

INTERNATIONAL SAVA RIVER BASIN COMMISSION

Lessons learned on monitoring, assessment and data exchange in Sava Basin



Implemented by:
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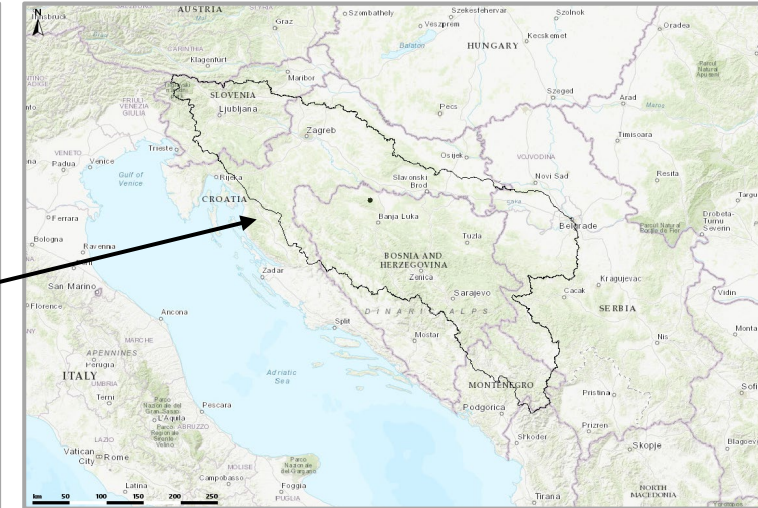
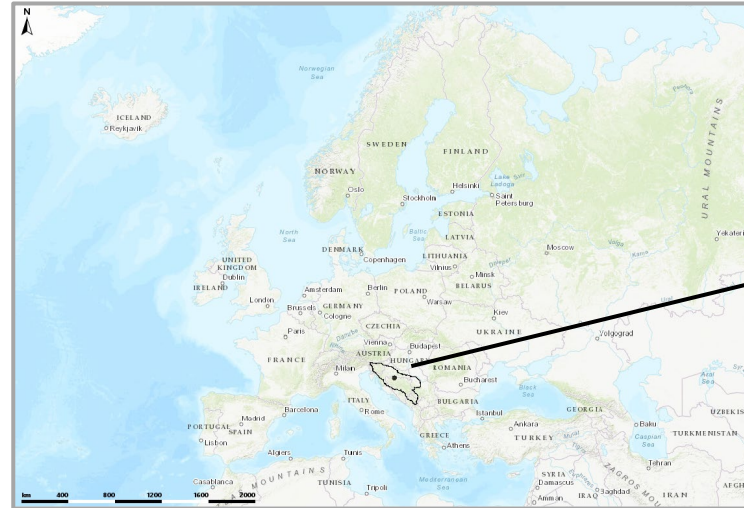
**Regional Workshop on Monitoring, Assessment and Information Sharing
in Transboundary Basins in Central Asia**







1-2 February 2023

Astana, Kazakhstan

Sava River Basin

- ❖ **Area:** 97 713 km² (the second largest Danube sub-basin; share: 12%)
- ❖ **Average flow** at the mouth: 1722 m³/s (the largest Danube tributary)
- ❖ **River length:** 940 km (594 km of which is the waterway)
- ❖ **Population:** approx. 9 million



Country		Share of the basin (%)	Share of the territory (%)
Bosnia and Herzegovina		39.2	75.8
Croatia		26.0	45.2
Serbia		15.5	17.4
Slovenia		12.0	52.8
Montenegro		7.1	49.6
Albania		0.2	0.6

Sava spring - Slovenia



Sava mouth - Serbia



[FASRB \(savacommission.org\)](http://savacommission.org)

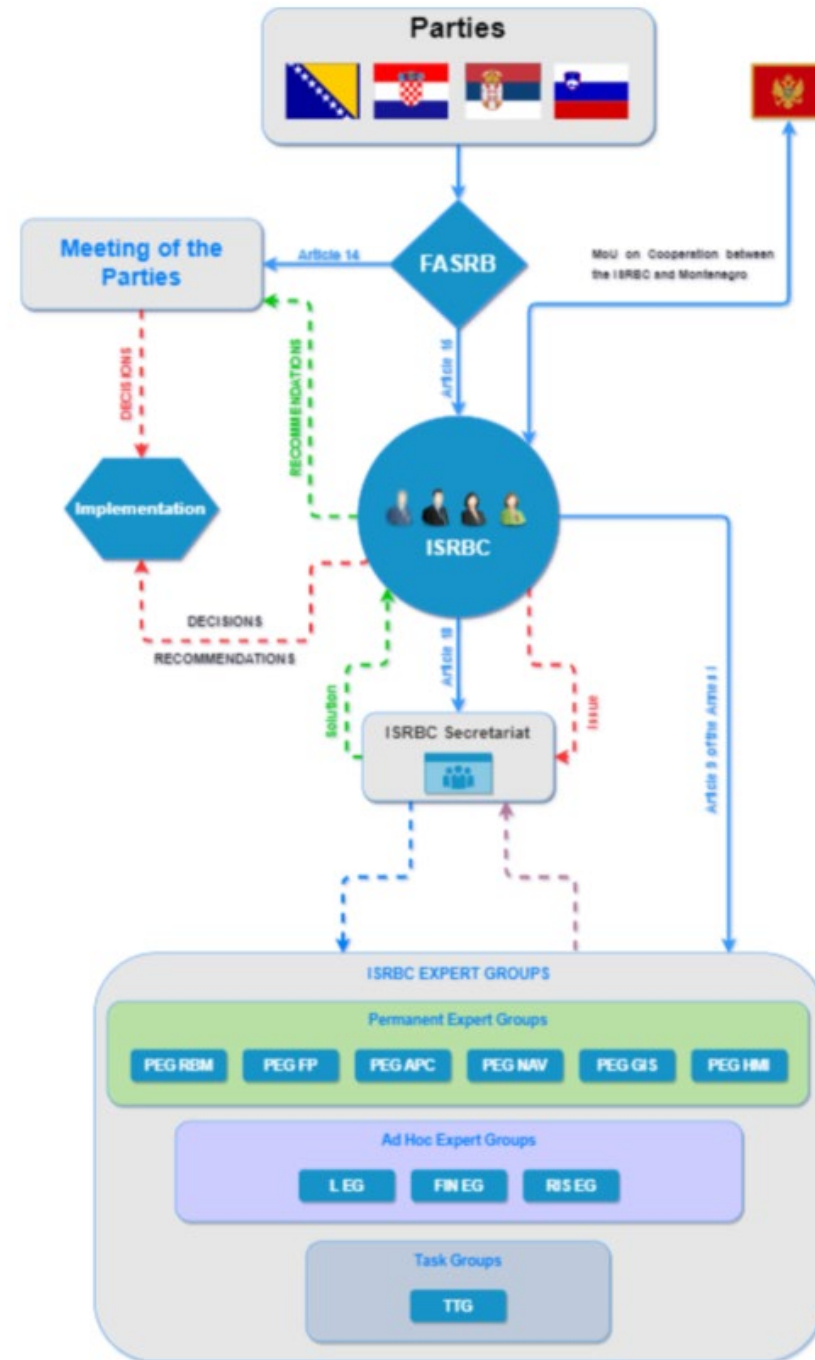
Background of cooperation

Framework Agreement on the Sava River Basin - FASRB

- ❖ **First development-oriented multilateral agreement in the region** (signed in 2002)
- ❖ **Parties:**
 - **Bosnia & Herzegovina**
 - **Croatia**
 - **Serbia**
 - **Slovenia**
 - (Montenegro – cooperation on technical level until full membership)
- ❖ **Implementation coordinated by ISRBC** (Secretariat – executive and administrative body of ISRBC)
 - Established in 2005 (Secretariat: in 2006, seated in Croatia)
 - Established for implementation of the Framework Agreement on the Sava River Basin
- ❖ **Key objective:** **Sustainable development** of the region through **transboundary water cooperation**
- ❖ **Particular objectives – to establish:**
 - International regime of **navigation**
 - Sustainable **water management**
 - Sustainable **management of hazards** (floods, droughts, accidents involving water pollution, etc.)

Framework Agreement on the Sava River Basin – FASRB

Structure and functioning



ISRBC Scope of cooperation



Management plans (river basin, flood risk, sediment, climate change adaptation)

Integrated systems (information, forecasting, warning)

Economic activities (navigation, river tourism)

Harmonization of **regulation** (national → EU)

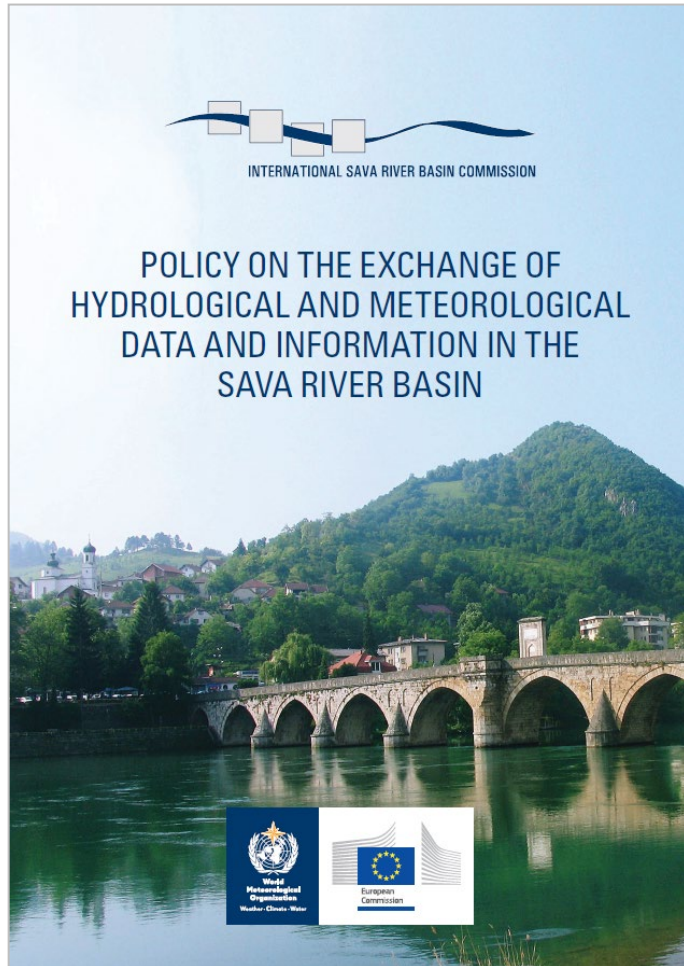
Protocols to the FASRB

One of the general principles of the FASRB cooperation

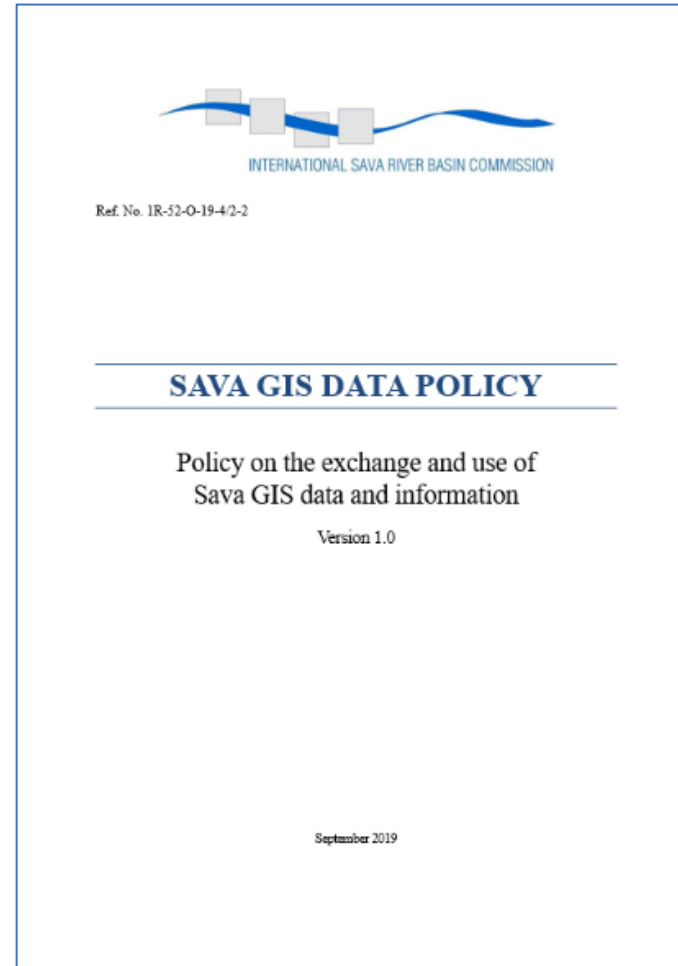
Exchange of data and information:

the Parties shall, **on a regular basis, exchange information on the water regime of the Sava River Basin, the regime of navigation,** legislation, organizational structures, and administrative and technical practices

Data Exchange Policies



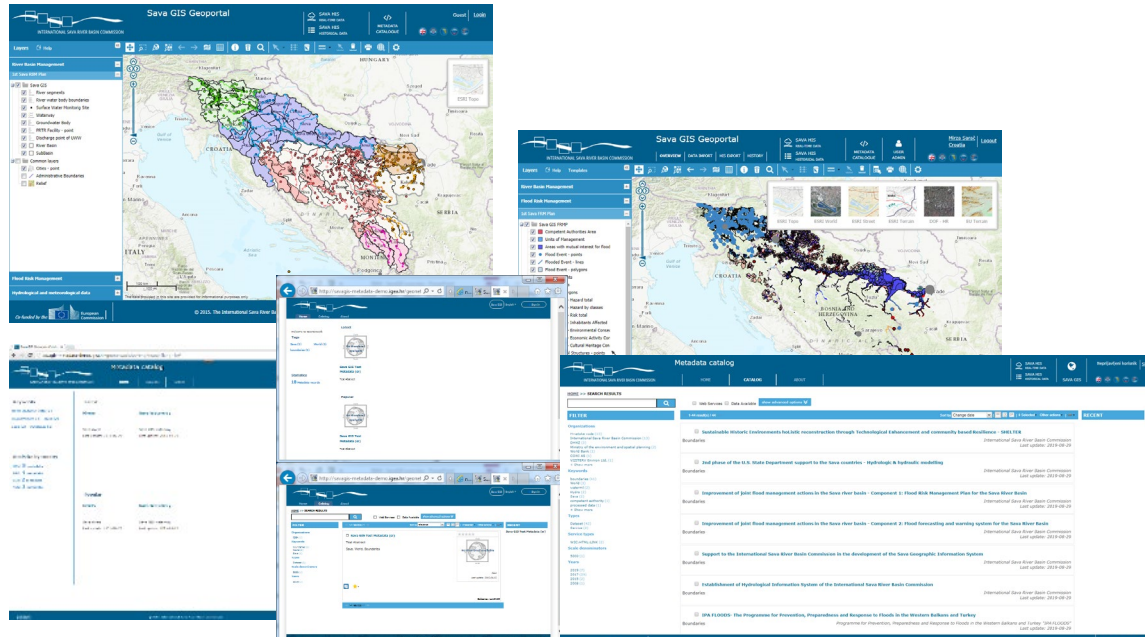
[HM data exchange policy \(savacommission.org\)](http://savacommission.org)



[GIS data exchange policy \(savacommission.org\)](http://savacommission.org)

- ❖ Principles (organizations, monitoring locations, data to be exchanged)
- ❖ Routes (procedures, timetable, quality standards, use and redistribution, ownership, charging, future harmonization)
- ❖ Organizations (data providers/receivers)
 - Hydro-meteorological services
 - Water / environment agencies
 - Hydropower companies (still pending)
- ❖ International legal framework
 - FASRB
 - Protocol on Flood Protection to FASRB
 - WMO Resolutions (25/Cg-XIII and 40/Cg-XII)
 - EU Directives (INSPIRE, Water, Floods)
 - Danube River Protection Convention
 - ISRBC's Data Exchange Policy
- ❖ National legal framework

Geographical Information System of the Sava River Basin – Sava GIS



Sava Geoportal www.savagis.org

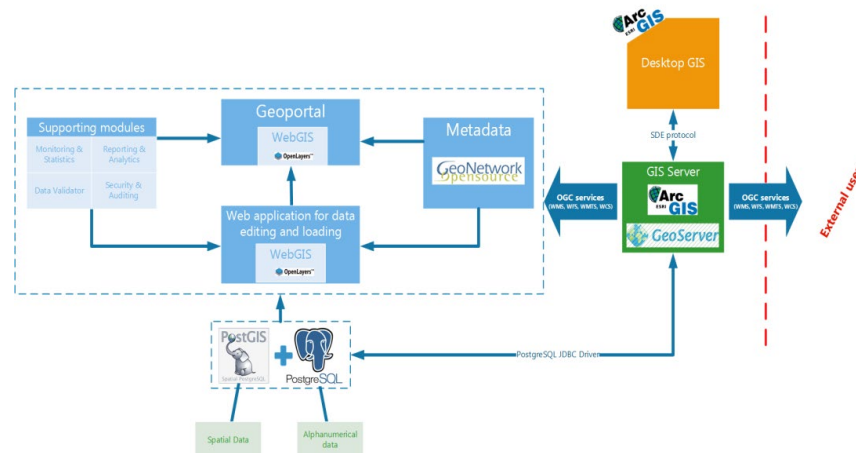
Public users:

- ❖ Overview of public spatial data
- ❖ Viewing attributes and features
- ❖ Filtering by attributes or spatial data
- ❖ Exporting areas of map to different format
- ❖ ...

Registered users

- ❖ Data upload & download (relevant authorities and institutions)

Sava Metadata Catalogue www.savagis.org/metadatalogue



Access to data via WMS/WFS services:
<http://savagis.org/wms>
<http://savagis.org/wfs>

Hydrological Information System of the Sava River Basin – Sava HIS



CUAHSI

Consortium of Universities for the Advancement of Hydrologic Science, Inc.

1. Standards

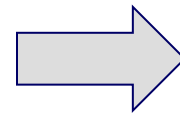
- WaterML language for describing water data

2. Services

- Catalog of water data sources – web services

3. End user applications

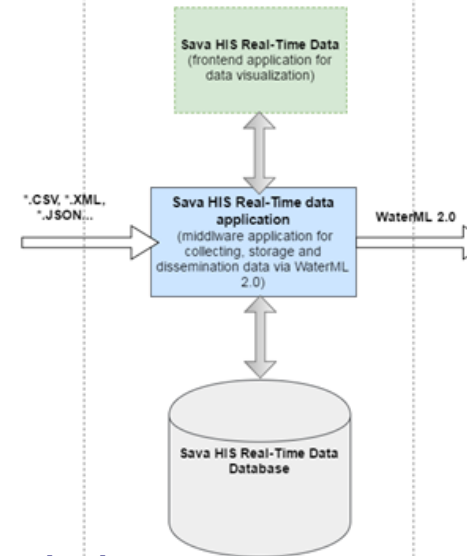
- Web apps and software for data access



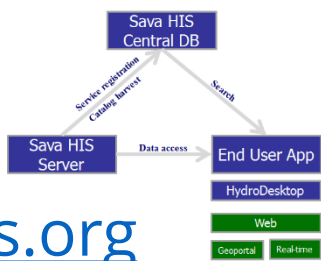
Data providers

- ARSO
- DHMZ
- RHMZRS
- AVPSAVA
- FHMZ
- RHMZ
- ZHMS

Sava HIS Real-Time Data System

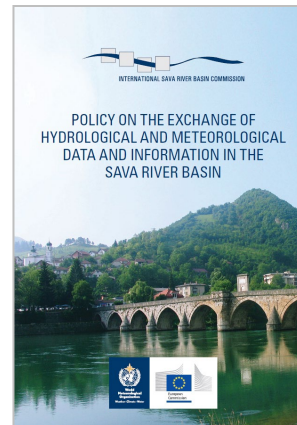
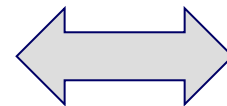


Sava HIS hydrological and meteorological data users



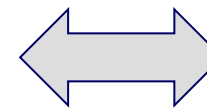
Database

- Historical HM data
- Real time HM data

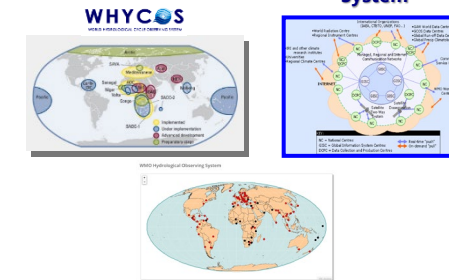


Standards

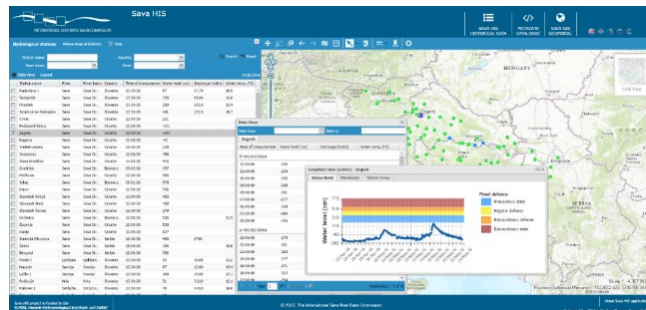
- INSPIRE
- WMO resolutions
- WaterML 2.0



WIS – WMO Information System



www.savahis.org



Hydrological Information System of the Sava River Basin – Sava HIS

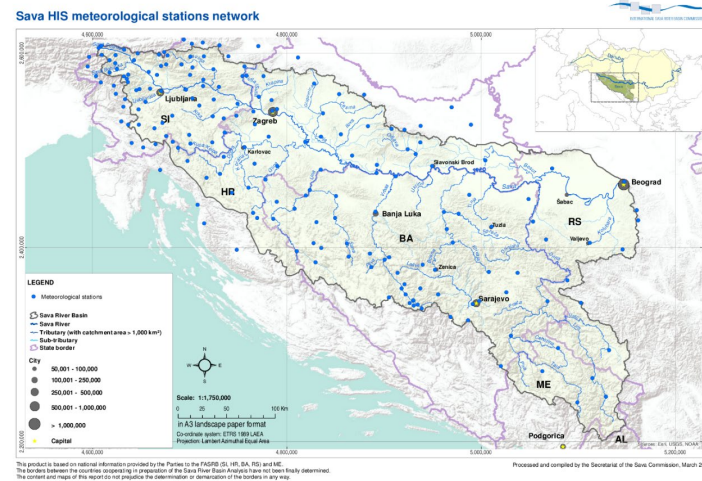
By Data Policy (2014)

❖ 93 **hydrological** stations

Sava HIS (2023)

Hydrological Stations	BA	HR	ME	RS	SI	Total
	108	131	11	28	32	310

Parameter	Temporal Resolution
River, Lake or Reservoir Level/Stage	Daily (Mean) Hourly
River Discharge	Daily (Mean) Hourly
Water Temperature	Daily (Mean)
Suspended Sediment Discharge	Daily (Mean) Hourly (Turbidity)
Ice Condition	Daily



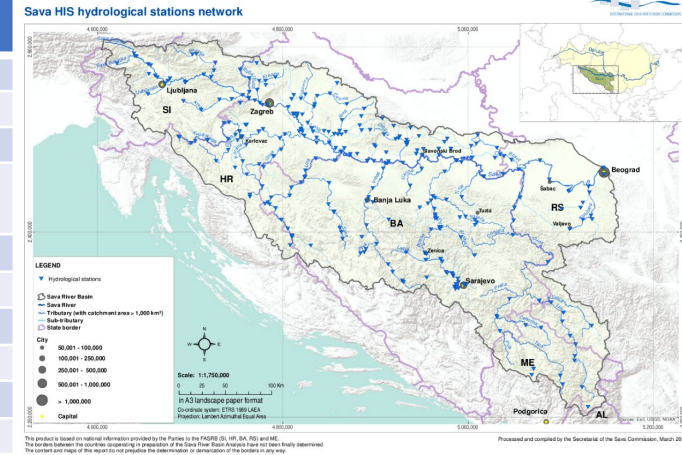
By Data Policy (2014)

❖ 53 **meteorological** stations

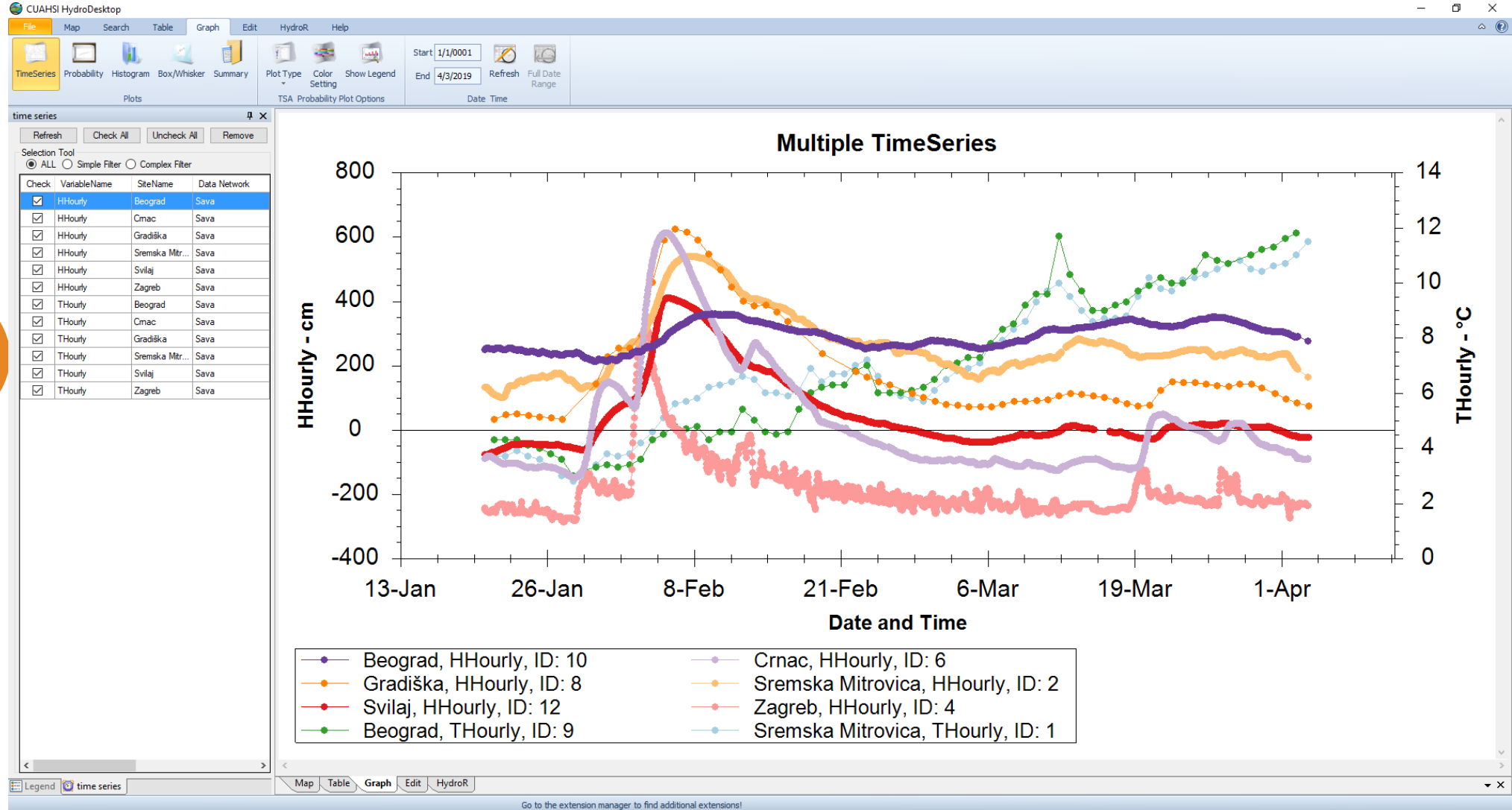
Sava HIS (2023)

Meteorological Stations	BA	HR	ME	RS	SI	Total
	78	49	5	12	76	220

Parameter	Temporal Resolution
Precipitation	Annual (Total)
	Monthly (Total)
	Daily (Total)
	6/12 Hourly (Total)
	Hourly (Total)
Air Temperature	Daily (Mean)
Relative Humidity	Hourly
Wind (Speed and Direction)	Daily Hourly
Snow Depth	Daily
Evaporation	Daily (Total)
Solar Radiation	Daily
Sunshine	Daily (Total)
Atmospheric Pressure	Daily



Hydrological Information System of the Sava River Basin – Sava HIS



Hydrological Information System of the Sava River Basin – Sava HIS

sava.dss - HEC-DSSVue DSS-7 Developmental Version

File Edit View Display Groups Data Entry Tools Collections Advanced Help

File Name: C:\Users\ISRBC Secretariat\Desktop\sava.dss

Pathnames Shown: 6 Pathnames Selected: 6 Pathnames in File: 21 File Size: 164 KB File Version: 7-CM Library Version: 7-CM Library Date: 13 December 2016 x64

sava.dss x

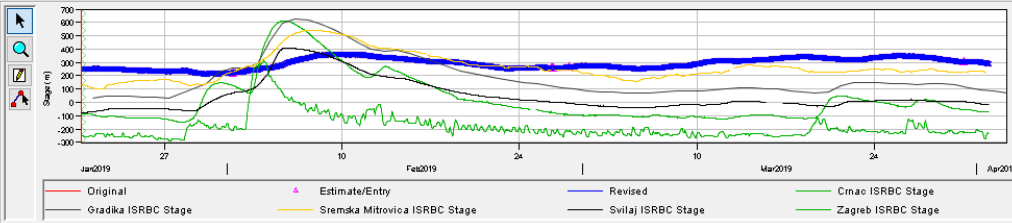
Search A: C: E: By Parts: B: D: F:

Number	Part A	Part B	Part C	Part D / range	Part E	Part F
1	Sava	Beograd	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC
2	Sava	Crnac	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC
3	Sava	Gradika	Stage	01Jan2019	R-Year	ISRBC
4	Sava	Sremska Mitrovica	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC
5	Sava	Svilaj	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC
6	Sava	Zagreb	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC

Graphical Editor

File Edit View Help

Selected Data Set: /Sava/Beograd/Stage/01Jan2019/1Hour/ISRBC/



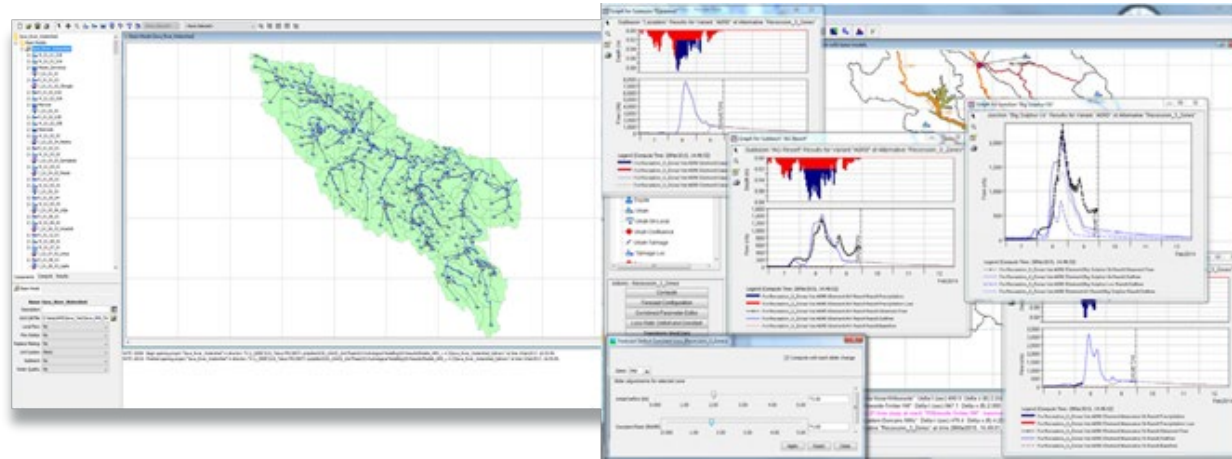
Date/Time (%G)	Original Stage (m)	Estimate/Entry Stage (m)	Revised Stage (m)
20Jan2019, 11:00	249.00		249.00
20Jan2019, 12:00	250.00		250.00
20Jan2019, 13:00	252.00		252.00
20Jan2019, 14:00	253.00		253.00
20Jan2019, 15:00	253.00		253.00
20Jan2019, 16:00	253.00		253.00
20Jan2019, 17:00	253.00		253.00
20Jan2019, 18:00	253.00		253.00
20Jan2019, 19:00	253.00		253.00
20Jan2019, 20:00	253.00		253.00
20Jan2019, 21:00	252.00		252.00

Buttons: Estimate, Estimate Missing, Estimate All, Accept, Accept All, Add Data, Delete Data

Select De-Select Clear Selections Restore Selections Set Time Window

No time window set.

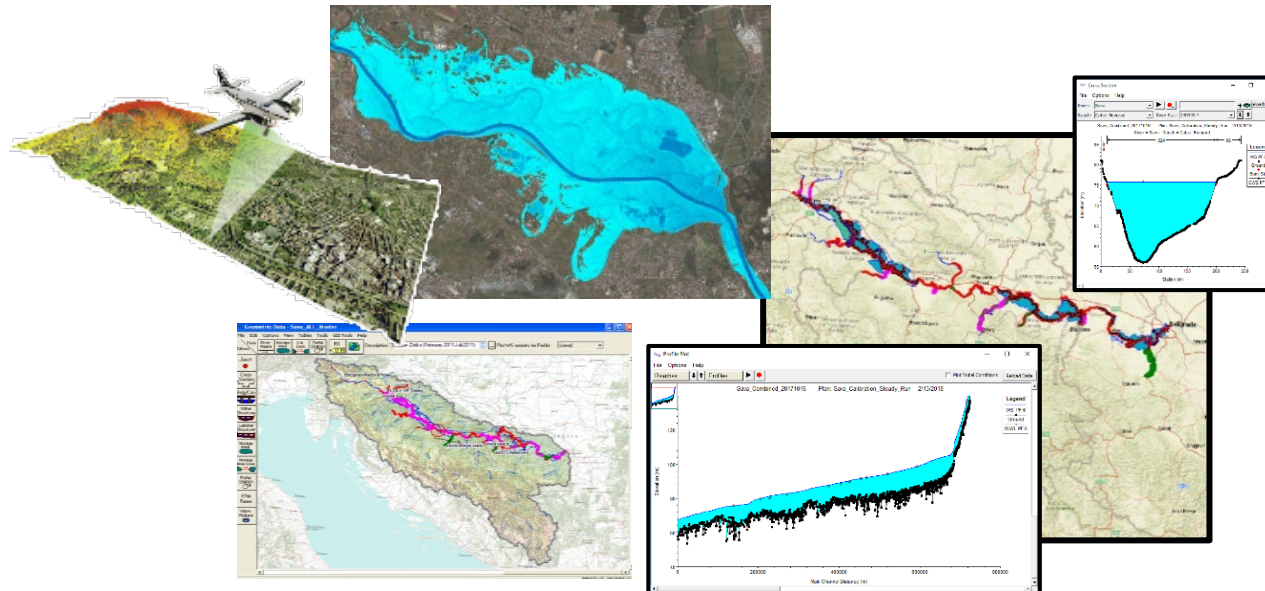
Hydrological and hydraulic modelling



Hydrologic model (HEC-HMS)

of the Sava River Basin (2010, 2014, 2016, 2021)

- ❖ 19 integrated models
- ❖ 235 subbasins
- ❖ 174 junctions
- ❖ 22 dams locations for the reservoirs analysis
- ❖ calibrated (as event-based) and re-calibrated (for long-term simulations)

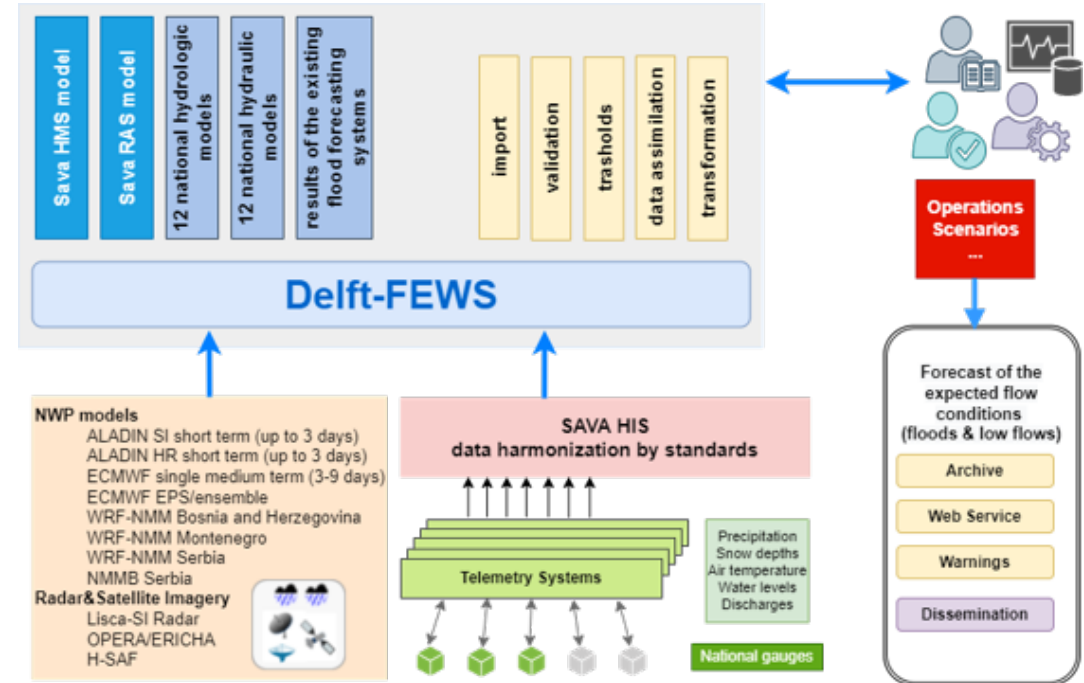
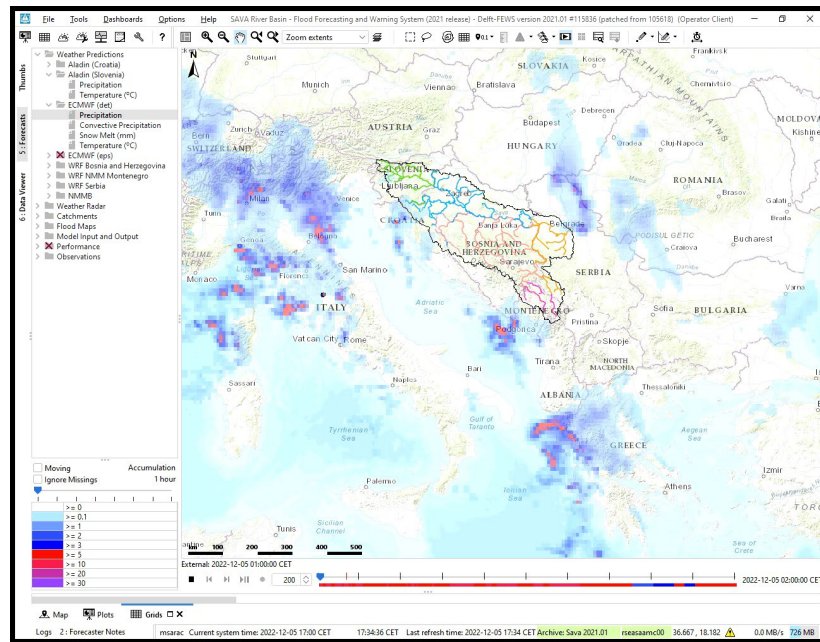
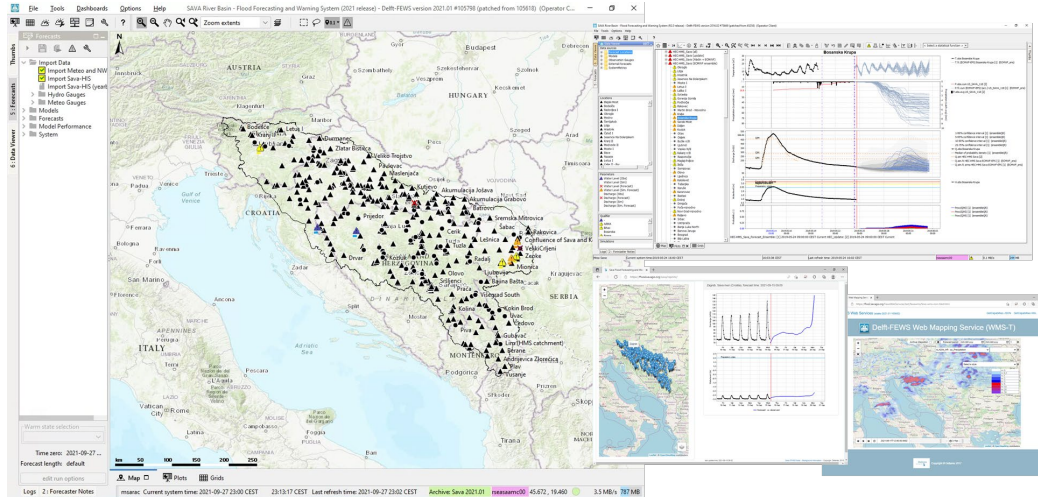


Hydraulic model (HEC-RAS)

of the Sava River (2012, 2018, 2022)

- ❖ Accurate terrain model (LiDAR)
- ❖ 1D/2D simulation possibilities
- ❖ Levee breach analysis

Flood Forecasting and Warning System in the Sava River Basin - Sava FFWS



System operational since 2018

- ❖ 10 users – responsible national forecasting organizations
- ❖ the system assessed as a versatile forecasting system and unique in the region and example for the rest of the world
- ❖ mature base for possible future extensions

Flood Forecasting and Warning System in the Sava River Basin - Sava FFWS

[MoU on SavaFFWS \(savacommission.org\)](http://savacommission.org)

MEMORANDUM OF UNDERSTANDING
ON COOPERATION CONCERNING REGULAR FUNCTIONING AND MAINTENANCE OF THE FLOOD FORECASTING AND WARNING SYSTEM IN THE SAVA RIVER BASIN

Whereas
Protocol on Flood Protection to the Framework Agreement on the Sava River Basin (hereinafter: the Protocol), signed in Gradiška on June 1, 2010, set up the obligation of Bosnia and Herzegovina, the Republic of Croatia, the Republic of Serbia and the Republic of Slovenia (hereinafter: the Parties) to establish a coordinated or joint Flood Forecasting, Warning and Alarm System in the Sava River Basin in coordination by the International Sava River Basin Commission (hereinafter: the Sava Commission),

The Parties fulfilled the obligation to establish the Flood Forecasting and Warning System in the Sava River Basin (hereinafter: the System), in accordance with Article 9, paragraphs 1, 2 and 3 of the Protocol, supported by the Project "Improvement of Joint Actions in Flood Management in the Sava River Basin", Component 2 - Flood forecasting and warning system for the Sava River Basin (hereinafter: the Project),

Montenegro, being non-party to the Protocol, took part in the System establishment on the basis of the Memorandum of Understanding on cooperation between the International Sava River Basin Commission and Montenegro, signed in Belgrade on 9 December 2013, and as a beneficiary of the Project,

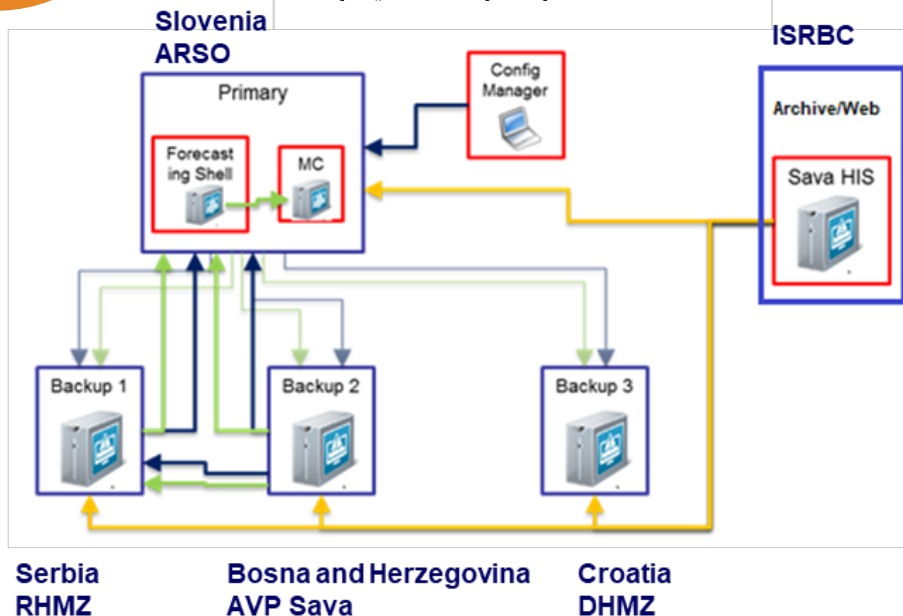
Pursuant to Article 9, paragraph 4 of the Protocol, the Parties undertook the obligation to ensure regular maintenance and performance control of the System, as well as regular training of the engaged personnel, with application of joint standards,

In order to fulfil the above obligation, it is required to establish an effective joint operation and maintenance structure and procedures,

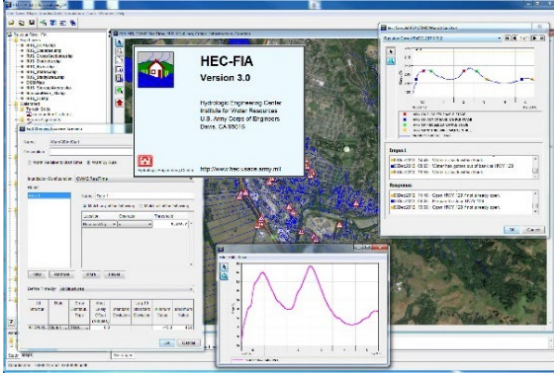
Therefore
Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry of Environment and Energy of the Republic of Croatia, Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, Ministry of the Environment and Spatial Planning of the Republic of Slovenia, Ministry of Agriculture and Rural Development of Montenegro (hereinafter: Signatories from the countries) and Sava Commission (hereinafter jointly: the Signatories), have reached the following understanding:

Memorandum of Understanding on cooperation on regular functioning and maintenance of Sava FFWS Signed and entered into force on July 1, 2020

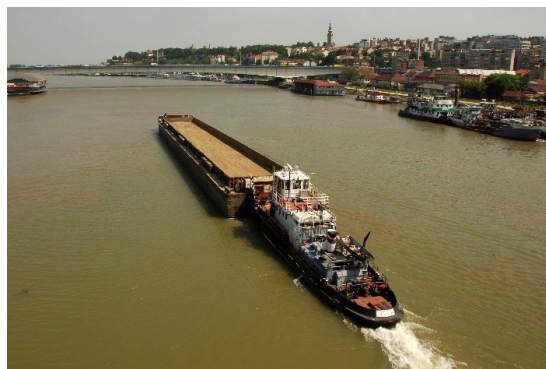
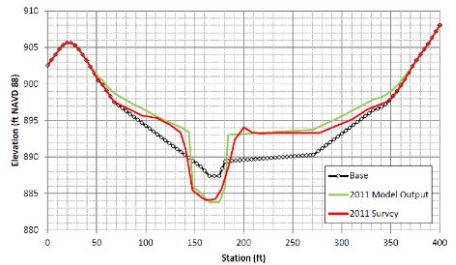
- ❖ Joint hosting and maintenance
- ❖ Using and forecasting (with individual warnings per countries)
- ❖ Further developments
- ❖ Evaluation and assessment of the work performed (technical and decision-making bodies established)
- ❖ Joint financing (by contribution of the countries on equal basis)
- ❖ Regular training of the engaged personnel



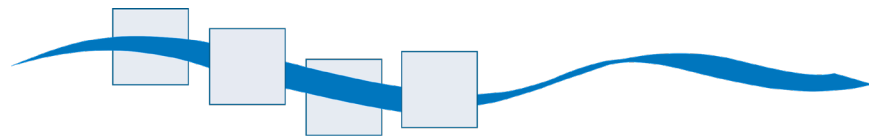
Awareness and looking for future products and users



- ❖ Flood impact analysis
- ❖ Water resources modeling
- ❖ Flow forecasting for the navigation purposes
- ❖ Sediment transport modeling
- ❖ Water quality modeling
- ❖ Climate change analysis



Sava and Drina River Corridors
Integrated Development Program
(finance by World Bank)



INTERNATIONAL SAVA RIVER BASIN COMMISSION

THANK YOU FOR YOUR ATTENTION

Mirza Sarač

Advisor for protection against detrimental effects from
waters and extraordinary impacts on the water regime

International Sava River Basin Commission

msarac@savacommission.org