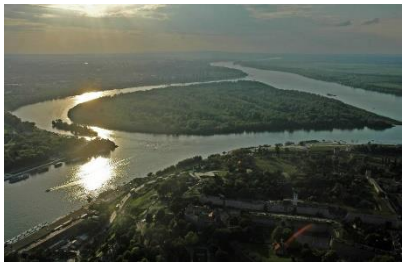
WATER RELATED DISASTER MANAGEMENT AND CLIMATE CHANGE RESILIENCE

International collaboration on flood risk management in the Sava River basin

Sava river basin

- **Sava – the largest Danube tributary** by discharge (contribution: 25%)

Sava spring - Slovenia



Sava mouth - Serbia

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

- **Area:** 97 713 km^2 (the second largest Danube sub-basin; share: 12%)
- **Average flow** at the mouth: 1722 m^3/s (the largest Danube tributary)
- **River length:** 940 km (594 km of which is the waterway)
- **Population:** approx. 9 million

Framework Agreement on the Sava River Basin

- **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.)

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**



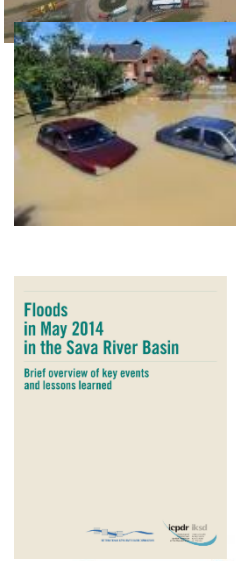



Flood Risk Management

Significant floods

Year of flood	Affected area/river
Oct/Nov 1896	Drina River
Apr 1932	Sava River
Oct 1933	Sava River
Nov 1944	Sava River
Oct 1964	Sava River
Dec 1966	Sava and Kupa rivers
Dec 1968	Bosna River
Jan 1970	Sava and Bosut rivers
Oct 1974	Sava, Krapina, Kupa and Una
Jul 1989	Krapina River
1990	Upper Sava River Basin
Oct/Nov 1998	Upper Sava River Basin
Nov 1998	Kupa River
Jul 1999	Tamnava, Ub and Gračica rivers
Jun 2001	Kolubara, Jadar and Ljubovića r.
Mar 2006	Tamnava, Ub and Gračica rivers
Apr 2006	Sava River
Sep 2007	Upper Sava River Basin
Mar 2009	Tamnava, Ub and Gračica rivers
Dec 2009	Upper Sava River Basin
May/Jun 2010	Middle Sava River Basin
Sep 2010	Middle Sava River Basin
Dec 2010	Drina, Kupa and Una rivers
Feb 2014	Kupa River
May 2014	**Middle/lower Sava River Basin**

Country	Affected	Evacuated	Casualties	Damage+losses (mil EUR)	Cause
Serbia	1.6 million	32 000	51	Damage: 860 Losses: 662 **Total: 1532**	Torrents, landslides, dike breach
Bosnia and Herzegovina	1 million	90 000	25	Damage: 1274 Losses: 763 **Total: 2037**	Torrents, landslides, dike breach
Croatia	38 000	15 000	3	**Total: 300**	Dike breach



Report on Floods in May 2014 in the Sava River Basin

Prepared jointly with the ICPDR

http://www.savacommission.org/publications

Protocol on Flood Protection to the FASRB

Signed in June 2010, **entered into force** in November 2015

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

Protocol implementation:

Preparation of the **Program for development of the Sava FRMP**

- Program **prepared in 2017**

Undertaking of the **Preliminary Flood Risk Assessment**

- Joint Sava PFRA Report **prepared in 2014**

Preparation of the **Flood Maps**

Development of the **Flood Risk Management Plan**

- Ongoing activity

Establishment of the **Flood Forecasting and Warning System**

- Ongoing activity

Exchange of information significant for sustainable flood protection

- **Sava GIS** established (including **Sava HIS**)

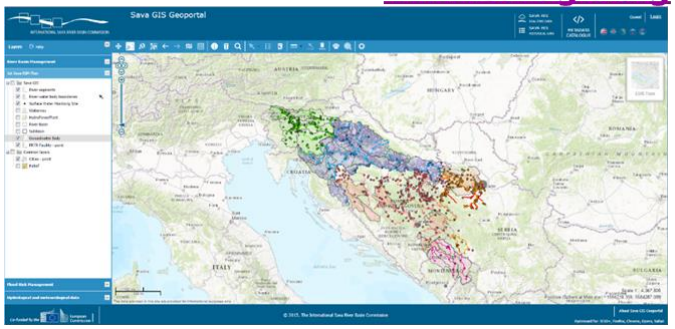
Flood defense emergency situations and mutual assistance

- Proposal for modalities under **preparation within the Sava FRMP**

Supporting actions for the Protocol implementation

Sava GIS - a common platform for sharing and dissemination of information and knowledge about WRM in the basin

www.savagis.org

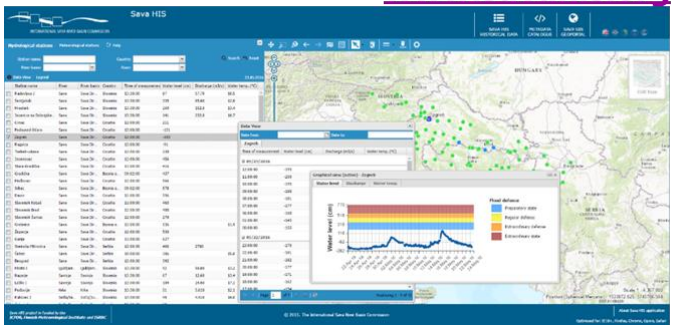


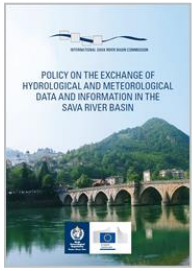
Flood management module for the spatial and attribute data on:

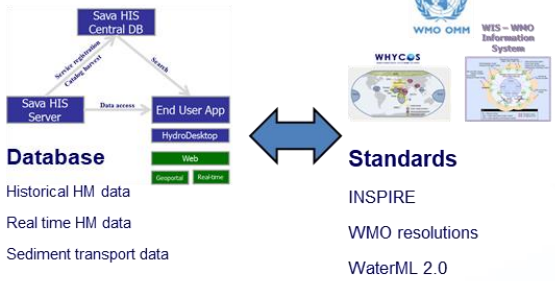
- Preliminary flood risk assessment
- Flood hazard and risk maps
- Flood protection structures
- FRM Plan (ongoing)

Metadata Catalogue

www.savahis.org







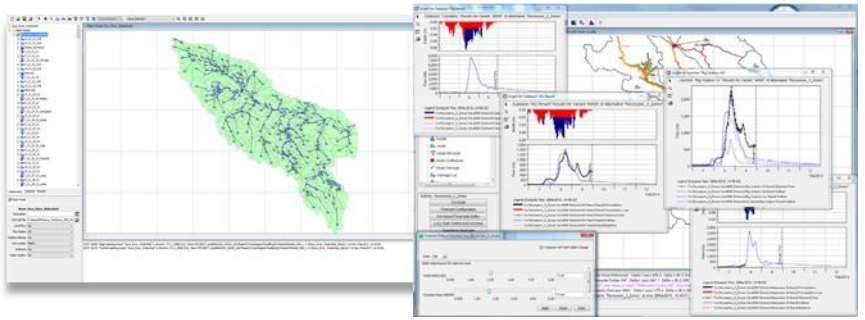
Supporting actions for the Protocol implementation

Flood modeling with technical support provided by the US Army Corps of Engineers

- **Hydrologic model**
  of the Sava River Basin (2010, 2014, **2016**)

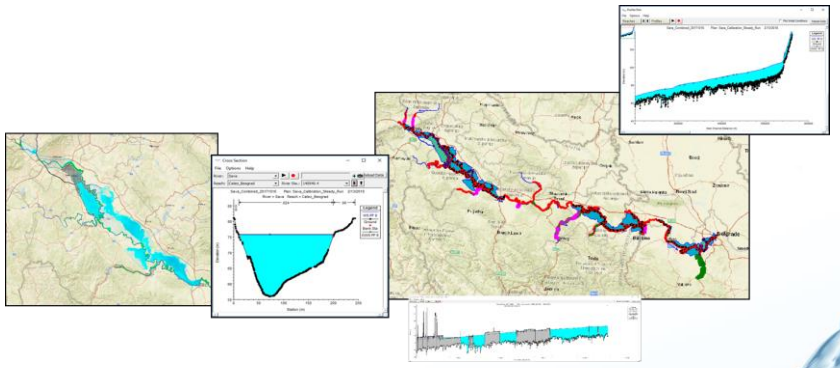
  Final Sava HEC-HMS model contains a separate basin models for each tributary basin and mainstem reach (**22 models in total**):

  - 1 for the complete Sava River basin (**SavaFFWS**)
  - 4 for the Sava River mainstem
  - 17 for the main tributaries



- **Hydraulic model**
  of the Sava River (2012, **2016-2018**)

  - areas (around 3.315 km2)
  - LiDAR based geometry (2017)
  - 2-D simulation possibilities
  - levee breach analysis

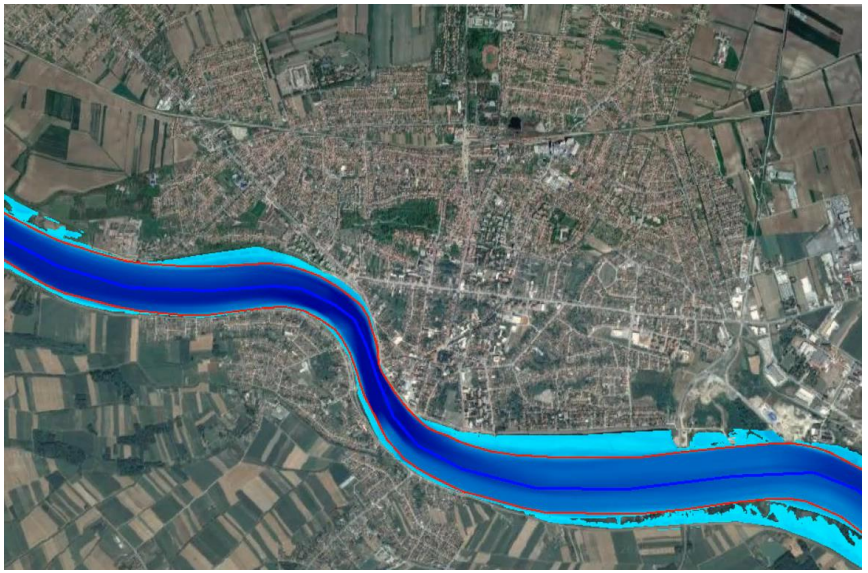


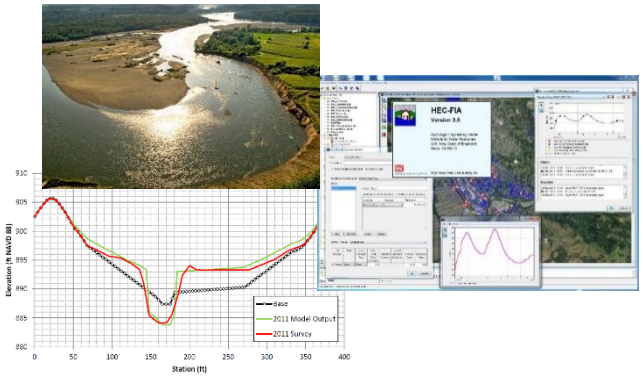
Awareness and looking for future products and users

For a number of purposes of ISRBC:

- **Flood forecasting**
- Flood impact analysis
- Sediment transport modeling
- Water quality modeling
- Climate change analysis
- Navigation purposes

Sava RAS hydraulic model – Levee breach simulation





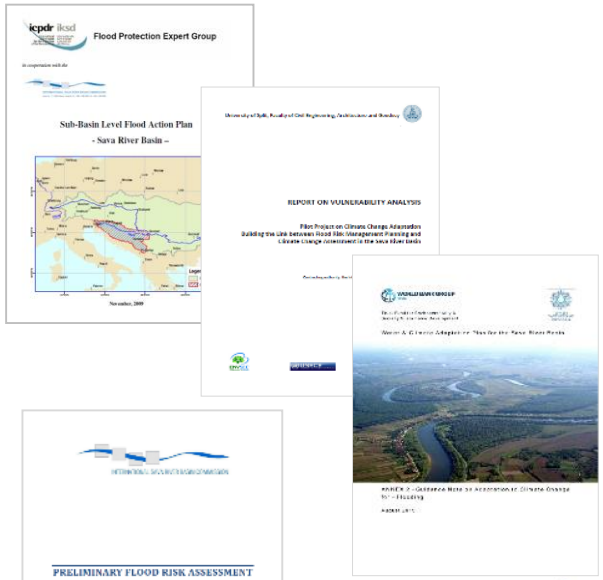
Flood Risk Management Plan

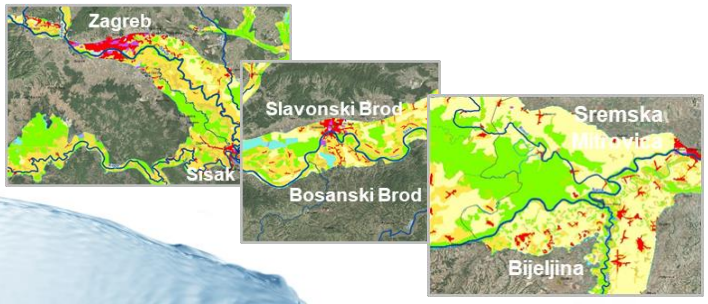
The Protocol states:

The Parties shall prepare the Flood Risk Management Plan for the Sava River Basin **in accordance with the content defined by the EU Floods Directive** (Directive 2007/60/EC), and taking into account all relevant aspects of flood risk management

Initial steps

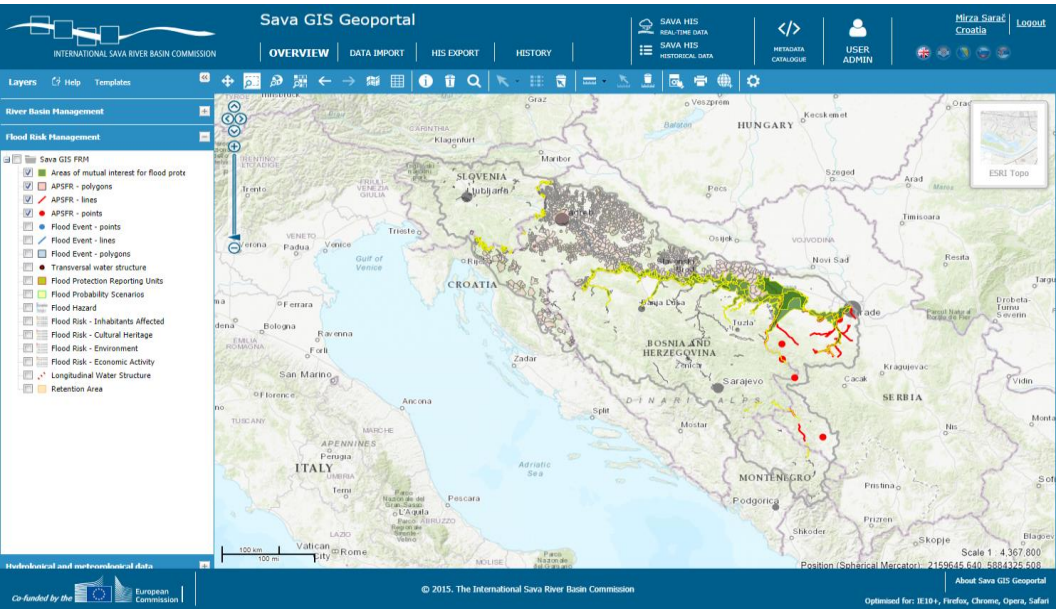
- **Sava Flood Action Plan**, 2009
- Initial **flood vulnerability assessment**, 2013
- **1st Draft Program** for preparation of the Plan, 2013
- Joint **PFRA Report**, 2014 (incl. May '14 flood)
- **Project proposal for Plan development approved** by WBIF, 2014
- **WATCAP**, 2015 (Guidance Note on **Adaptation to Climate Change for Flooding**)
- **Program** adopted, 2017





Flood Risk Management Plan

- Countries have defined the ***Areas of mutual interest for flood protection*** **(AMIs)**, taking into account the national APSFRs shared by two or more countries



AMIs aims to:

- ensure a consistent and coordinated approach to flood risk management in the basin
- set up common objectives of flood risk management on the basin scale, based on long-term sustainable approaches
- prepare the Summary of Measures (structural and non-structural) relevant for the entire river basin by compiling the national measures to be implemented by the countries and assessing their impact in transboundary context, their spatial distribution, prioritization, timing and modes of implementation

Flood Forecasting and Warning

The Protocol states

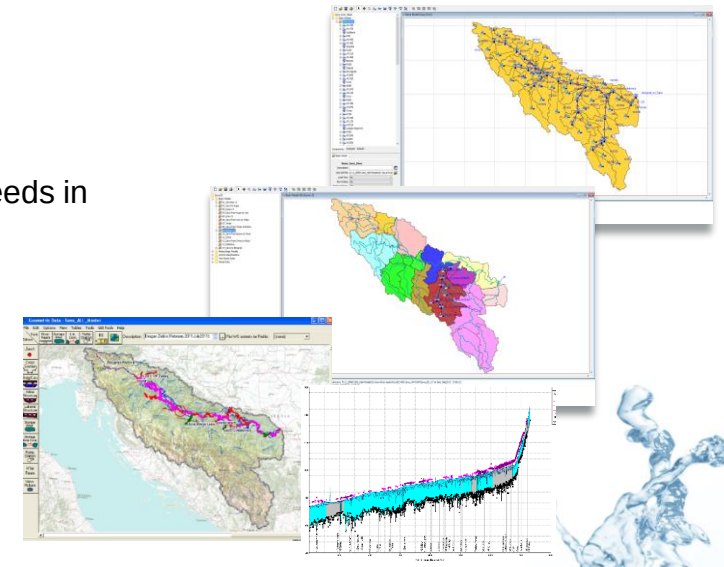
The Parties shall establish a Flood Forecasting, Warning and Alarm System in the Sava River Basin and to jointly undertake all necessary actions for establishment of the System, including the development of the project documentation

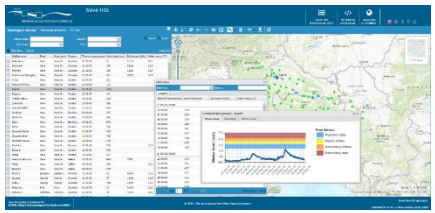
The Sava Commission shall coordinate the activities on establishment of the System

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

Initial steps

- **Initiated by national NHMSs** of the Sava countries, 2003
- **ISRBC supported the initiative** since its establishment, 2006
- **World Bank supported** preparation of assessment of the status and needs in national institutions, 2007
- Development of the **first ever basin-wide hydrologic model**, 2010
- Development of the **first ever Sava mainstem hydraulic model**, 2012
- Hydrologic **model improvements**, 2014
- **Project proposal for FFWS establishment approved by WBIF,** 2014
- Development of the **system for real-time HM data collection**, as a part of Sava HIS, 2015
- Hydrologic and hydraulic **models improvements**, 2016-2017



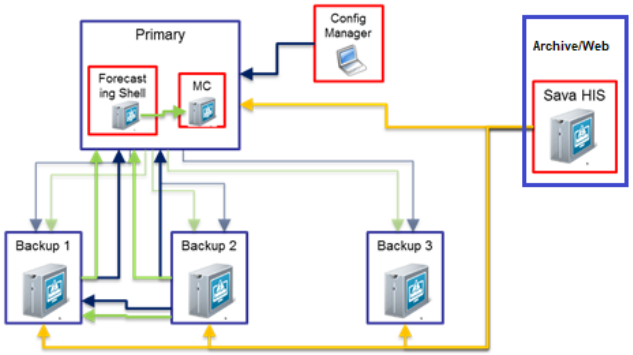


Flood Forecasting and Warning

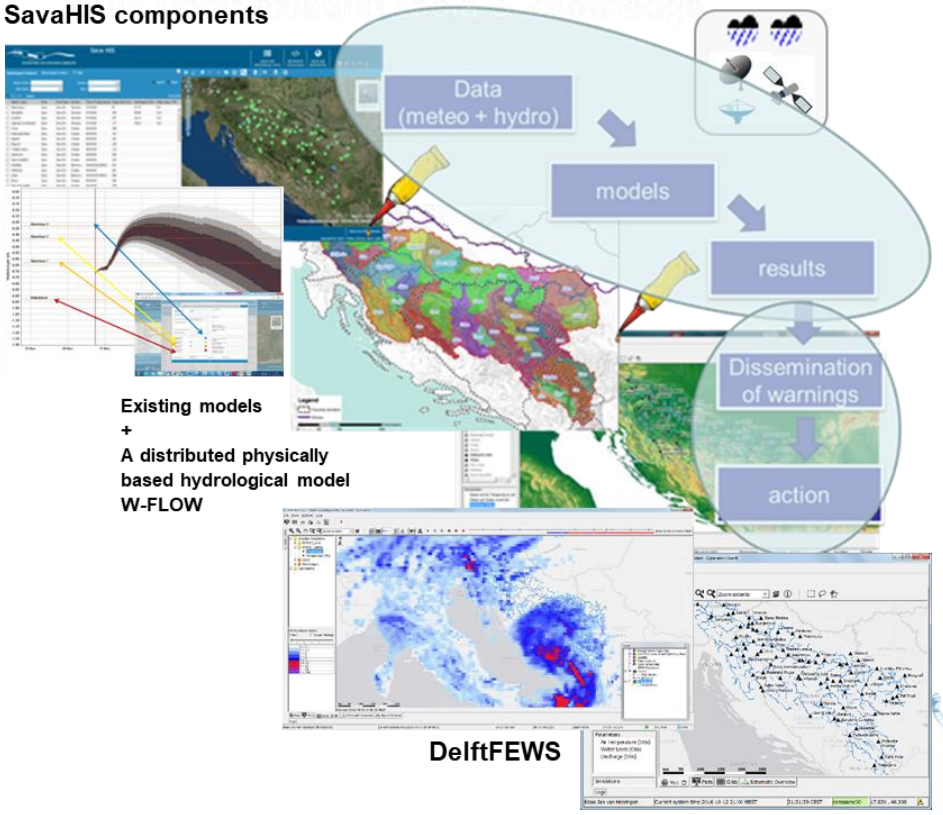
Integration & Cooperation

Numerical Weather Prediction models (8)
Radar and satellite images (OPERA and H-SAF)
Observed data collection (Sava HIS)
Hydrological forecasts and systems (2)
Hydrological models (12)
Hydraulic models (30)

A Joint System Hosting



SavaHIS components

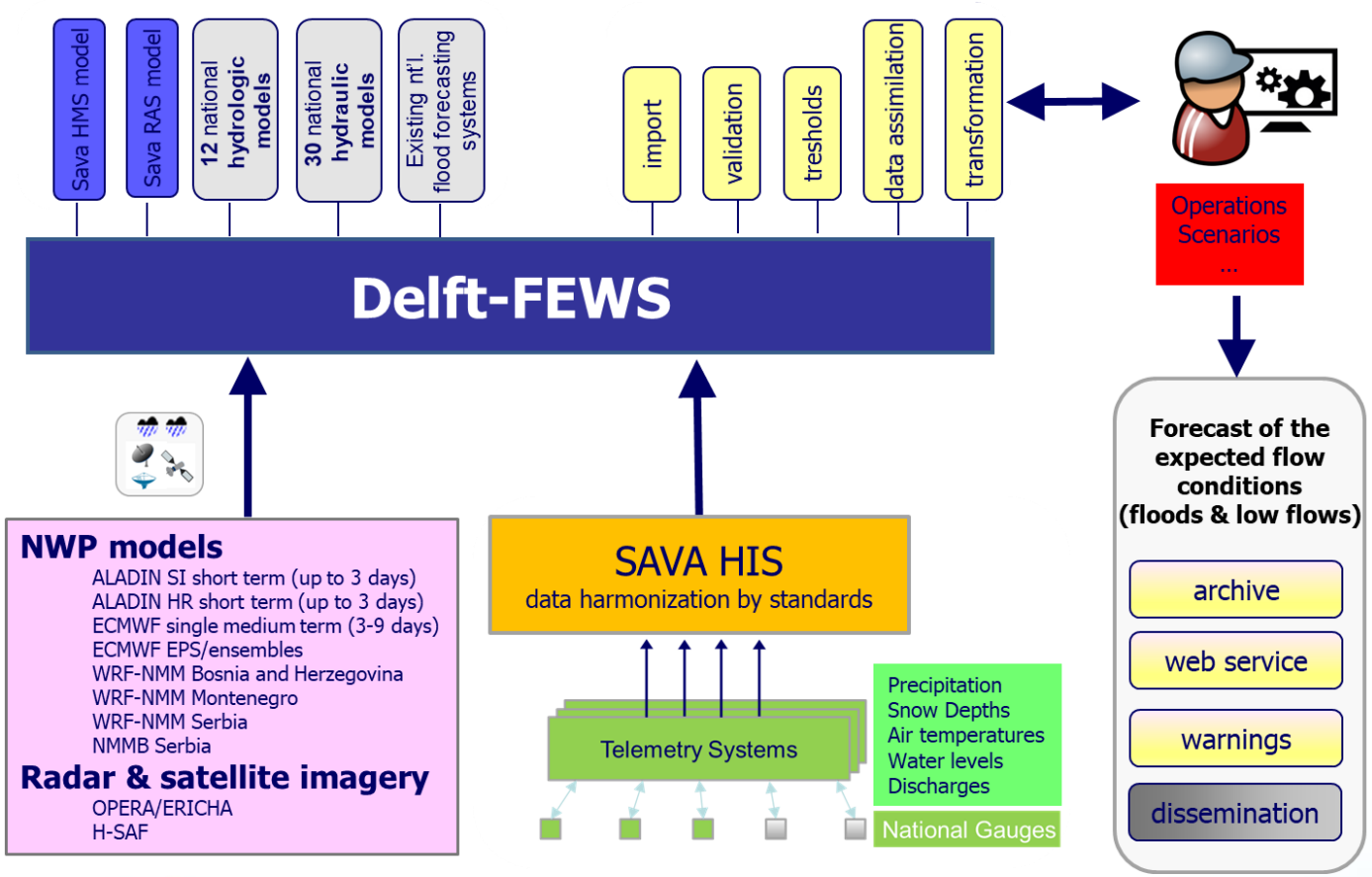


Existing models
+
A distributed physically based hydrological model
W-FLOW

DelftFEWS

Flood Forecasting and Warning

- **Sava FFWS – schematic overview**

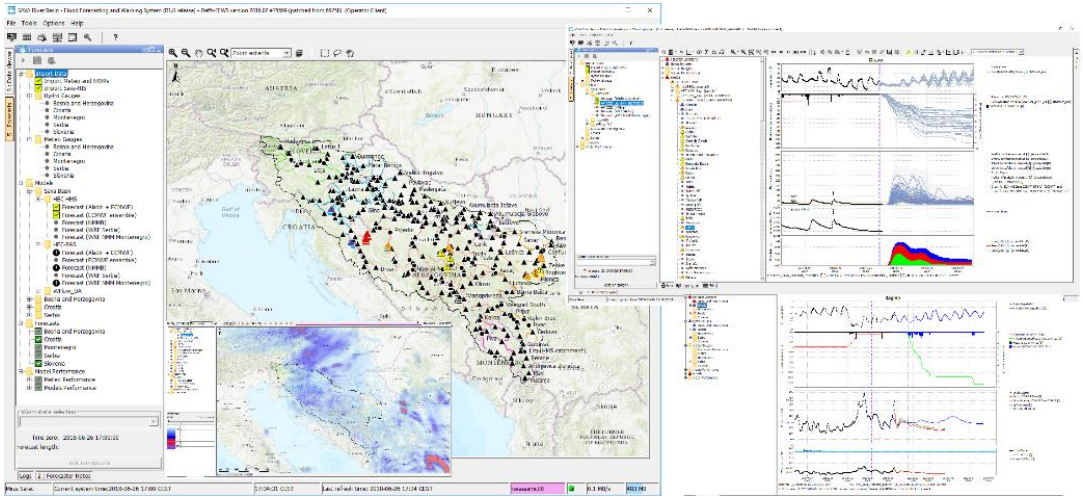


Flood Forecasting and Warning

System working in pre-operational version

3 pre-releases and release 1.0 versions completed and delivered
System servers established
3 workshops and user trainings completed

Sava FFWS – interface overview



International collaboration on flood risk management in the Sava River basin

Challenges

- **Response of institutions**
  - Data submission
  - Participation in the specific activities (human resources)
- **Differencies between the countries**
  - Status of activities
  - Existing infrastructure (e.g. for data exchange)
  - Standards, formats

Opportunities

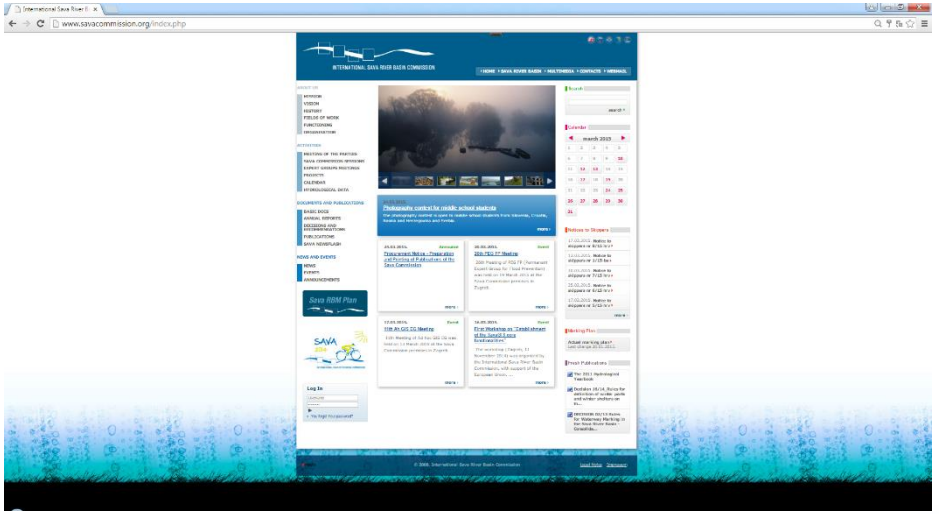
- **Policy framework** (Protocol, Data Exchange Policy, ...)
- **Platforms** (Sava GIS, Sava HIS, Sava FFWS, …)
- **Externally funded joint projects**
  - Implementation of activities (development of systems / models)
  - Trainings, courses, equipment
- **High-level political commitment**

International Sava River Basin Commission

Kneza Branimira 29

10000 Zagreb

Croatia



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