

SESSION 3: Dialogue with stakeholders

Sava River Flood Forecasting and Warning System - operational since October 2018 -

WMO RA VI Hydrology Forum

Bratislava, 2-4 April 2019

Mirza Sarač,
ISRBC Secretariat

Legal background

Framework Agreement on the Sava River Basin

- Main objective: **Prevent or limit floods, and reduce and eliminate adverse consequences**



Protocol on Flood Protection

- **Flood Risk Management Plan** (EU Flood Directive)
- **Flood forecasting and warning system (FFWS)**
- **Exchange of information**
- **Flood defence emergency situations** (incl. mutual assistance)

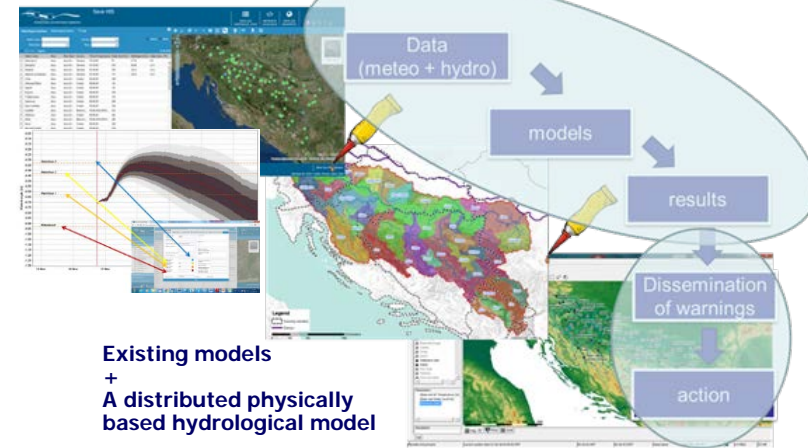


Flood forecasting and warning

Chronology

- **Initiated in 2003** by national NHMSs of the Sava countries
- **ISRBC supported the initiative** since its establishment
- **World Bank supported** preparation of assessment of the status and needs in national institutions in 2007 (estimate 16 mil USD)
- **Concept and 1st proposal** prepared and supported by the relevant national institutions in 2011, for SEE TCP
- Development of the **hydrologic and hydraulic models**, 2010, 2012, 2014
- **Proposal approved by WBIF in June 2014**
- Development of the **system for real-time HM data collection**, as a part of Sava HIS, 2015
- Hydrologic and hydraulic **models improvements**, 2016-2018

SavaHIS components



Supporting actions for the Protocol implementation – observed HM data



CUAHSI

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

1. Standards

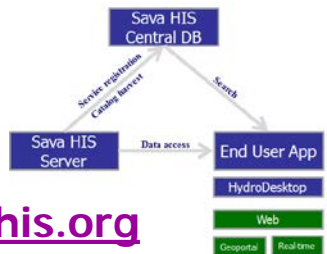
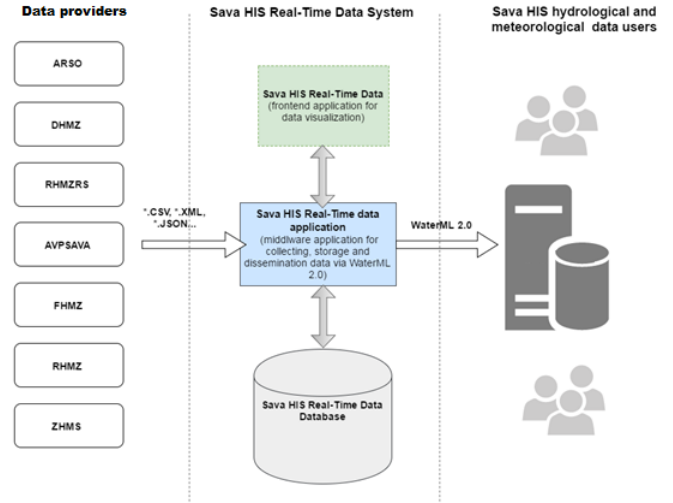
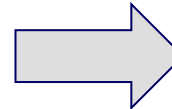
- WaterML language for describing water data

2. Services

- Catalog of water data sources – web services

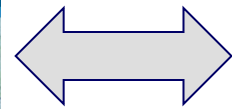
3. End user applications

- Web apps and software for data access

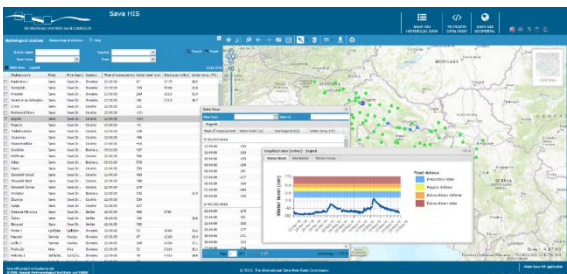


Database

- Historical HM data
- Real time HM data

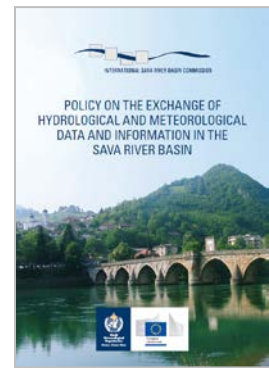
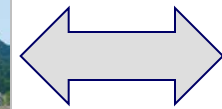


www.savahis.org

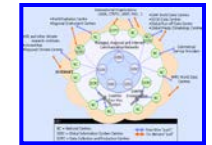


Standards

- INSPIRE
- WMO resolutions
- WaterML 2.0



WIS – WMO Information System



Sava HIS

Sava HIS hydrological stations network



This product is based on national information provided by the Parties to the IASRB (SI, HR, BA, RS) and ME. The borders between the countries cooperating in preparation of the Sava River Basin Analysis have not been finally determined. The content and maps of this report do not prejudice the determination or demarcation of the borders in any way.

Processed and compiled by the Secretariat of the Sava Commission, March 2019

Parameter	Temporal Resolution	Units
River, Lake or Reservoir Level/Stage	Daily (Mean)	cm
	Hourly	
River Discharge	Daily (Mean)	m ³ s ⁻¹
	Hourly	
Water Temperature	Daily (Mean)	°C
Suspended Sediment Discharge	Daily (Mean)	kg s ⁻¹
	Hourly (Turbidity)	mg/l; NTU
Ice Condition	Daily	% of river cross section
		or text description

Hydrological Stations	BA	HR	ME	RS	SI	Total
Sava HIS (2019)	104	131	11	25	33	304
Data Policy (2014)	34	22	2	18	17	93

Sava HIS

Sava HIS meteorological stations network



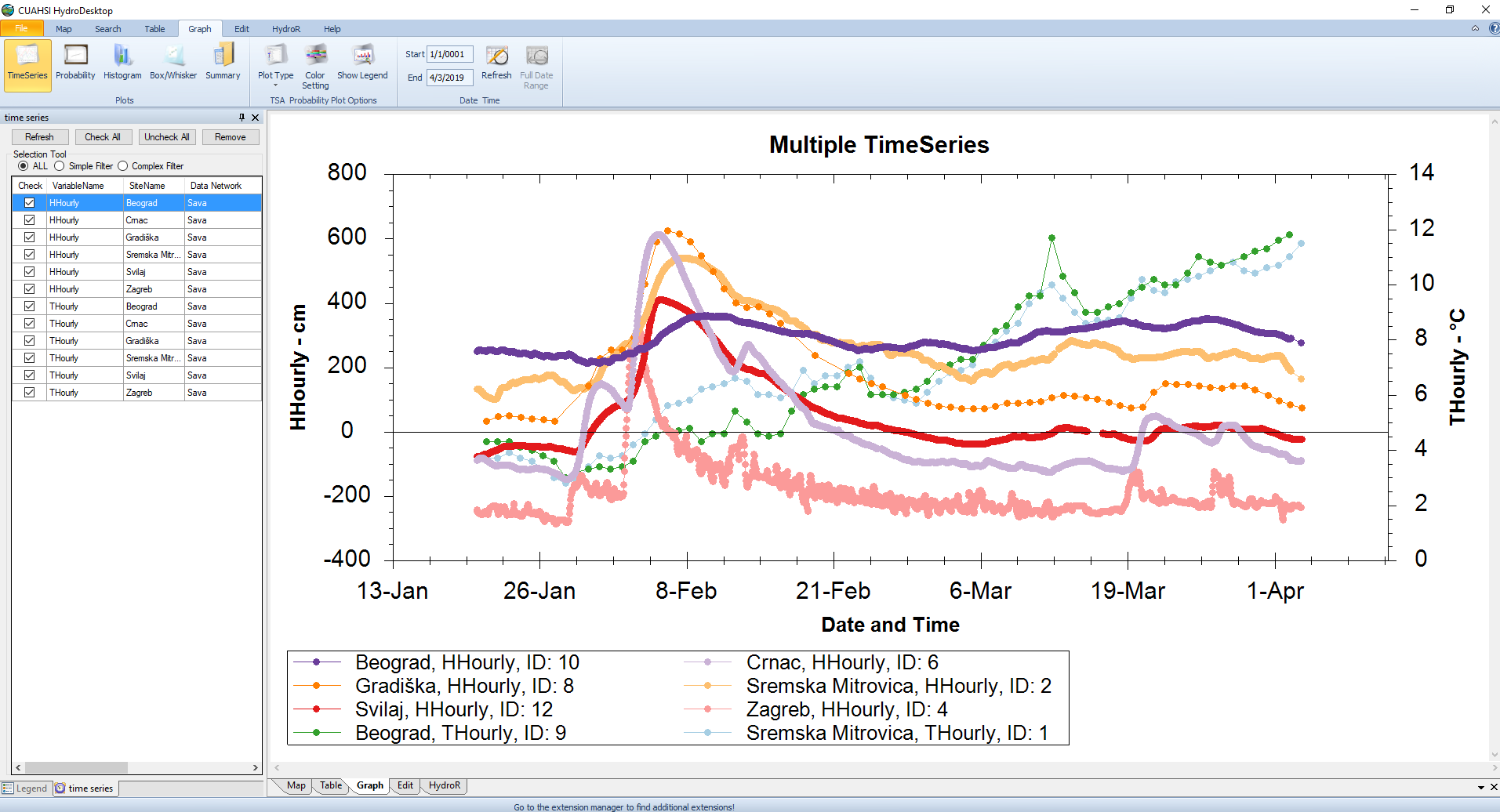
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Processed and compiled by the Secretariat of the Sava Commission, March 2019

Parameter	Temporal Resolution	Units
Precipitation	Annual (Total)	mm
	Monthly (Total)	
	Daily (Total)	
	6/12 Hourly (Total)	
Air Temperature	Hourly (Total)	°C
	Daily (Mean)	
Relative Humidity	Daily	%
	Hourly	
Wind (Speed and Direction)	Daily	m/s
	Hourly	
Snow Depth	Daily	cm
Evaporation	Daily (Total)	mm
Solar Radiation	Daily	J m ⁻²
Sunshine	Daily (Total)	Hours
Atmospheric Pressure	Daily	hPa

Meteorological Stations	BA	HR	ME	RS	SI	Total
Sava HIS (2019)	53	49	5	12	76	195
Data Policy (2014)	28	11	3	6	5	53

Sava HIS – HydroDesktop



Export data

Sava HIS – HEC-DSSVue

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

File Edit View Display Groups Data Entry Tools Collections Advanced Help

File Name: C:\Users\SRBC 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

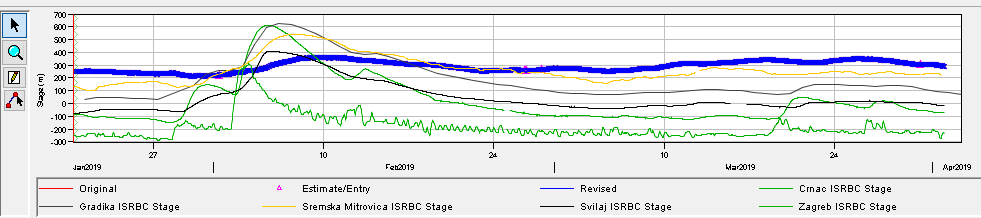
Search A: C: E: By Parts: B: D: F:

Number	Part A	Part B	Part C	Part D / range	Part E	Part F
1	Sava	Beograd	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC
2	Sava	Cmac	Stage	01Jan2019 - 01Apr2019	1Hour	ISRBC
3	Sava	Gradka	Stage	01Jan2019	1R-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 (%S)	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

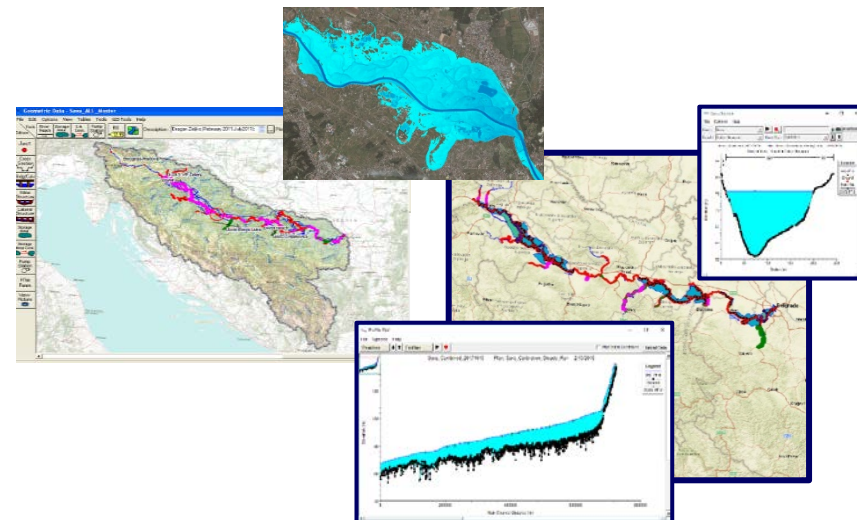
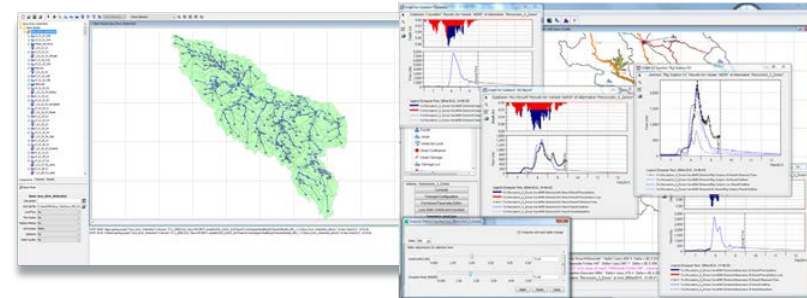
Export data

Supporting actions for the Protocol implementation – floods modelling

US Government support to the Sava countries

Technical support was provided by the **US Army Corps of Engineers**

- **Hydrologic model (HEC-HMS)** of the Sava River Basin (2010, 2014, 2016)
 - 1 for the complete Sava River basin (SavaFFWS)
 - 4 for the Sava River mainstem (Sava hydraulic model)
 - 17 for the main tributaries
- **Hydraulic model (HEC-RAS)** of the Sava River (2012, 2016-2018)
 - Accurate terrain model (LiDAR)
 - 1D/2D simulation possibilities
 - Levee breach analysis



Models integrated within Sava FFWS

Support to the Protocol implementation by WBIF project

Official Title:

Improvement of Joint Flood Management Actions in the Sava River Basin

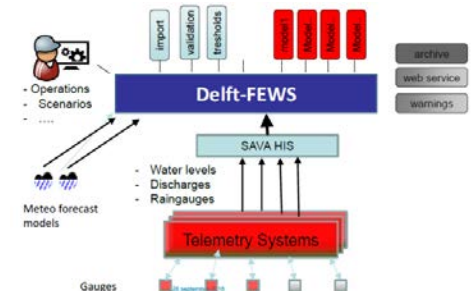
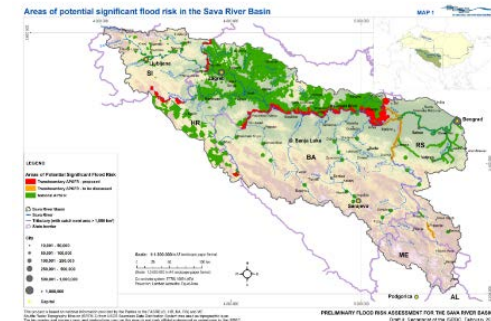
- **Beneficiary countries:** 19 institutions from 5 countries (BA, HR, ME, RS, SI)
- **Two Components:**

C1 - Flood Risk Management Plan for the Sava River Basin

- Technical support was provided by experts led by **Eptisa**
- Implementation period: 2017-2018

C2 - Flood Forecasting and Warning System for the Sava River Basin

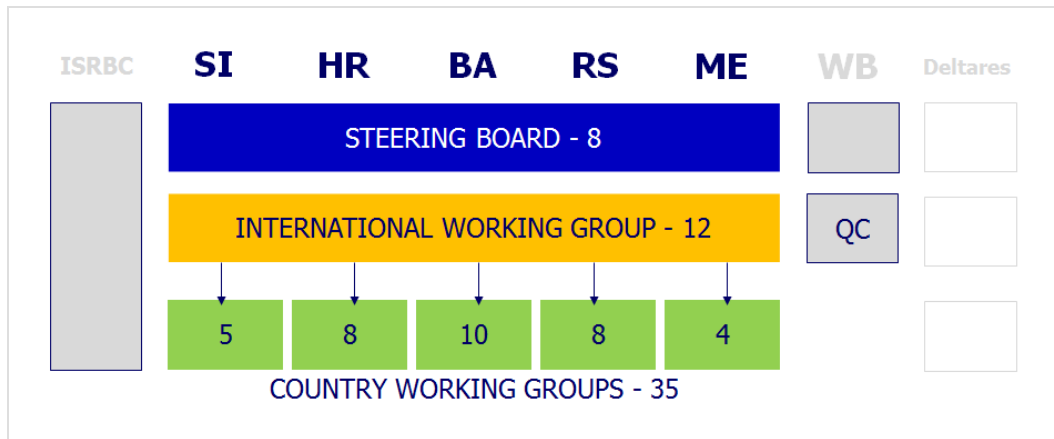
- Technical support was provided by a consortium led by **Deltares**
- Implementation period: 2016-2018



Sava FFWS

The project organizational structure and beneficiaries

- **Steering Board** (5 meetings)
to perform the overall monitoring of the project performance
- **International Working Group** (9 meetings)
to harmonize the input of the Country Working Groups, follow the overall progress, and provide input to the Steering Board
- **5 Country Working Groups** (up to 3 meetings)
to provide all data and other related information required for development of the Sava FFWS, and provide input to the International Working Group



Slovenia

Ministry of the Environment and Spatial Planning

Slovenian Environment Agency



Croatia

Ministry of Environment and Energy

Meteorological and Hydrological Service

Croatian Waters



Bosnia and Herzegovina

Ministry of Foreign Trade and Economic Relations of BiH

Ministry of Agriculture, Water Management and Forestry of Federation BiH

Ministry of Agriculture, Forestry and Water Management of Republika Srpska

Federal Hydrometeorological Institute Sarajevo

Republic Hydrometeorological Institute Banja Luka

Sava River Watershed Agency Sarajevo

Public institution "Vode Srpske" Bijeljina



Serbia

Ministry of Agriculture, Forestry and Water Management

Republic Hydrometeorological Service of Serbia

Public water management company "Srbijavode"

Public water management company "Vode Vojvodine"

Public water management company "Beogradvode"



Montenegro

Ministry of Agriculture and Rural Development

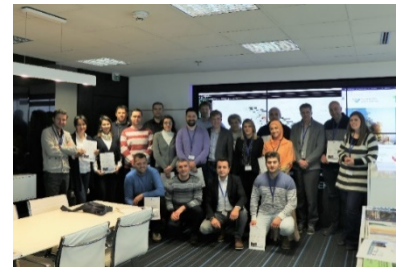
Institute of Hydrometeorology and seismology of Montenegro



Sava FFWS

Implementing phase

- 3 pre-releases
- version 1.0 (testing version)
- version 2.0 (final version)
- 4 workshops
- 9 admin and user trainings

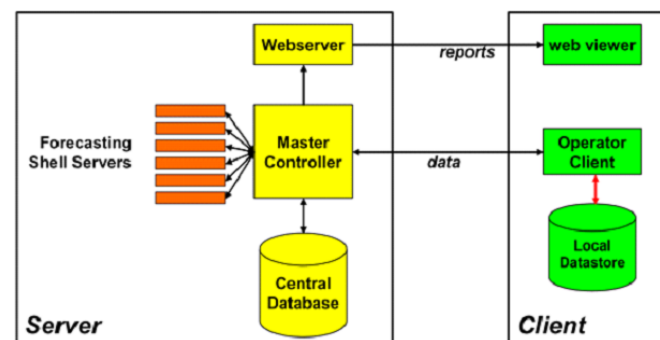


Sava FFWS

Implementing phase

Components

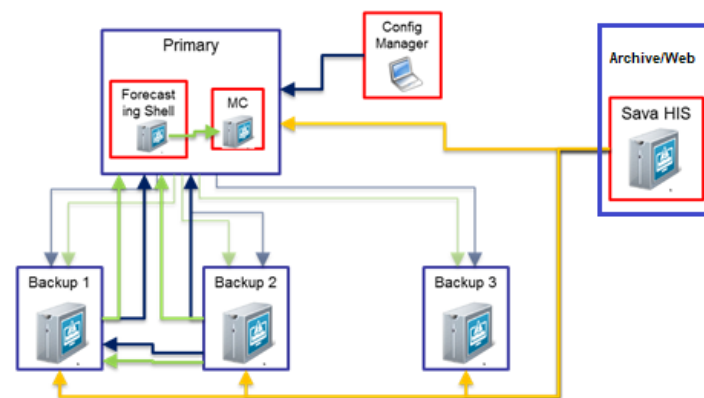
- On the server side, the main component is the Master Controller (MC) which monitors the status of all components and distributes tasks to the Forecasting Shell Servers (FSS)
- The system uses a central database in PostgreSQL to manage all data in the system
- The components could be run on physical servers ('bare metal') or in virtual machines
- On the client (a laptop or PC), the so-called Operator Client (OC) is run which connects to the MC through https over the internet and data is read and cached in a local data repository



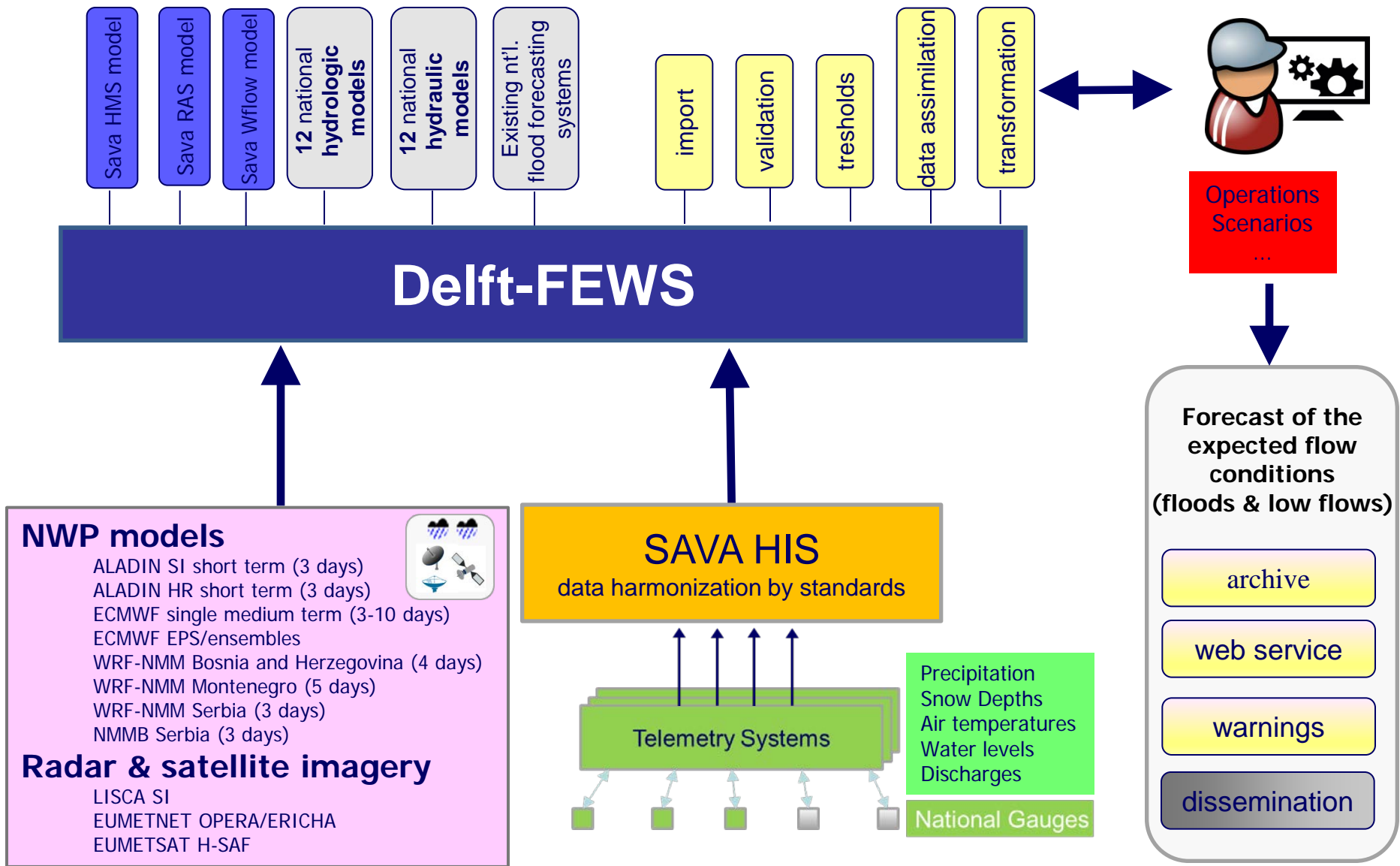
Hosting

5 technical solutions for Hosting of the Operational System analyzed

- ❖ Primary and Backup Host
- ❖ Dual Host
- ❖ **One system per country – with data synchronization**
- ❖ One system per country – with disconnected systems
- ❖ Cloud



Sava FFWS - schematic overview



Sava FFWS

Implementing phase

Final workshop and the hand-over ceremony held on 25th of October 2018

Deliverables

- Sava FFWS installation v.2.0
- Final Report
- User Manual
- Technical Reference
- System documentation
- Gap Analysis
- Post-Project Organization



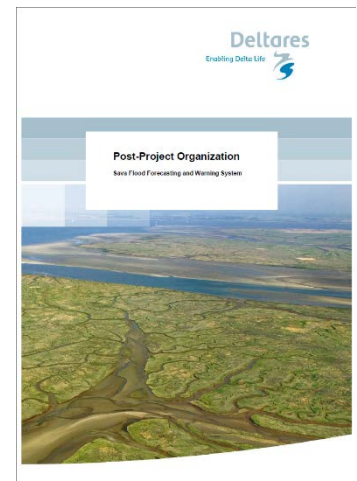
- ❖ Versatile forecasting system for the Sava river basin
- ❖ Unique in the region and example for the rest of the world when it comes to transboundary cooperation on flood forecasting
- ❖ Technically challenging
- ❖ Organizationally challenging (5 countries, 19 organizations)
- ❖ Mature base for possible future extensions
- ❖ Sava FFWS is ready for operational use

Sava FFWS operational period after October 2018

Protocol on flood protection to the FASRB

After the System is established, **the Parties shall ensure its regular maintenance and performance control**, as well as regular training of the engaged personnel, with application of joint standards

- Technical documentation prepared (the PPO document)
- Consultation process on the technical level finalized
- Preparation of the *Memorandum of Understanding on cooperation on regular functioning and maintenance of Sava FFWS* ongoing



Sava FFWS operational period

Consultation process on technical level - results

List of the Sava FFWS users

Country	Institution
Slovenia	ARSO, Ljubljana
Croatia	DHMZ, Zagreb
	Croatian Waters, Zagreb
Bosnia and Herzegovina	FHMZ, Sarajevo
	RHMZRS, Banja Luka
	AVP Sava, Sarajevo
	JU Vode Srpske, Bijeljina
Serbia	RHMZ, Belgrade
Montenegro	ZHMS, Podgorica
	ISRBC

All organizations have the following roles:

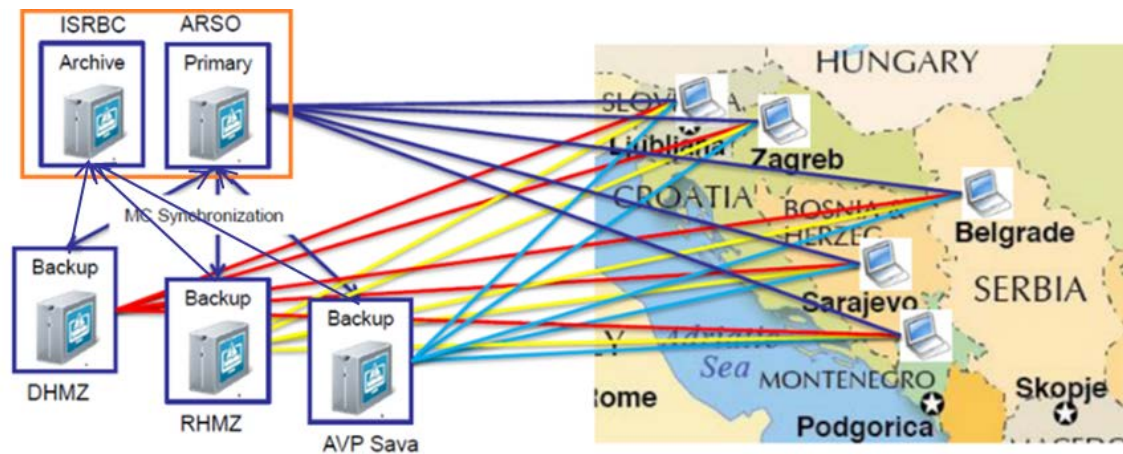
- ❖ Operator Client (Sava OC)
- ❖ Stand-Alone Client (Sava SA)
- ❖ Configuration Manager Client (Sava CM)
- ❖ Testing Client (Sava Test OC and Sava Test CM)

Sava FFWS operational period

Consultation process on technical level - results

System hosting structure

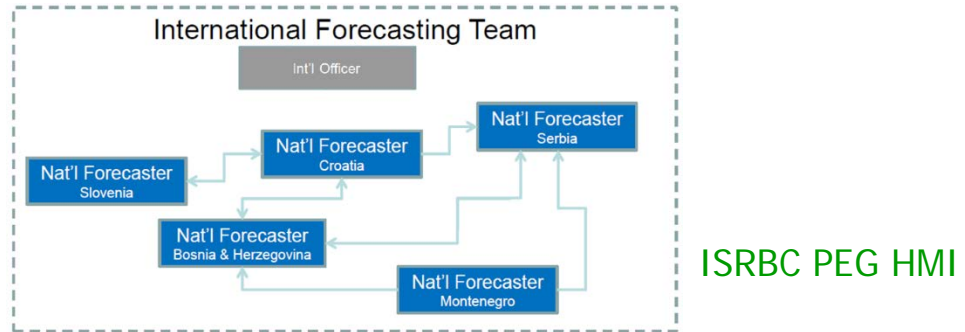
- ❖ Primary server and SavaHIS-RT: ARSO (Slovenia)
- ❖ 1st Backup and Testing server: RHMZ (Serbia)
- ❖ 2nd Backup server: AVP Sava (Bosnia and Herzegovina)
- ❖ 3rd Backup server: DHMZ (Croatia)
- ❖ Web/Archive server and SavaHIS :
(back-up to the SavaHIS-RT) ISRBC



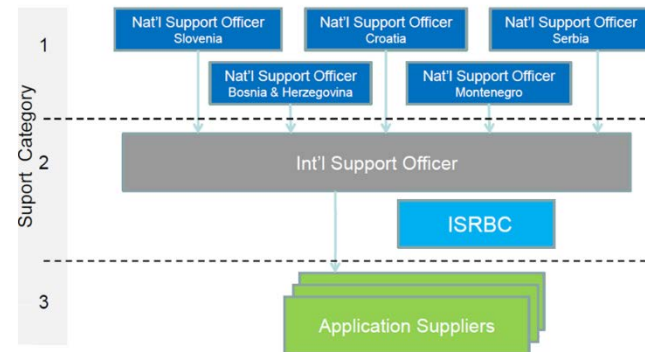
Sava FFWS operational period

Consultation process on technical level - results

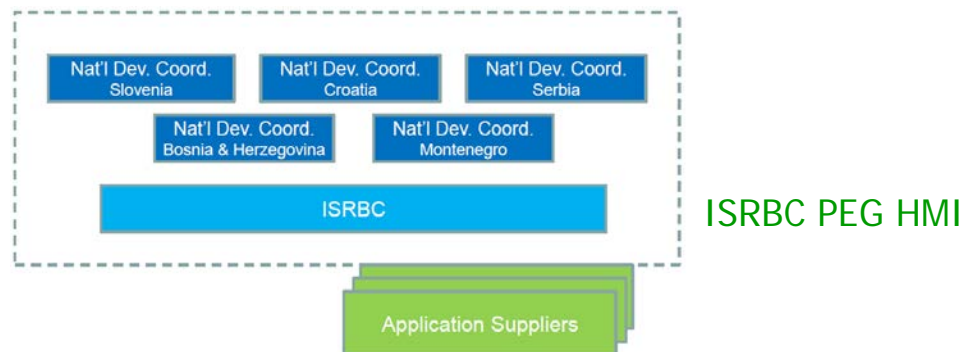
DUTY FORECASTING



SUPPORT AND MAINTENANCE



DEVELOPMENTS



Sava FFWS operational period

Consultation process on technical level – remaining issues



Financing

Total costs estimate (Euros per year) for operating, supporting and developing the Sava FFWS prepared

- ❖ National costs made by forecasting organizations for their national responsibilities
- ❖ International costs made to enable international forecasting and cooperation and to cover third party support, both for support contracts and developments

Topics which **needs to be agreed** within the ongoing consultation process:

- Verification of the costs estimation
- Costs distribution and funding

Sava FFWS operational period

Ongoing consultation process

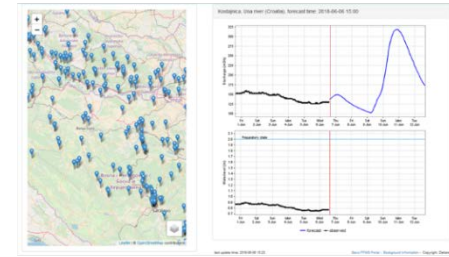
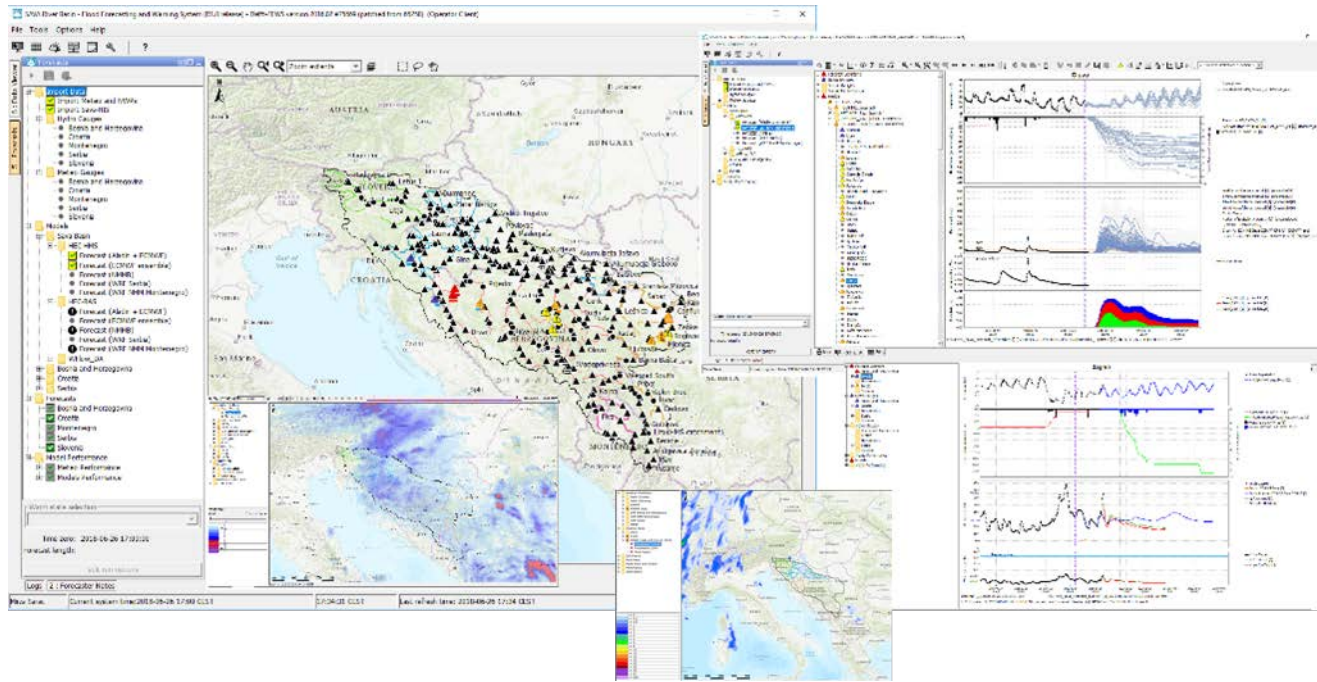
ISRBC on its 49th Session has established the Sava FFWS Task Group for the purpose of development of an agreement on the duties, responsibilities, mutual rights and obligations on regular maintenance of the common Sava FFWS platform

- ❖ 1st meeting was held on Oct 04, 2018
- ❖ 2nd meeting was held on Nov 13, 2018
- ❖ 3rd meeting was held on Jan 25, 2019
- ❖ 4th meeting was held on Feb 12, 2019
 - Draft MoU with annexes prepared, fine-tuning ongoing

The subject of the Memorandum is to agree upon duties, responsibilities, mutual rights and obligations by:

- ❖ Defining the organizational structure for the System operating and using
- ❖ Defining the bodies for evaluation and assessment of work performed for the purpose of the System operation and overall monitoring of technical issues
- ❖ Defining the funding and distribution of costs
- ❖ Defining conditions of access to the System

Sava FFWS in use



Sava FFWS html web viewer

Delft-FFWS PI Service

[Please try out the new test page developments](#)

Service name	FewsPIService (2016.02)
WSDL	http://ffws2.sava.rbc.org:80/FewsPIService/fewsPIService?wsdl
Region	C:\Fews\Tomcat_Pi\Fews\Region_Home
MC ID	svsasm004

[Refresh](#)

Submit

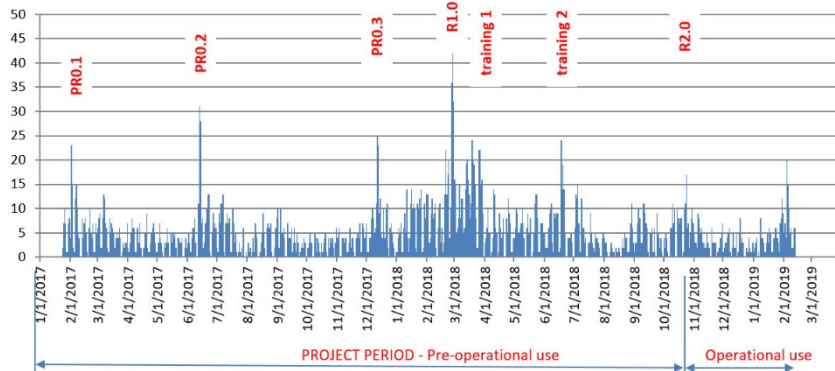
Select Method:

Filter ID:

Version:

Submit

unique daily logins to Sava FFWS



WaterML 2 Service for DAC

GetCapabilities [GetCapabilities](#)

GetFeature [GetFeature](#)

GetObservations-GET [/waterml?request=GetObservation&featureOfInterest=1&observedProperty=Parameter&beginPosition=2013-02-01T00:00:00%2B01:00&endPosition=2013-03-01T00:00:00%2B01:00&analysisTime=2013-02-01T00:00:00%2B01:00](#)

GetObservations-POST

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xmlns:sos="http://schemas.opengis.net/sos/2.0.0/"
xmlns:wfs="http://www.opengis.net/wfs"
xmlns:ogc="http://www.opengis.net/ogc"
xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
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```

Demo Web Application [Demo](#)