	36,50	Brežice	19,30
Slovenia/Croatia	Sutla	Sutla	Vonarje	19,00	Sutlansko jezero	12,40
Croatia	Sava direct	n/r			Odransko polje	297,00
					Žutica	87,00
					Lonjsko polje	790
					Opeka	67,00
					Zelenik	153,00
					Trstik	53,00
					Mokro polje	465

Country	Sub-basin	River	Dam		Reservoir/Retention area	
			Name	Dam height (m)	Name	Volume (Mm^3)
Bosnia and Herzegovina	Vrbas	Pliva/Vrbas	Jajce I	no dam	Plivsko jezero	23,00
		Vrbas	Jajce II/Barevo	26,00	Barevo	3,9
			Bočac	66,00	Bočac	52,70
			Bočac II	15,00	Bočac II	2,31
	Bosna	Spreča	Modrac	28,00	Jezero Modrac	102,93
	Tinja		Hazna	-	Hazna	0,72
			Vidara	-	Vidara	3,23
	Drina	Drina	Višegrad	79,50	Višegradsko jez.	161,00
Serbia	Drina	Drina	Bajina Bašta	90,50	Jezero Perućac	340,00
		Lim	Potpeć	46,00	Potpećko jezero	27,50
		Uvac	Uvac	110,00	Sjeničko jezero	200,00
		Uvac	Radoinja/Bistrica	42,00	Radoinja	7,60
		Uvac	Kokin Brod	82,00	Zlatarsko jezero	250,00
		Drina	Zvornik	42,00	Zvornik	47,40
Montenegro	Drina	Piva	Piva	220,00	Mratinje	880,00
		Ćehotina	Otilovići	59,00	Otilovići	18,00

5 CONCLUSIONS

- The Flood Hazard and Risk Maps in the Sava River Basin – Update 2024 is prepared in accordance with the Protocol on Flood Protection to the Framework Agreement on the Sava River Basin and the EU Floods Directive and based on the national planning documents of the Parties to the FASRB (Slovenia, Croatia, Bosnia and Herzegovina, and Serbia) and Montenegro.

- For the purpose of preparation of the Sava Flood Maps update 2024, the countries have exchanged/updated all relevant data and information through a common data sharing platform - Sava GIS.
  It was the first time that countries exchanged the flood maps related GIS datasets through ISRBC as stipulated by Article 7.2 of the Protocol which requires that *each country shall, through the ISRBC, inform other countries on the flood maps prepared for its territory*, as well as by Article 6.2 of the EU FD which requires that *the preparation of flood hazard maps and flood risk maps for areas identified under Article 5 (APSFR) which are shared with other countries should be subject to prior exchange of information between the country concerned*.

- The amount of exchanged information has improved in the second cycle of the flood risk management planning at the Sava River Basin level; however, quality and consistency of information still should be enhanced.

- In addition to a review and update of information on methodologies and criteria used by the countries, the Sava Flood Maps update 2024 provides an overview of flood maps designated in AMIs, i.e. APSFRs shared by two or more countries.

- The flood hazard maps include total surface of hazard area in AMIs for the medium probability scenario of 4.596,6 km^2, meaning 48,7 km^2 in Slovenia, 423,3 km^2 in Croatia, 1.053,0 km^2 in Bosnia and Herzegovina, 3.069,0 km^2 in Serbia and 2,7 km^2 in Montenegro, while total surface for the low probability scenario is 5.934,6 km^2, respectively 55,7 km^2 in Slovenia, 1.285,3 km^2 in Croatia, 1.073,7 km^2 in Bosnia and Herzegovina, 3.517,0 km^2 in Serbia and 2,9 km^2 in Montenegro.

  In these areas the fluvial/river floods that are most frequently registered as a source of significant flooding. The most common mechanism of floods happening in AMIs are defence exceedance and defence or infrastructural failure and the most common characteristic is medium onset and other rapid onset flooding.

- The flood risk maps include the potential adverse consequences in AMIs on human health, economic activity, environment (including affected waterbodies, installations, pollution sources and effects on protected areas) as well as cultural heritage.

  The medium probability scenario includes the following potential adverse consequences in AMIs:
  - inhabitants affected: 591.268 inhabitants
  - economy affected: 424 different economic activity types (28 economic activities, 62 infrastructure facilities, 197 property, 137 rural land use)

- environment affected:
  - *number of surface water bodies which ecological status could be endangered*
    - high status/maximum potential: 1
    - good status: 27
    - moderate status/potential: 40
    - poor status/potential: 21
    - bad status/potential: 10
    - unknown status/potential: 11
  - *number of surface water bodies which chemical status could be endangered:*
    - good status: 66
    - failing to achieve good status: 15
    - unknown status: 29
  - *number of surface water bodies with hydro-morphological alterations that could be endangered:*
    - near natural: 42
    - slightly modified: 16
    - moderately modified: 30
    - extensively modified: 13
    - severely modified: 1
    - no information: 8
  - *number of ground water bodies which chemical status could be endangered:*
    - good status: 36
    - failing to achieve good status: 8
    - unknown status: 11
  - *number of protected areas which could be endangered, per legislation:*
    - EU WFD (art. 7, abstraction for drinking water): 26
    - EU Birds Directive: 8
    - EU Habitats Directive: 42
    - National legislation: 1
    - Other legislation: 15
  - *number of pollution sources which could be endangered:*
    - collecting system without UWW treatment: 39
    - operating UWW treatment: 7
    - significant industrial pollution sources: 20
- cultural heritage affected:
  - archaeological heritage: 30
  - secular architectural heritage: 36
  - sacral architectural heritage: 2
  - sacral-secular architectural heritage: 13
  - memorial heritage: 42
  - garden architectural heritage: 2
  - urban heritage: 16
  - cultural landscape: 2
  - other cultural heritage: 22

- The Sava Flood Maps update 2024 will represent a basis for the Sava FRMP update 2026, as a framework for identification of non-structural and national structural measures that may contribute to achieving flood risk management objectives of the common interest, taking into consideration that the national maps and planning documents will be the main input. More comprehensive conclusions on the Sava Flood Maps will be analysed and elaborated within development of the Sava FRMP update 2026.

APPENDICES

ANNEX 1: LIST OF THE AREAS OF MUTUAL INTEREST FOR FLOOD PROTECTION

No.	River / AMI[i]		AMI surface		Country	Share of potential flood areas in the AMI	
			km²	% of basin		km²	%
1	Sava	SI_HR_Sava	18,87	0,019%	Slovenia	8,54	45%
					Croatia	10,33	55%
2		HR_BA_Sava	1635,72	1,674%	Croatia	909,48	56%
					Bosnia and Herzegovina	726,24	44%
3		HR_BA_RS_Sava	1624,14	1,662%	Croatia	31,14	2%
					Bosnia and Herzegovina	166,09	10%
					Serbia	1426,91	88%
4		RS_Sava	155,06	0,159%	Serbia	155,06	100%
5	Sutla/ Sotla	HR_SI_Sutla_1 [ii]	10,60	0,095%	Slovenia	53,88	58%
					Croatia	38,62	42%
6		HR_SI_Sutla_2 [ii]	15,30	0,095%	Slovenia	53,88	58%
					Croatia	38,62	42%
7		HR_SI_Sutla_3 [ii]	66,32	0,095%	Slovenia	53,88	58%
					Croatia	38,62	42%
8	Bregana	HR_SI_Bregana [ii]	9,13	0,009%	Slovenia	2,05	22%
					Croatia	7,08	78%
9	Kupa/ Kolpa	HR_SI_Kupa_1 [ii]	9,04	0,009%	Slovenia	4,77	53%
					Croatia	4,27	47%
10		HR_SI_Kupa_2 [ii]	37,12	0,038%	Slovenia	14,96	40%
					Croatia	22,16	60%
11		HR_SI_Kupa_3 [ii]	111,37	0,114%	Slovenia	44,71	40%
					Croatia	66,66	60%
12		HR_BA_Glina [iii]	79,57	0,081%	Croatia	69,51	87%
					Bosnia and Herzegovina	10,06	13%
13	Una	HR_BA_Una_1	220,59	0,226%	Croatia	157,52	71%
					Bosnia and Herzegovina	63,06	29%
14		HR_BA_Una_2 [iii]	23,47	0,024%	Croatia	21,67	92%
					Bosnia and Herzegovina	1,80	8%
15	Drina	BA_RS_Drina	954,66	0,977%	Bosnia and Herzegovina	115,00	12%
					Serbia	839,66	88%
16		ME_BA_Drina	6,02	0,006%	Montenegro	-	-
					Bosnia and Herzegovina	6,02	100%
17		ME_RS_Lim	2,5	0,003%	Montenegro	2,5	100%
					Serbia	-	-
18		RS_BA_Lim	17,79	0,018%	Serbia	7,07	40%
					Bosnia and Herzegovina	10,72	60%
19	Bosut	HR_RS_Bosut	736,97	0,754%	Croatia	355,47	48%
					Serbia	381,50	52%
TOTAL			**5.734,5**	**6%**		**5.734,5**	

(i) River and/or subbasin with identified areas, shared by two or more countries, for which potential significant flood risk exists
(ii) For area in Slovenia complete settlement surface used, since the national APSFRs not defined
(iii) For area in Bosnia and Herzegovina an indicative flooding area is included, since the national APSFRs not defined

ANNEX 2: WORK PLAN FOR THE 2ND FLOOD RISK MANAGEMENT PLANNING CYCLE

Activities at the country level

Protocol article	EU FD article	Task	Country / Entity		Initial		Review and Update		Review and Update		Responsibility
6	4, 5	Preliminary Flood Risk Assessment (and APSFR)	Slovenia		22 Dec 2011	✓	Jun 2019	✓	22 Dec 2024	underway	Competent Authorities of the FASRB Parties and Montenegro
			Croatia		22 Dec 2011	✓	22 Dec 2018	✓	22 Dec 2024	underway	
			Bosnia and Herzegovina	FBiH RS BD	2013 2015 n/a	✓ ✓ n/a	2026	planned			
			Serbia		2019	✓	2026	planned			
			Montenegro		2021	✓	2026	planned			
7	6	Flood maps	Slovenia		22 Dec 2013	✓	22 Dec 2019	✓	22 Dec 2025	planned	
			Croatia		22 Dec 2013	✓	22 Dec 2019	✓	22 Dec 2025	planned	
			Bosnia and Herzegovina	FBiH RS BD	2020 2020 2020	✓ ✓ ✓	2028	planned			
			Serbia		2020	✓	2028	planned			
			Montenegro		2022	✓	2029	planned			
8	7	Flood Risk Management Plan	Slovenia		22 Dec 2015		Sep 2022	✓	22 Dec 2027	planned	
			Croatia		22 Dec 2015		22 Dec 2021	✓	22 Dec 2027	planned	
			Bosnia and Herzegovina	FBiH RS BD	2023 2026 2023	✓ planned ✓	2030	planned			
			Serbia		2023	✓	2030	planned			
			Montenegro		2023	✓	2030	planned			

Activities at the Sava River Basin level (by the Protocol on Flood Protection)

Protocol article	EFD article	Subject	Outcome	Task	Status	Responsibility
6	4, 5	Preliminary Flood Risk Assessment	Update of the Report	Undertaking the national PFRA and APSFR identification	✓	Competent Authorities of the FASRB Parties and Montenegro
				Collection of the national PFRA and APSFR data through Sava GIS	✓	ISRBC Secretariat PEG FP PEG GIS
				Harmonisation of the shared APSFRs and identification of AMIs	✓	ISRBC Secretariat PEG FP
7	6	Flood maps	Update of flood hazard and risk maps	Preparation of national flood maps	✓	Competent Authorities of the FASRB Parties and Montenegro
				Collection of national flood maps for 2 scenarios (probability: medium and low/extreme event scenario) through Sava GIS	✓	ISRBC Secretariat PEG FP PEG GIS
				Informing other countries on national flood maps and preparation of a common maps at the AMIs level based on the national maps Note: Flood maps included a common presentation of flood hazards and risks within AMIs based on the simplified methodology.	✓	ISRBC Secretariat PEG FP
8	7	Flood Risk Management Plan	Update of the Plan	Review of changes and updates of the previous version of FRMP; an assessment of the progress made towards the achievement of the common objectives; a description of, and an explanation for, any measures foreseen in the previous version of FRMP which were planned to be undertaken and have not been taken forward; a description of any additional measures	(Q4 2024 – Q4 2026)	ISRBC Secretariat PEG FP
	n/a			Review of mechanisms of coordination on the basin-wide level, mode of joint cooperation in flood defence emergency situations		
11	n/a			Review of actions and activities related to the assistance of other countries in case of flood defence emergency situations		Competent Authorities of the FASRB Parties and Montenegro

ANNEX 3: INTERNET LINKS TOWARDS NATIONAL METHODOLOGIES AND THE FLOOD MAPS

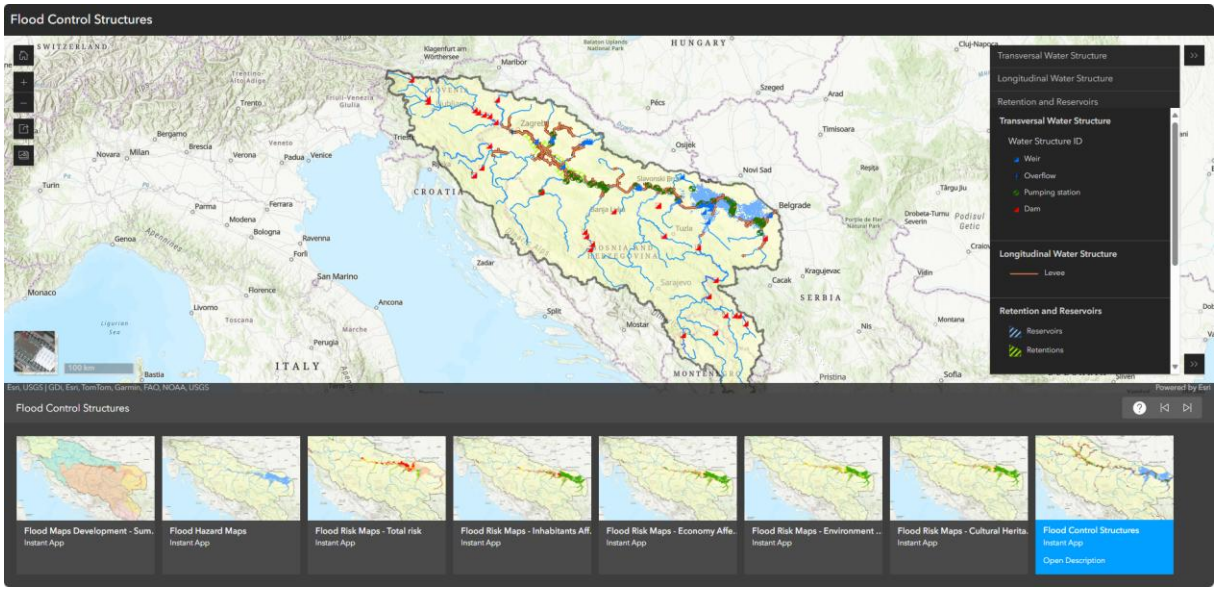
Slovenia	**Report:** https://www.gov.si/assets/ministrstva/MNVP/Dokumenti/Voda/NZPO/Posodobitev_in_izdelava_kart_poplavne_nevarnosti_in_ogrozenosti.pdf **Maps:** • Flood Hazard maps: https://www.gov.si/teme/karte-poplavne-nevarnosti-in-karte-poplavne-ogrozenosti-za-obmocja-pomembnega-vpliva-poplav/#e87290 • Flood Risk maps: https://www.gov.si/teme/karte-poplavne-nevarnosti-in-karte-poplavne-ogrozenosti-za-obmocja-pomembnega-vpliva-poplav/#e87485
Croatia	**Report:** https://voda.hr/sites/default/files/dokumenti/upravljanje-vodama/karte_opasnosti_od_poplava_i_karte_rizika_od_poplava_-_2019.pdf **Maps:** • Flood Hazard maps: - Medium probability https://preglednik.voda.hr/?lang=hr&topic=Opasnosti%20od%20poplava&bgLayer=hr.raster.tk-crno-bijeli&layers=hr.karta-opasnosti-od-poplava-srednja-vjerojatnost_2019&catalogNodes=1275 - Low probability https://preglednik.voda.hr/?lang=hr&topic=Opasnosti%20od%20poplava&bgLayer=hr.raster.tk-crno-bijeli&layers=hr.karta-opasnosti-od-poplava-mala-vjerojatnost_2019&catalogNodes=1275 • Flood Risk maps: - Medium probability https://preglednik.voda.hr/?topic=Rizici%20od%20poplava&bgLayer=hr.raster.tk-crno-bijeli&layers=hr.karta-rizika-od-poplava-srednja-vjerojatnost_2020&lang=hr&catalogNodes=1283 - Low probability https://preglednik.voda.hr/?topic=Rizici%20od%20poplava&bgLayer=hr.raster.tk-crno-bijeli&layers=hr.karta-rizika-od-poplava-mala-vjerojatnost_2020&lang=hr&catalogNodes=1283
Bosnia and Herzegovina	**Report:** https://www.voda.ba/uploads/docs/Izvjestaj20za20Mape20opasnosti20od20poplava.zip https://www.voda.ba/uploads/docs/Izvjestaj20za20Mape20rizika20od20poplava.zip **Maps:** • Flood Hazard maps: https://avpsava.maps.arcgis.com/apps/View/index.html?appid=2c56327132ee4f72b13fb7394adf2331 https://rvisportal.voders.org/RBM_FRM_ETW/GIS_FRM/ • Flood Risk maps: https://avpsava.maps.arcgis.com/apps/View/index.html?appid=c39813c7433944168c7c76339286f758 https://rvisportal.voders.org/RBM_FRM_ETW/GIS_FRM/
Serbia	**Report:** https://www.rdvode.gov.rs/lat/uredjenje-vodotoka.php **Maps:** • Flood Hazard and Risk maps: https://www.srbijavode.rs/karte-ugrozenosti-i-karte-rizika-od-poplava.html#
Montenegro	**Report:** Not publicly available **Maps:** Not publicly available

ANNEX 4: INTERNET LINKS TOWARDS THE FLOOD MAPS IN THE AREAS OF MUTUAL INTEREST

Atlas 2019:
https://www.savacommission.org/UserDocsImages/05_documents_publications/water_management/eng/SavaFRMPlan/sfrmp_atlas.pdf?vel=41036633

Atlas 2024:

https://portal.savacommission.org/arcgis/apps/instant/portfolio/index.html?appid=2325999a9c50460a8b22d7a726c97fbc



International Sava River Basin Commission
Kneza Branimira 29/11
10000 Zagreb, Croatia
+385 1 4886960
isrbc@savacommission.org