High-Resolution Flood Mapping at Regional to Continental Scales

ERDC
Engineer Research and Development Center

Global Flood Partnership Conference 2017

Tuscaloosa, AL | June 29th, 2017

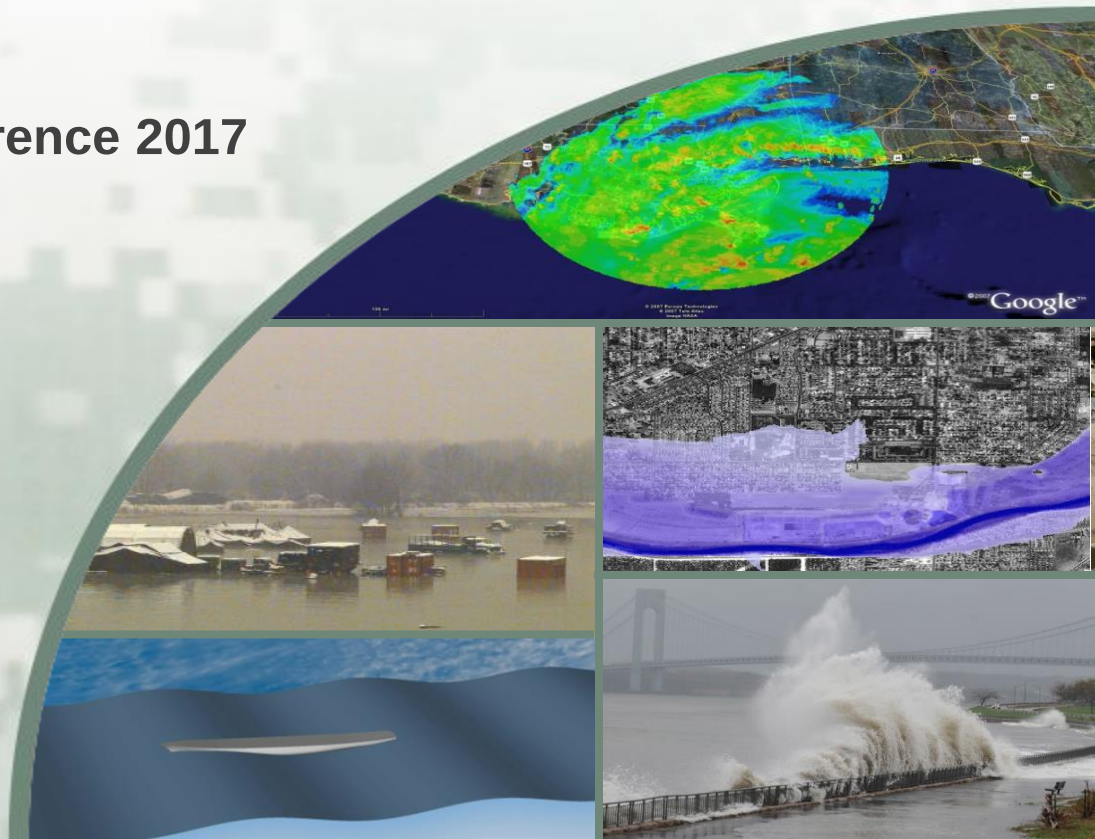
Mike Follum
Michael.L.Follum@usace.army.mil

Ahmad Tavakoly, PhD
Ahmad.A.Tavakoly@usace.army.mil

Mark Wahl, PhD
Mark.D.Wahl@usace.army.mil

Alan Snow
Alan.D.Snow@usace.army.mil

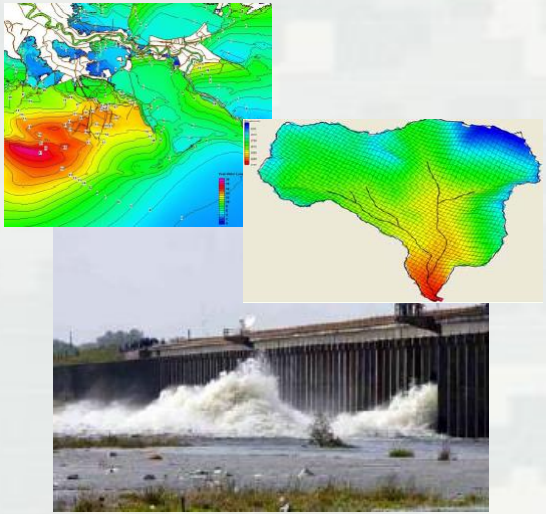
Overall Classification of Briefing is UNCLASSIFIED



USACE – ERDC – CHL: Three Focus Areas

Navigation

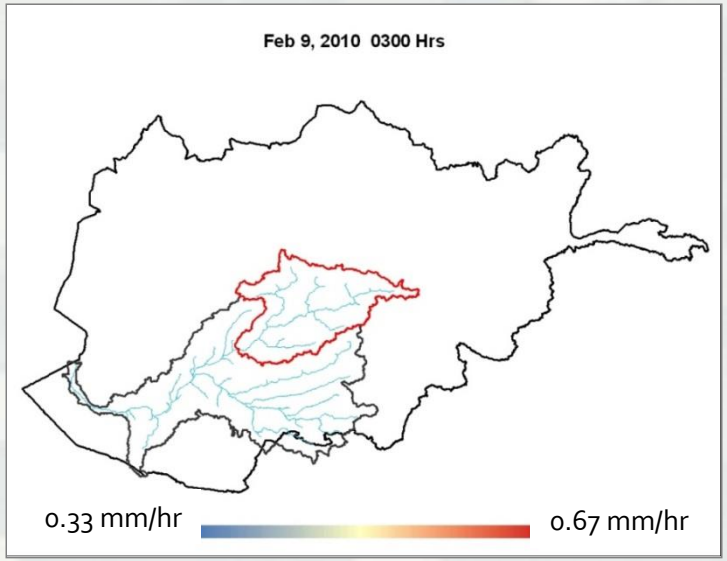
Flood and Coastal Storm Damage Reduction



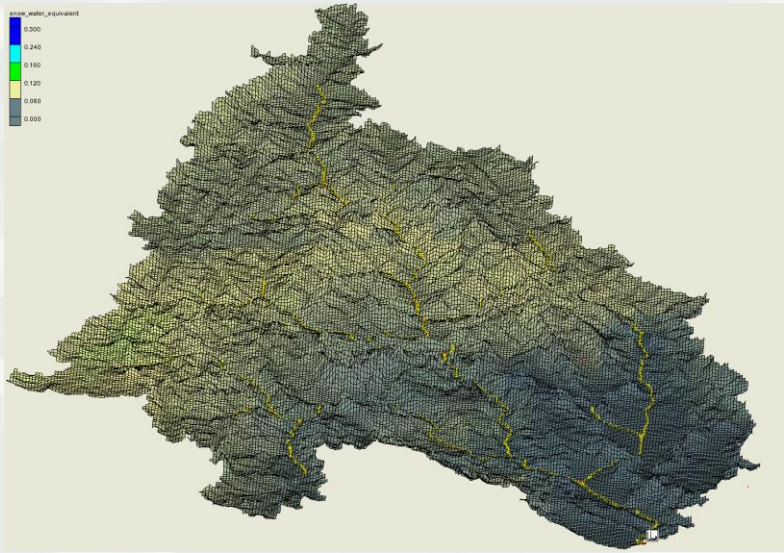
Military Hydrology

- CHL develops / deploys physical and numerical models to answer questions in these areas

Weather Informed Hydrology



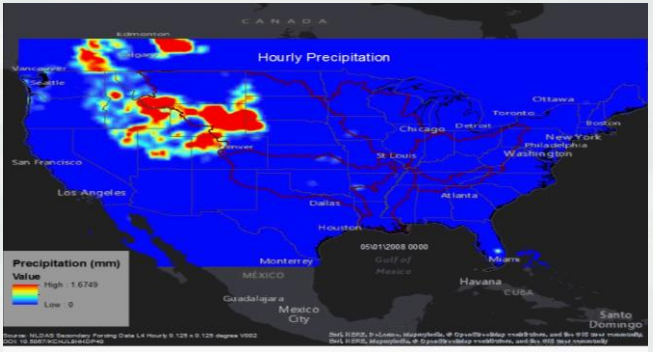
Upper Helmand Basin Simulation: January – June 2010

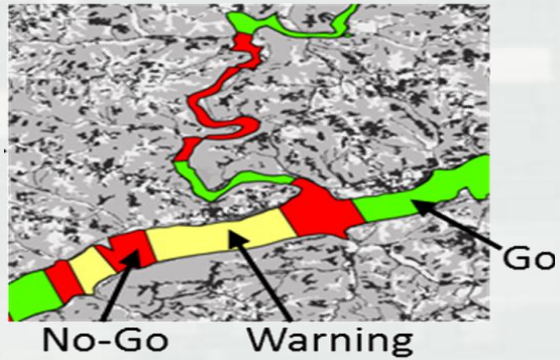


- **Watershed-based**
- **Manual setup**
- **Limited forecasting window**

Operational Informed Hydrology

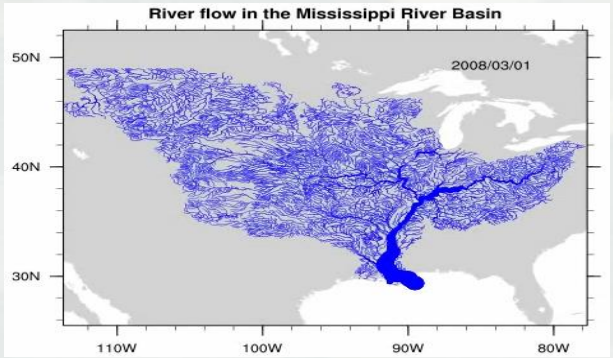
Operational Runoff Forecasts

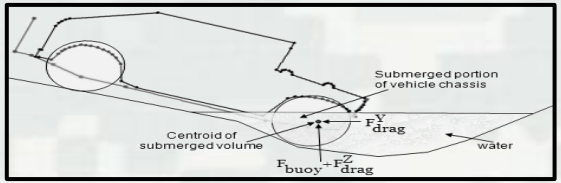


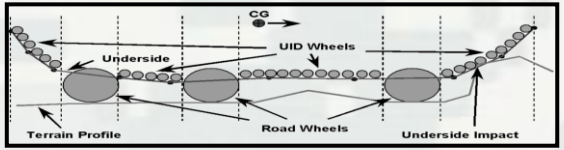


Gap-Crossing Maps

Streamflow: RAPID TEXAS

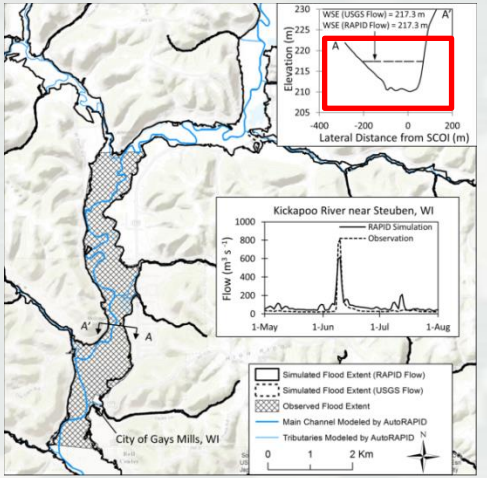






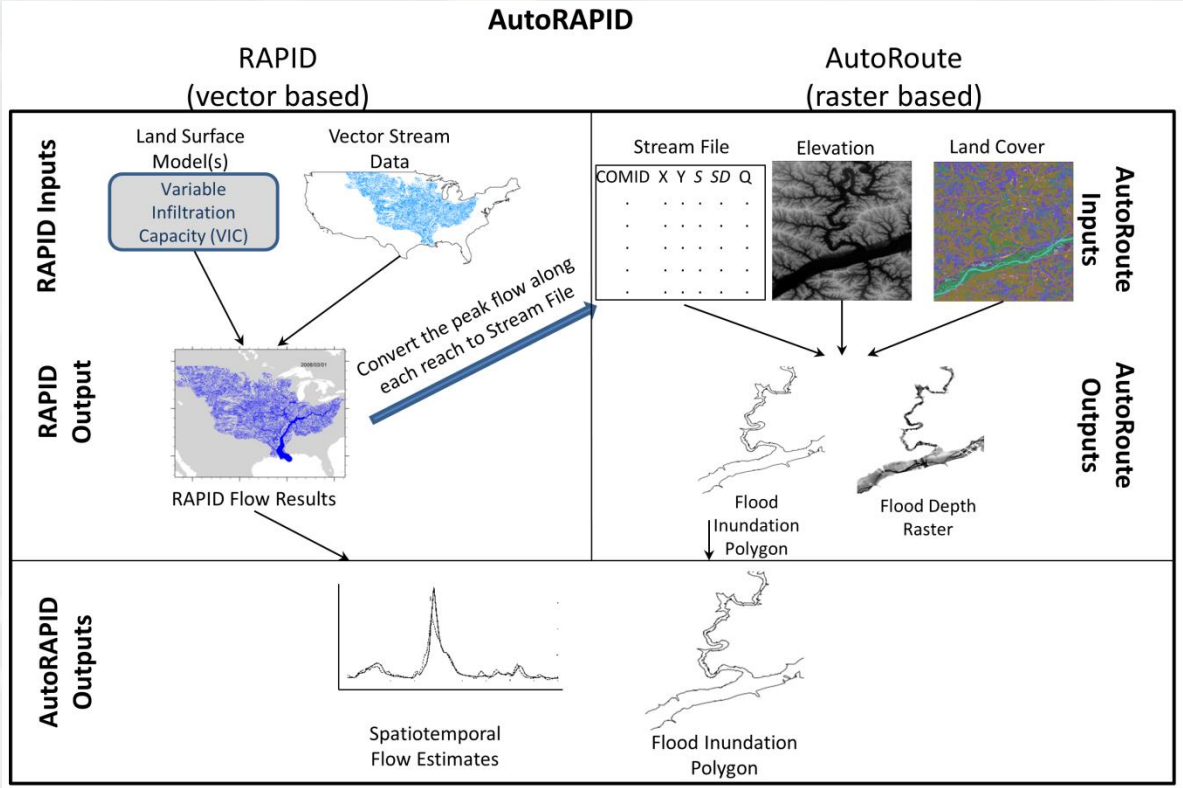
Mobility: VehDyn

Flood Map: AutoRoute



AutoRoute – Quick, Initial Estimate of Flood Inundation

- Raster-based model that calculates the normal flow depth for a large number of sampled floodplain cross-sections.
- Given a flow, AutoRoute quickly produces a flood depth raster and flood inundation polygon over large regions (1000's of km^2).



Follum et al., 2017

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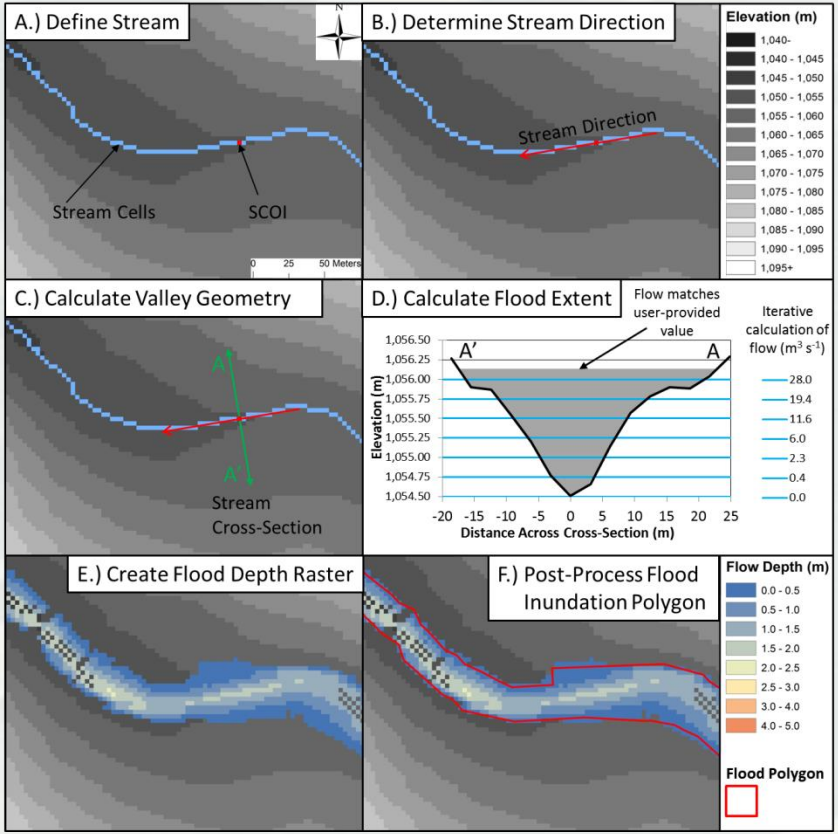


Follum et al., 2017

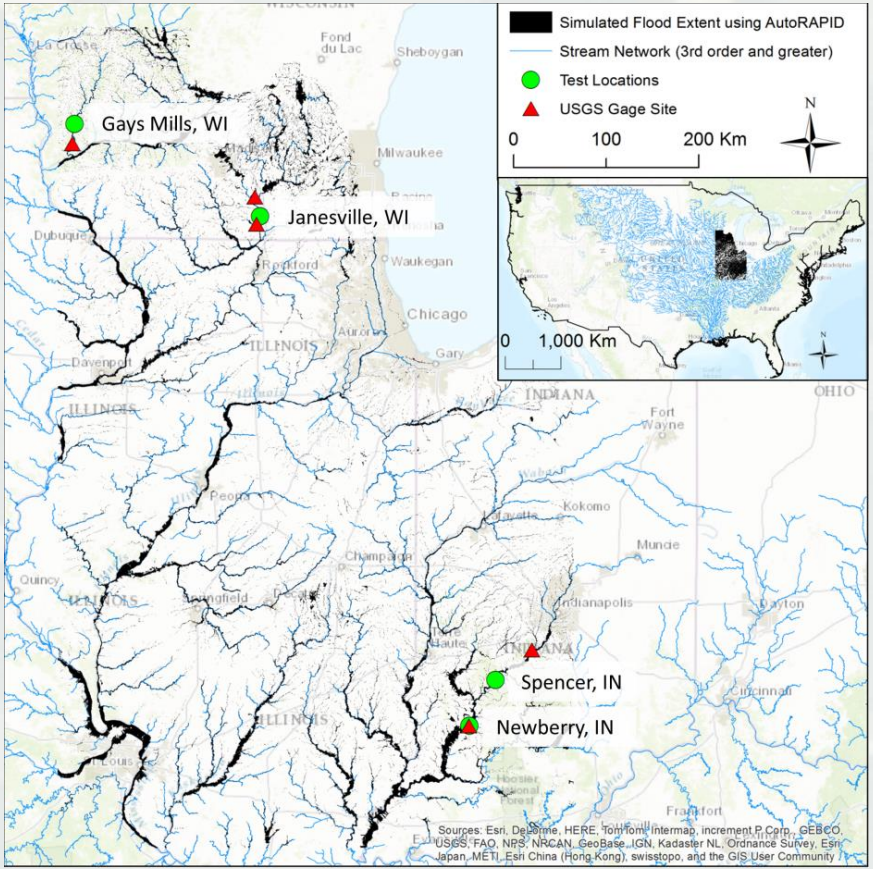
AutoRoute – June 2008 Flood Event

Terrain:

- Medium Topography

Issues:

- Urban areas overestimated
- Dependent on accurate streamflow estimates
- Dams



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- Area: ~230,000km^2
- 27- 1°x1° Tiles
- ~88 million cross-sections
- ~20 min / tile
- now ~5 min / tile

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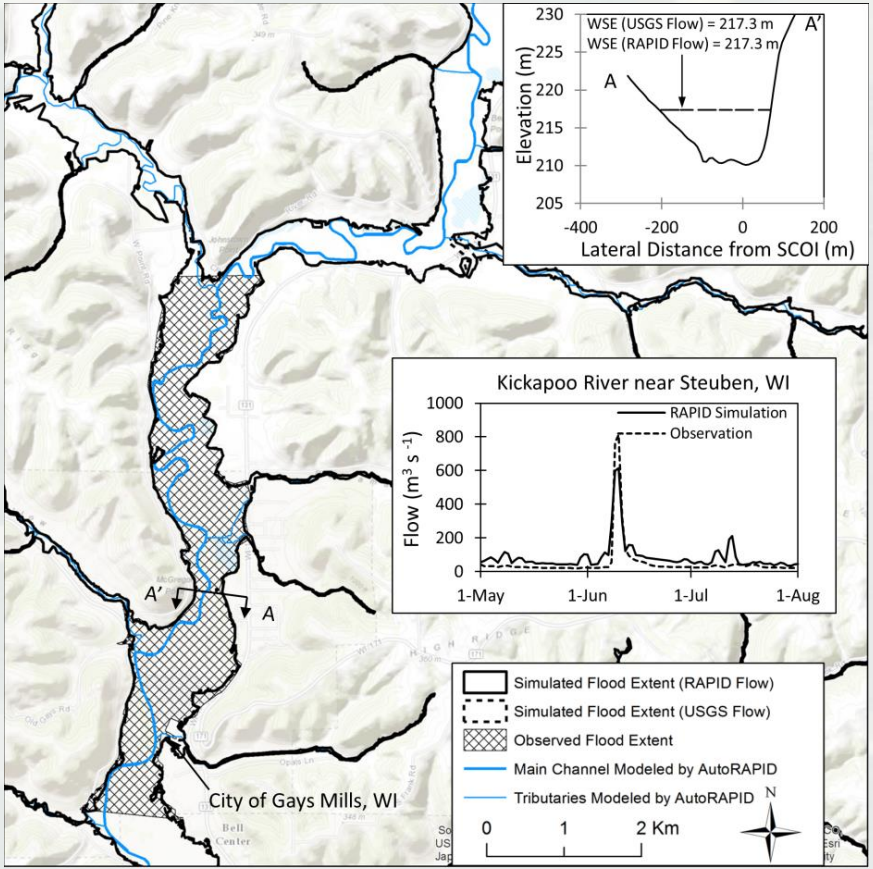

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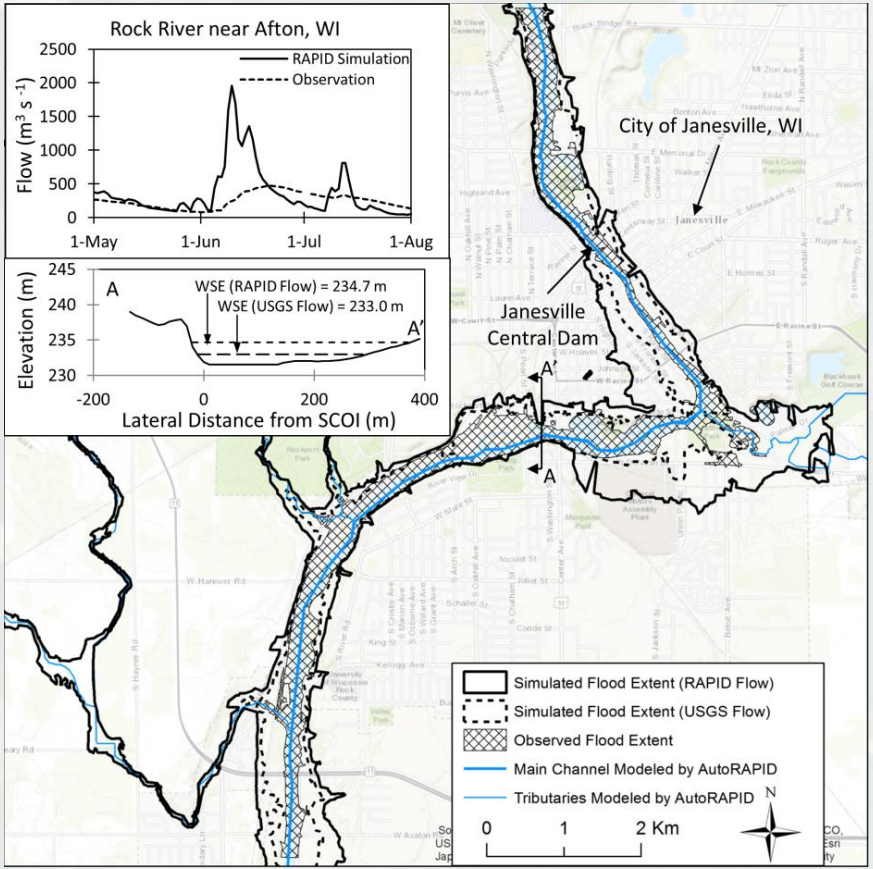

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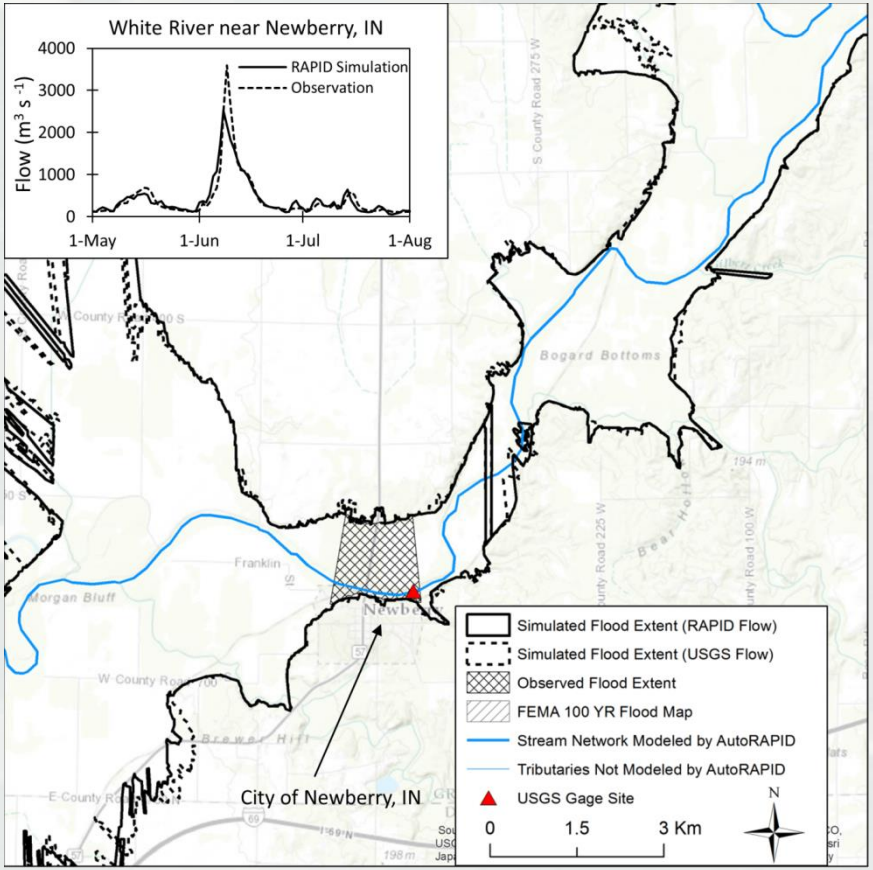
AutoRoute Example of June 2008 Flood Event

Tributaries Matter!



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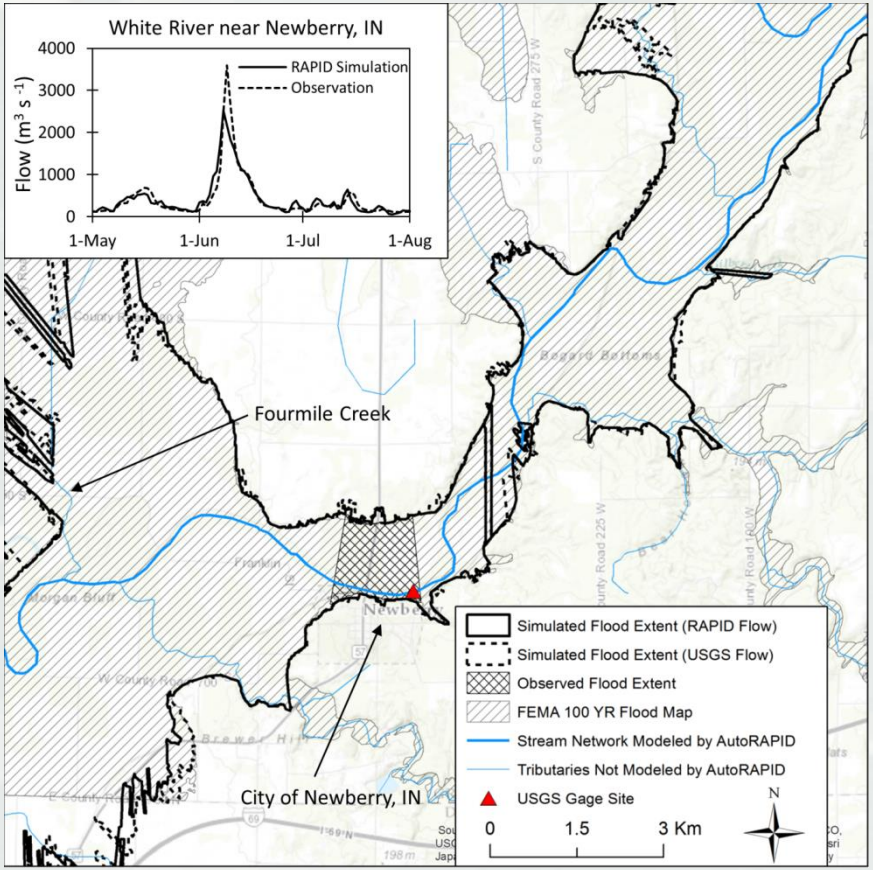

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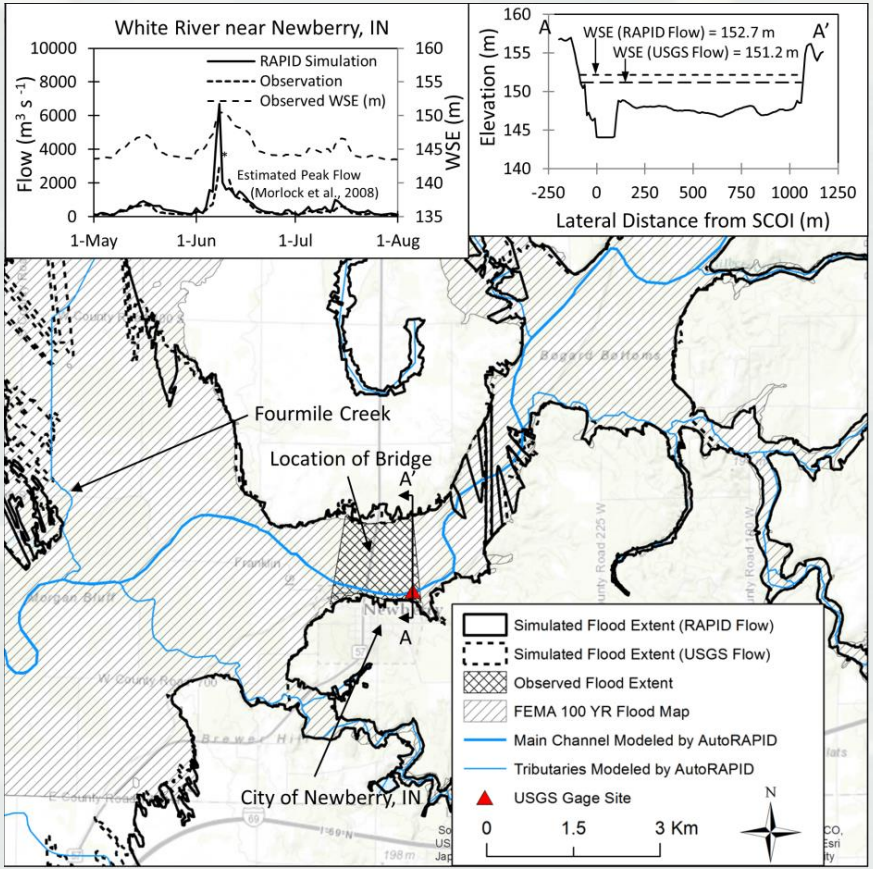

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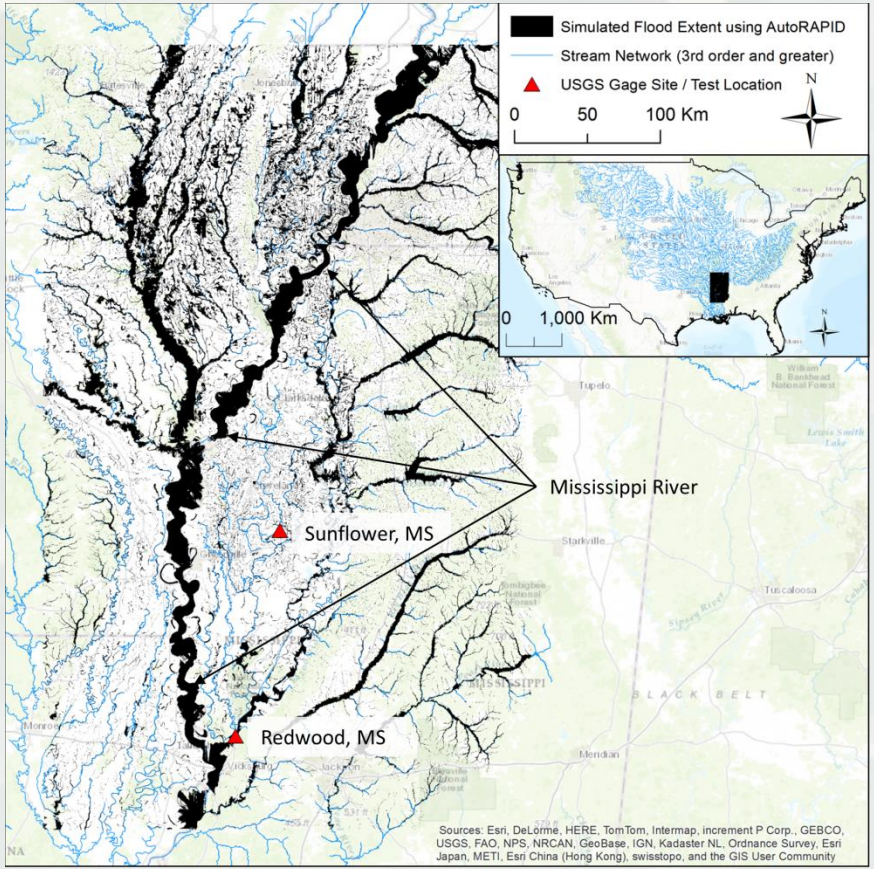
AutoRoute – May/June 2011 Flood Event

Terrain:

- Flat
- Routing from terrain to channel not explicitly included in RAPID model.

Backwater:

- Muskingum approach (RAPID model) not able to capture backwater flooding.
- Methods in AutoRoute likely not applicable



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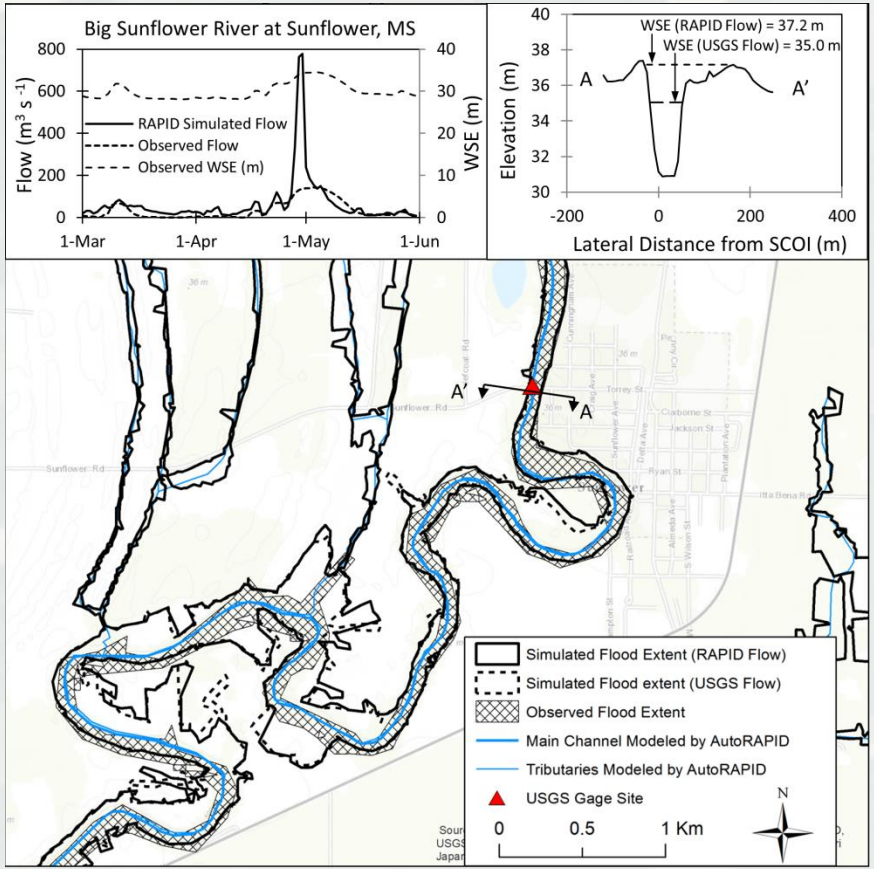

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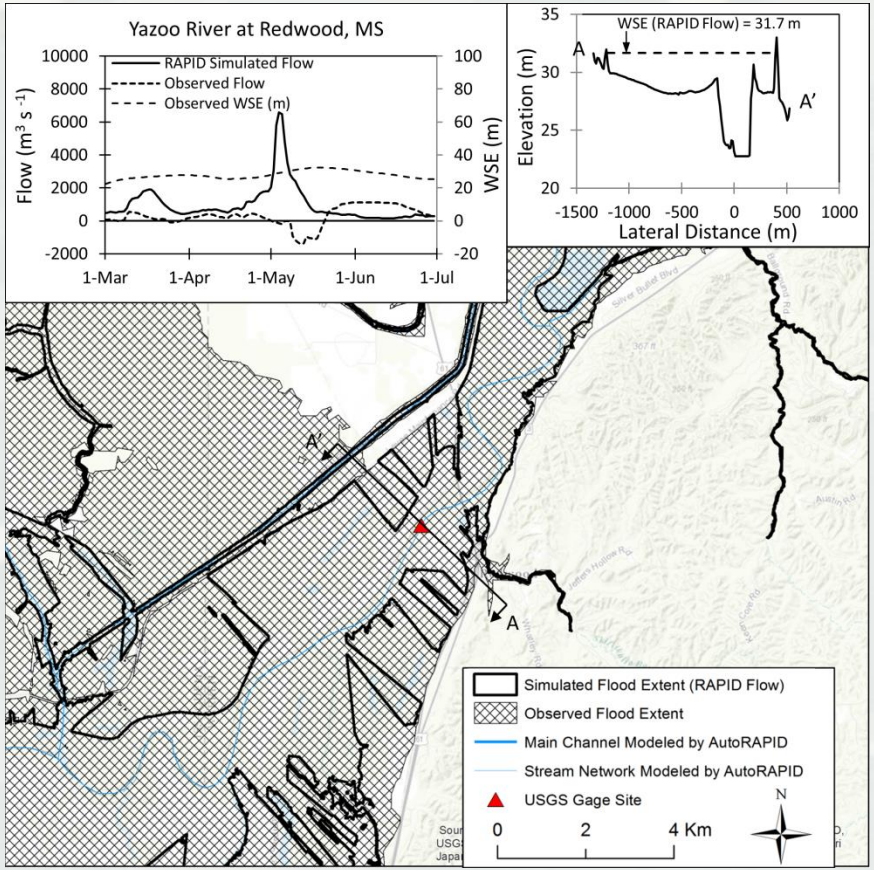

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OCONUS Applications

Attributes Required for Each Reach:
Stream location and slope
Drainage area
Connectivity between reaches

Data Required:
Elevation Data

Tool Required:
ESRI ArcGIS 10.3
-Tool currently being tested for inclusion into ArcToolbox / ArcHydro

What Can Improve Hydrography Data:
Any info on stream, dam, and lake locations in GIS format

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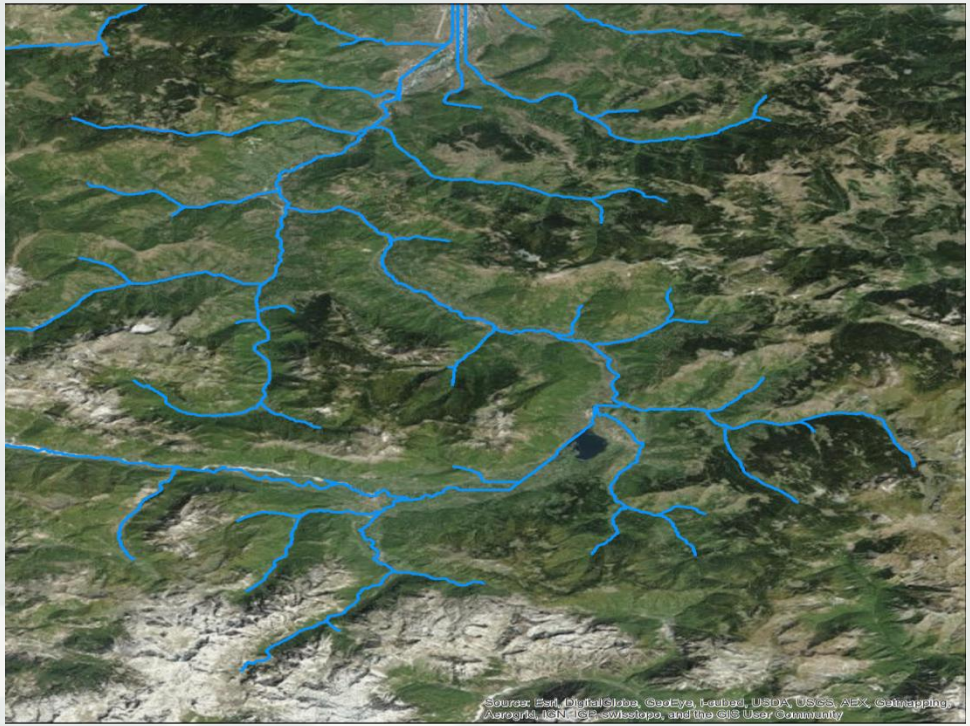

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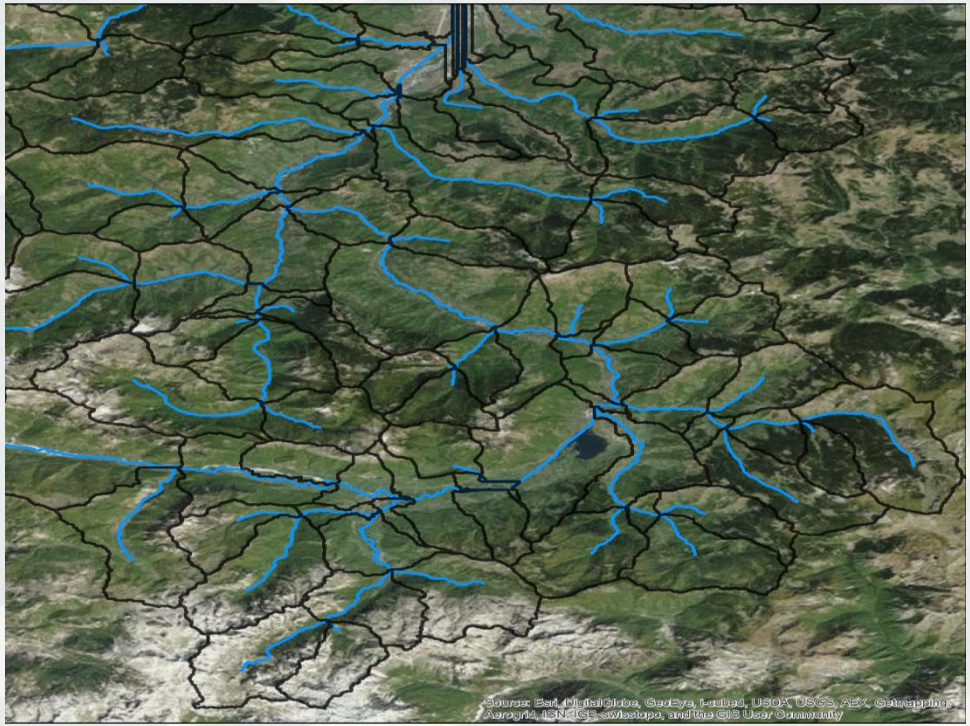

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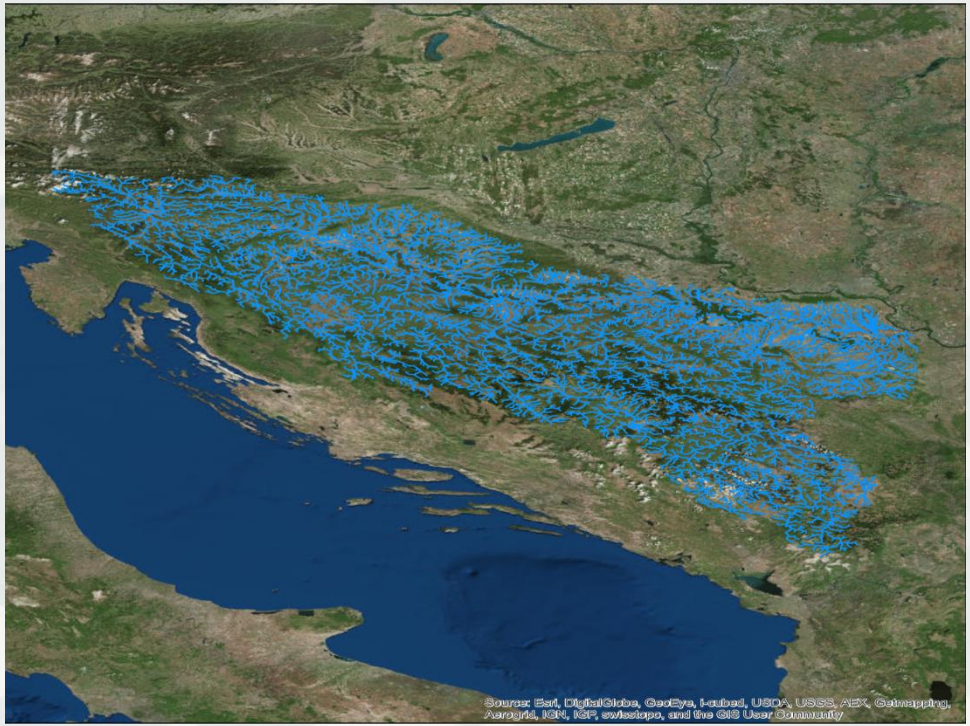

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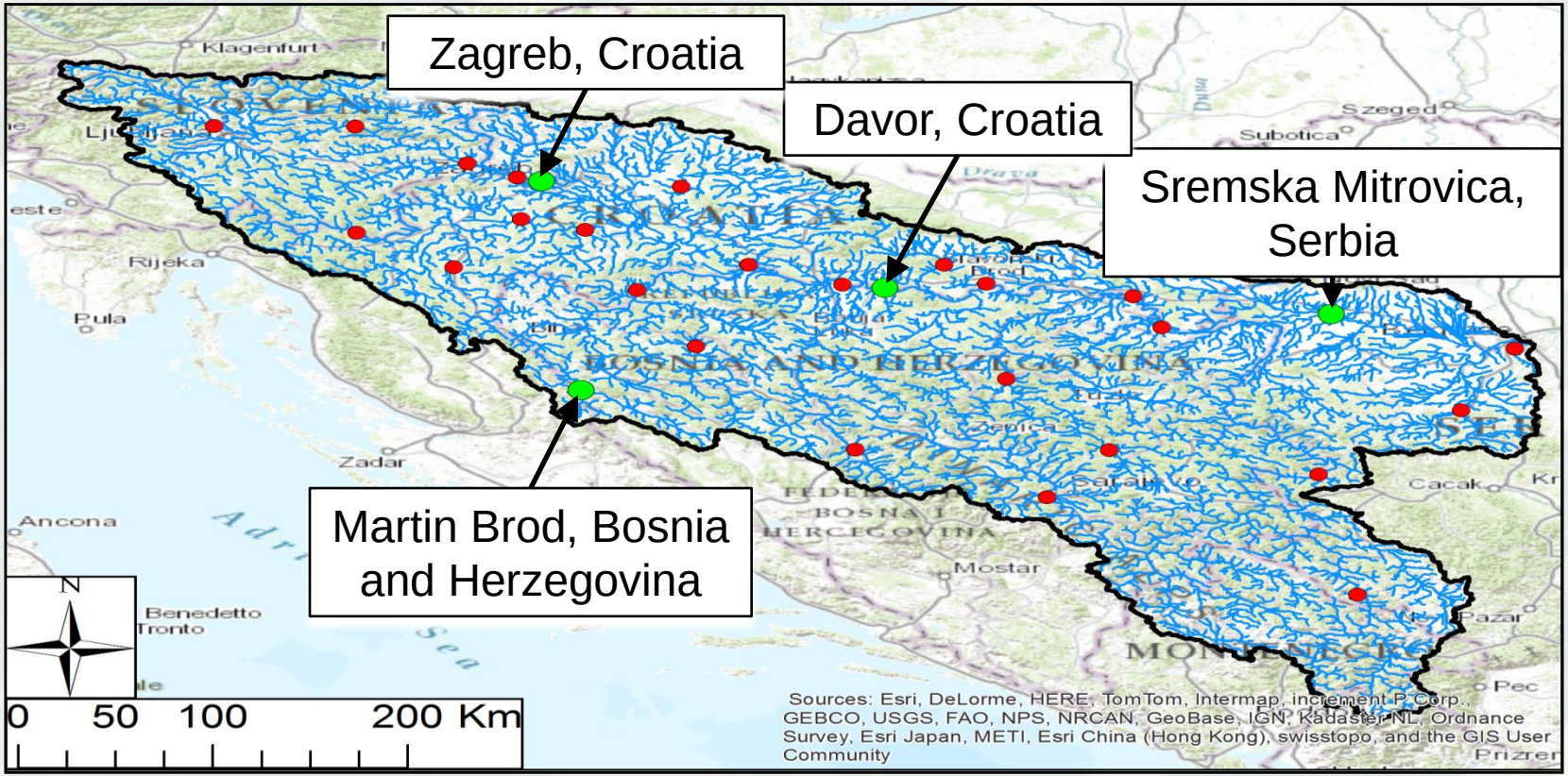

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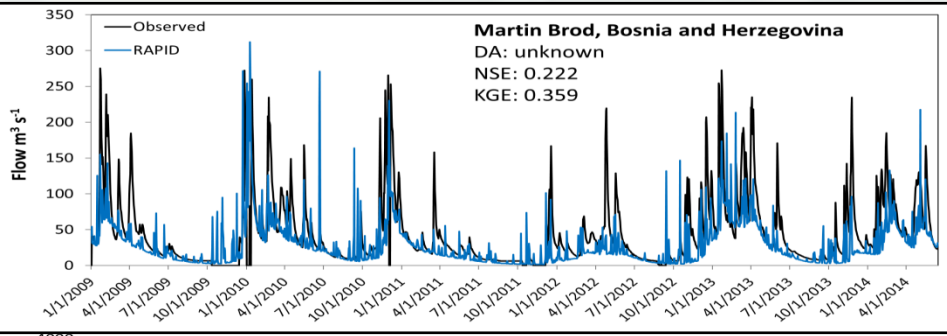

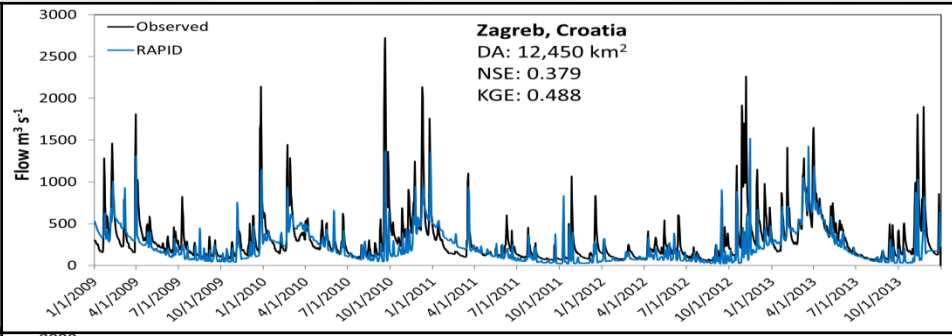

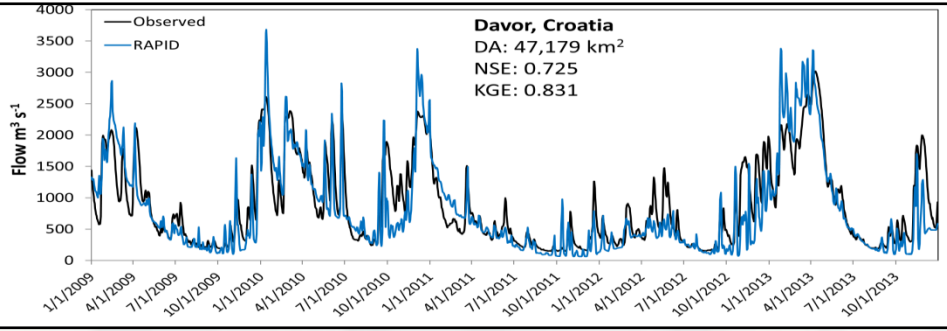

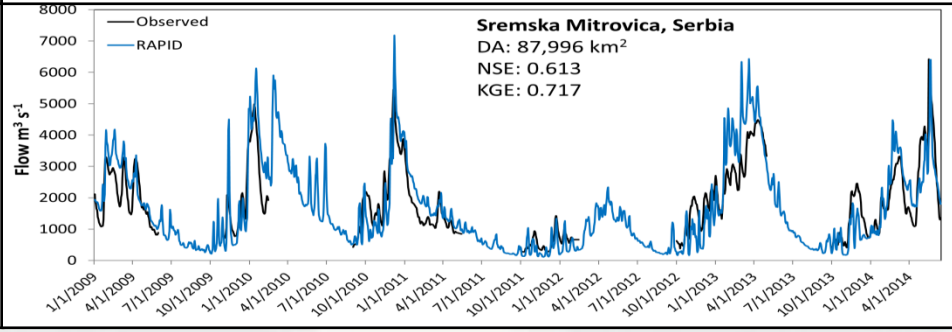

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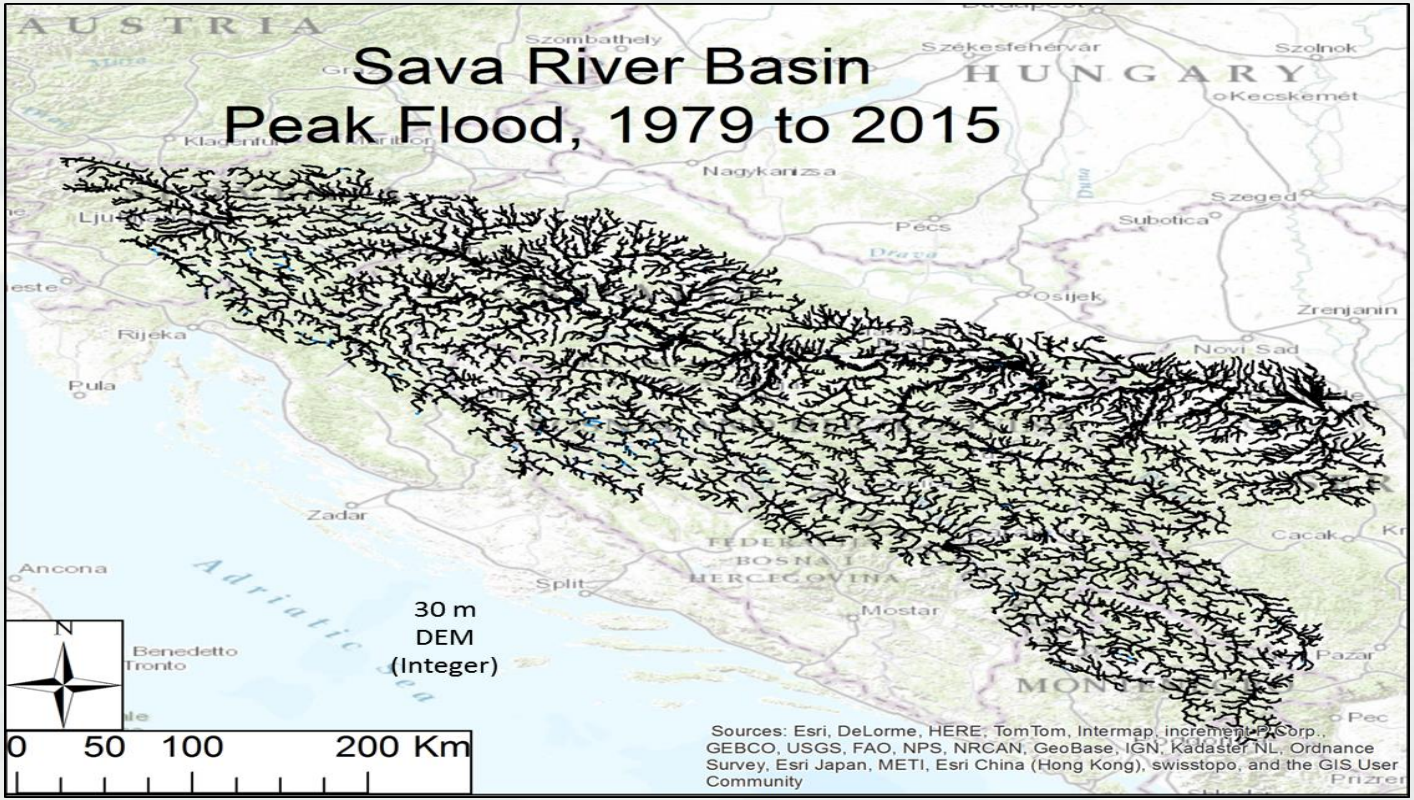

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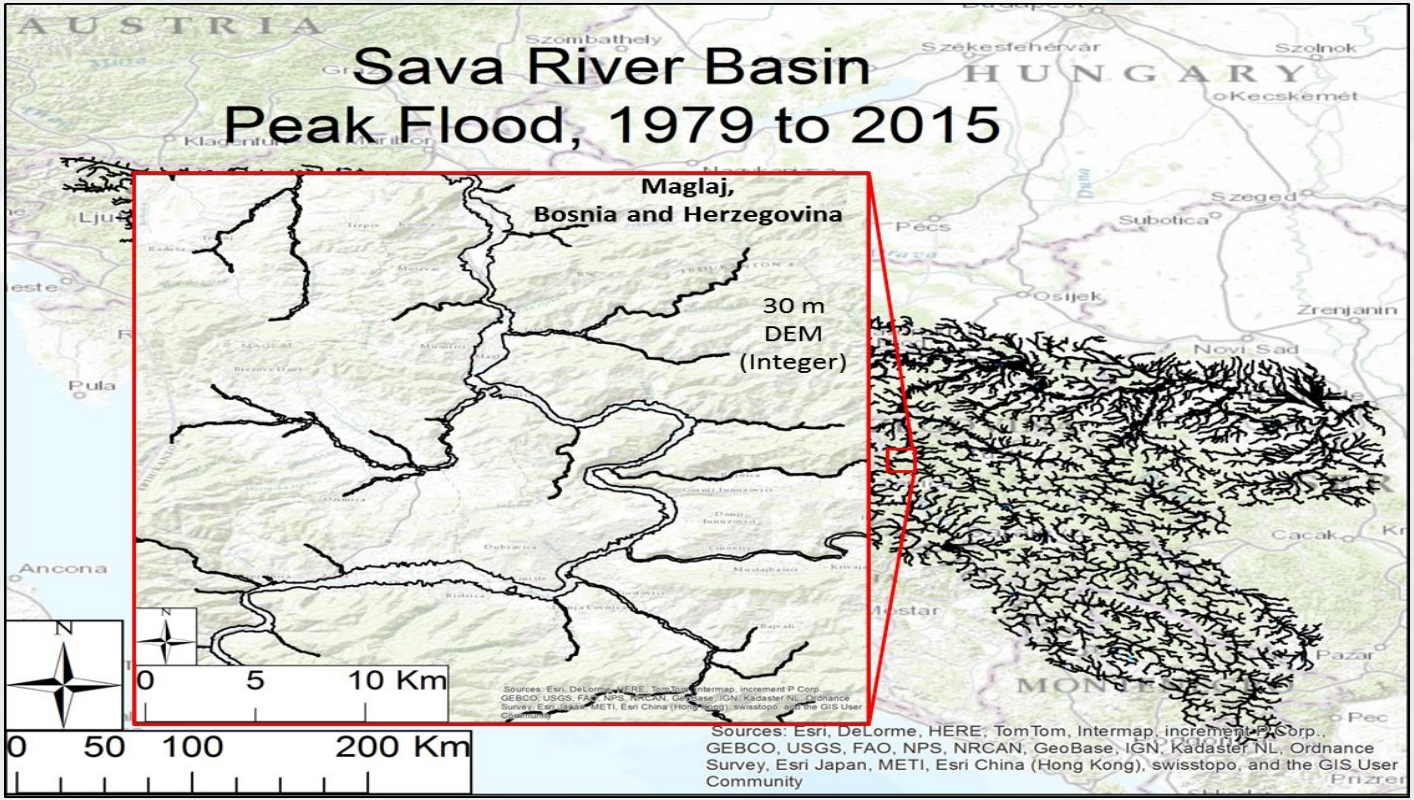

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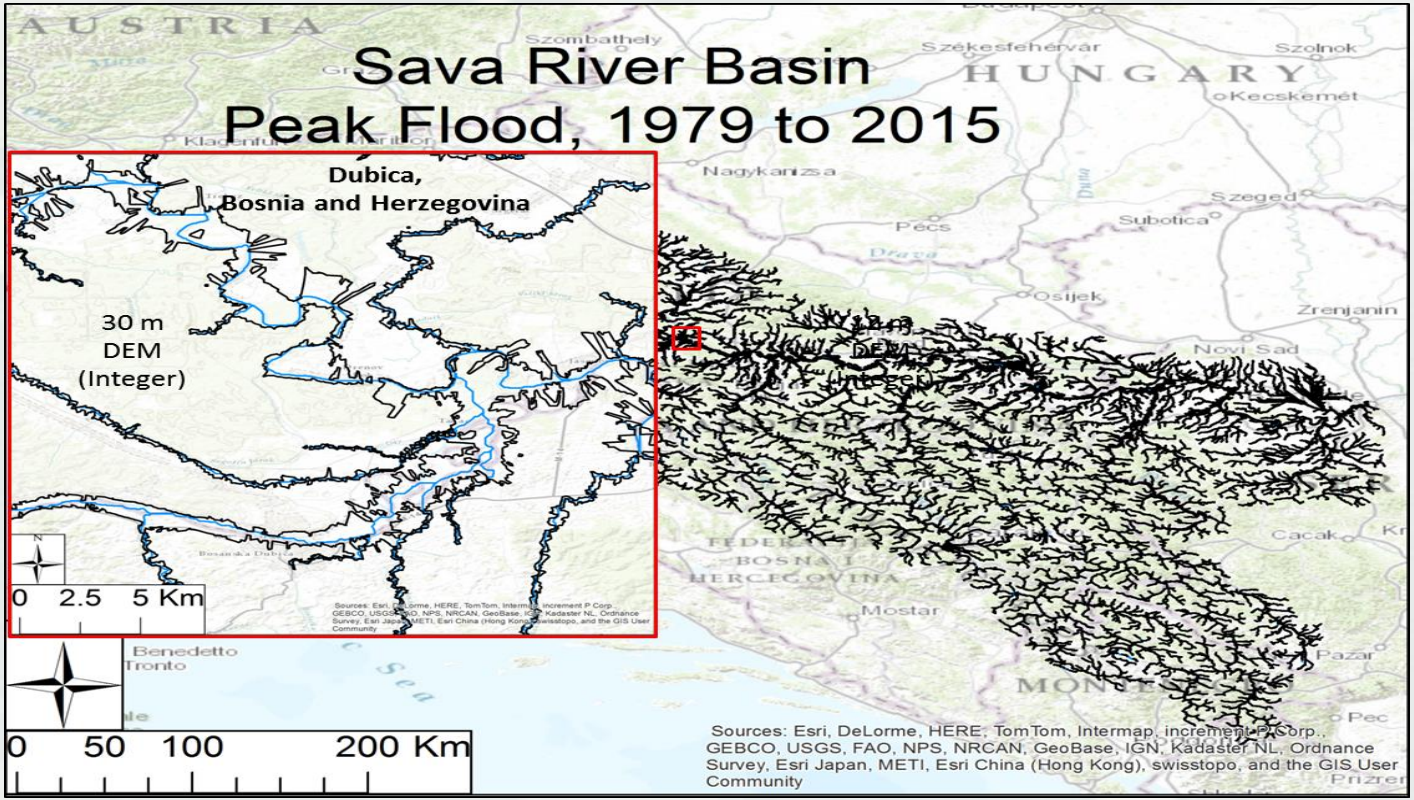

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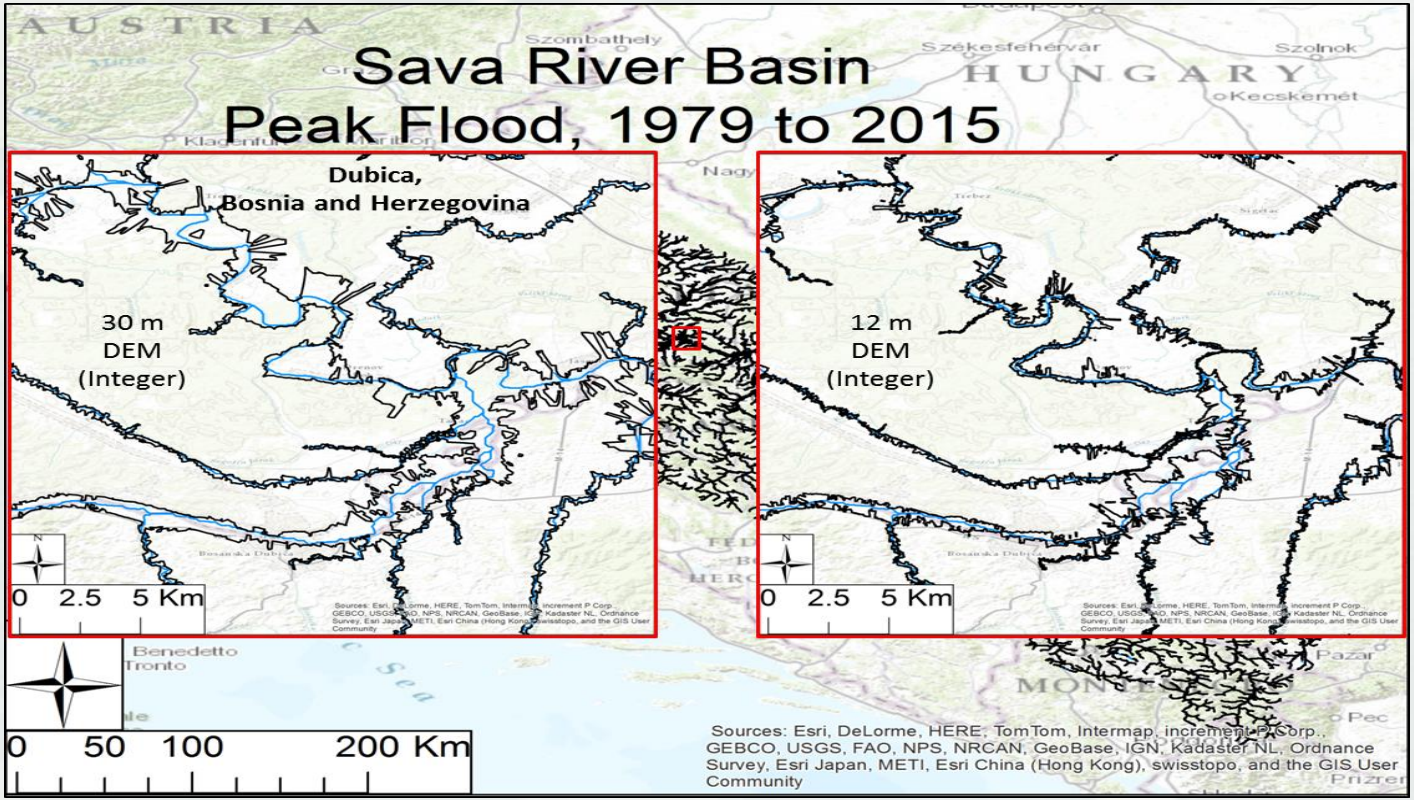

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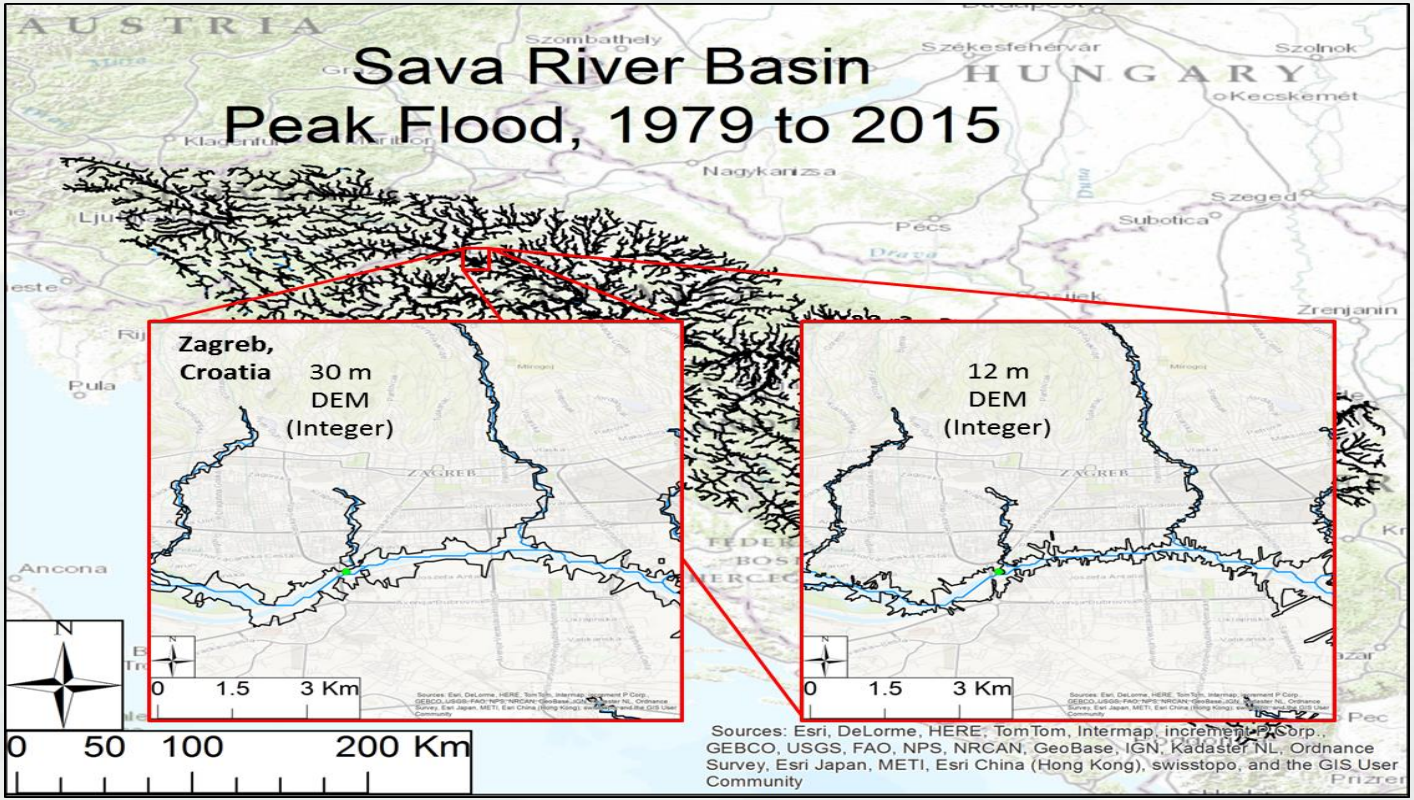

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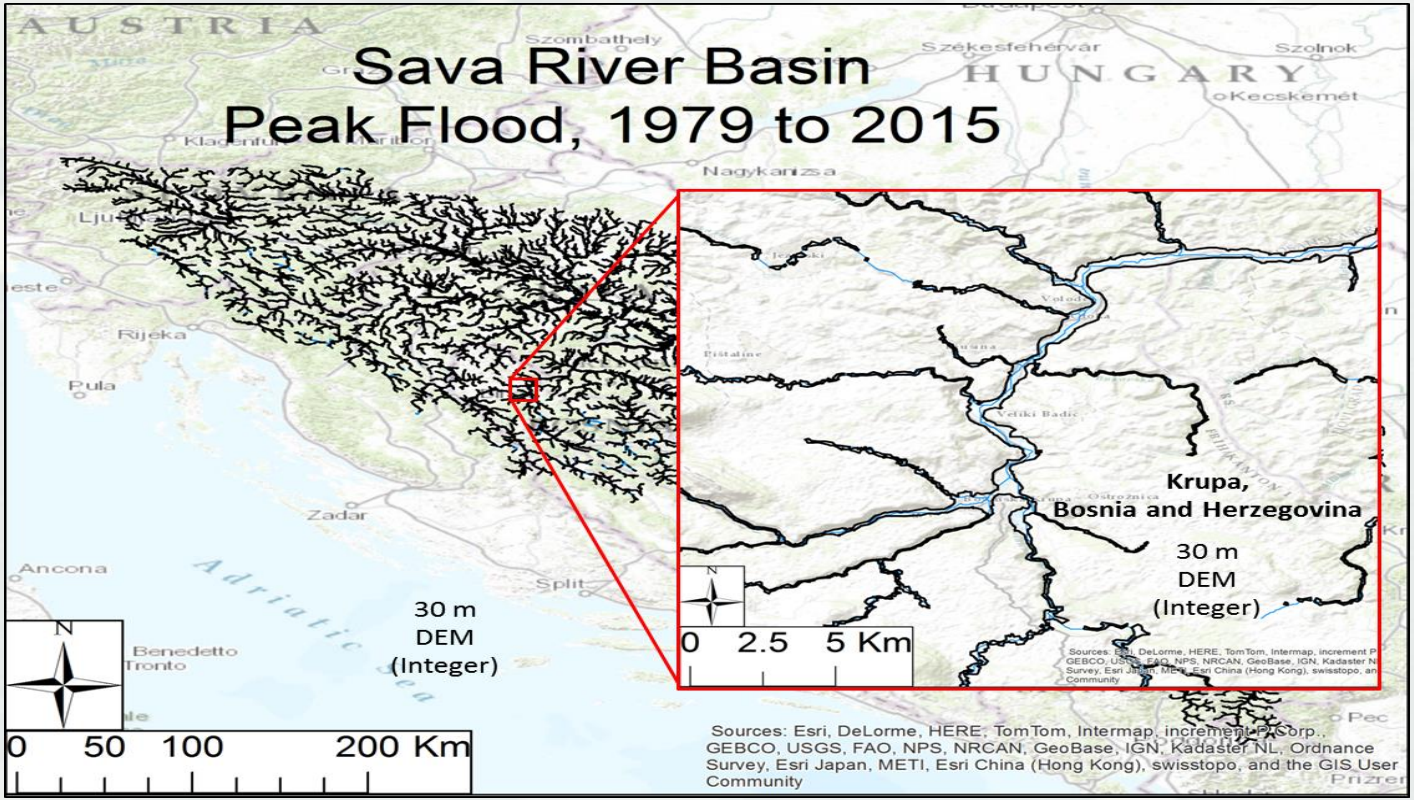

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Azerbaijan


Cherkessk
Pyatigorsk
Nalchik
Grozny
Khasavyurt
Aktau
Vladikavkaz
Makhachkala
CAUCASUS MOUNTAINS
Caspian Sea
GEORGIA
Tbilisi
Derbent
Kura Nehri
Gyumri
Kars
ARMENIA
Ganca
AZERBAIJAN
Sumgait
Baku
Yerevan
Erzurum
Agri
Igdir
Xankandi
Parsabad
Mus
Lake Van
Van
Khoy
Ardabil
Tabriz
Siirt
Batman
Hakkari
Orumiyeh
Maragheh
Rasht
Kiziltepe
Dahuk
Mahabad
Bukan
Zanjan
Amol
Mosul
Irbil
Saqqez
Qazvin
EL BURZ MOUNTAINS
Karaj
Tehran
Kirkuk
As Sulaymaniyah
Sanandaj
Varamin
Saveh
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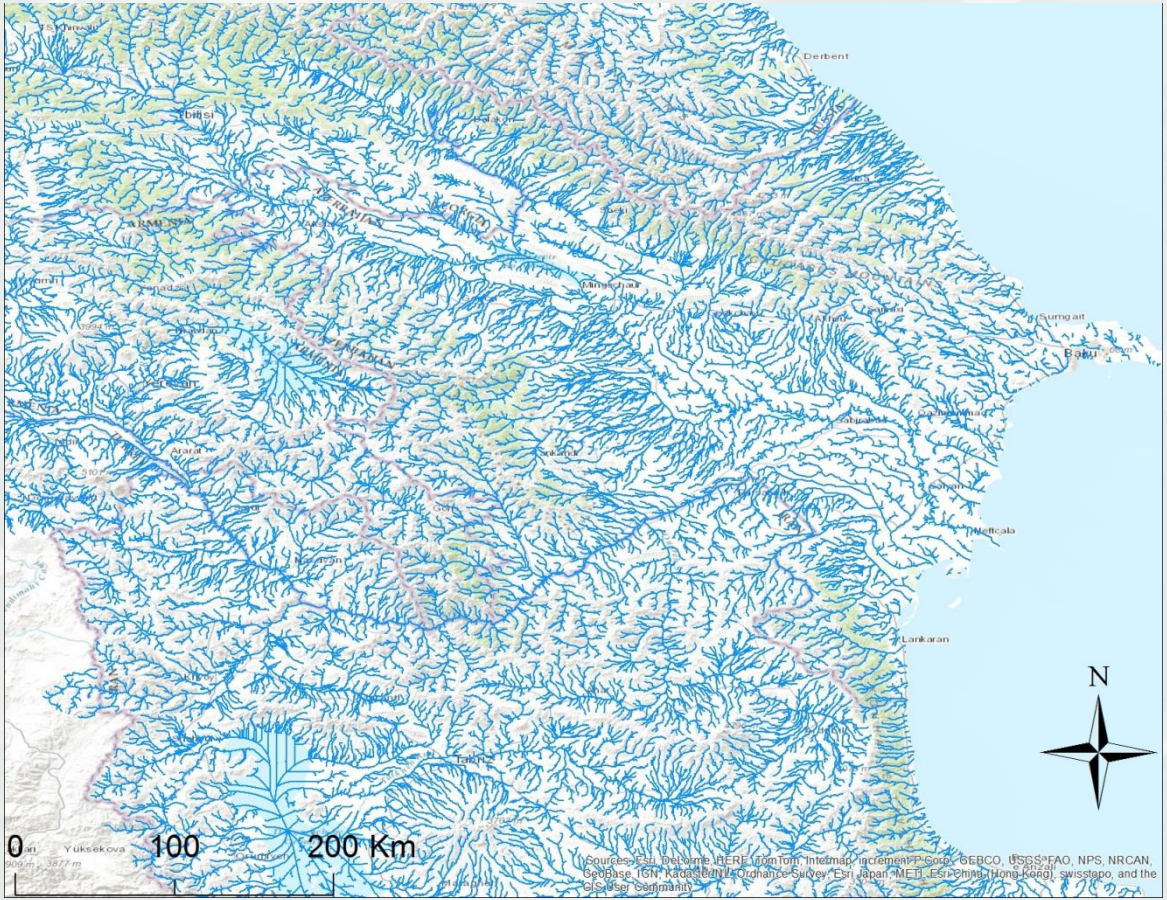
Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Azerbaijan


Derbent
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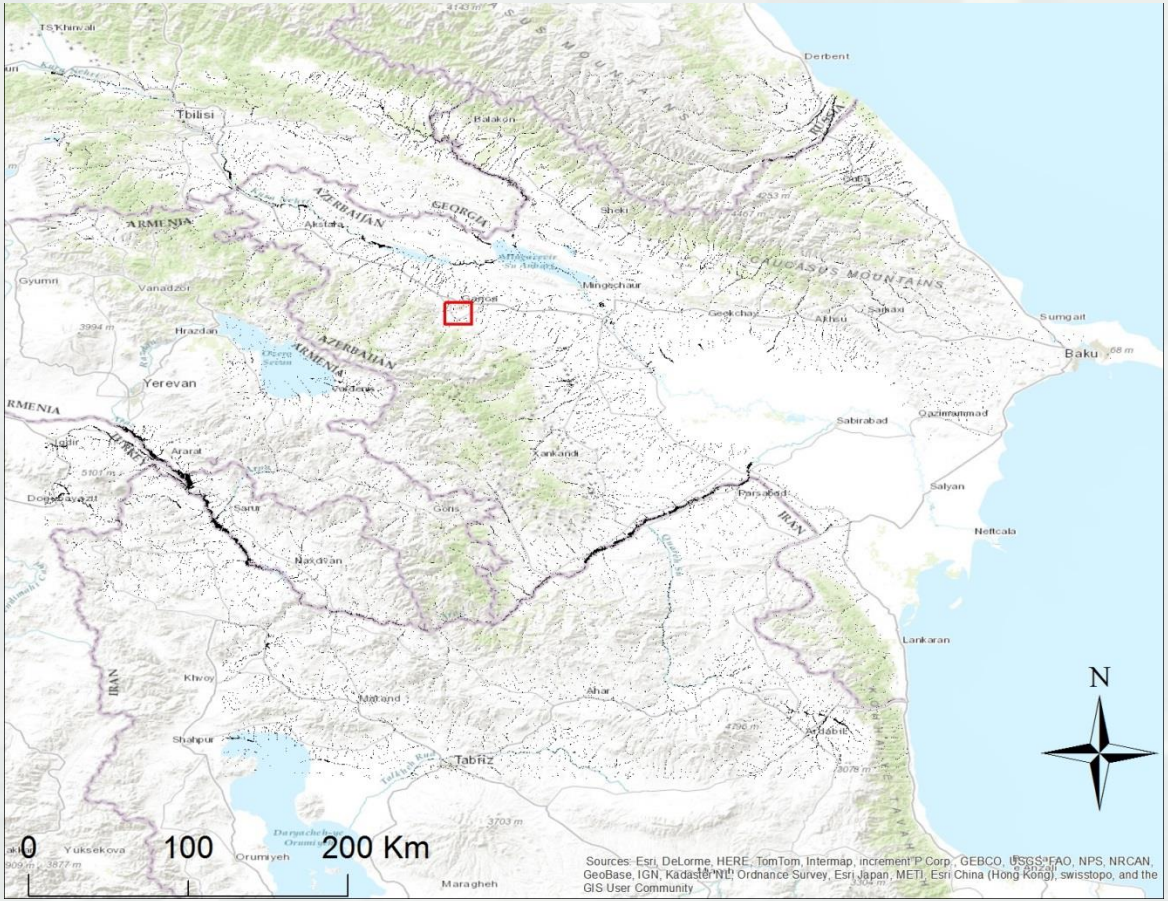
Tbilisi
Balakən
Derbent
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ARMENIA
AZERBAIJAN
GEORGIA
Akstafa
Gyumri
Vanadzor
Gəncə
Mingəçaur
Geokchay
Ağsu
Şamaxı
Sumgait
Baku
Hrazdan
Yerevan
Sabirabad
Qazimammad
Ararat
Xankəndi
Salyan
Saatlı
Goris
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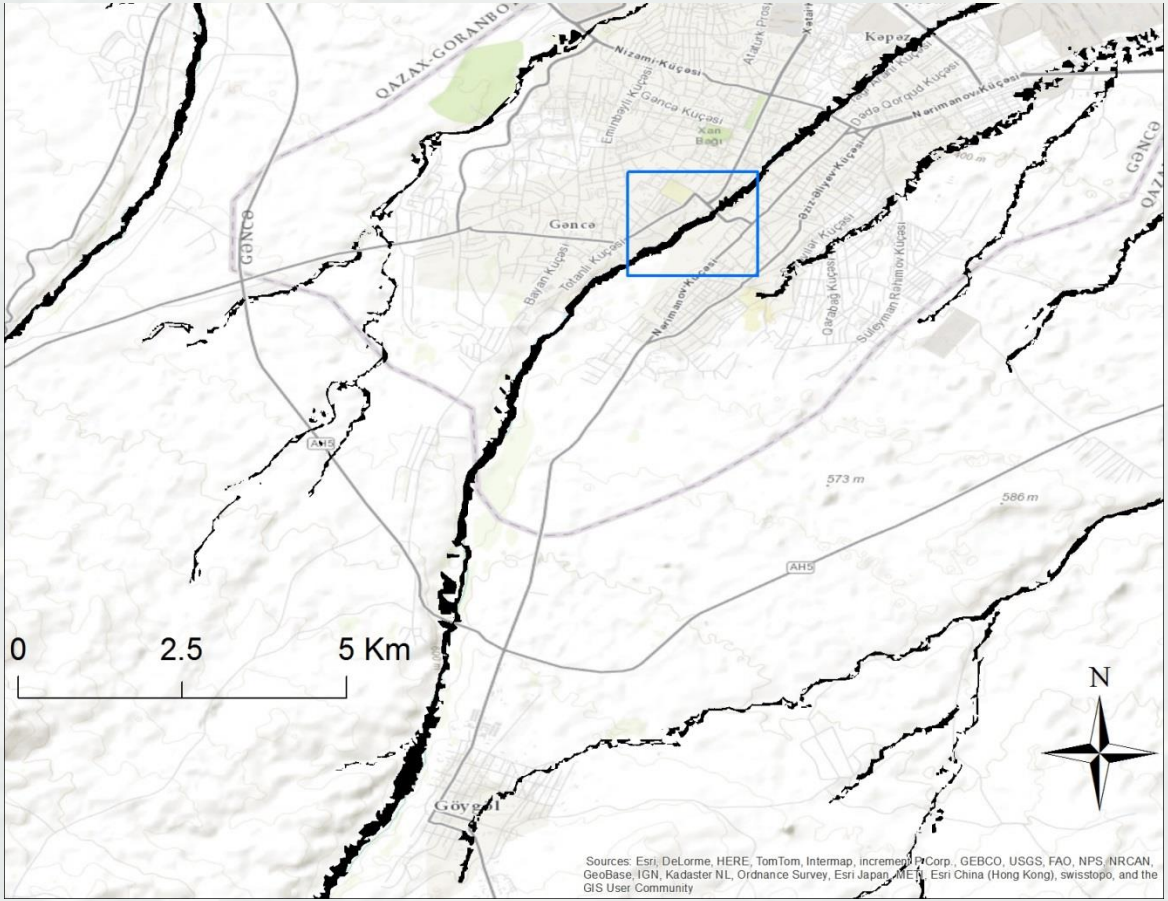
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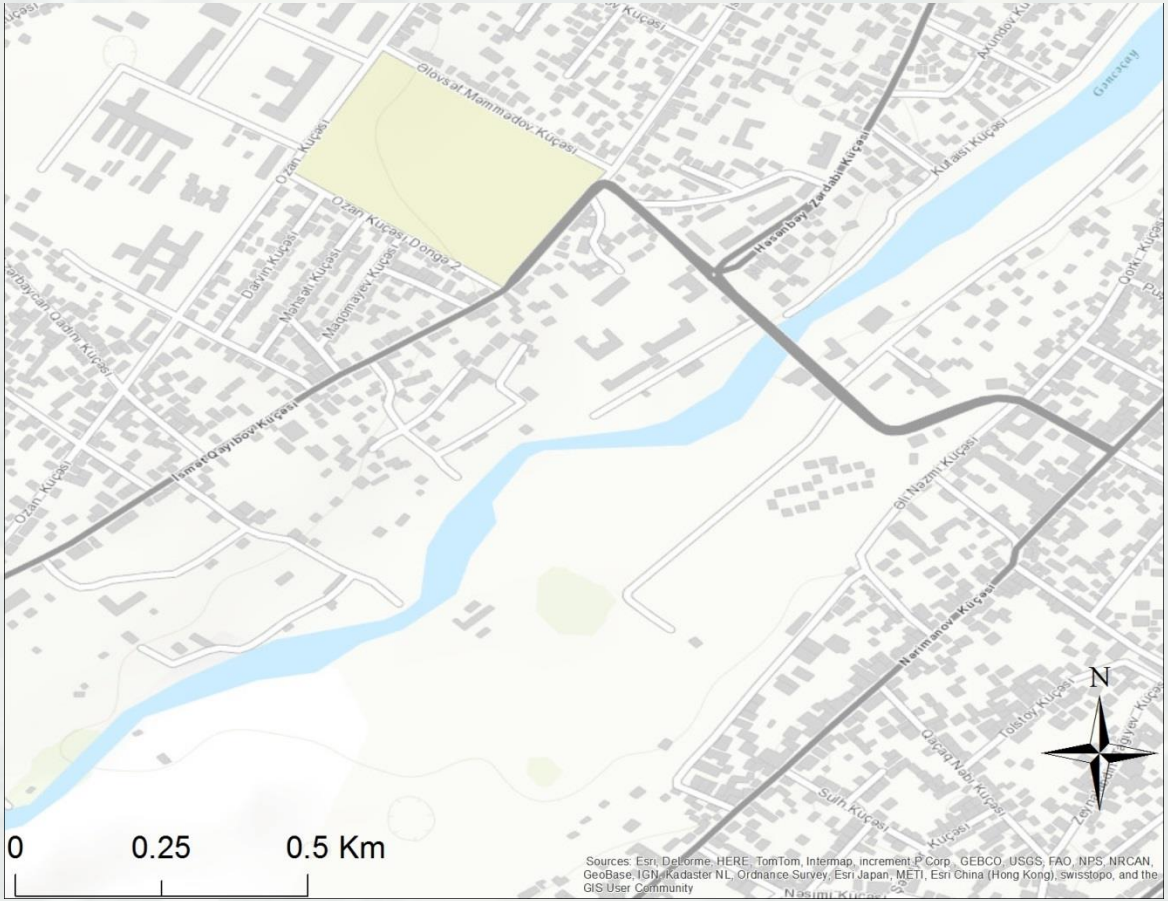
Ozan Kuçası
Ozan Kuçası Donga 2
Hasanbəy Zərdabinskiy Küçəsi
Ismayil Qayibov Küçəsi
Gili Nazmi Küçəsi
Narimanov Küçəsi
Tolstoy Küçəsi
Suleyman Rahimov Küçəsi
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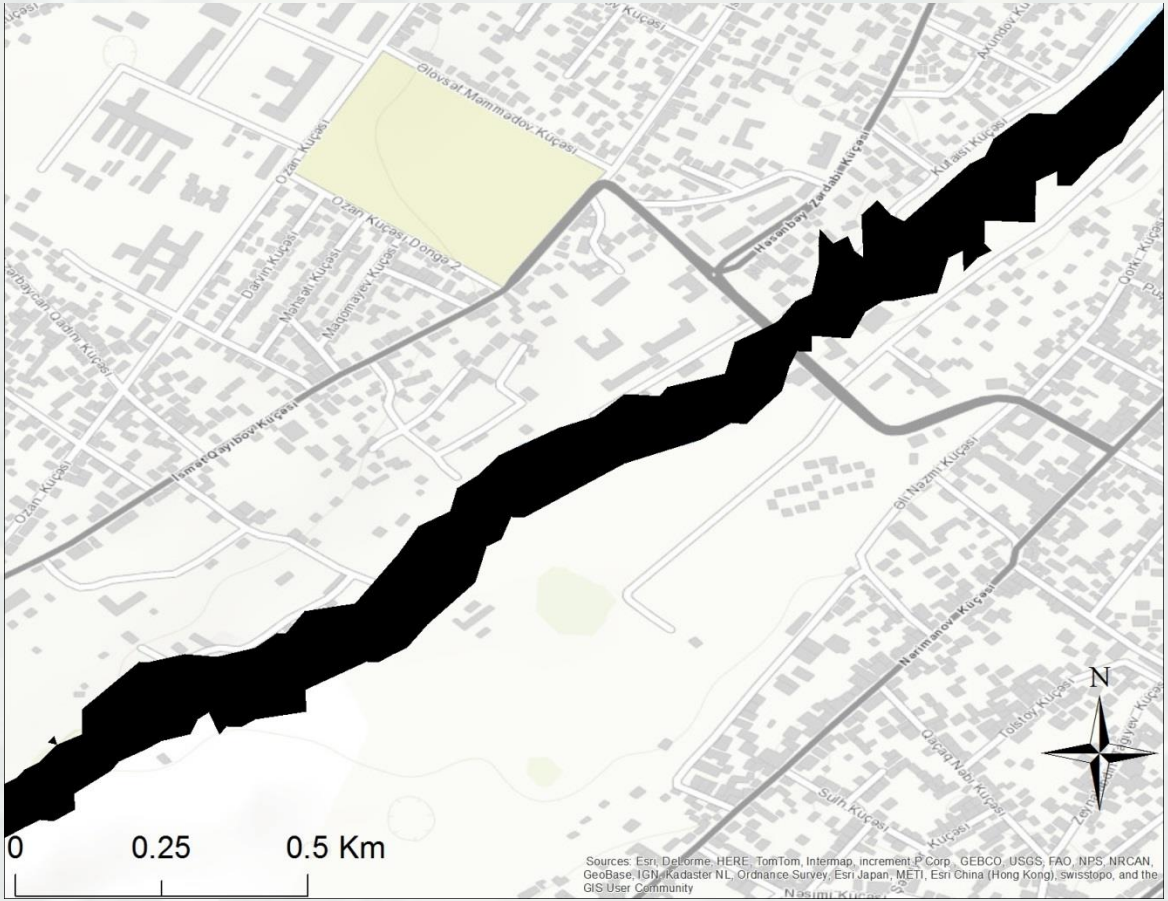
0.5 Km
Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Azerbaijan


Ozan Kuçasi
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Hasanbay Zardabi Kuçasi
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Gili Nazmi Kuçasi
Narimanova Kuçasi
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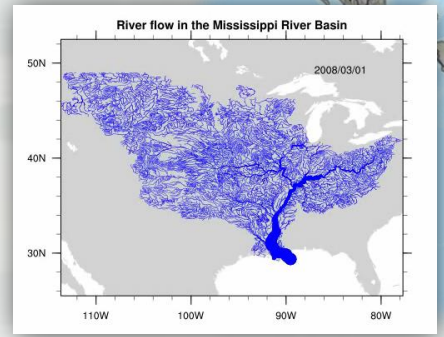
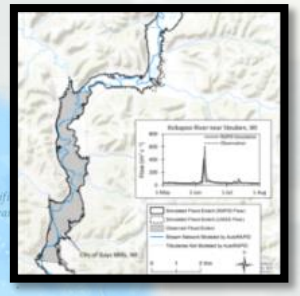
Streamflow Prediction Tool (SPT)

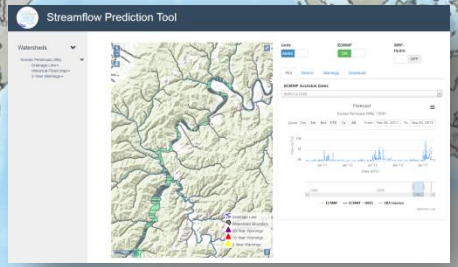
Providing hydrologic information that is globally aware and locally precise

U.S. Army ERDC, along with university partners, has developed a method for forecasting streamflow and mapping inundation by routing globally available runoff estimates over continental-scale stream networks. This is a first-order approach for estimating streamflow in ungaged basins. The tool provides a15-day hydrologic forecast.

BYU
BRIGHAM YOUNG UNIVERSITY

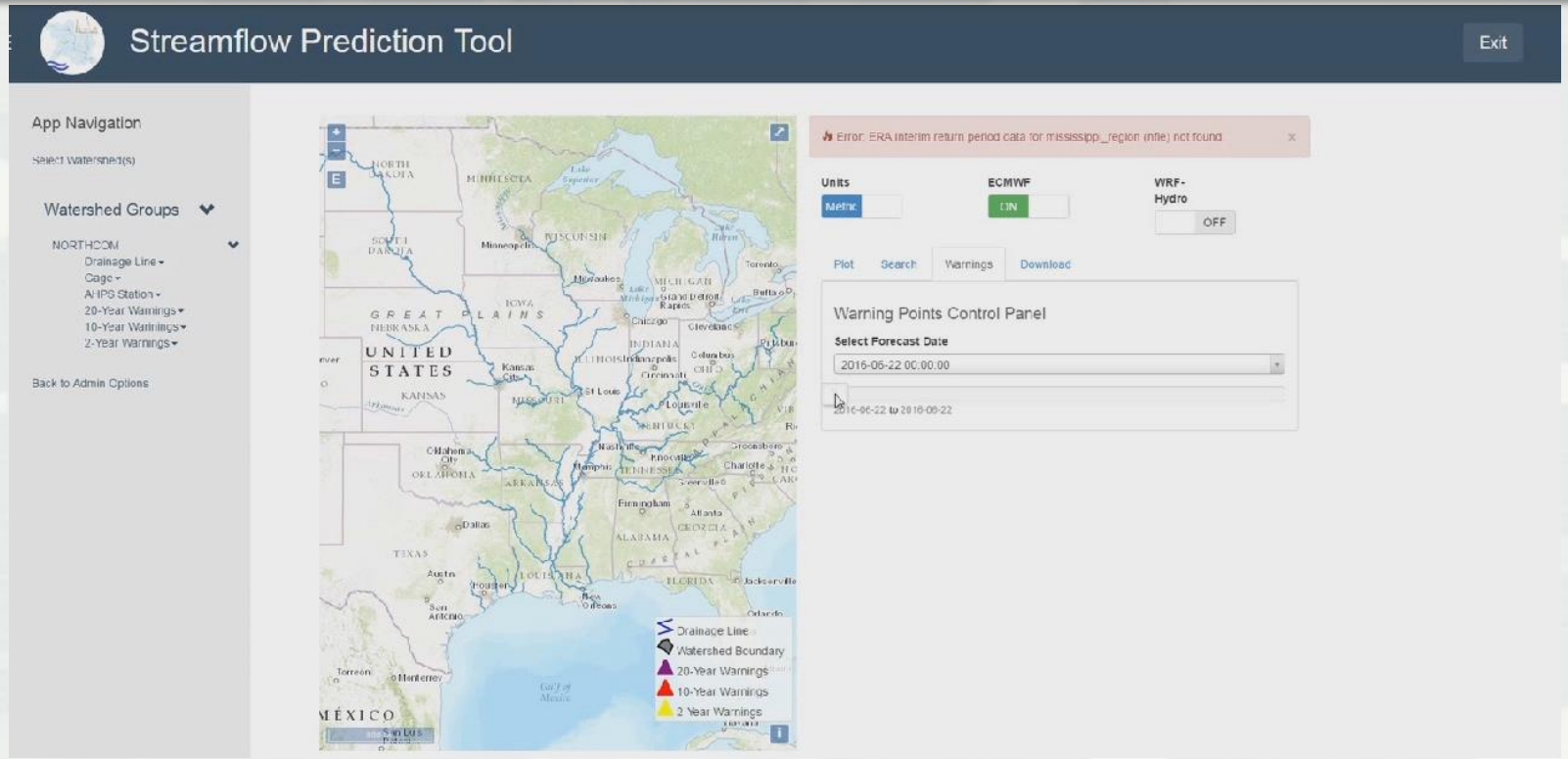






Web-based Graphical User Interface

Making hydrologic information accessible and comprehensible



Limitations and Ongoing Research

Global, High-Resolution Elevation Data:

- Recent release of provisional TanDEM-X DEM products (Krieger et al., 2007) to the United States Department of Defense (DOD) at a 12-meter horizontal resolution (Boeer et al., 2014).
- Not hydrologically “cleaned-up”… yet.

Reservoirs:

- Include if we know the operational outflow schedule.
- Currently implementing methods to account for reservoirs based on inflow and storage capacity.

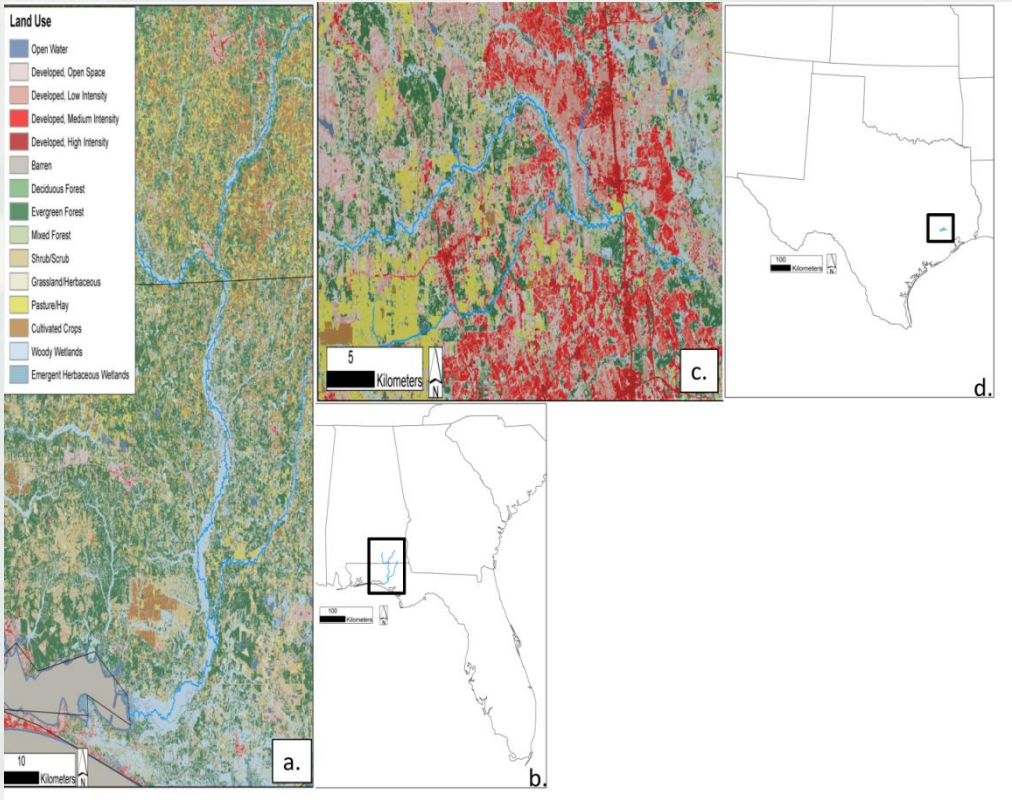
Snow:

- We have found larger errors in flow simulations during snow melt events.

Flat Terrain and Coastal Regions:

- Need for a Diffusive Wave approach??
- Connect to more sophisticated models??

Limitations and Ongoing Research



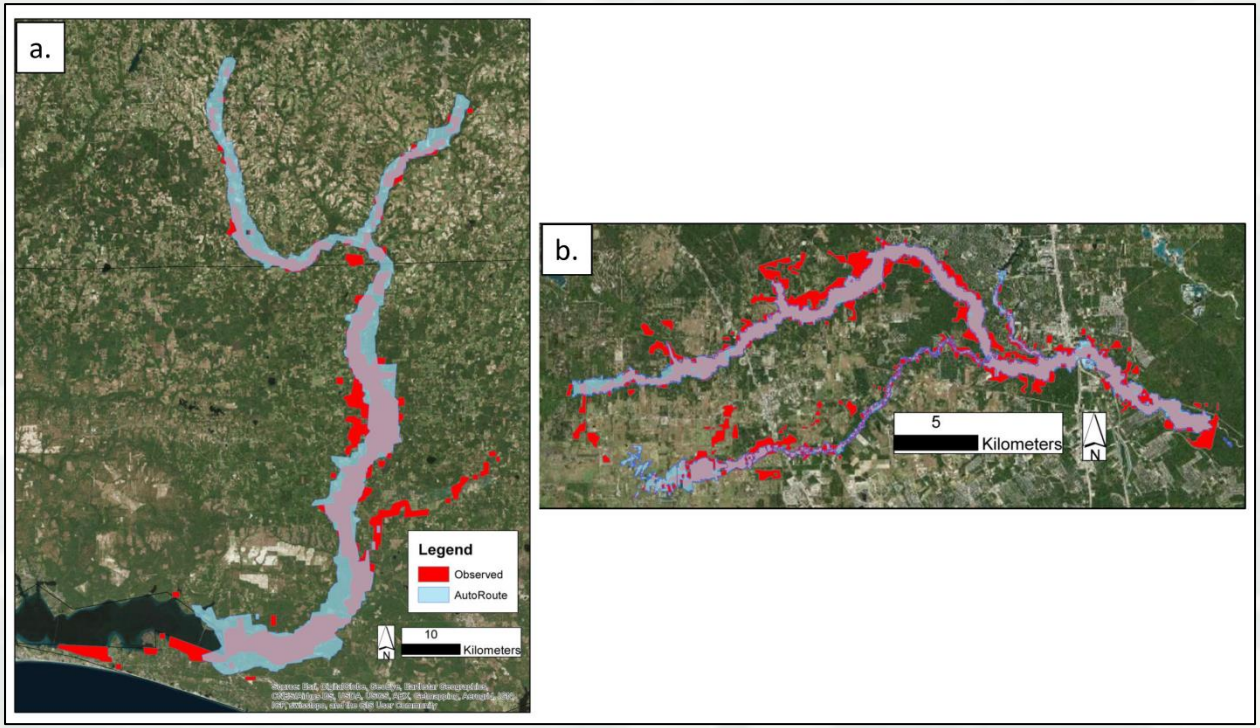
Choctawhatchee River in AL and FL; and Spring and Willow Creeks, TX

Comparisons / Validation:

Praskievicz et al., “Evaluation of AutoRoute-simulated flood-inundation extents using remotely sensed imagery: 2016 Alabama/Florida and Texas Floods”, In Progress.

Sarah Praskievicz
Assistant Professor
Department of Geography
University of Alabama
spraskievicz@ua.edu

Limitations and Ongoing Research



AutoRoute vs. LandSat-derived flood maps
(https://sdml.ua.edu/usfimr/)

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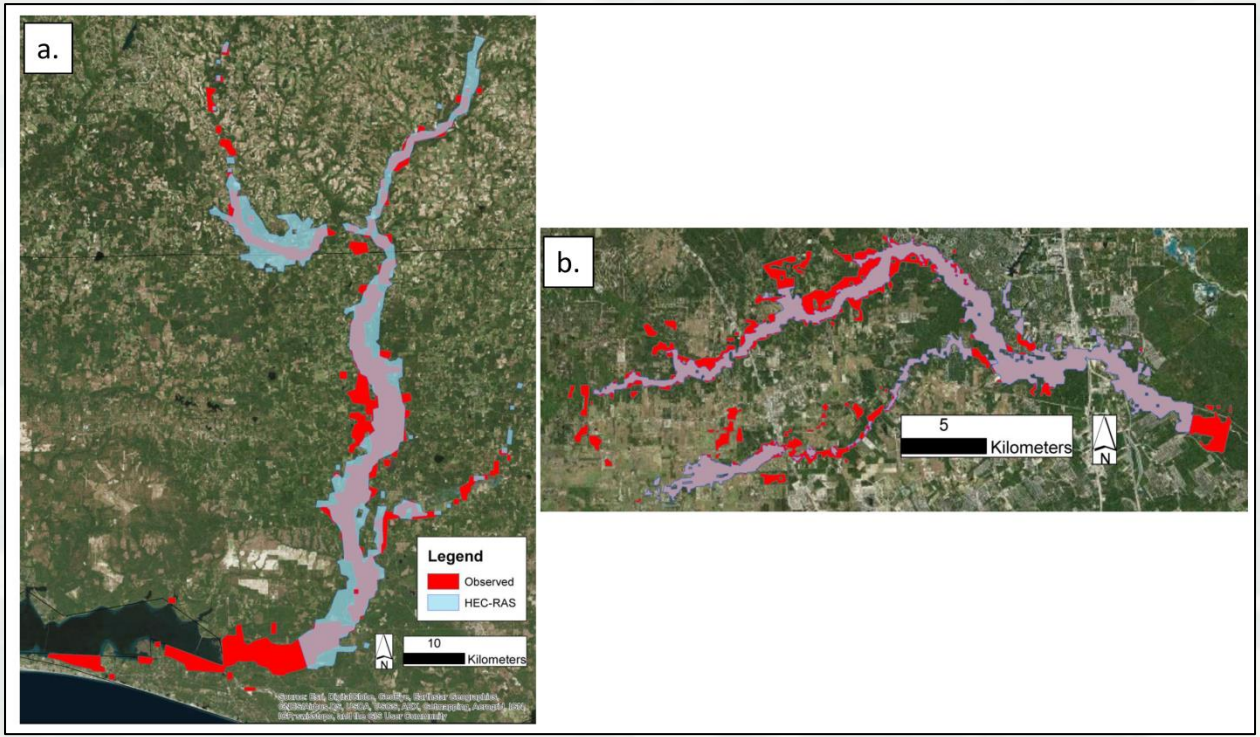

HEC-RAS vs. LandSat-derived flood maps (https://sdml.ua.edu/usfimr/)

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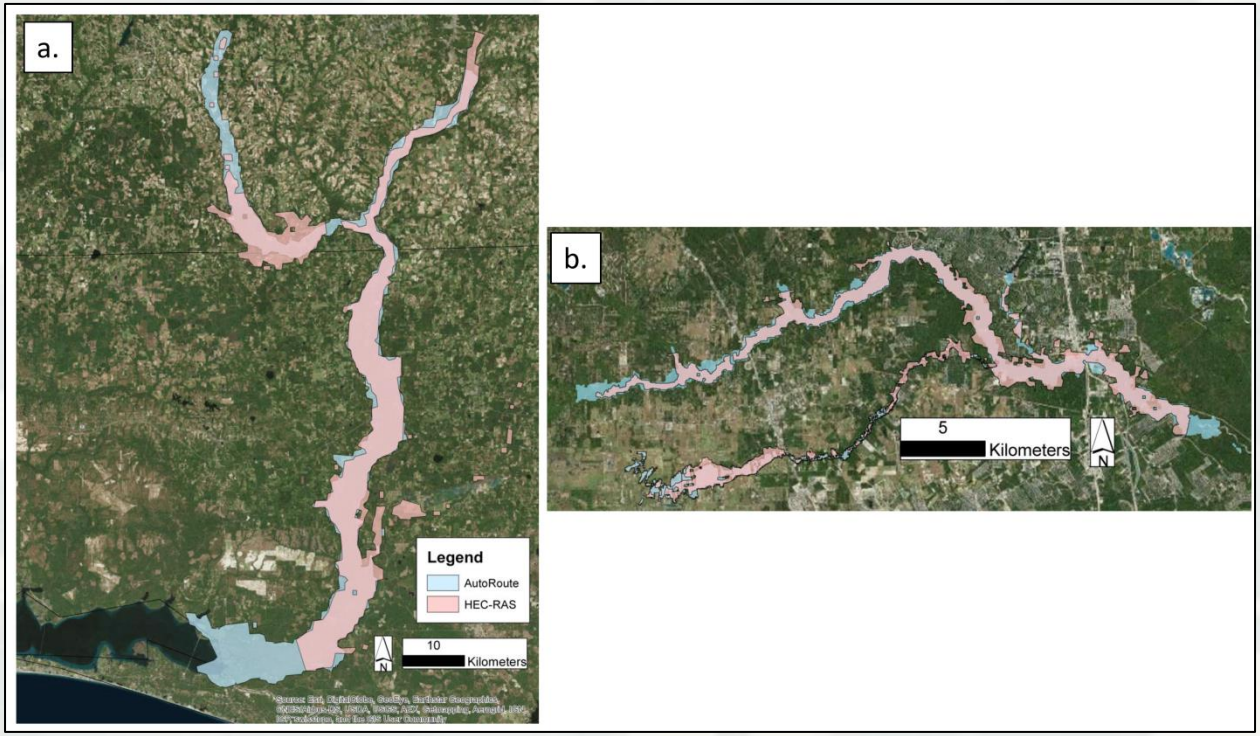

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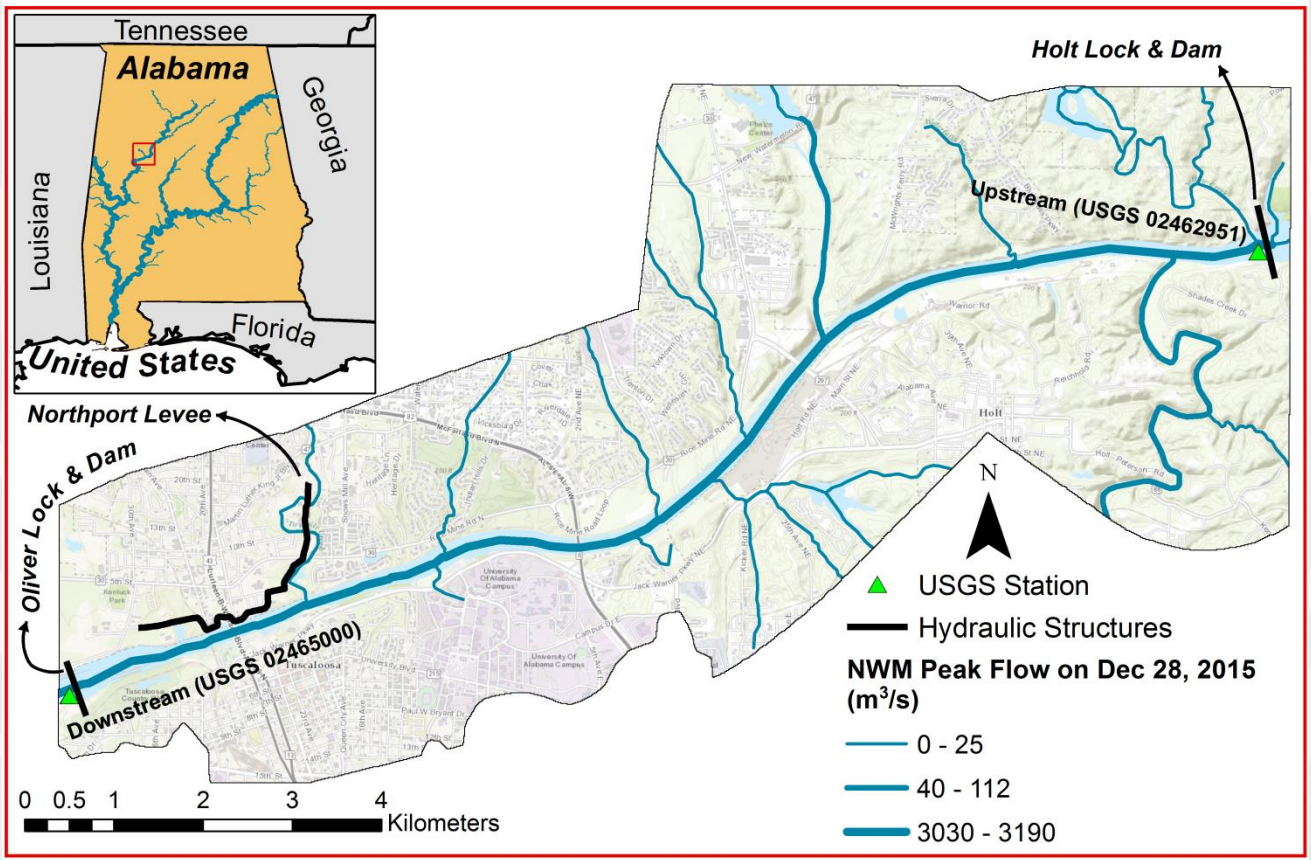
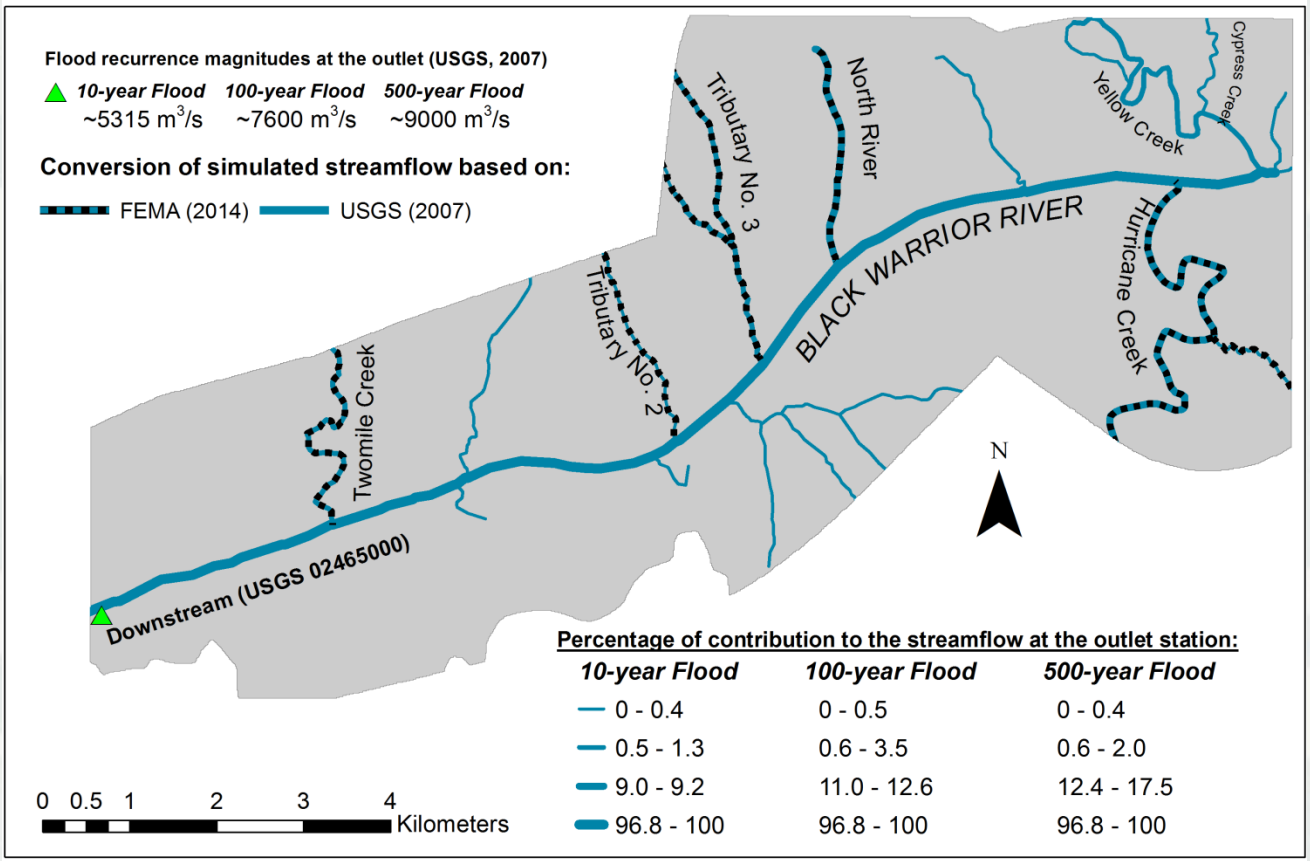


Bathymetry / Levees:

Afshari et al., “Comparison of new generation low-complexity flood inundation mapping tools with a hydrodynamic model”, In Review at Journal of Hydrology.

Shahab Afshari
Ph.D. Candidate
City University of New York
safshar00@citymail.cuny.edu

Limitations and Ongoing Research



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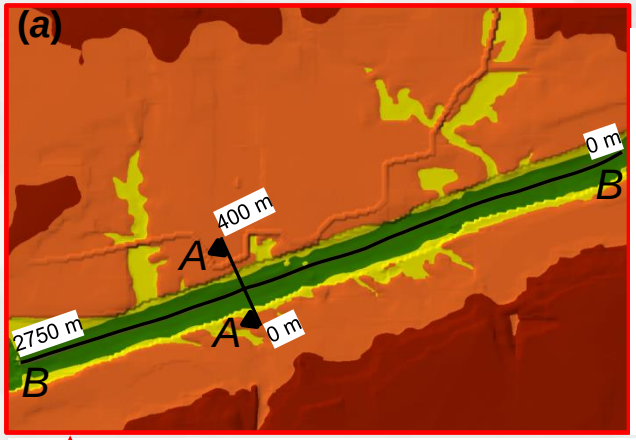

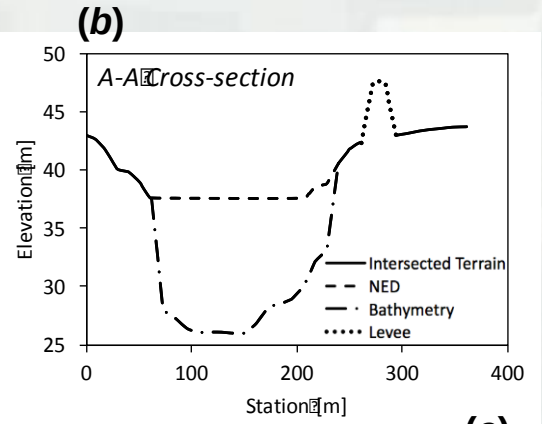

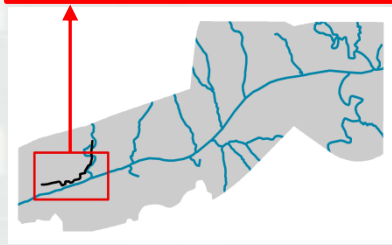

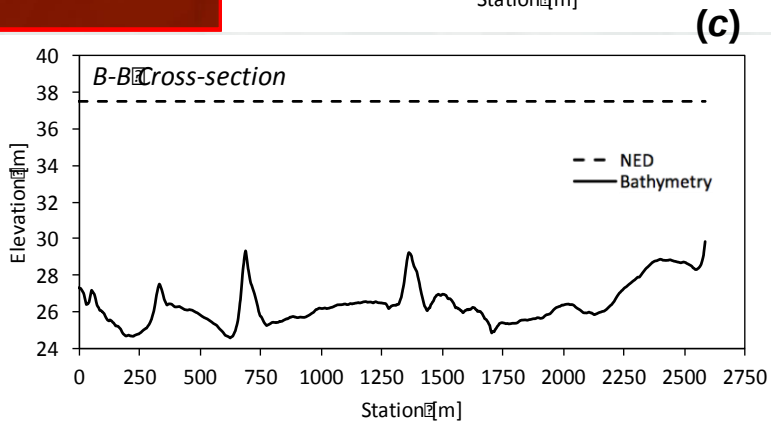

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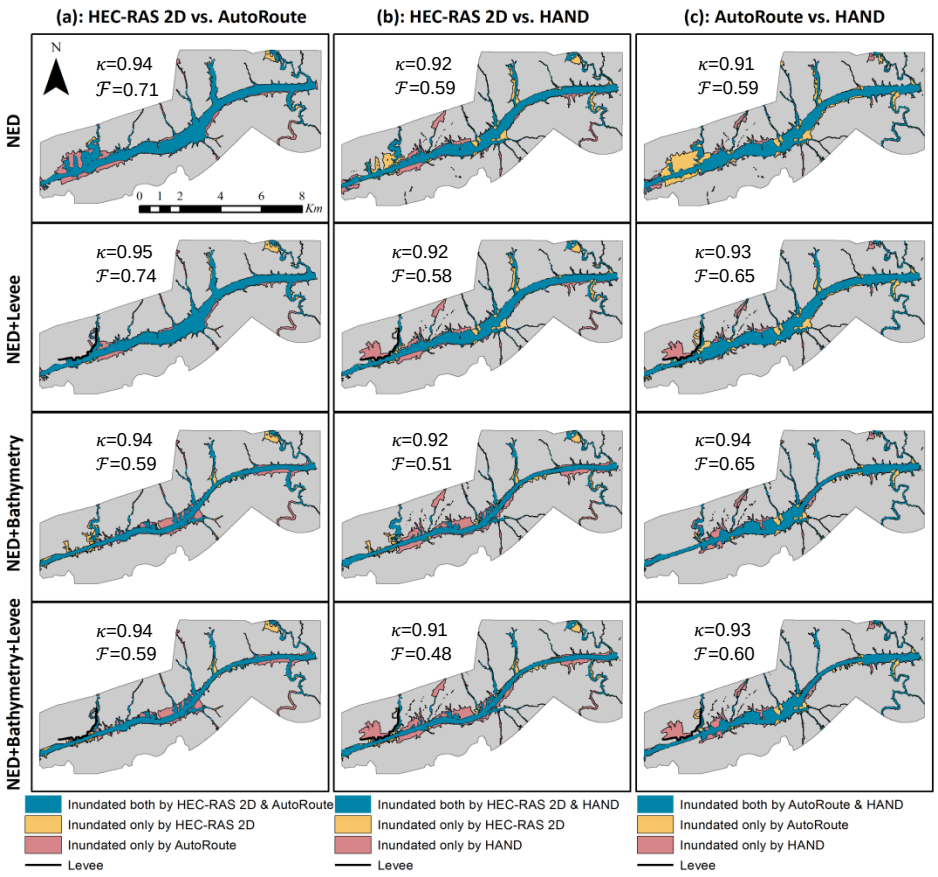
Limitations and Ongoing Research

10-Yr Flood



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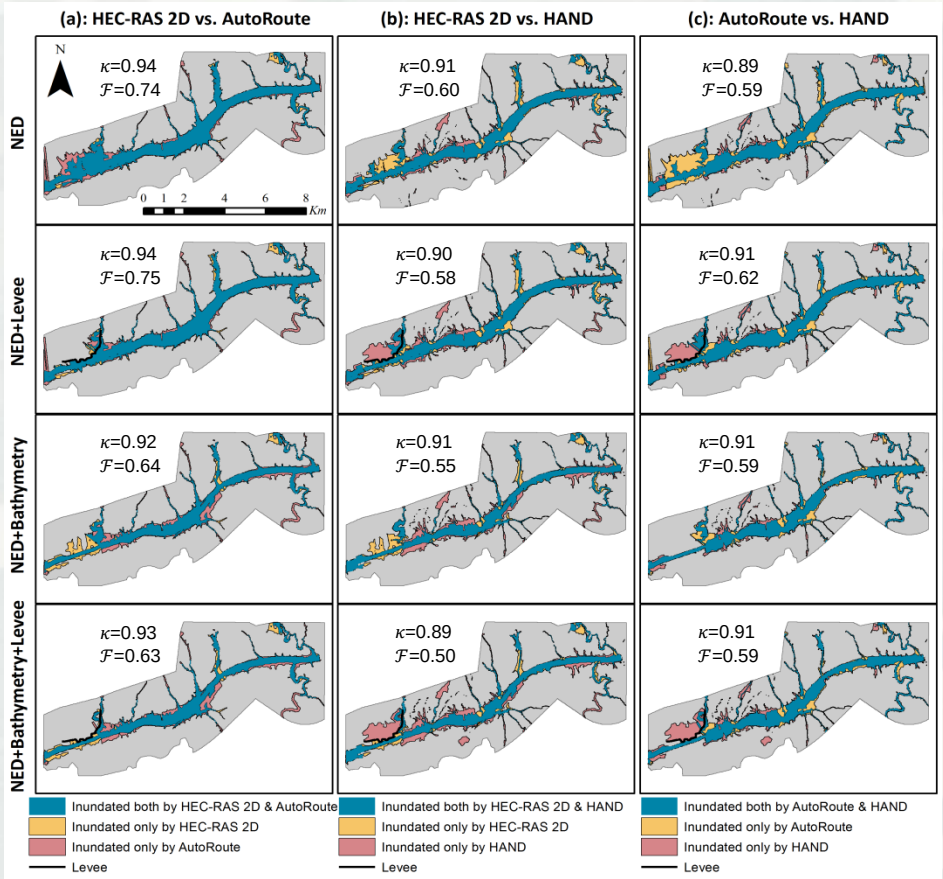
Shahab Afshari
Ph.D. Candidate
City University of New York
safshar00@citymail.cuny.edu

Limitations and Ongoing Research

100-Yr Flood



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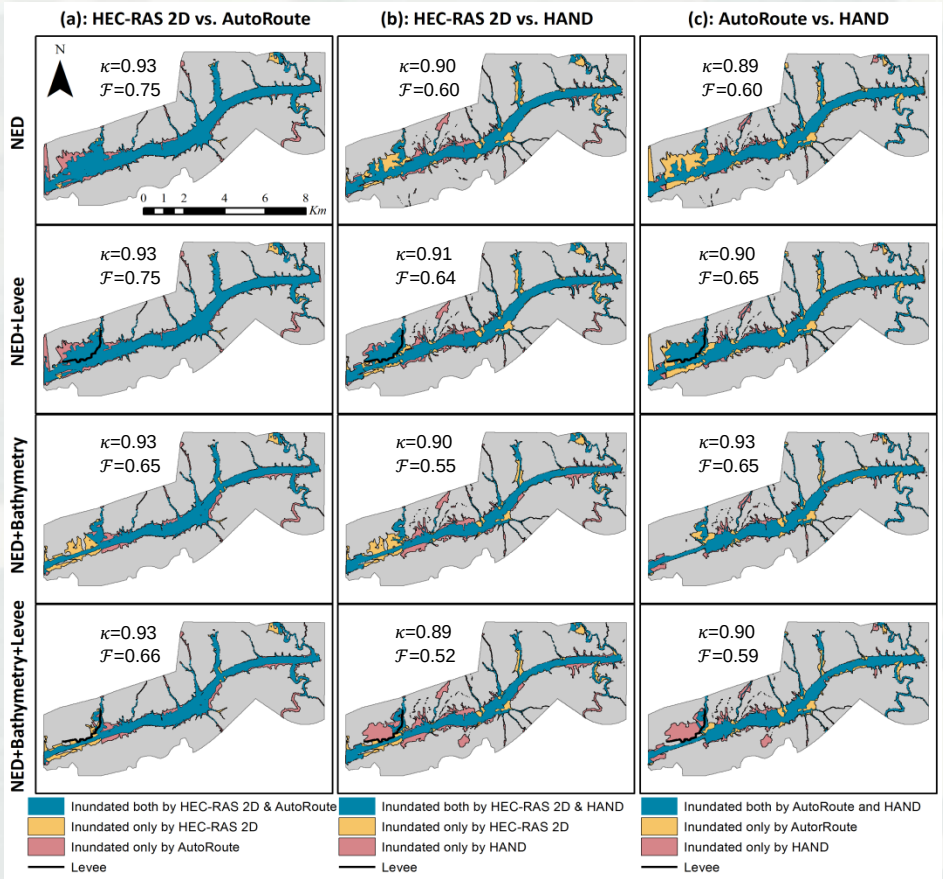
Ph.D. Candidate
City University of New York
safshar00@citymail.cuny.edu

Limitations and Ongoing Research

500-Yr Flood



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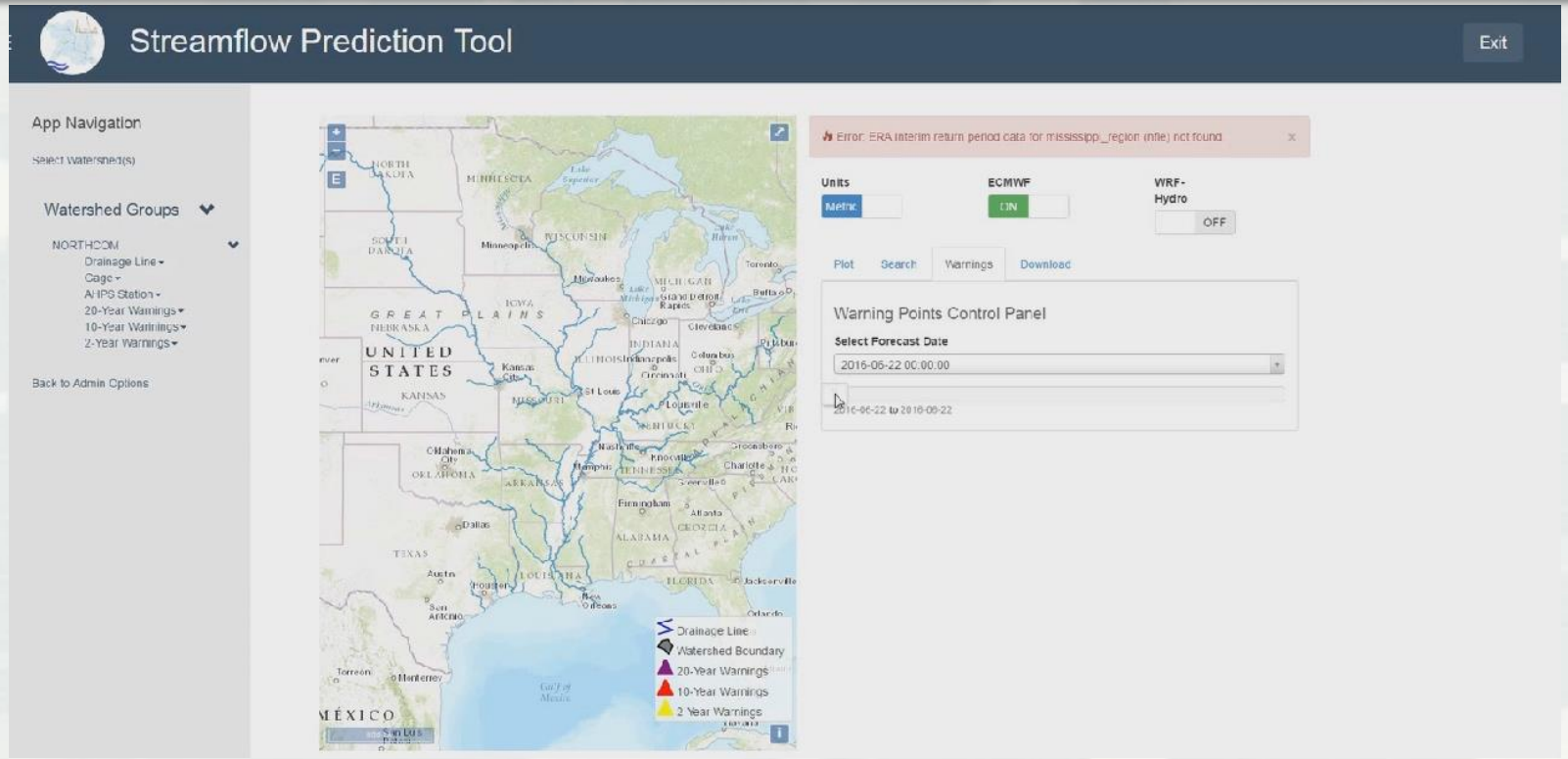

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- Praskievicz et al., “Evaluation of AutoRoute-simulated flood-inundation extents using remotely sensed imagery: 2016 Alabama/Floria and Texas Floods”, In Progress.

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Streamflow Prediction Tool:

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ERDC-CHL Military Hydrology Team:

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QUESTIONS