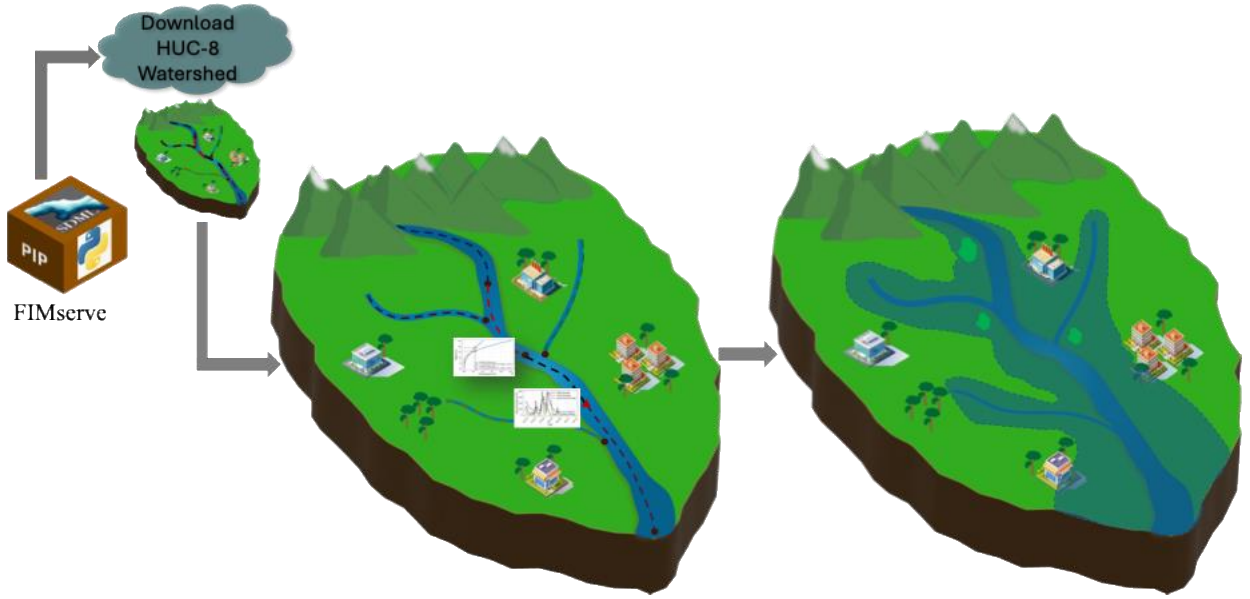
FIMserv v.1.1: A Tool for Streamlining Flood Inundation Mapping (FIM) using the United States operational hydrological forecasting with Deep Learning Surrogacy

Link for github repo



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CIROH
Cooperative Institute for Research to Operations in Hydrology

THE UNIVERSITY OF ALABAMA

Workshop Agenda

1) Introduction to OWP HAND-FIM model

2) FIMserv v.10

3) Introduction to FIMserv v.1.1

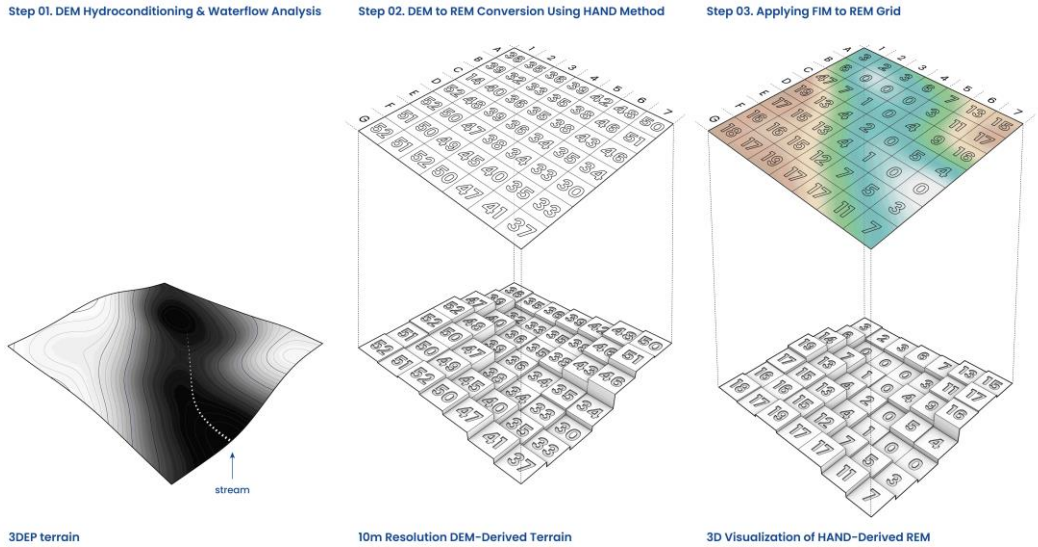
Hands On

1) Running FIMServ v1.1 for Hurricane Mathew flooding , 2016

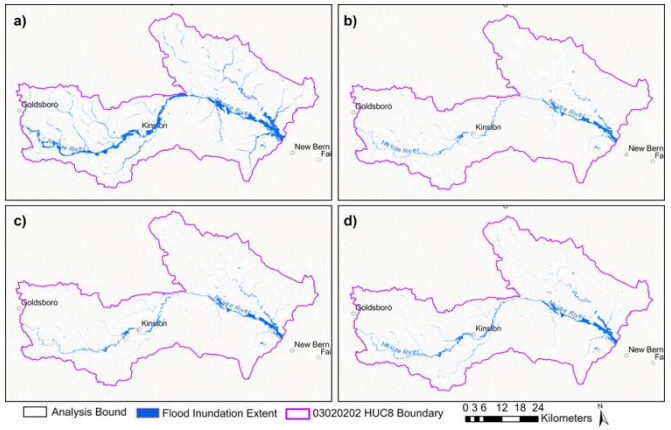
2) FIM Visualization and Impact assessment

OWP HAND-FIM method

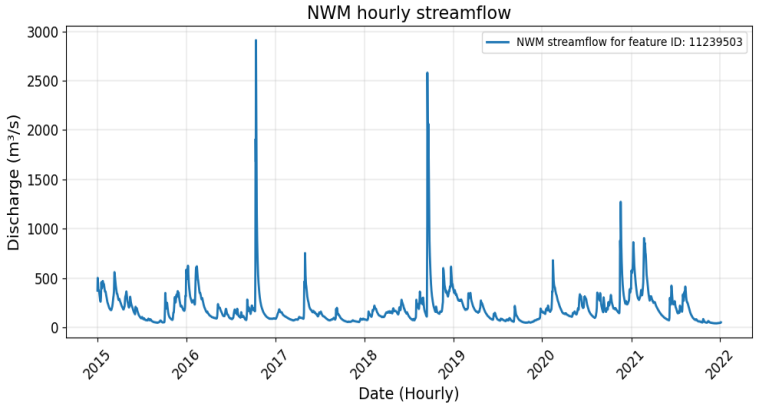
STEP-1: Hydro-conditioning at HUC-8 scale



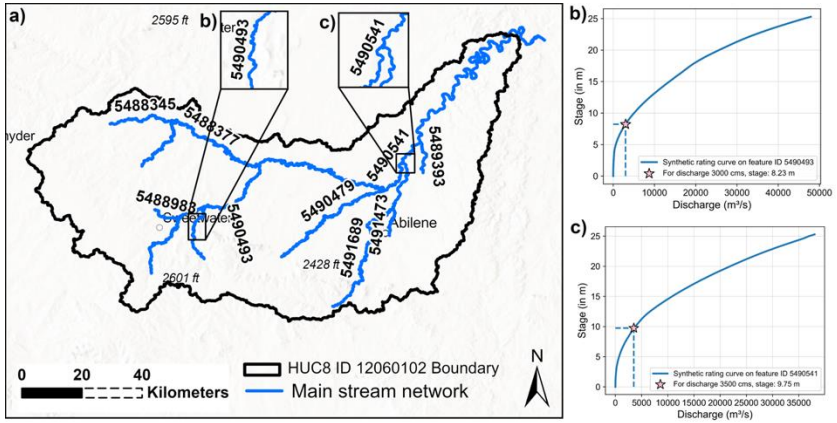
STEP-4:FIM



STEP-3: NWM Streamflow



STEP-2: Creating the reach scale SRC



Source: https://github.com/NOAA-OWP/inundation-mapping/wiki/3.-HAND-Methodology

FIMServ v 1.0

- FIMserv is a **python wrapper** for Operational FIM generation pipeline.
- Provides more functionality to the users and Researchers

Serial No	Module	Purpose	Arguments
1	DownloadHUC8	Download the HUC8 level FIM-Hydrofabric dataset hosted in CIROH S3 Bucket.	hucID*, stream_order
2	getNWMretrospectivedata	Download the NWMv3.0 retrospective discharge data.	start_date, end_date, hucID, value_time, huc_event_dict
3	plotNWMDischarge	Plot the discharge time series for NWM reach.	hucID*, start_date*, end_date*, feature_id
4	GetUSGSIDandCorrFID	Get the USGS gauge station IDs interecting with NWM reaches.	hucID*
5	getUSGSsitedate	Download the USGS retrospective discharge data.	start_date*, end_date*, usgs_sites*, hucID*
6	CalculateStatistics	Statistical evaluation of NWMv3.0 discharge with USGS discharge.	hucID*, feature_id*, usgs_site*, start_date*, end_date*
7	getNWMForecasteddata	Download the NWMv3.0 short, medium and long-range discharge forecasts.	hucID*, forecast_range*, forecast_date, hour, sort_by
8	runOWPHANDFIM	Run the OWP HAND-FIM model.	hucID*

★ Indicates the essential argument when calling the corresponding module.

FIMServ - Research Testbed for Operational Flood Inundation Mapping:

- Chen et al.,' Merging Remote Sensing Derived River Slope Datasets with High-Resolution Hydrofabrics for the United States'.

- Zarrabi et al.,' Impacts of Channel Representation on Flood Inundation Extent through Bathymetric Terrain Adjustments'

- Dhital et al.,' Enhancement of the NOAA Flood Inundation Mapping Framework (OWP HAND-FIM) through Surrogate Modeling'

Upcoming Project:

- Selecting the Optimal Synthetic Rating Curve Calibration Approach for Operational Flood Inundation Mapping using Large-Scale Benchmark Flood Maps

- A Framework to Enhance Floodwater Depth Accuracy for Operational FIM

FIMserv v1.1 : A Deep Learning Emulator

LF-FIMs; derived using the NOAA operational framework (OWP-HAND)

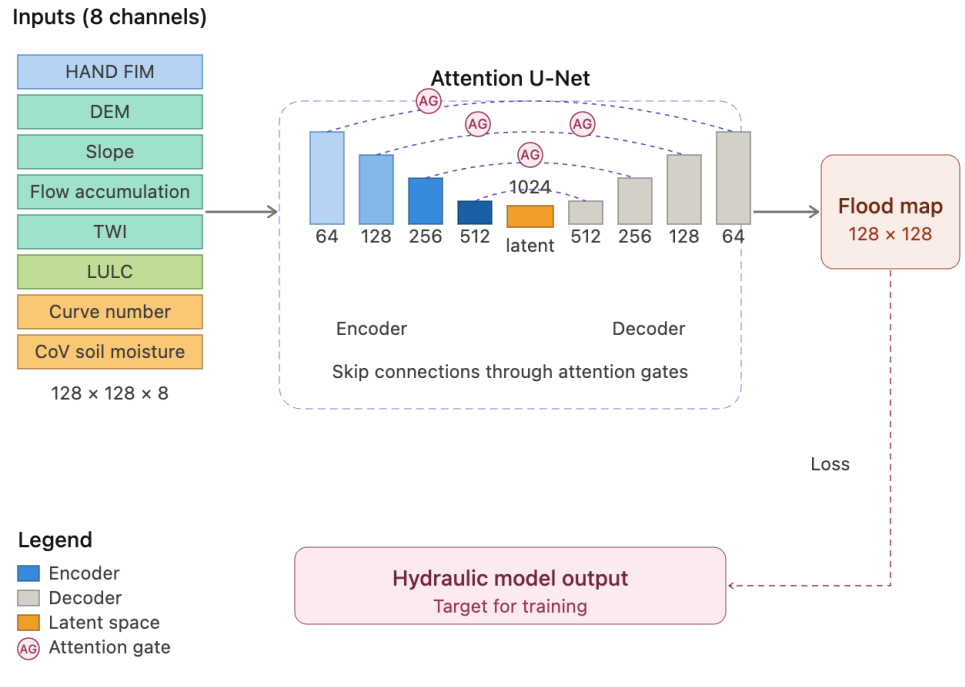
HF-FIMs; based on HEC-RAS simulations

Topographical and hydrological predictors were used

Development of Surrogate Model; based on attention U-Net based CNN

Model inference evaluation/ exploration

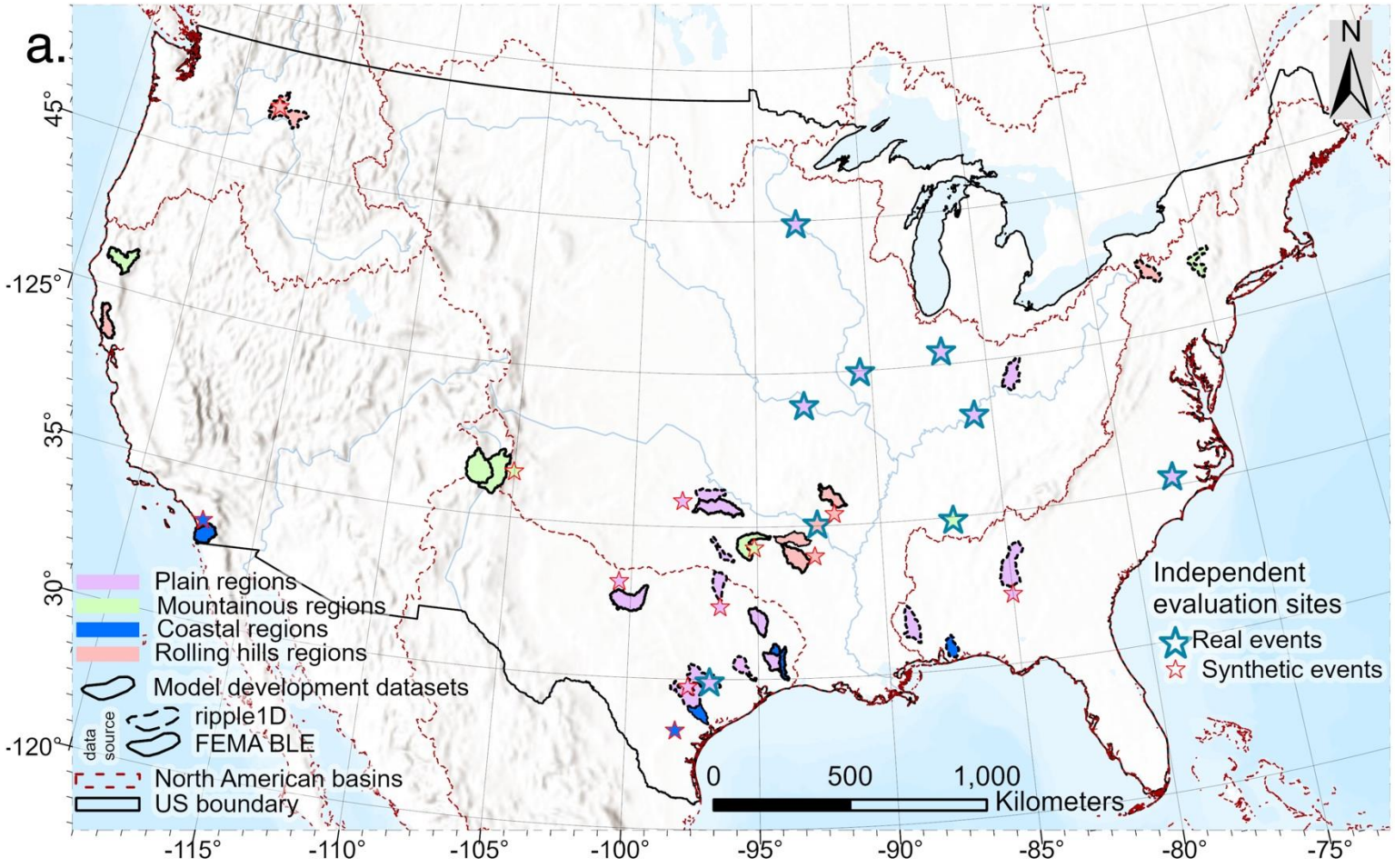
Integration into Operational framework



OWP-HAND- Office of Water Prediction, Height Above Nearest Drainage

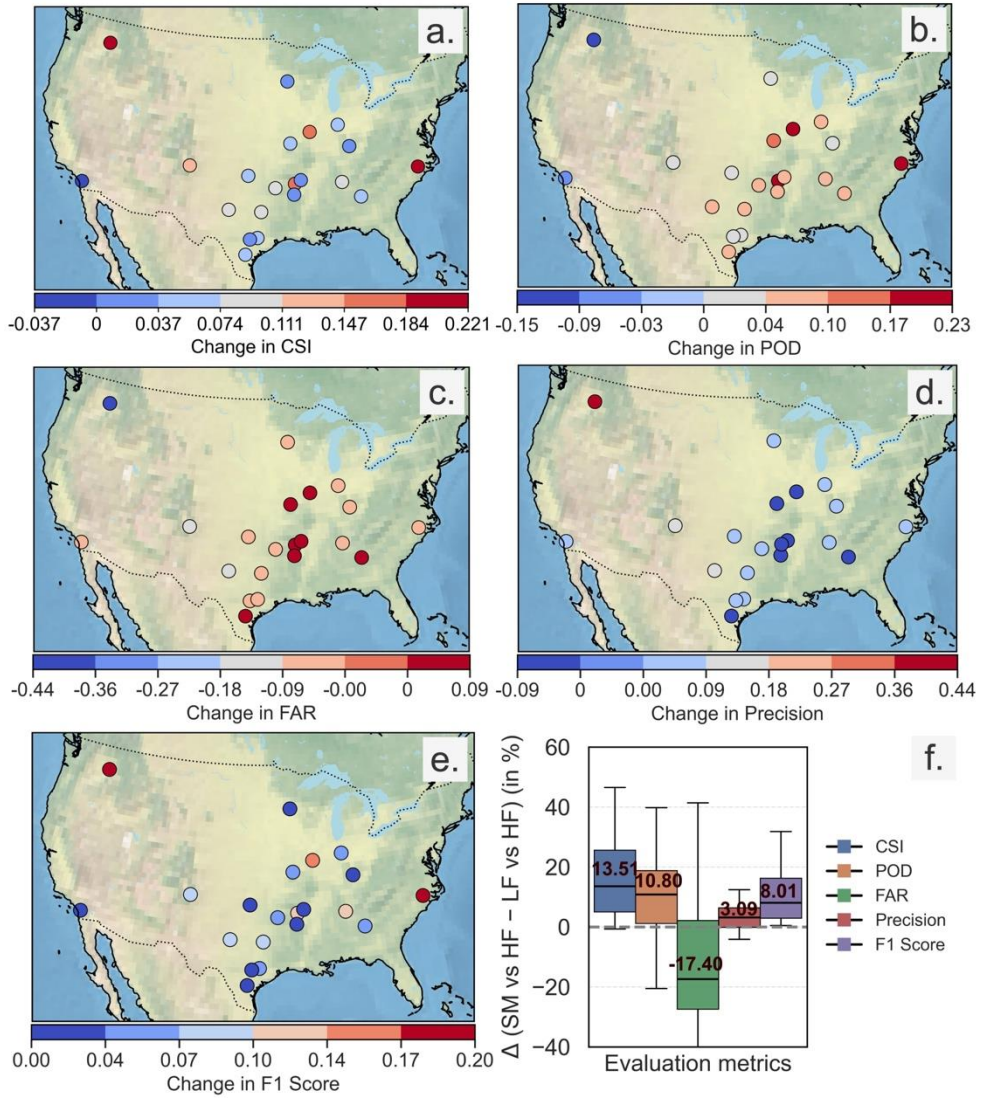
Datasets used for modeling

- Modeling was done on: Total of **28 different sites(>125,000 sq km of areas)**
- Model transferability was done in unseen **20 different sites (9 real and 11 synthetic case studies)**



Performance on unseen cases

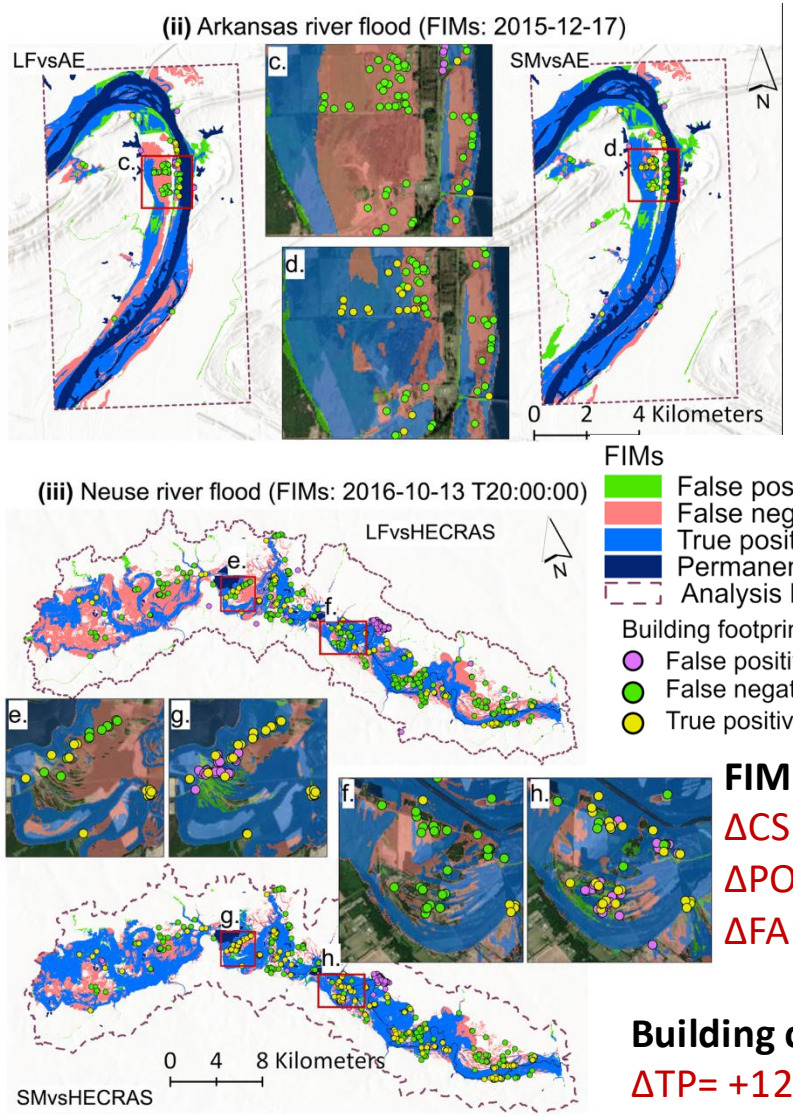
CONUS wide evaluation



Evaluation using building footprint

FIM intercomparison

ΔCSI= +27.59% , ΔPOD= +34.59%, ΔFAR= +7.50%



Building counts

ΔTP= +18, ΔFP = -4

FIM intercomparison

ΔCSI= +46.52% , ΔPOD= +46.95%, ΔFAR= -24.24%

Building counts

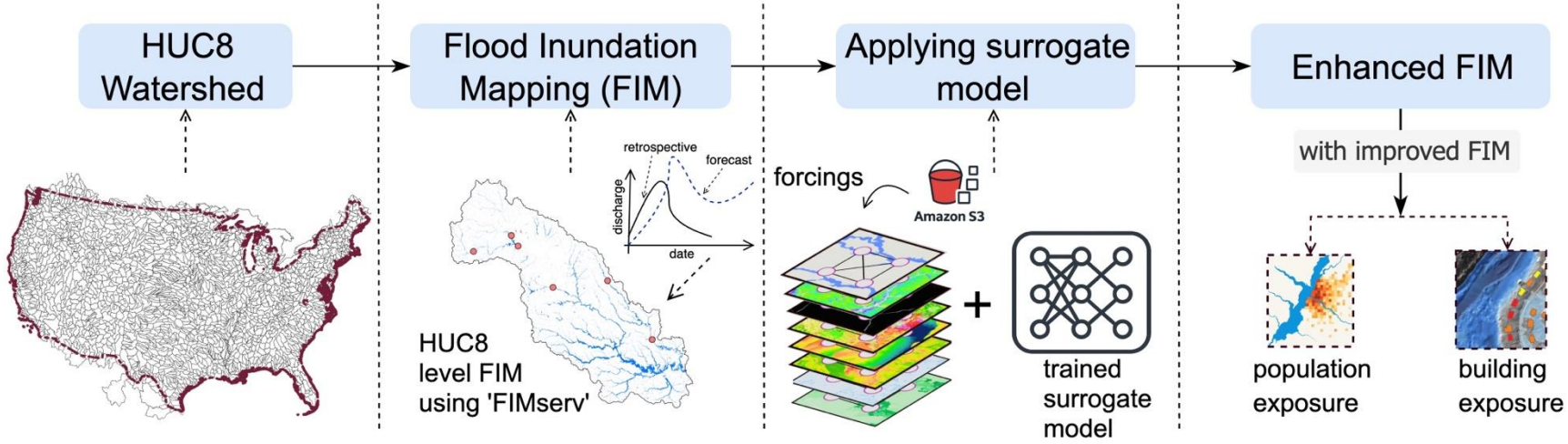
ΔTP= +129, ΔFP = +42

Integration into operational framework

FIMs	Model	Computational time (Seconds)	Speed-up vs HF-model
HF (CPU)	HEC-RAS 2D	171720 (48 hour)	Baseline
LF (CPU)	HAND	148.4	1157.14
SM (CPU)	Attention U-Net CNN	226.81	757.10
SM (GPU)	Attention U-Net CNN	75.6	2271.42

Area for this region- approx. **1000 sq km**

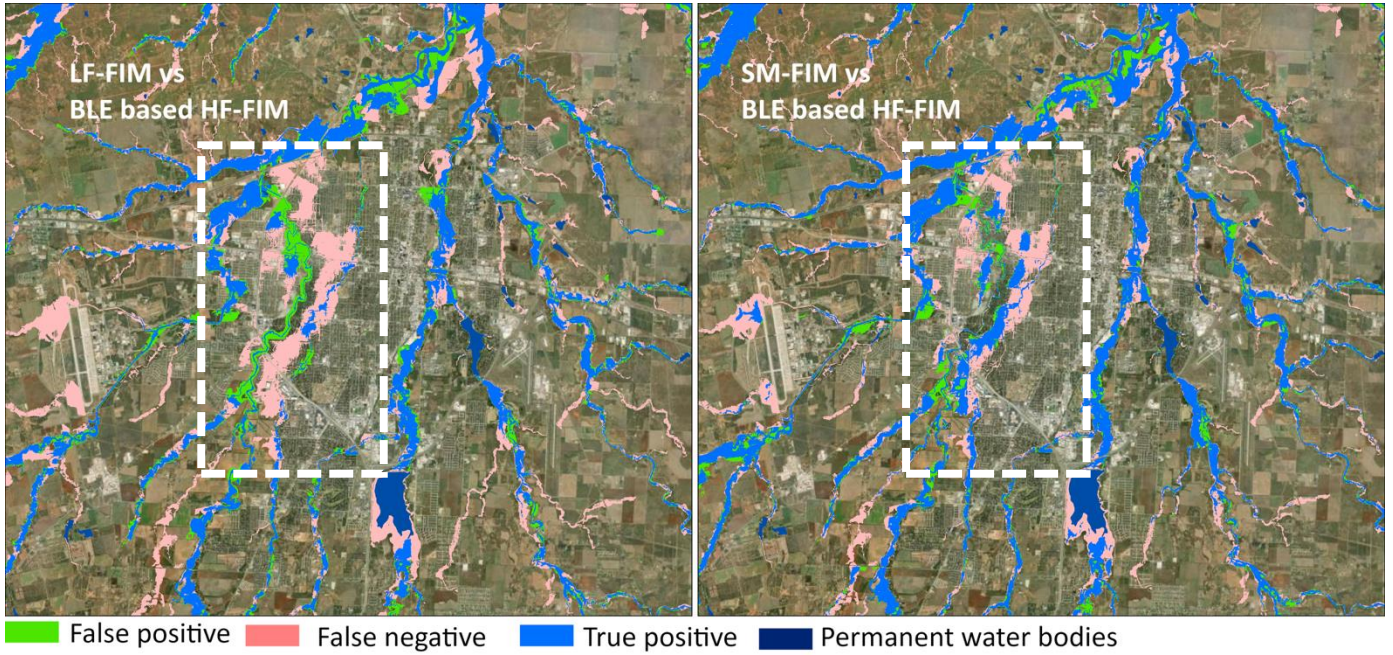
Integration of developed SM into the **NOAA Operational framework through FIMserv**



Limitations

- **FAR in low elevations;** high dependence of SM in LF-FIM
  - Agricultural lands --> moderately high TWI
  - Strong TWI dependence of SM --> **TP (↑), in the expense of FP**; shallow depressions, drainage ditches, backswamps

- Complex hydraulic dynamics; where seed water in LF-FIMs were poorly represented



Acknowledgement

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Lab members of SDML

https://github.com/RTIInternational/teehr RTI International

Git Hub Link for FIMserv

Link for manuscript

HANDS-ON

T1

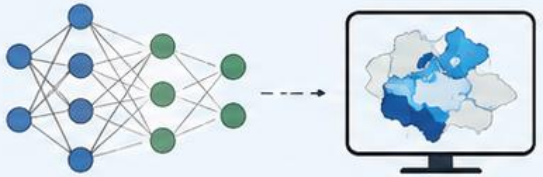
Running FIMserv

to generate flood inundation maps using NWM retrosprctive discharge for Hurricane Matthew, in October 2016

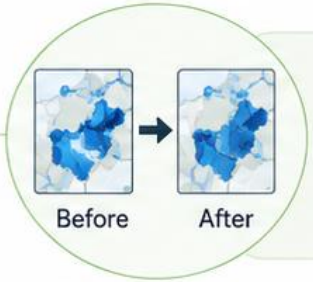
T2

Download the forcings

and apply the pre-trained surrogate model

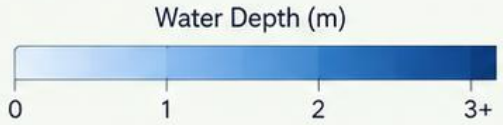


T3



FIM visualization

before and after applying the surrogate model



T4

Buildings hits and population exposure visualization