Western Balkans Investment Framework WBIF

Deltares
Enabling Delta Life

HEIS

Royal HaskoningDHV
Enhancing Society Together

Mihailo Anđelić

eptisa

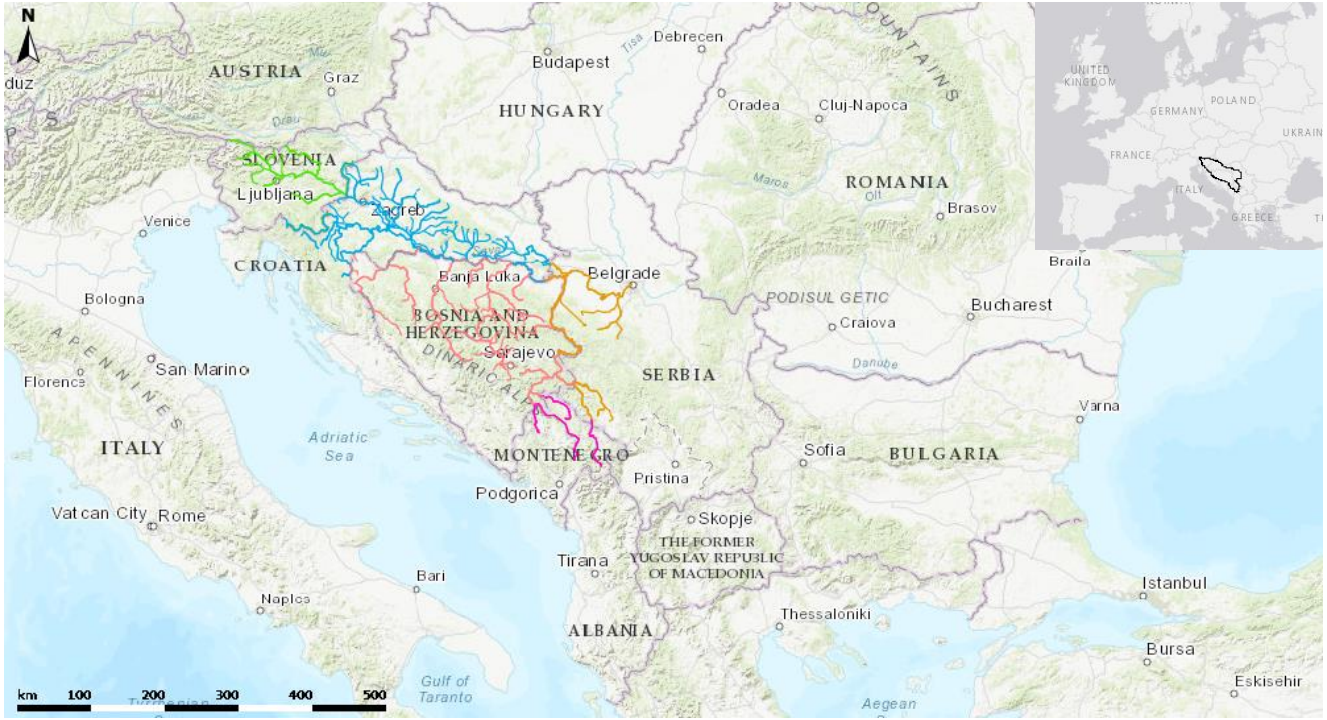
Sava Flood Forecasting and Warning System

Lessons from a Transboundary Basin

Delft-FEWS User Conference, March 2019

Klaas-Jan van Heeringen, Deltares, Delft

Sava river basin



- Slovenia
- Serbia
- Montenegro
- Croatia
- Bosnia and Herzegovina

Sava river basin

- **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
-

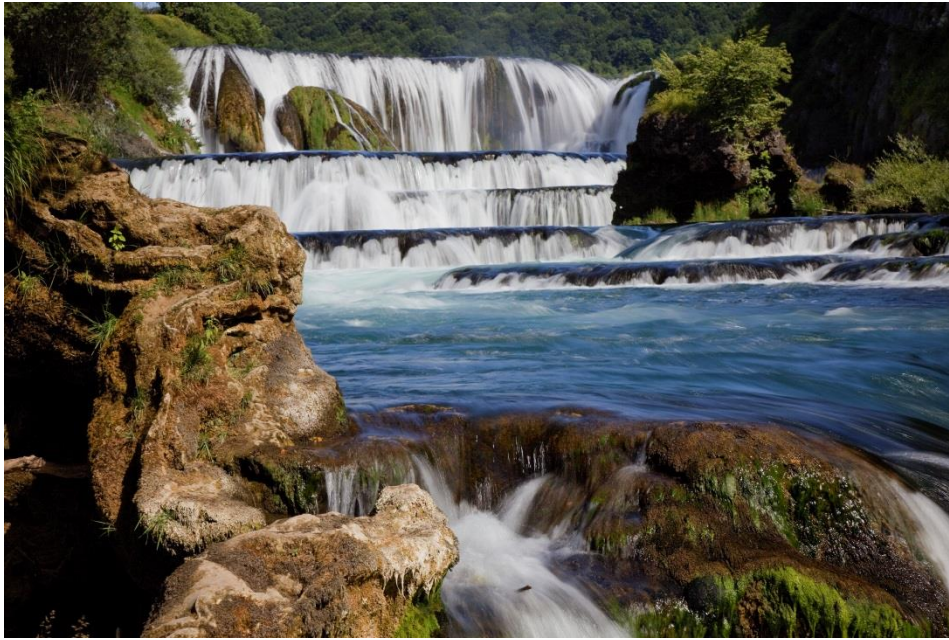
Country	Share of the basin (%)	Share of the territory (%)
Bosnia & Herzegovina	39.2	75.8
Croatia	26.0	45.2
Serbia	15.5	17.4
Slovenia	12.0	52.8
Montenegro	7.1	49.6
Albania	0.2	0.6

Sava river basin

Sava spring - Slovenia

Sava mouth - Serbia

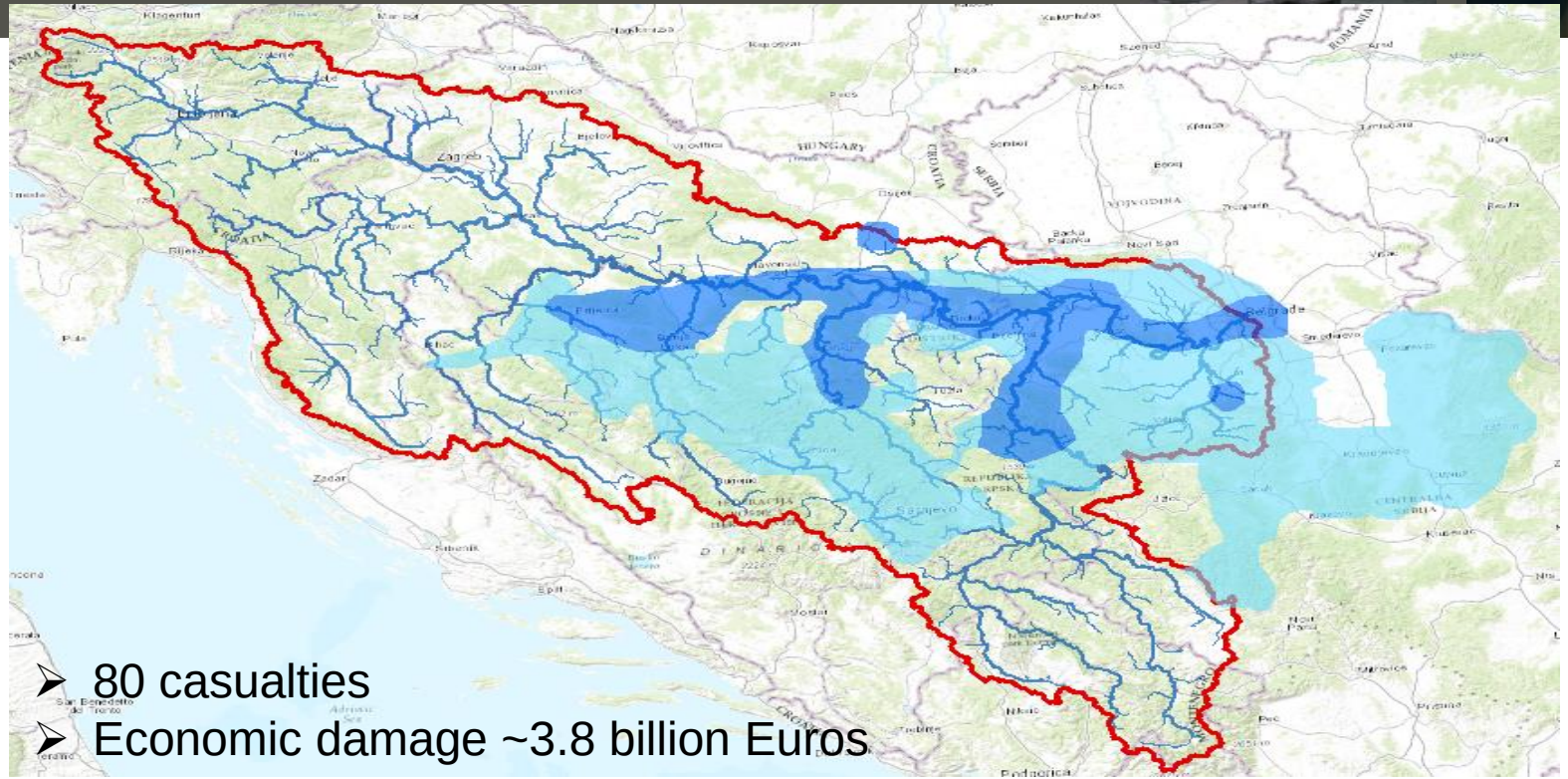
Tip for your next vacation?



May 2014

Photo taken by
Mathijs van Ledden @Royal HaskoningDHV

Affected communities….



- 80 casualties
- Economic damage ~3.8 billion Euros

Long way to the project

- From ’60s long and professional experience on hydro-meteo fc
- War in ’90s → all expertise drained
- After 2014 flood: Western Balkans Investment Framework WBIF

- Improvement of Joint Flood Management Actions in the Sava Basin
- Two components:
  - **Flood Forecasting and Warning System**
  - Flood Risk Management Plan

Consortium

Deltares
Enabling Delta Life

Lead, Delft-FEWS

Royal HaskoningDHV
Enhancing Society Together

Data and modeling

HEIS

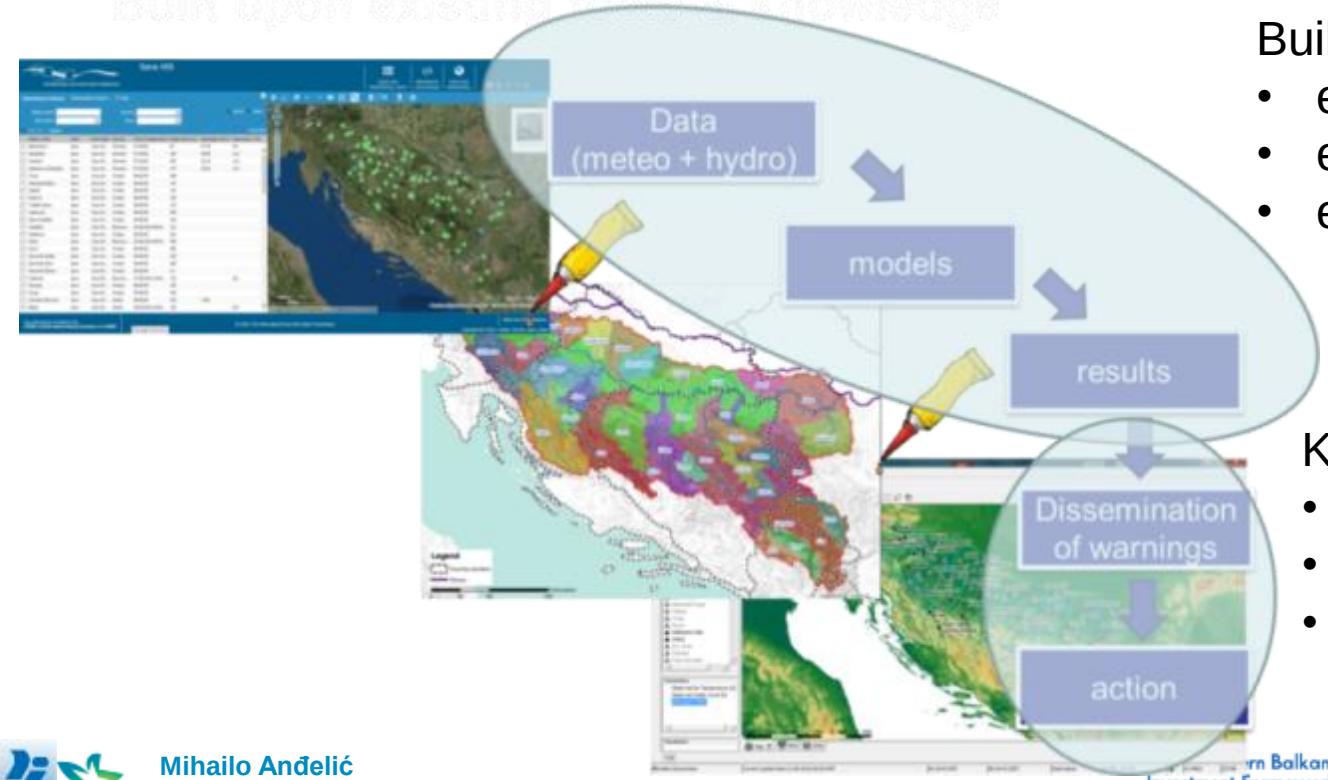
eptisa

Local expertise, data collection

Mihailo Anđelić

Independent, retired UN / FAO specialist

Project Scope



Built upon:

- existing Sava HIS
- existing models
- expert tool for forecasters

Key elements:

- one client-server platform
- hosted at 4 locations
- knowledge transfer & capacity building

Stakeholders

“5 countries”

Internat. Sava River Basin Commission

Hydrometeorological Services

Water Management Agencies

Ministeries

→ Total of 19 involved stakeholders over 5 countries
only 9 of them do actual hydrological forecasting

Stakeholder involvement

Country Working Group

→To secure the input of the **local interests**, knowledge and workflows

International Working Group

→ To harmonize the input of the Country Working groups

→ **Discuss international elements** of Sava FFWS

→ Test the milestone products before Steering Board meetings

Steering Board

→ To **monitor** FFWS development

→ Responsible for final **decision** and resolving issues if they arise

→ Assist Project team and share their opinion about the deliverables to WB and beneficiaries

Project Planning

June, 2016

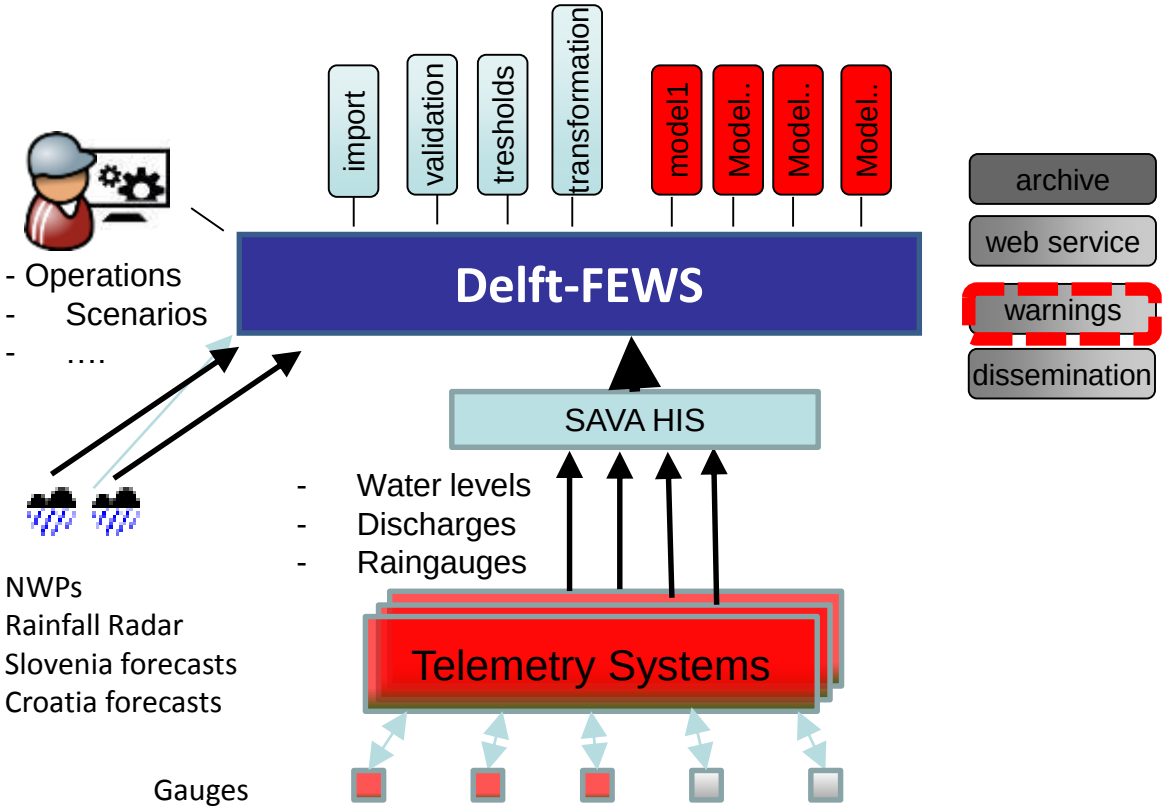
Oct 31, 2018

Month/phase	1	2	3	4	5	6	7	8	9	10	SB	WG	PM	reports	Deliverable
Jun 2016															
Jul 2016														draft inception	
Aug 2016														Inception	inception report
Sep 2016															
Oct 2016											A.1				
Nov 2016															
Dec 2016											A.2	IW1			
Jan 2017														manual	pre release 0.1
Feb 2017														intermediate	
Mar 2017												IW2			
Apr 2017											B				
May 2017															
Jun 2017												IW3		manual	pre release 0.2 + models
Jul 2017															
Aug 2017															
Sep 2017															
Oct 2017												IW4			
Nov 2017											C				
Dec 2017												IW5		manual	pre release 0.3
Jan 2018															
Feb 2018												IW6		manual	release 1.0
Mar 2018											D			T	
Apr 2018															
May 2018												IW7		intermediate	
Jun 2018												IW8		T	
Jul 2018															
Aug 2018														draft	testing results
Sep 2018															
Oct 2018											E	IW9		WS final	release 2.0

- Inception phase
- Data and GIS information
- Models in FFWS
- Uncertainty and forecasting
- Testing
- Testing by users
- Finalization

WS	Work shop
SB	Steering board
WG	International work group
PM	Project management
T	Training
	meetings
	monthly meeting

Components in Sava FFWS

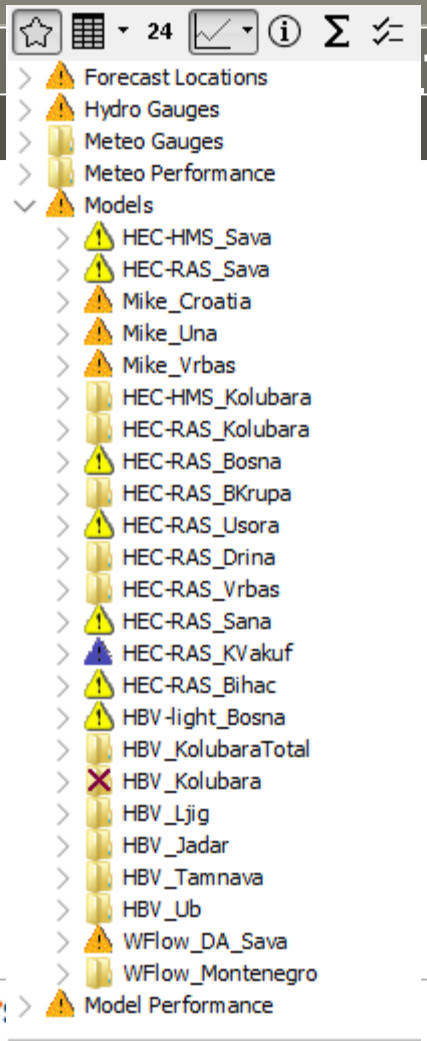


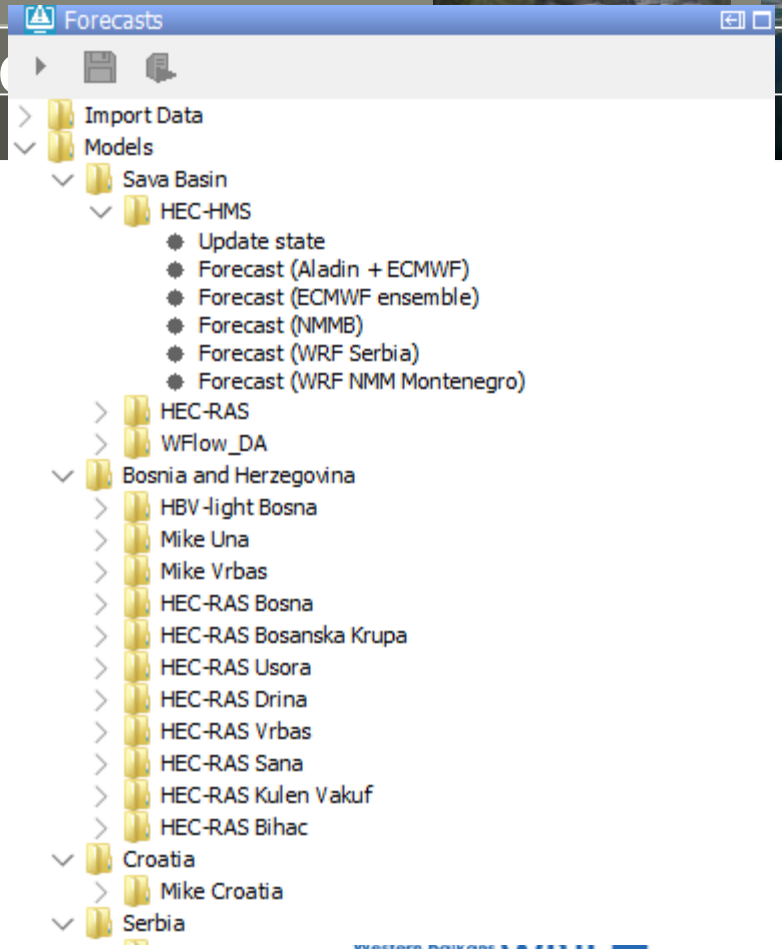
Deltares

Model implementations

Models \ NWP			Default Run			Manual User Run				
	Hydrological	Hydraulic	Aladin SI + ECMWF	Aladin HR + ECMWF	ECMWF EPS	NMMB	WRF BiH	WRF MNE 1km	WRF MNE 3km	WRF SRB
Basin	HEC-HMS Sava	HEC-RAS Sava	X		X	X			X	X
BA/RS/ME	WFlow (BA/RS/MNE)		X		X	X			X	X
Local	Mike-NAM (HR)	Mike 11 Croatia		X						
	Mike-NAM Una (BA)	Mike 11 Una		X						
	HBV-light Bosna (BA)		X		X	X	X		X	X
	HEC-HMS Sava	HEC-RAS Bosna (ISRBC)	X		X	X			X	X
	HEC-HMS Sava	HEC-RAS (BA) [9]	X		X	X			X	X
	Mike-NAM Vrbas	Mike 11 Vrbas	X		X	X	X		X	X
	Wflow MNE		X		X	X		X	X	X
	HEC-HMS Kolubara (SRB)	HEC-RAS Kolubara (SRB) [17]	X		X	X			X	X
	HBV (SRB) [5] Jadar, Kolubara, Tamnava,Ub, Ljig		X		X	X			X	X

Model

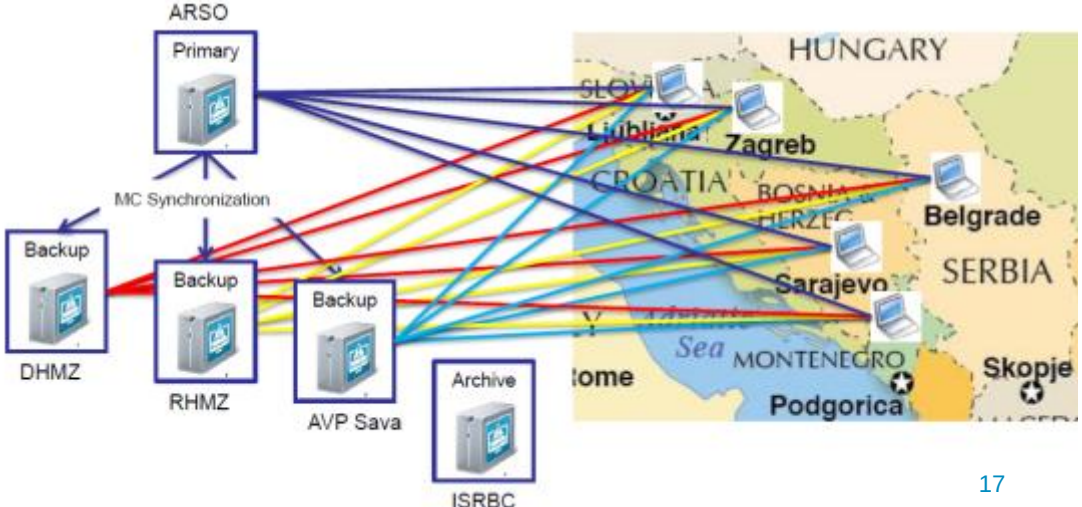

24
Forecast Locations
Hydro Gauges
Meteo Gauges
Meteo Performance
Models
HEC-HMS_Sava
HEC-RAS_Sava
Mike_Croatia
Mike_Una
Mike_Vrbas
HEC-HMS_Kolubara
HEC-RAS_Kolubara
HEC-RAS_Bosna
HEC-RAS_BKrupa
HEC-RAS_Usora
HEC-RAS_Drina
HEC-RAS_Vrbas
HEC-RAS_Sana
HEC-RAS_KVakuf
HEC-RAS_Bihac
HBV-light_Bosna
HBV_KolubaraTotal
HBV_Kolubara
HBV_Ljig
HBV_Jadar
HBV_Tamnava
HBV_Ub
WFlow_DA_Sava
WFlow_Montenegro
Model Performance

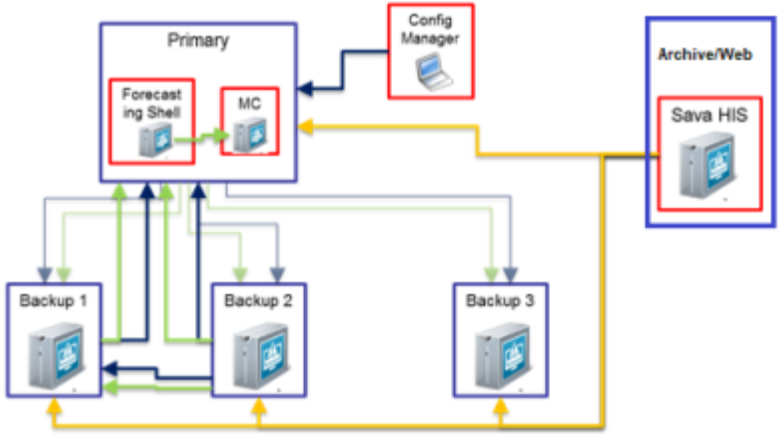

Forecasts
Import Data
Models
Sava Basin
HEC-HMS
Update state
Forecast (Aladin + ECMWF)
Forecast (ECMWF ensemble)
Forecast (NMMB)
Forecast (WRF Serbia)
Forecast (WRF NMM Montenegro)
HEC-RAS
WFlow_DA
Bosnia and Herzegovina
HBV-light Bosna
Mike Una
Mike Vrbas
HEC-RAS Bosna
HEC-RAS Bosanska Krupa
HEC-RAS Usora
HEC-RAS Drina
HEC-RAS Vrbas
HEC-RAS Sana
HEC-RAS Kulen Vakuf
HEC-RAS Bihac
Croatia
Mike Croatia
Serbia


Sava

Hosting

- Primary server and SavaHIS-RT: ARSO (Slovenia)
- 1st Backup and Testing server: RHMZ Serbia
- 2nd Backup server: AVP Sava (Sarajevo)
- 3rd Backup server: DHMZ Croatia
- Web/Archive server and SavaHIS : ISRBC (Zagreb)



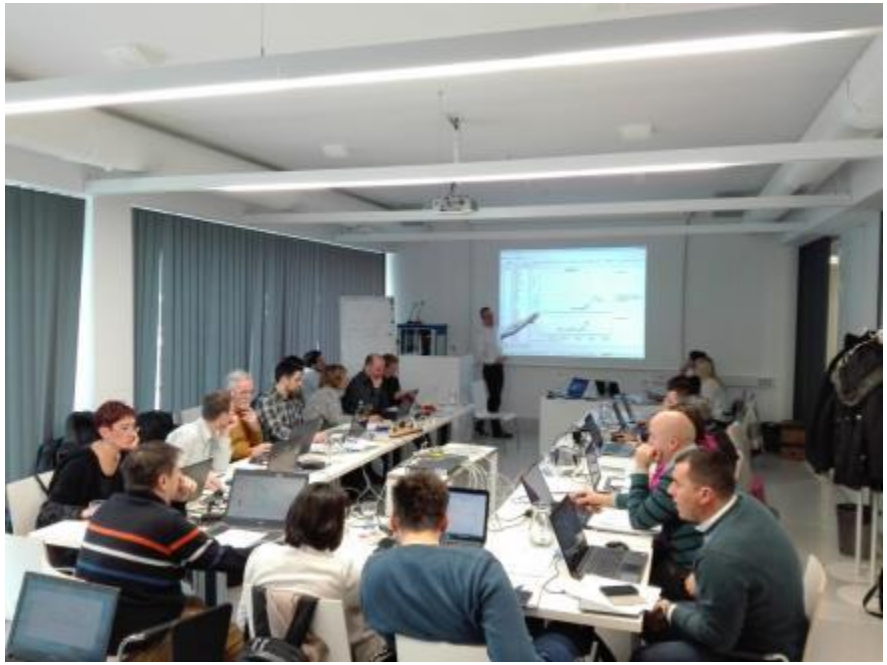


Events

→ Stakeholder involvement

- Kick off
- Inception Workshop
- Pre-releases
- Training IT staff
- Training of forecasters
- Workshops and meetings
- Webinars

Events: Pre-release 0.1 – Feb.2017 - Ljubljana



24 participants

Client-server at ARSO
Full telemetry and NWP collection

Events: Pre-release 0.2 – June 2017 - Ljubljana

31 participants

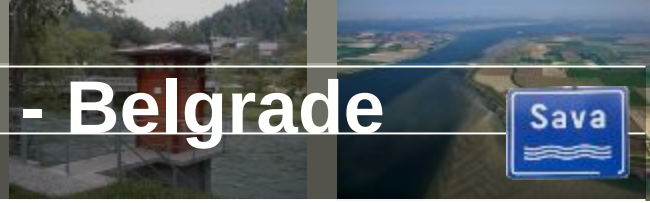
Client-server at ARSO
Full telemetry and NWP collection
Models included

Events: Pre-release 0.3 – Dec. 2017 - Ljubljana

31 participants

Client-server at 4 hosts
Full telemetry and NWP collection
Models included, **uncertainties, data assimilation, flood maps**
All features prior to testing

Events: Release 1.0 – Mar. 2018 - Belgrade



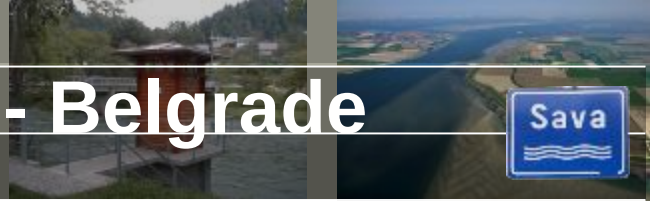
33 participants
Start of pre-operational testing

Trainings

- Along with pre-releases
- IT staff
- Forecasters – round 1, March 2018
  (Zagreb + Sarajevo)
- Forecasters – round 2, June 2018
  (Zagreb + Belgrade)

→ Key to (sometimes very needed) knowledge transfer

Events: Evaluation - Sept. 2018 - Belgrade



34 participants
Finalization towards release 2.0

Events: Release 2.0, Oct 25 - Final delivery

Official start of operational use by 9 forecasting institutions + ISRBC

Final delivery

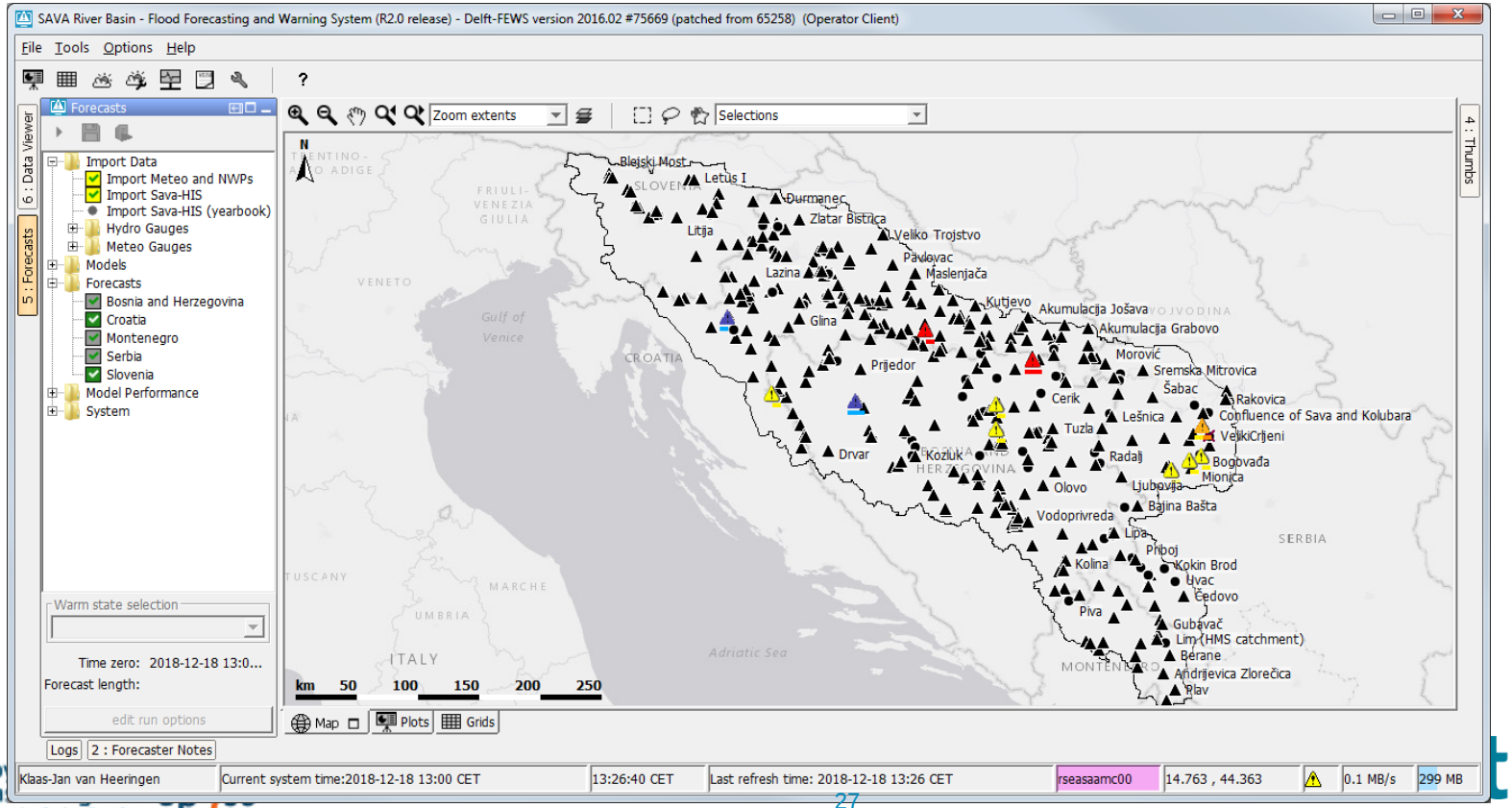
Project closure

Start of post-project phase

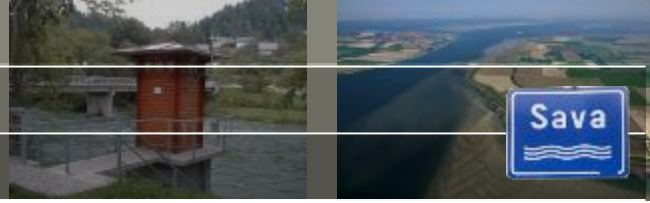
The Forecasting System

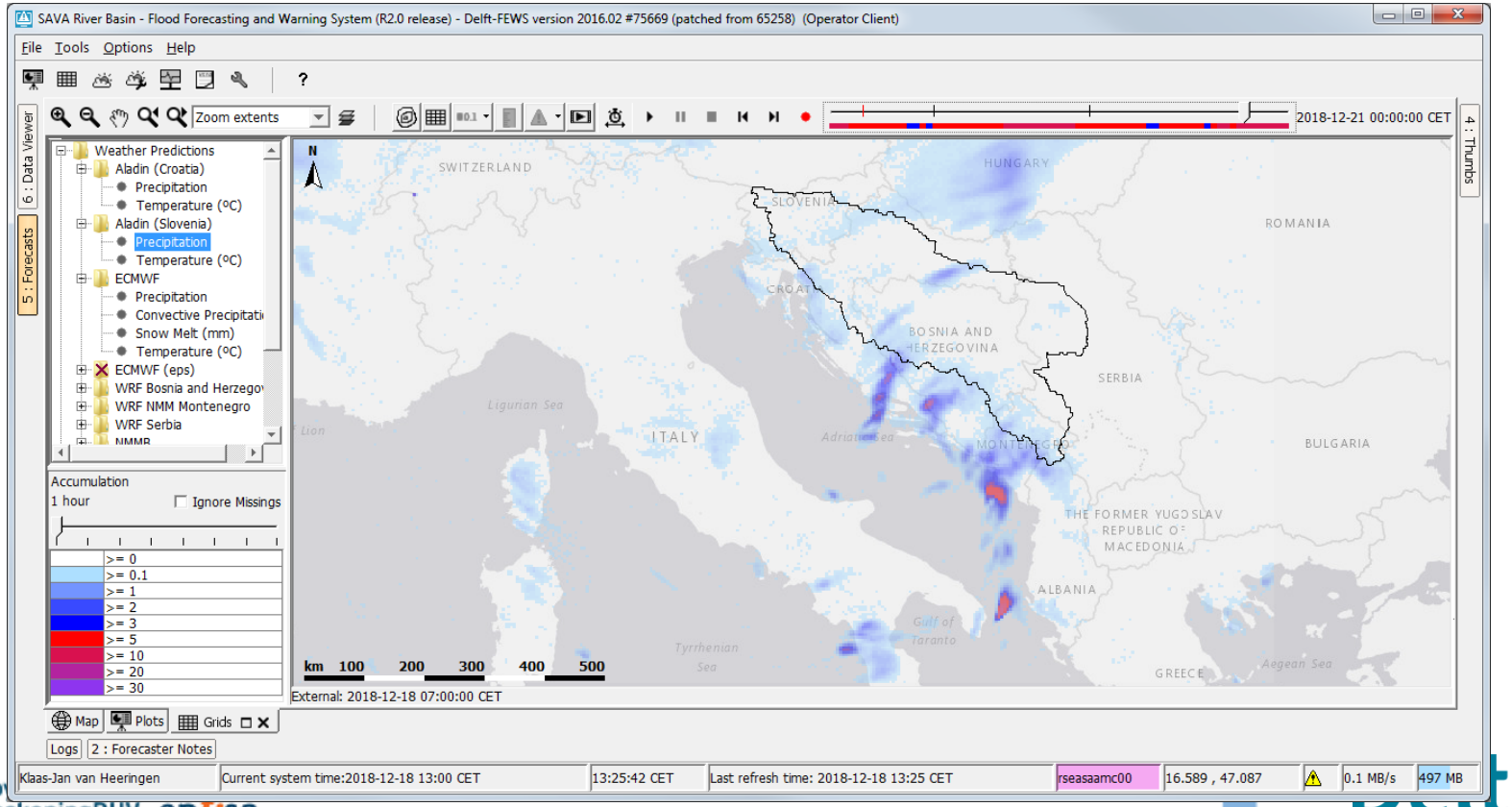
Splash screen …..

The Forecasting System



The Forecasting System





The Forecasting System

SAVA River Basin - Flood Forecasting and Warning System (R2.0 release) - Delft-FEWS version 2016.02 #75669 (patched from 65258) (Operator Client)

File Tools Options Help

Forecasts

- Import Data
  - Import Meteo and NWPs
  - Import Sava-HIS
  - Import Sava-HIS (yearbook)
  - Hydro Gauges
  - Meteo Gauges
- Models
- Forecasts
  - Bosnia and Herzegovina
  - Croatia
  - Montenegro
  - Serbia
  - Slovenia
- Model Performance
- System

Warm state selection

Time zero: 2018-12-18 13:0...

Forecast length:

edit run options

Šabac

Temperature (oC)

Precipitation (cumulative) (mm)

Precipitation (catch avg) (mm)

Discharge (m3/s)

Waterlevel (m)

2018-12-11 00:00 | 2018-12-14 00:00 | 2018-12-17 00:00 | 2018-12-20 00:00 | 2018-12-23 00:00 | 2018-12-26 00:00

T.obs Sremska Mitrovica
T.fc (ECMWF) Sremska Mitrovica [2]
P.obs.cum US_SAVA_358 [3]
P.fc.cum (ECMWF) (acc.) US_SAVA_358 [2]
P.obs.avg US_SAVA_358 [3]
P.fc.avg (ECMWF) US_SAVA_358 [2]
Q.sim WFlow SavaDown [4]
Q.sim.fc arma WFlow SavaDown ECMWF [5]
Q.sim.fc official [6]
H.obs Šabac
H.fc external [1]
H.sim.fc official [6]

Thumbs

Čemanov Most

Čedovo

Šabac

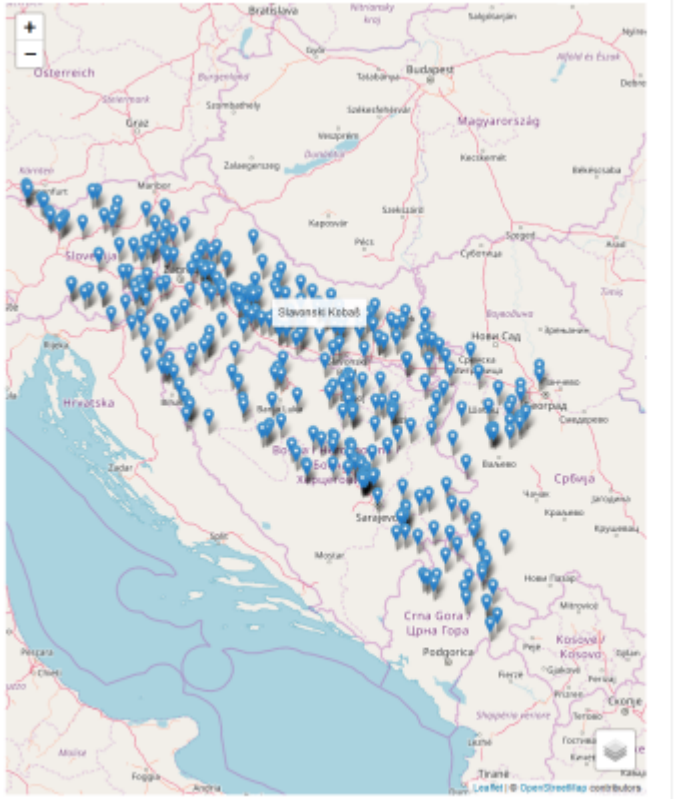
Map Plots Grids

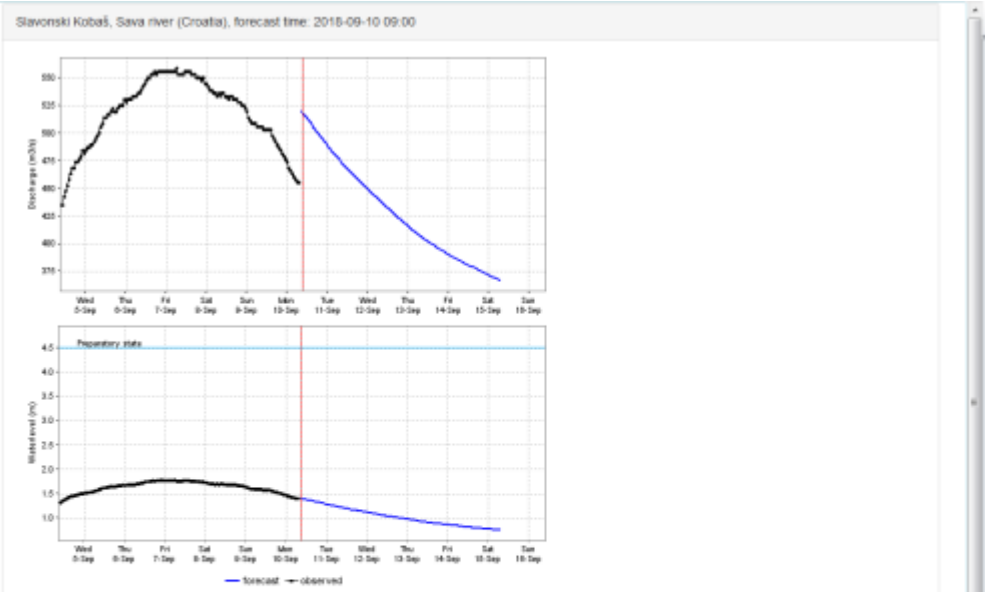
Logs 2 : Forecaster Notes

Klaas-Jan van Heeringen | Current system time:2018-12-18 13:00 CET | 13:36:00 CET | Last refresh time: 2018-12-18 13:35 CET | rseasaamc00 | 14.335 , 42.520 | 0.1 MB/s | 369 MB

Web Portal


Sava


Slavonski Kobaš
Österreich
Graz
Slovenija
Hrvatska
Budapest
Magyarország
Srbija
Crna Gora
Црна Гора
Podgorica
Kosovo
Косово
Tirane


Slavonski Kobaš, Sava river (Croatia), forecast time: 2018-09-10 09:00
Discharge (m3/s)
Waterlevel (m)
Preparatory state
forecast
observed

Post Project Organization

Three organizational levels:

1. Real-time operations (using the system)
2. Support and maintenance
3. Developments

Using various levels of communication and decision making

MoU in preparation (update March ’19: almost to be signed)

Sava FFWS and it's future potential

Identify and facilitate developments:

- Gap analysis (topics)
- Post Project Organization (process)
- Implementation of full DRM cycle

Awareness and looking for future products and users:

- Operational Water Management
- Navigation
- Tourism
- Hydropower
- Design
- Policy making (flood management plans)

Source: icpdr.org

Conclusions

- Sava FFWS is ready for operational use
- Focus to PPO and Gaps
- The Sava FFWS is solid platform for transboundary cooperation
- The Sava FFWS is solid platform for future extension

→ Not the first transboundary/int'l forecasting system,
but benchmark for others!?

Questions

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www.deltares.com

Software Delft-FEWS: http://fews.deltares.nl