

Coupling energy system modelling with hydrological modelling

Possible use of Sava River Basin Hydrological Model

Final Workshop on

ASSESSING THE WATER-FOOD-ENERGY-ECOSYSTEMS NEXUS AND BENEFITS OF TRANSBOUNDARY COOPERATION IN THE DRINA RIVER BASIN

19-20 April 2017 Sarajevo

Samo Grošelj, Mirza Sarač, International Sava River Basin Commission

ISRBC activities in modeling

Preliminary hydrological and hydralic models

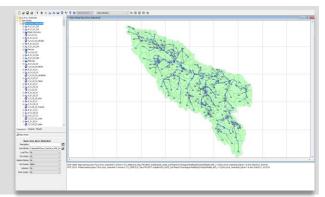
prepared by the USACE within the 1st phase of the US Government Support to the Sava countries (2009-2010)

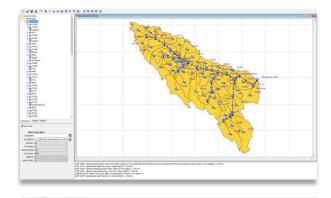
• Improved hydrological model

prepared by COWI within "WATCAP" project of the World Bank (2014)

Enhanced hydrological model

prepared by the USACE & ISRBC within the 2nd phase of the US Government Support to the Sava countries (2015-2017)





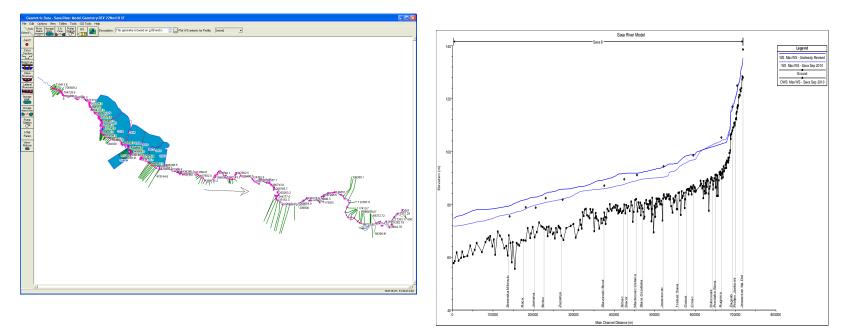


US Government support to the Sava countries (1st phase)



2009 - 2011

 Main goal: to develop a *single hydraulic model* of the Sava River and its major tributaries for the purpose of developing a comprehensive systems approach to flood risk management in the Sava River Basin



• **HEC products used** (HEC-RAS, HEC-DSS)

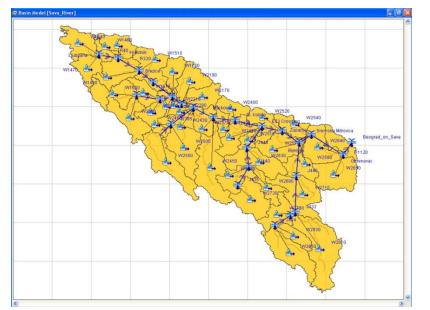
US Government support to the Sava countries (1st phase)

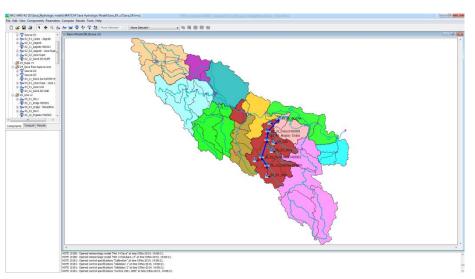


2009 - 2011

Hydrological model (HEC-HMS):

- for the sole purpose of developing flow hydrographs for a representative unsteady flow hydraulic model
- serve as a good starting point for further hydrologic analysis





• 1st Sava River Basin Modelling Workshop – September 2010

Further development of the models



2012 -2015

• Hydrologic model (HEC-HMS): WATCAP

- Purpose of this project was to assess the potential impacts of climate change on various water sectors such as navigation, hydropower, flood control, and irrigation
- Long-term continuous simulation model run at a daily time interval
- 14 models of main river basins separately analyzed
- Total delination: 44 sub-basins

No.	Sub-basin name	Area (km ²)
01	Sava to HS Čatež	10186
02	Sava to Kupa	2584
03	Kupa	10032
04	Sava to Una	6627
05	Una	9524
06	Sava to Vrbas	1840
07	Vrbas	6386
08	Sava to Bosna	4491
09	Bosna	10457
10	Sava to Drina	2866
11	Drina	19946
12	Sava to Kolubara	6818
13	Kolubara	3636
14	Sava to Beograd	1007



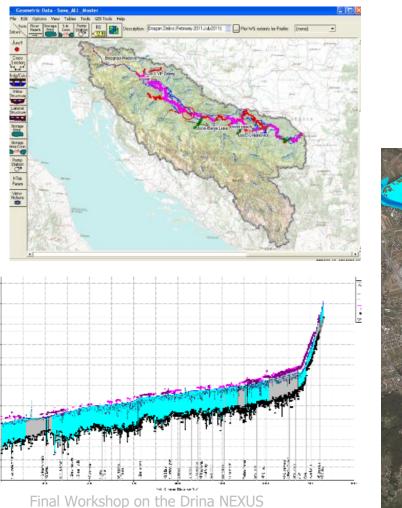
• 2nd Sava River Basin Modelling Workshop – December 2014

Further development of the models



2012 - 2015

• Hydraulic model (HEC-RAS) of the Sava River: ISRBC Secretariat





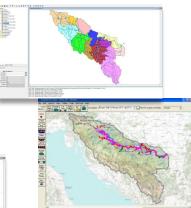


Activities within the U.S. Government – support to the Sava countries (2nd phase)



2015 - 2017

- 1. To support the **development of hydrological and hydraulic models** of the Sava River Basin, tools that will strengthen multilateral cooperation in the basin, primarily in the area of flood protection
- To support activities leading to the preparation of a flood risk management plan as well as the **development of the system for** flood forecasting
- 3. To establish the models that could be used for other purposes in future (modeling sediment transport, water quality, climate change analysis, etc.)
- Develop and Calibrate a flood event-based hydrologic model
- Improve upon the latest mainstem Sava River hydraulic model





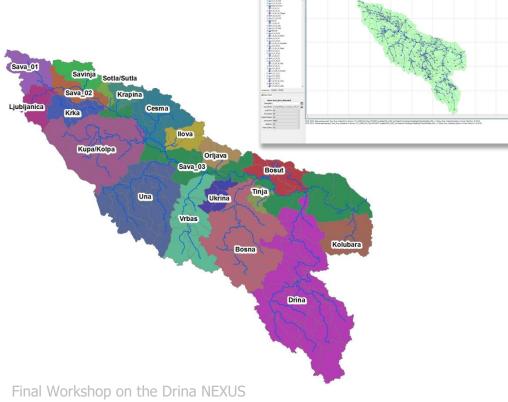
Sava HMS hydrological model

Technical support was provided by

US Army Corps of Engineers

Final 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 (Sava hydraulic model)
- 17 for the main tributaries





- On 16 Jan 2017, model(s) have been distributed to:
- ministries of the Parties to FASRB
- agencies/institutions responsible for water management of the Parties
- hydro-meteorological services of the Parties,
- relevant ministry of Montenegro
- in addition, models for specific sub-basins (Drina, Vrbas) have been delivered to hydropower companies which provided data for the related sub-models
- On 02-03 Mar 2017, workshop
 have been held
- attended by more than 40 participants representatives of the Parties, Montenegro and HPP companies



Sava RAS hydraulic model

Sava LiDAR project

• Areas (around 3.315 km2)

- Sava River course "levee to levee with
 the buffer zone" from SI-HR border to Belgrade
- Main retention areas along the Sava River
- Flooded areas due to levee breach 2014
- Bosutsko-Morovicka lowland forest area
- Cities Zagreb and Belgrade

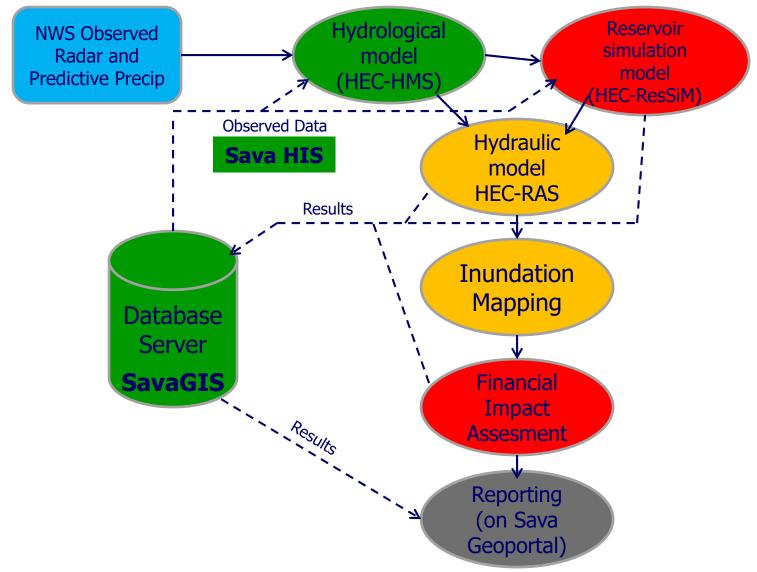


INTERNATIONAL SAVA RIVER BASIN COMMISSION

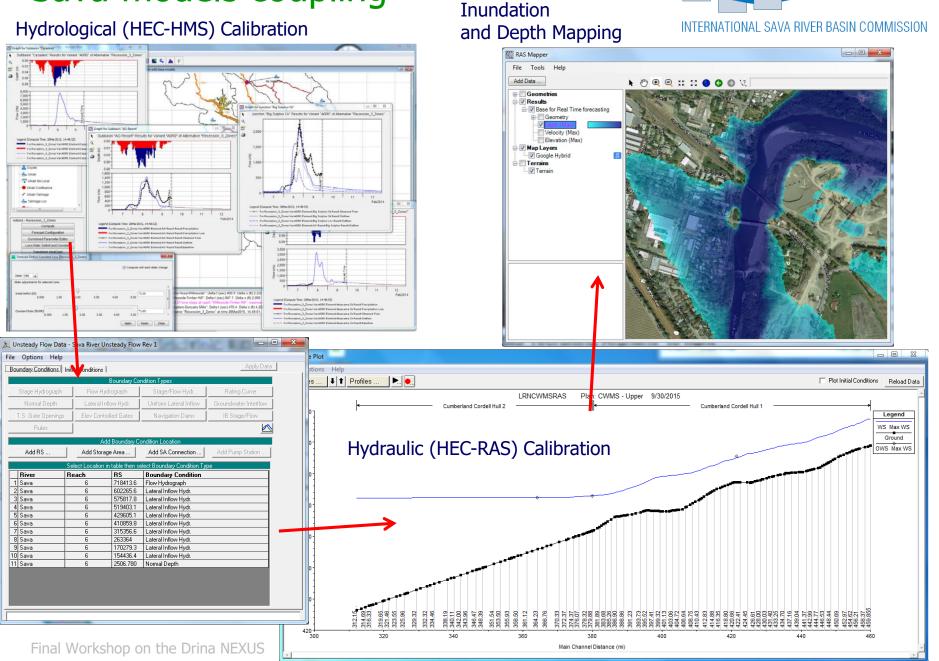
- The Consultant has contracted with the deadline end of May, 2017 for the final submission of products
- Improve upon the latest mainstem Sava River **hydraulic model**
 - Once the LiDAR derived products are completed, setting up of a new geometry of the model will start
 - The results from the calibrated hydrological HEC-HMS model (already completed as a first activity), will be used in hydraulic modelling

Sava models coupling - HEC structure





Sava models coupling

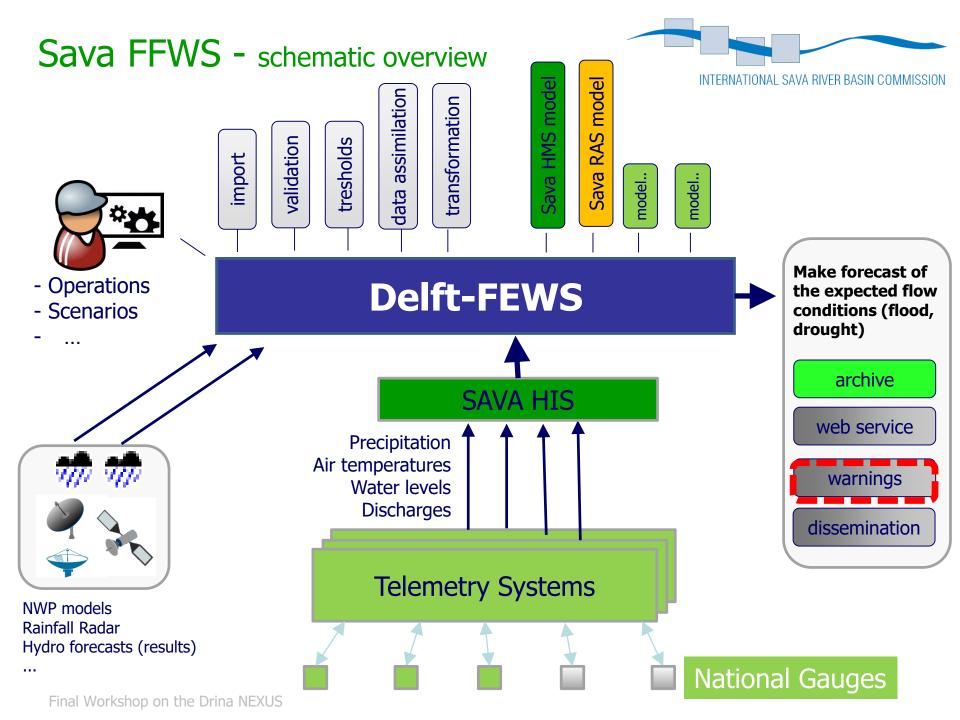


HEC-ResSIM – Further steps



- Modeling component simulates **reservoir operation**
- Allows user to input rules that **define guidelines** for reservoir operation
- Model then uses the rules to make decisions on how the reservoir should be operated
- User has ability to override ResSIM decisions

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