



**Geographical & Hydrological Information System
of the Sava River Basin**

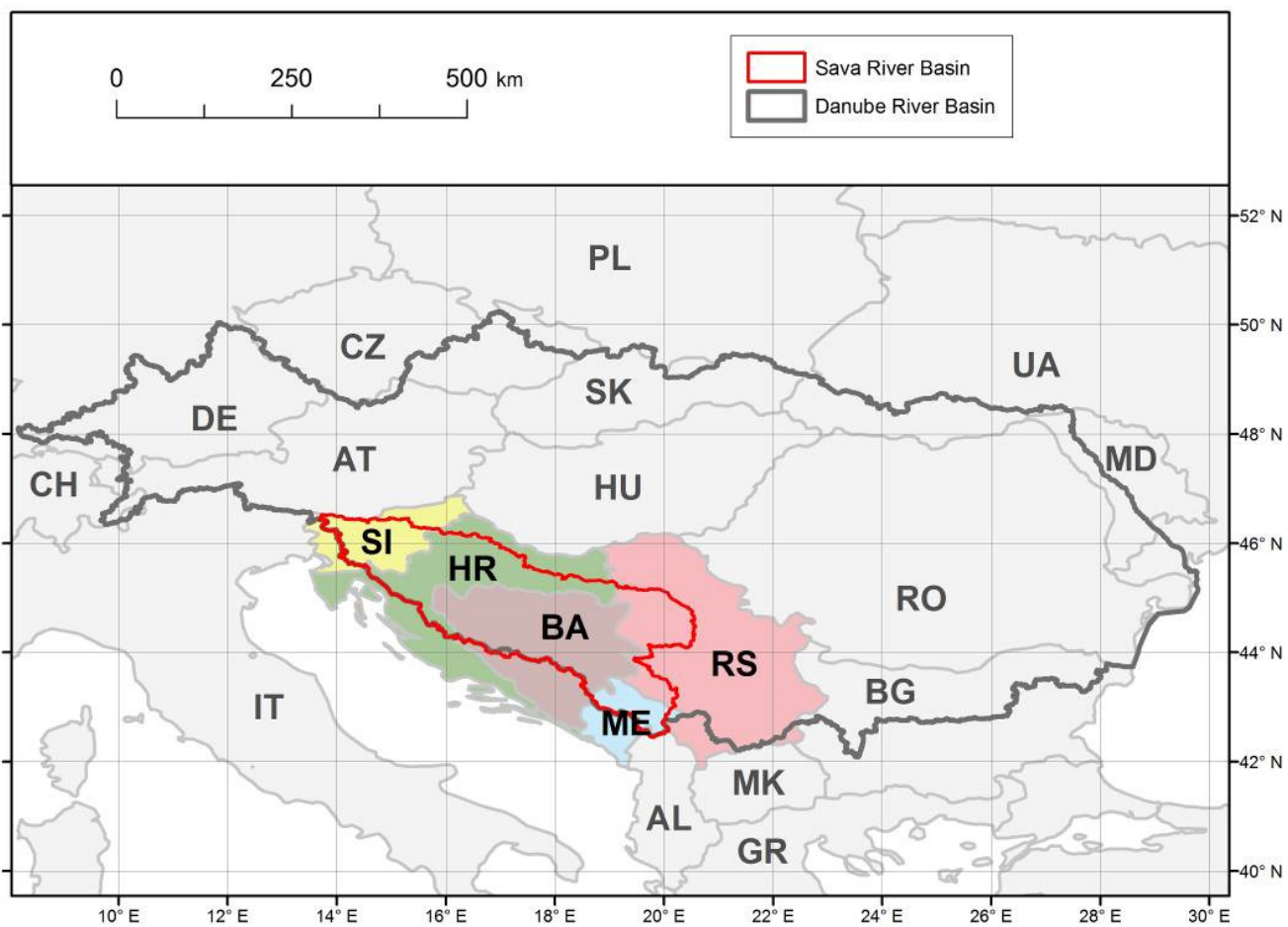
Sava GIS & Sava HIS

Overview

OGC/WMO Workshop, Koblenz June 13, 2016

Mirza Sarač
International Sava River Basin Commission - ISRBC Secretariat

Sava river basin



Sava river basin

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



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 & 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

International Sava River Basin Commission

- **Established in** 2005 (Secretariat: in 2006; Seated in Croatia)
- **Established for** implementation of the Framework Agreement on the Sava River Basin (FASRB, signed in 2002)
- **Four countries involved**
 - **Bosnia and Herzegovina,**
 - **Croatia,**
 - **Serbia and**
 - **Slovenia**
 - Montenegro
 - It **was involved** at the beginning (as a part of Serbia & Montenegro)
 - **Cooperation on technical level**, in some fields of work
 - **Formalization of cooperation** (until the full membership) under consideration

ISRBC links to national institutions

- Institutions **officially nominated by the governments** (mostly ministries)
- **NHMSs**
 - **Expert Group for HM issues** – all members come from the NHMSs
 - **Annual meetings** with directors of the NHMSs representatives
- **Water agencies** and other institutions
 - **Expert Groups** (River Basin Management, Floods Prevention, Accident Control, GIS, Navigation,...)
 - Core Working Groups

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



Sava Geographical Information System

- **Overall objective of the SavaGIS**

- common platform of the **ISRBC community** to enable sharing and disseminating of information and knowledge about protection of the water resources and water management activities in the Sava River Basin

Establishment of the Sava GIS is focused in following benefit areas:

Modules

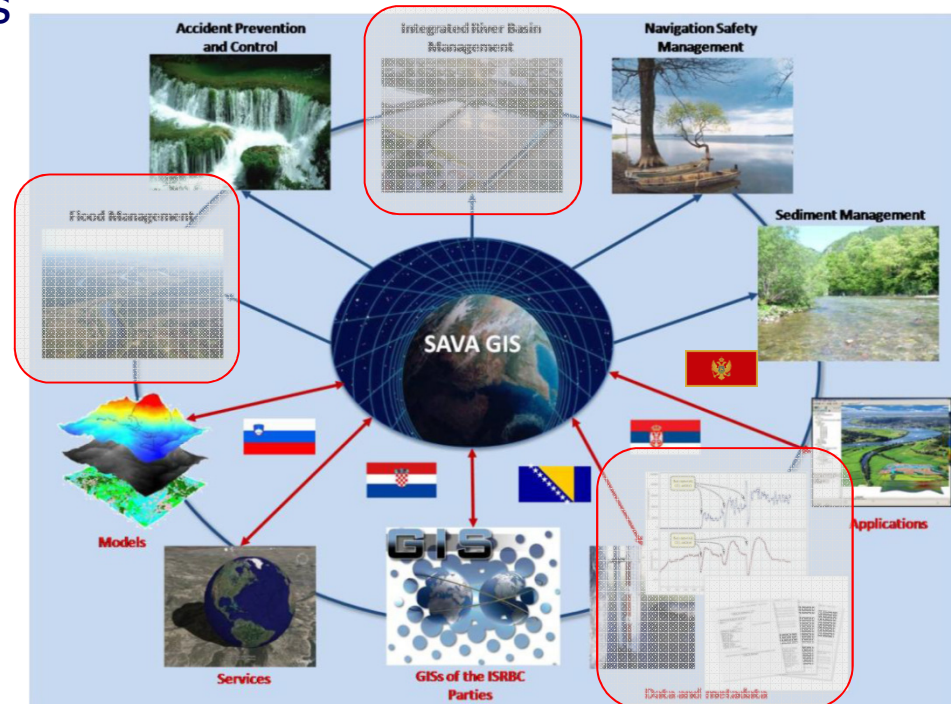
1. Int. River Basin Management
2. Flood Management
3. Accident Prevention and Control
4. Navigation Safety Management
5. Sediment Management

SavaGIS project

Submodules

- Time-Series Data Management
- Metadata Management

SavaHIS project



Sava GIS project

- Project scope

Service/deliverable

Establishment Sava GIS database (**geodatabase**)

Establishment of **web-based application for data and metadata management**

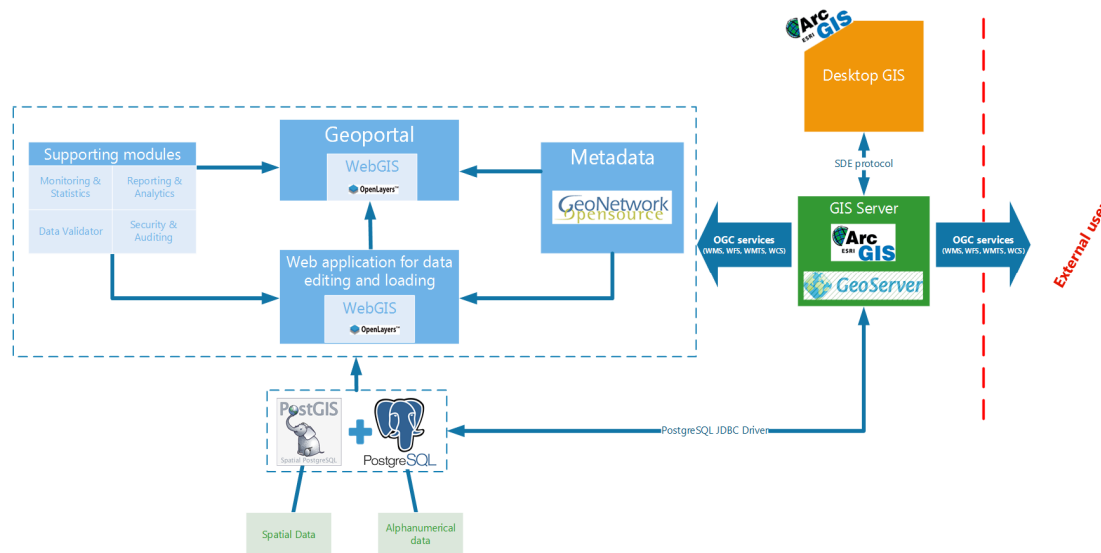
Establishment of **Sava Geoportal** for searching, disseminating, processing and visualization information to the stakeholders and public

Knowledge transfer/Trainings

- Supported by – European Commission
- Consultant – IN2&IGEA Consortium
- Duration of assignment – from January to October 2015

SavaGIS architecture and infrastructure

- OS: Windows Server 2012 R2 Standard
- RDBMS: PostgreSQL ver. 9.3.5 with PostGIS ver. 2.1.7 extension
- GIS Server:
 - **GeoServer** ver. 2.7.0 (multiple instances related to cluster)
 - Esri ArcGIS for Server Enterprise Standard ver. 10.3
- Metadata catalogue: GeoNetwork ver. 2.10.5
- Java server: Apache Tomcat ver. 7.x
- Desktop GIS software: Esri ArcGIS for Desktop Standard ver. 10.3



Databases (*.fgdb)

- **Database model is created based on**

- WFD reporting Guidance 2016 v.4.9
- FD reporting Guidance 2013
- INSPIRE Directive and professional requirements
- ICPDR database models

RBM database model contains

- Topographic
- Management
- Surface waters
- Ground waters
- Protected areas
- Pollution
- Urban Waste Waters
- Monitoring

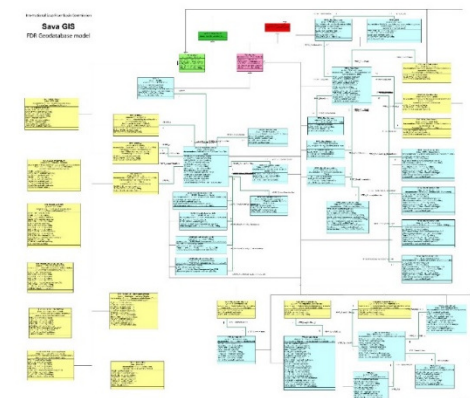
2 Feature Datasets,
27 Feature Classes,
88 Tables (Object Classes),
93 Relationship Classes and
109 Domains



FRM database model contains

- Preliminary Flood Risk Assessment
- Areas with Potential Significant Flood Risk
- Flood Hazard and Risk Maps
- Historical Floods
- Flood Protection Structures

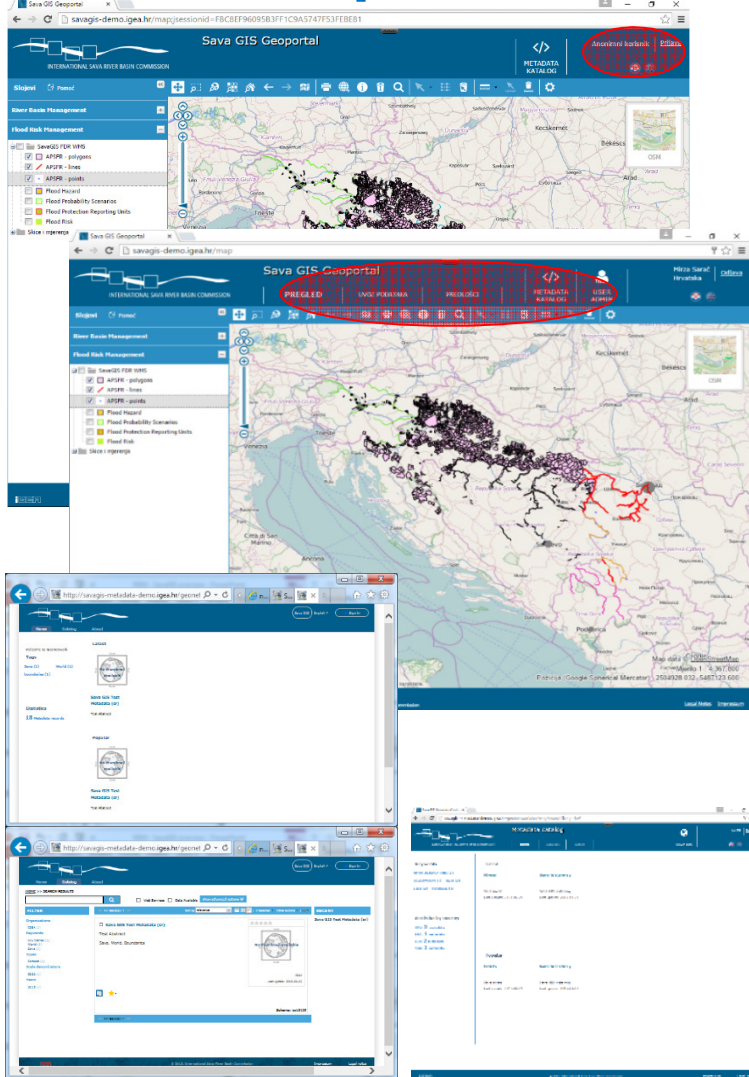
1 Feature Dataset,
17 Feature Classes,
26 Tables (Object Classes),
30 Relationship Classes and
26 Domains



SavaGIS products



SavaGIS Geoportal <http://savagis.org/>



Public users

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

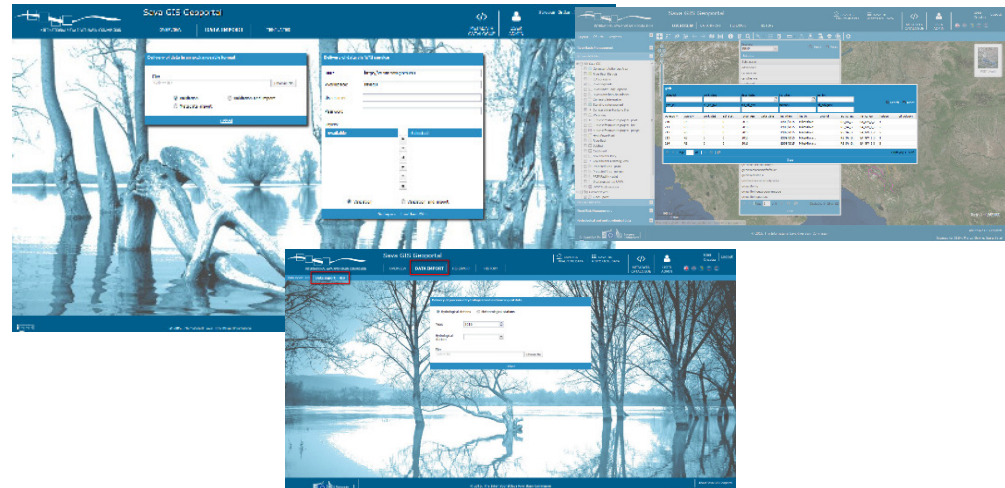
Registered users

web application for data management

Data and metadata upload Data and metadata download

- | | | |
|---|--|---|
| <ul style="list-style-type: none"> - FGDB - XLS - XML - WFS of GML format - Harvesting - Manually | <p>Spatial formats</p> <ul style="list-style-type: none"> - SHAPE file - GeoJSON file - KML file - GML2 file - WFS & WMS services | <p>Attribute formats</p> <ul style="list-style-type: none"> - CSV - XLS - MSAccess2010 - DBF - XML - WATER ML 2.0 service |
|---|--|---|

Data management



Metadata catalogue

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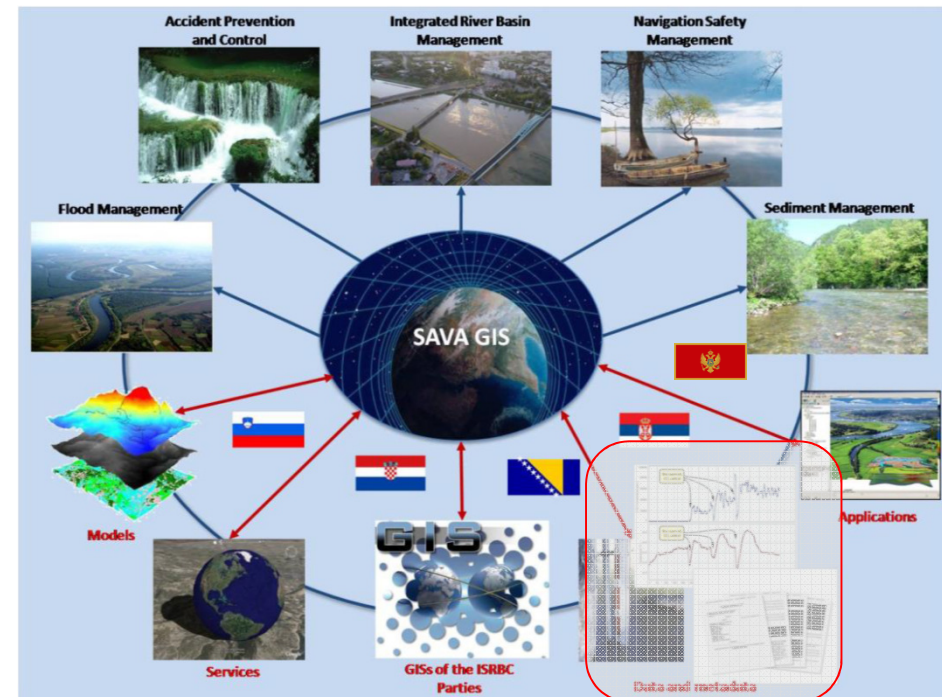
Time-series data management

Sava Hydrological Information System



- **Overall objective of the SavaHIS**

- To support **the ISRBC community** in sharing and disseminating of hydrologic and meteorological data, information and knowledge about the water resources in the Sava River basin
- To enable an **effective common channel** for exchanging and viewing the hydrologic and meteorological data and information in emergency situations, primarily those related to flood events



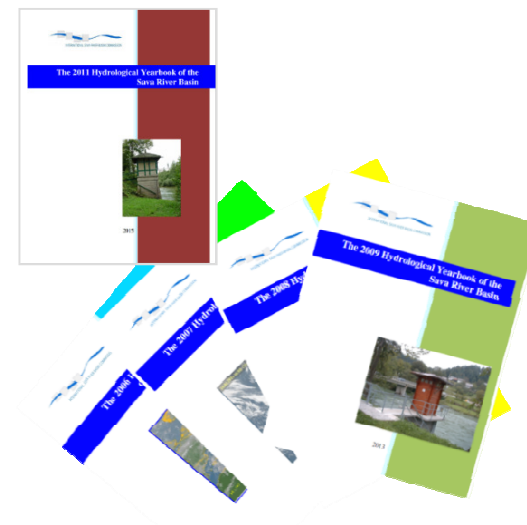
Report on **Floods in May 2014**



Implementing Documents for Establishment of the Sava GIS, 2010

Exchange of H&M data and information

- Development of **Hydrological Yearbooks**
 - Data on **selected hydrological gauging stations**
 - Data on **selected meteorological stations**
 - the **first since 1986**
 - **2006, 2007, 2008, 2009, 2010 and 2011 issues** available on the ISRBC web-site
 - **2000-2005 issue** under finalization
 - Starting with the 2007 issue, **data for Montenegro included**
- **System for exchange** of hydrological data
 - **first ever web app that provide** the water users with the **access to a complete, basic information** on the **water regime** in the SRB at one place (web page of the ISRBC)
- **Joint in-situ discharge measurements** at border river sections



Exchange of H&M data and information

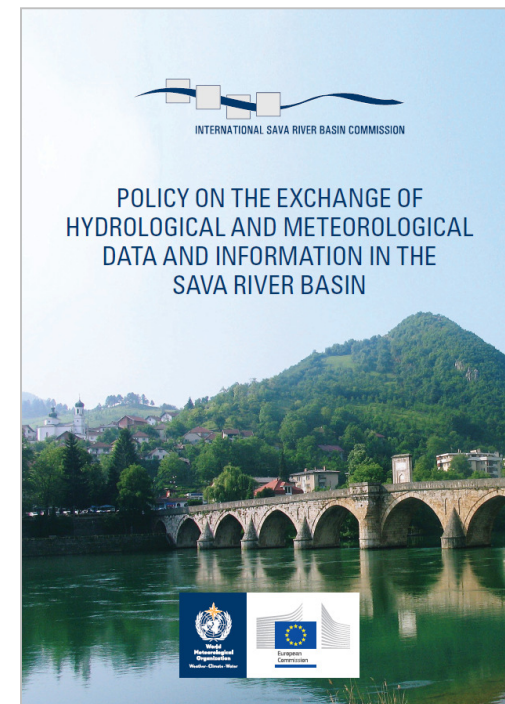
Step Forward – Data Policy



- International Legal Background
 - **Framework Agreement on the Sava River Basin**
 - **Protocol on Flood Protection to the FASRB**
 - WMO Resolution 25 (Cg-XIII) - Exchange of Hydrological Data and Products and Resolution 40 (Cg-XII) - Policy and Practice for the Exchange of Meteorological and Related Data and Products, the World Meteorological Organization
 - WMO encourages its Members to provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services in support of the protection of life and property and for the well-being of all peoples
 - The Convention on Cooperation for the Protection and Sustainable use of the Danube River
 - the Contracting Parties have agreed to the exchange of data related to the Danube River Basin and cooperation in the field of monitoring and assessment
- National Legal Background
- Data Policy - in accordance with the WMO/UNESCO International Glossary of Hydrology (WMO, No. 385, 3rd Edition, 2012)
 - First Data Policy document initiated by int'l basin organizations and supported by the WMO
 - Principles of exchange + Minimum level of exchange
 - Signed by NHMSs (6/6) and water agencies (2/4)

http://www.savacommission.org/basic_docs

OGC/WMO Workshop, Koblenz 13 June 2016



Time-series HM data management within Sava GIS Concept



CUAHSI Consortium of Universities for the Advancement of Hydrologic Science, Inc.
A consortium representing 125 US universities

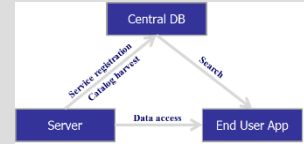
1. Standards

- WaterML language for describing water data



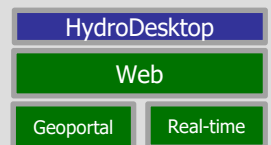
2. Services

- Catalog of water data sources – web services



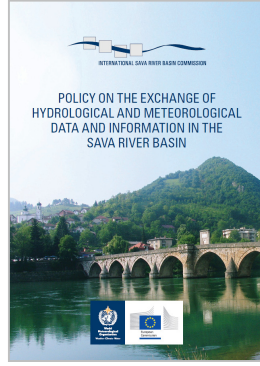
3. End user application

- Free software for data access



H&M database models are created based on

- WaterML 2.0 part 1: Timeseries model implementation
- INSPIRE Directive and professional requirements



Sava HIS project

- Project scope

Service/deliverable

Assessment of the **current hydrological and meteorological data collection**

Establishment of **Sava HIS geodatabase** for data storing as a part of Sava GIS database

Establishment of **web-based application for data management** as a part of Sava GIS Geoportal

Establishment of **web-based application for real time data management**

Knowledge transfer/Trainings

- Supported by – ICPDR, FMI and ISRBC
- Consultant – IN2&IGEA Consortium (SavaGIS project)
- Duration of assignment – from July to October 2015

Sava HIS project



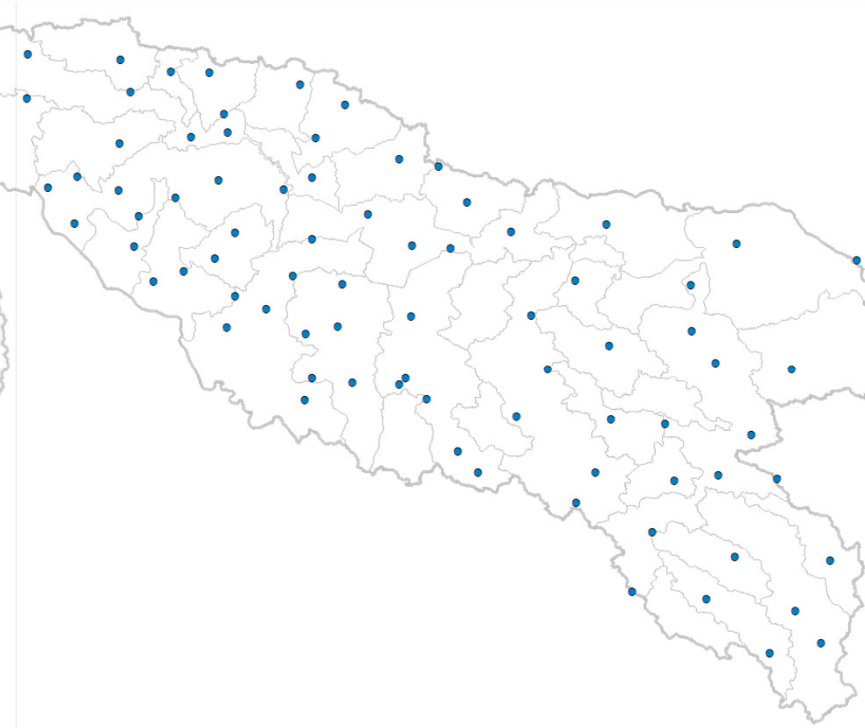
- **Assessment Phase** (during July)
 - Technical meetings was conducted in period 08-24 July:
 - BA:
 - 1. Republic Hydro-Meteorological Service of RoS**
 - 2. Federal Hydrometeorological Service**
 - 3. Sava River Watershed Agency**
 - ME:
 - 4. Institute of Hydrometeorology and Seismology**
 - HR:
 - 5. Meteorological and Hydrological Service**
 - 6. Croatian Waters**
 - RS:
 - 7. Republic Hydrometeorological Service**
 - 8. Agency for Environmental Protection**
 - SI:
 - 9. Slovenian Environment Agency**
 - Analyze of current status of processed and real time data delivery
 - Proposed format of data delivery

Sava HIS project

- **Gauges for the real-time application**



hydro: 88



meteo: 84

Sava HIS project



- Hydro Gauges for the real-time application**

ID	COUNTRY	NAME	RIVER
1	SI	Radovljica I	Sava
2	SI	Šentjakob	Sava
3	SI	Litija I	Sava
4	SI	Hrastnik	Sava
5	SI	Jesenice na Dolenjskem	Sava
6	HR	Crnac	Sava
7	HR	Podsused/Ž	Sava
8	HR	Zagreb	Sava
9	HR	Rugvica	Sava
10	HR	Trebež Gate	Sava
11	HR	Jasenovac	Sava
12	HR	St.Gradiška	Sava
13	BA	Gradiška	Sava
14	HR	Mačkovac	Sava
15	BA	Srbac	Sava
16	HR	Davor	Sava
17	HR	Sl.Kobaš	Sava
18	HR	Sl.Brod	Sava
19	HR	Sl.Šamac	Sava
20	BA	Grebnice	Sava
21	HR	Županja	Sava
22	HR	Gunja	Sava
23	RS	Jamena	Sava
24	RS	S.Mitrovica	Sava
25	RS	Šabac	Sava
26	RS	Beograd	Sava

ID	COUNTRY	NAME	RIVER
27	SI	Moste I	Ljubljana
28	SI	Nazarje	Savinja
29	SI	Laško I	Savinja
30	SI	Veliko Širje I	Savinja
31	SI	Podbočje	Krka
32	SI	Rakovec I	Sotla
33	HR	Zelenjak	Sutla
34	HR	Zlatar Bistrica	Krapina
35	HR	Kupljenovo	Krapina
36	SI	Metlika	Kolpa
37	HR	Karlovac	Kupa
38	HR	Jamnička Kiselica	Kupa
39	HR	Farkašić	Kupa
40	HR	Turkovići	Gornja Dobra
41	HR	Lešće Toplice	Donja Dobra
42	HR	Slunj-uzv.	Korana
43	HR	Veljun	Korana
44	HR	Velemerić	Korana
45	HR	Karlovac	Korana
46	HR	Vranovina	Glina
47	HR	Glina	Glina
48	HR	Maslenjača	Ilova
49	HR	Garešnica	Ilova
50	HR	Pavlovac	Česma
51	HR	Čazma	Česma
52	HR	Kostajnica	Una
53	BA	Kulen Vakuf	Una
54	BA	Kralje	Una
55	BA	Bosanska Krupa	Una
56	BA	Novi Grad-nizv.	Una
57	BA	Rmanj Manastir	Unac
58	BA	Sanski Most	Sana
59	BA	Prijedor	Sana
60	HR	Vidovci	Orljava
61	HR	Frkljevci	Orljava
62	BA	Gornji Vakuf	Vrbas
63	BA	Banja Luka	Vrbas
64	BA	Delibašino Selo	Vrbas
65	BA	Vrbanja	Vrbanja

ID	COUNTRY	NAME	RIVER
66	BA	Reljevo	Bosna
67	BA	Zenica	Bosna
68	BA	Maglaj-Poljice	Bosna
69	BA	Doboj	Bosna
70	BA	Sarajevo-Ćumurija	Bosna
71	BA	Olovo	Krivaja
72	BA	Kaloševići	Usora
73	BA	Strašanj	Spreča
74	BA	Karanovac	Spreča
75	BA	Srebrenik	Tinja
76	BA	Foča-nizv.	Drina
77	BA	Goražde	Drina
78	RS	Radalj	Drina
79	ME	Trebaljevo	Tara
80	ME	Bijelo Polje	Lim
81	RS	Prijepolje	Lim
82	RS	Lešnica	Jadar
83	HR	Vinkovci	Bosut
84	HR	Nijemci	Bosut
85	RS	Valjevo	Kolubara
86	RS	Slovac	Kolubara
87	RS	Beli Brod	Kolubara
88	RS	Draževac	Kolubara

Meteo Gauges for the real-time application

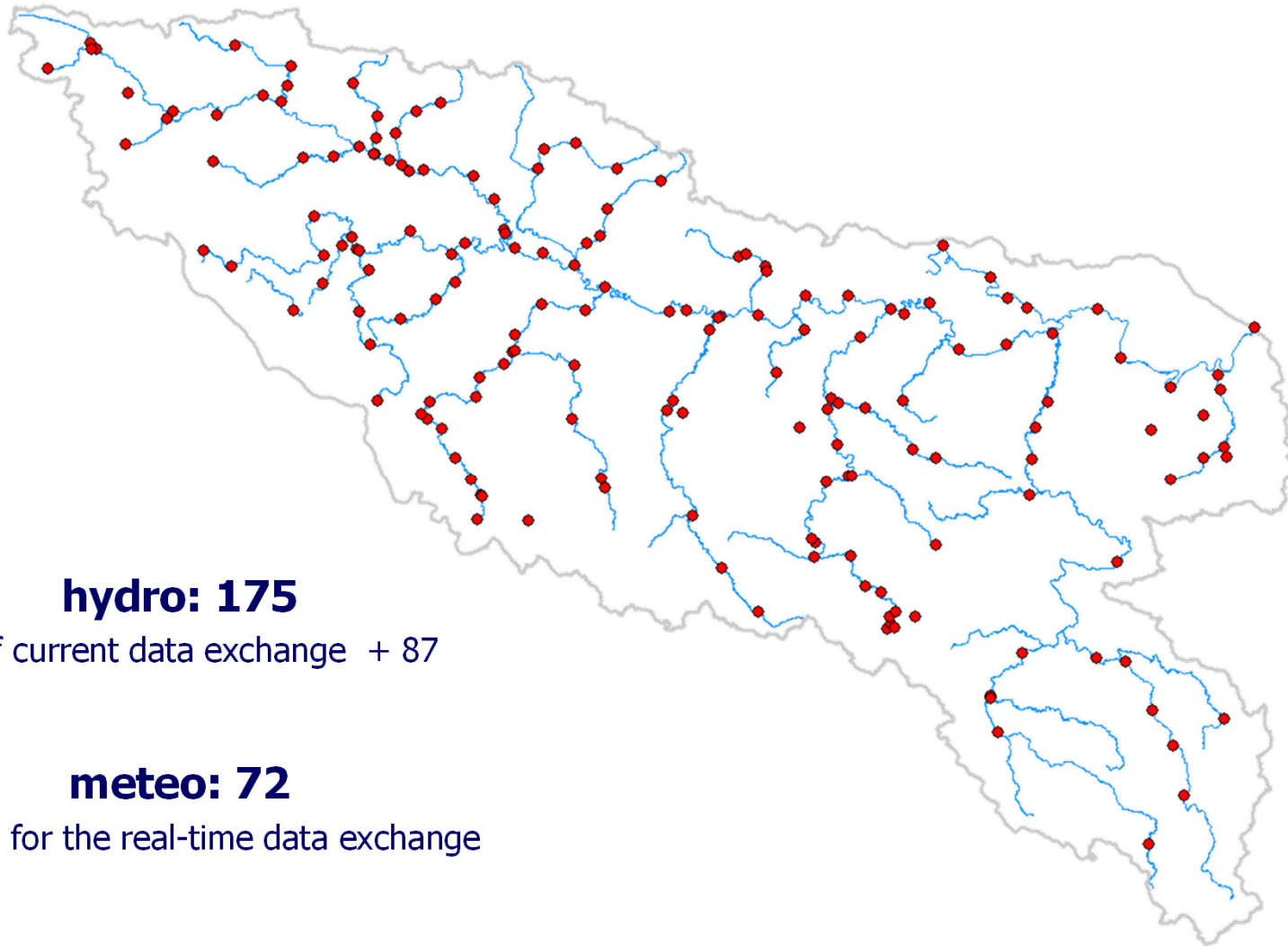


ID	COUNTRY	NAME	RIVER BASIN/SUBBASIN	
1	SI	Rateče	Sava Direct	Sava Direct
2	SI	Kredarica	Sava Direct	Sava Direct
3	SI	Vogel	Sava Direct	Sava Direct
4	SI	Lesce	Sava Direct	Sava Direct
5	SI	Krvavec	Sava Direct	Sava Direct
6	HR	Zagreb Grič	Sava Direct	Sava Direct
7	HR	Slavonski Brod	Sava Direct	Sava Direct
8	RS	Sremska Mitrovica	Sava Direct	Sava Direct
9	BA	Gradiška	Sava Direct	Sava Direct
10	BA	Srbac	Sava Direct	Sava Direct
11	SI	Postojna	Ljubljanica	Ljubljanica
12	SI	Ljubljana - Bežigrad	Ljubljanica	Ljubljanica
13	SI	Celje - Medlog	Savinja	Savinja
14	SI	Lisca	Savinja	Savinja
15	SI	Novo Mesto	Krka	Krka
16	SI	Podčetrtek - Atomske Toplice	Sotla/Sutla	Sotla/Sutla
17	HR	Krapina	Krapina	Krapina
18	HR	Puntijarka	Krapina	Krapina
19	HR	Stručec	Lonja	Lonja
20	HR	Križevci	Lonja	Glogovnica
21	HR	Bjelovar	Lonja	Česma
22	HR	Daruvar	Ilova	Ilova
23	HR	Parg	Kolpa/Kupa	Kolpa/Kupa
24	SI	Kočevje	Kolpa/Kupa	Kolpa/Kupa
25	SI	Črnomelj - Dobliče	Kolpa/Kupa	Kolpa/Kupa
26	HR	Karlovac	Kolpa/Kupa	Kolpa/Kupa
27	HR	Sisak	Kolpa/Kupa	Kolpa/Kupa
28	HR	Ogulin	Kolpa/Kupa	Dobra
29	BA	Cazin	Kolpa/Kupa	Korana
30	BA	Velika Kladuša	Kolpa/Kupa	Glina
31	BA	Drvar	Una	Una
32	BA	Bihać	Una	Una
33	BA	Bosanska Krupa	Una	Una
34	BA	Novi Grad	Una	Una
35	BA	Drinić	Una	Una
36	BA	Ribnik	Una	Sana
37	BA	Lušci Palanka	Una	Sana
38	BA	Sanski Most	Una	Sana
39	BA	Prijedor	Una	Sana
40	BA	Gornji Vakuf	Vrbas	Vrbas
41	BA	Bugojno	Vrbas	Vrbas
42	BA	Jajce	Vrbas	Vrbas

ID	COUNTRY	NAME	RIVER BASIN/SUBBASIN	
43	BA	Mrkonjić Grad	Vrbas	Vrbas
44	BA	Šipovo	Vrbas	Vrbas
45	BA	Banja Luka	Vrbas	Vrbas
46	BA	Bjelašnica	Bosna	Bosna
47	BA	Sarajevo-Bjelave	Bosna	Bosna
48	BA	Zenica	Bosna	Bosna
49	BA	Olovo	Bosna	Bosna
50	BA	Zavidovići	Bosna	Bosna
51	BA	Tuzla	Bosna	Bosna
52	BA	Doboj	Bosna	Bosna
53	BA	Gradačac	Tinja	Tinja
54	BA	Foča	Drina	Drina
55	RS	Zlatibor	Drina	Drina
56	BA	Višegrad	Drina	Drina
57	BA	Han Pijesak	Drina	Drina
58	RS	Bajina Bašta	Drina	Drina
59	RS	Krupanj	Drina	Drina
60	RS	Loznica	Drina	Drina
61	BA	Bijeljina	Drina	Drina
62	ME	Kolašin	Drina	Tara
63	ME	Žabljak	Drina	Tara
64	ME	Pljevlja	Drina	Čehotina
65	ME	Berane	Drina	Lim
66	ME	Bijelo Polje	Drina	Lim
67	RS	Sjenica	Drina	Uvac
68	BA	Sokolac	Drina	Prača
69	HR	Gradište	Bosut	Bosut
70	RS	Valjevo	Kolubara	Kolubara
71	BA	Čemerno	<i>Adriatic Sea</i>	<i>Adriatic Sea</i>
72	RS	Beograd-Vračar	<i>Danube</i>	<i>Danube</i>

Gauges for the Sava Geoportal

Historical (processed) data exchange



hydro: 175

list of current data exchange + 87

meteo: 72

same as for the real-time data exchange

Sava HIS project

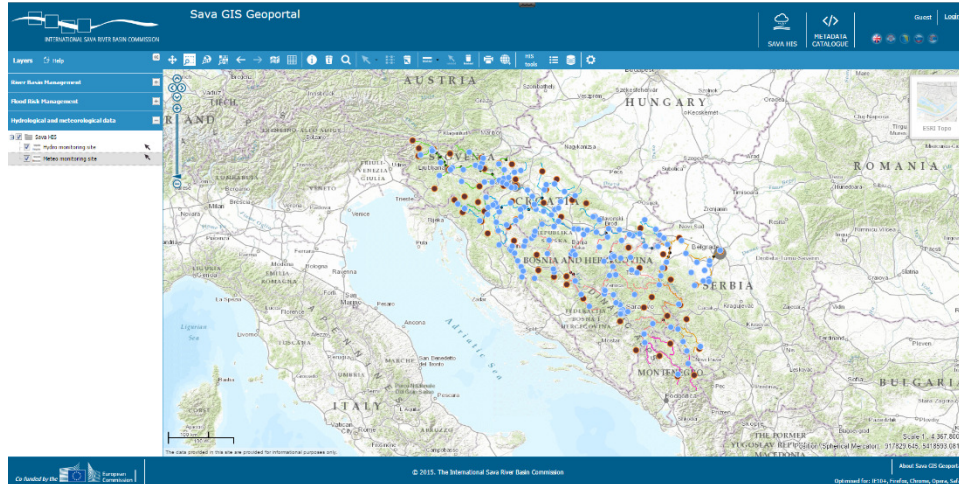


- Hydro Gauges for the Sava Geoportal – processed data exchange**

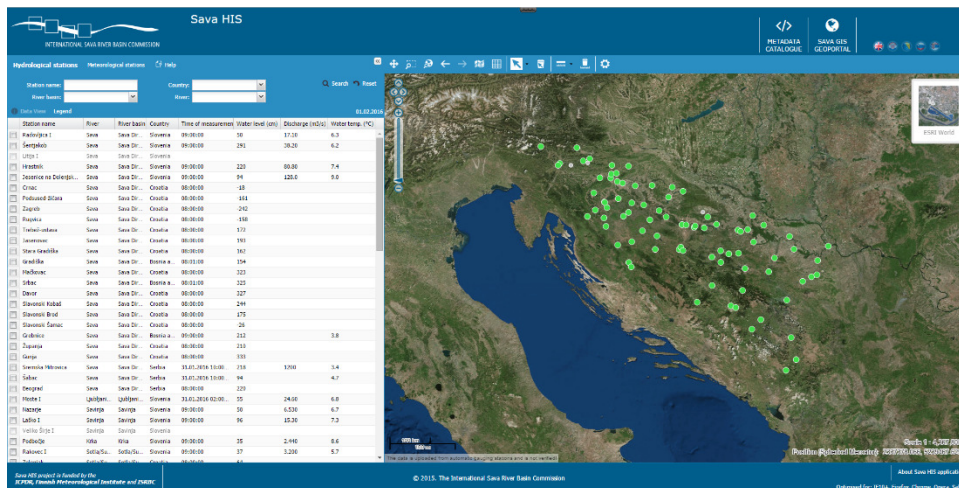
ID	COUNTRY	NAME	RIVER	ID	COUNTRY	NAME	RIVER	ID	COUNTRY	NAME	RIVER
1	SI	Blejski most	Sava Dolinka	31	HR	Veliko Vukovje	Ilova	61	BA	Kakanj n/B	Bosna
2	SI	Sveti Janez	Sava Bohinjka	32	HR	Ilova	Ilova	62	BA	Raspotočje	Bosna
3	SI	Bodešče	Sava Bohinjka	33	HR	Narta	Česma	63	BA	Žepče	Bosna
4	SI	Čatež I	Sava	34	HR	Šiščani	Česma	64	BA	Zavidovići n/B	Bosna
5	HR	Jesenice 2	Sava	35	HR	Donja Suvaja	Una	65	BA	Modriča	Bosna
6	HR	Medsave	Sava	36	BA	Martin Brod	Una	66	BA	Šamac	Bosna
7	HR	Jankomir-Preljev	Sava	37	HR	Štrbački Buk	Una	67	BA	Ilidža	Željeznica
8	HR	Dubrovčak Lijevi	Sava	38	BA	Ripač	Una	68	BA	Merdani	Lašva
9	HR	Tišina	Sava	39	BA	Bihać	Una	69	BA	Zavidovići n/K	Krivaja
10	HR	Strelečko	Sava	40	BA	Kostela	Una	70	BA	Karuše	Usora
11	HR	Gušće	Sava	41	BA	Bosanska Otoka	Una	71	BA	Modrac	Spreča
12	BA	Svilaj	Sava	42	HR	Dobretin	Una	72	BA	Stanić Rijeka	Spreča
13	BA	Brčko	Sava	43	BA	Novi Grad-uzv.	Una	73	BA	Bastasi	Drina
14	BA	Rača	Sava	44	HR	Struga Banska	Una	74	RS	Bajina Bašta	Drina
15	RS	Beljin	Sava	45	HR	Dubica	Una	75	BA	Šepak	Drina
16	SI	Suha I	Sora	46	BA	Drvar	Unac	76	BA	Čehotina	Čehotina
17	SI	Vrhnika	Ljubljana	47	BA	Donji Ribnik	Sana	77	RS	Brodarevo	Lim
18	SI	Celje II - brv	Savinja	48	BA	Ključ	Sana	78	RS	Priboj	Lim
19	SI	Podbukovje	Krka	49	HR	Požega	Orljava	79	BA	Rudo	Lim
20	SI	Gorenja Gomila	Krka	50	HR	Pleternica	Orljava	80	RS	Čedovo	Vapa
21	HR	Bratkovec	Sutla	51	BA	Daljan	Vrbas	81	BA	Drinjača	Drinjača
22	HR	Bračak	Krapina	52	BA	Kozluk	Vrbas	82	RS	Batrovci	Bosut
23	SI	Petrina	Kolpa	53	BA	Razboj	Vrbas	83	RS	Morović	Studva
24	HR	Hrvatsko	Kupa	54	BA	Viseći most	Ukrina	84	RS	Obrenovac	Kolubara
25	HR	Ladešić Draga	Kupa	55	BA	Prljača	Ukrina	85	RS	Bogovađa	Ljig
26	HR	Brodarci	Kupa	56	BA	Vrelo Bosne	Bosna	86	RS	Koceljewa	Tamnava
27	HR	Šišinec	Kupa	57	BA	Otes	Bosna	87	RS	Ćemanov most	Tamnava
28	HR	Stative Donje	Donja Dobra	58	BA	Butile n/B	Bosna				
29	HR	Plitvice	Plitvica	59	BA	Ljubnići	Bosna				
30	HR	Široka Rijeka	Glina	60	BA	Visoko n/B	Bosna				

- Meteo Gauges for the Sava Geoportal – same as for the real-time**

Sava HIS products



<http://savagis.org/>



<http://savahis.org/>

OGC/WMO Workshop, Koblenz 13 June 2016

- historical (processed) data exchange

Parameter	Temporal Resolution (Statistic)
Water Stage	Daily (Mean)
River Discharge	Daily (Mean)
Water Temperature	Daily (Mean)
Suspended Sediment Discharge	Daily (Mean)
Groundwater Level	Daily; Every 5/10th Day
Ice Condition	Daily
Relative Humidity	Daily
Wind (Speed and Direction)	Daily
Snow Depth	Daily
Evaporation	Daily (Total)
Solar Radiation	Daily
Sunshine	Daily (Total)
Atmospheric Pressure	Daily

- real-time data exchange

Parameter	Temporal Resolution
Precipitation	Daily (Total)
Air Temperature	Current
Water Stage	Current
River Discharge	Current
Water Temperature	Current

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