



NOAA

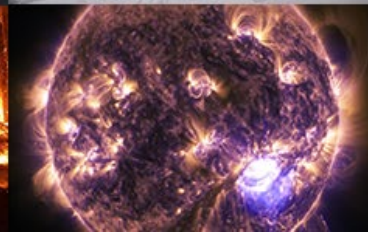
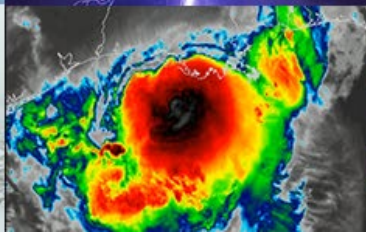
**National
Weather Service**

Optimizing Synthetic Rating Curves for National Water Center Flood Inundation Mapping

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Member of the NWC Geospatial Intelligence Division - FIM Dev Team





Outline



- Summarize the National Water Center (NWC) flood inundation mapping approach to generating synthetic rating curves (SRCs)
- Addressing the missing bathymetric component
- Improving synthetic rating curves (SRCs) using benchmark data
- Overall Goal: Improve inundation accuracy for operational real-time FIM services





Height Above Nearest Drainage (HAND) Method



Digital Elevation Model

80.1	80.2	80.3	82.1	82.1
80.1	80	80	80.5	82.1
81.2	80.8	79	78.6	79.5
82.1	79.3	78.3	78	76.2
82.1	80.5	79.2	76.1	76

- Height Above Global Datum -

Geospatial

Processing

Relative Elevation Model

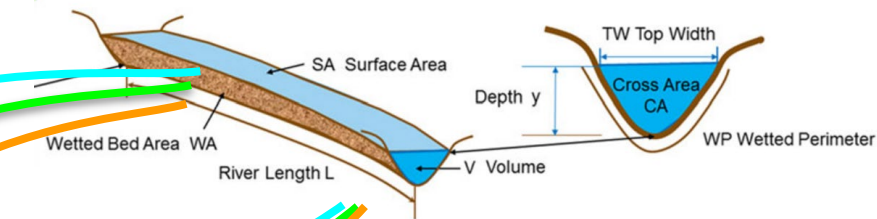
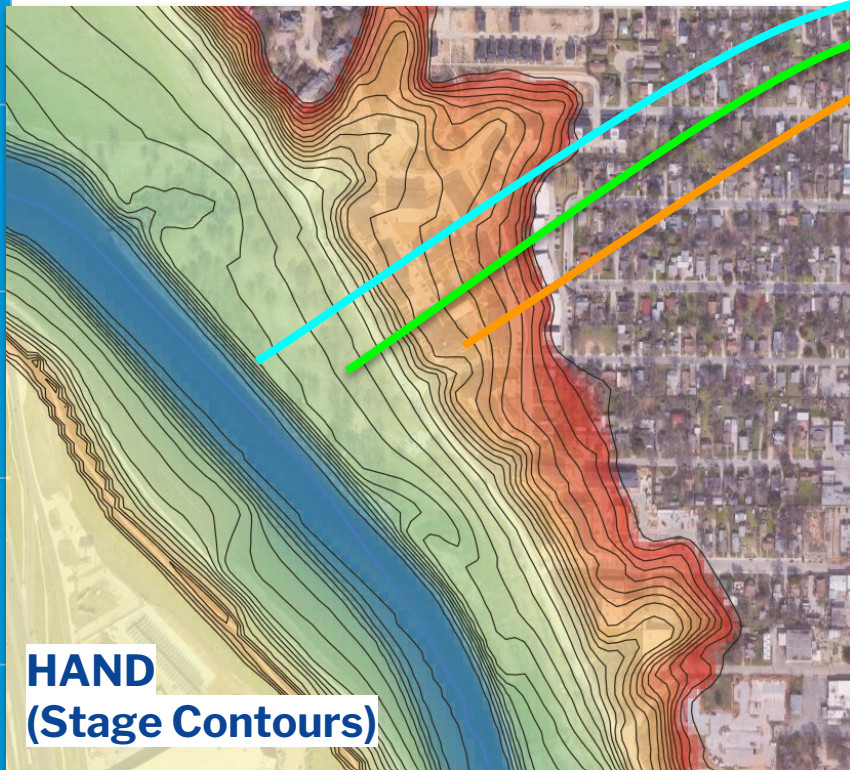
0.1	0.2	0.3	2.1	2.1
0.1	0	0	0.5	2.1
1.2	0.8	0	0.6	1.5
2.1	1.3	0.3	0	0.2
4.1	2.5	1.2	0.1	0

HAND = 2

- Height Above Local Channel
(i.e. nearest drainage) -



Synthetic Rating Curve



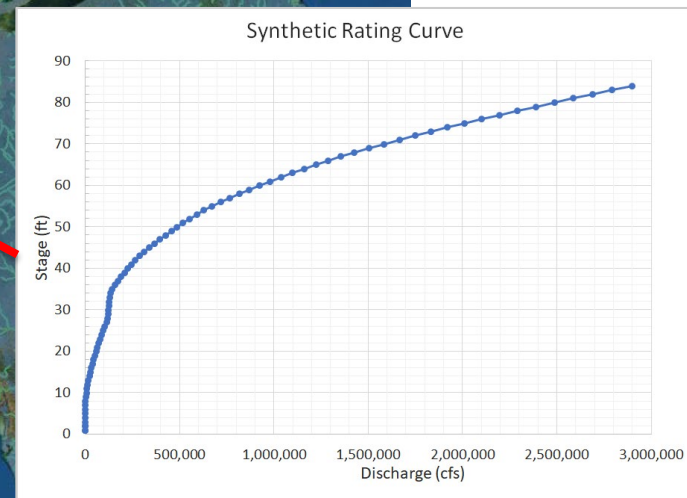
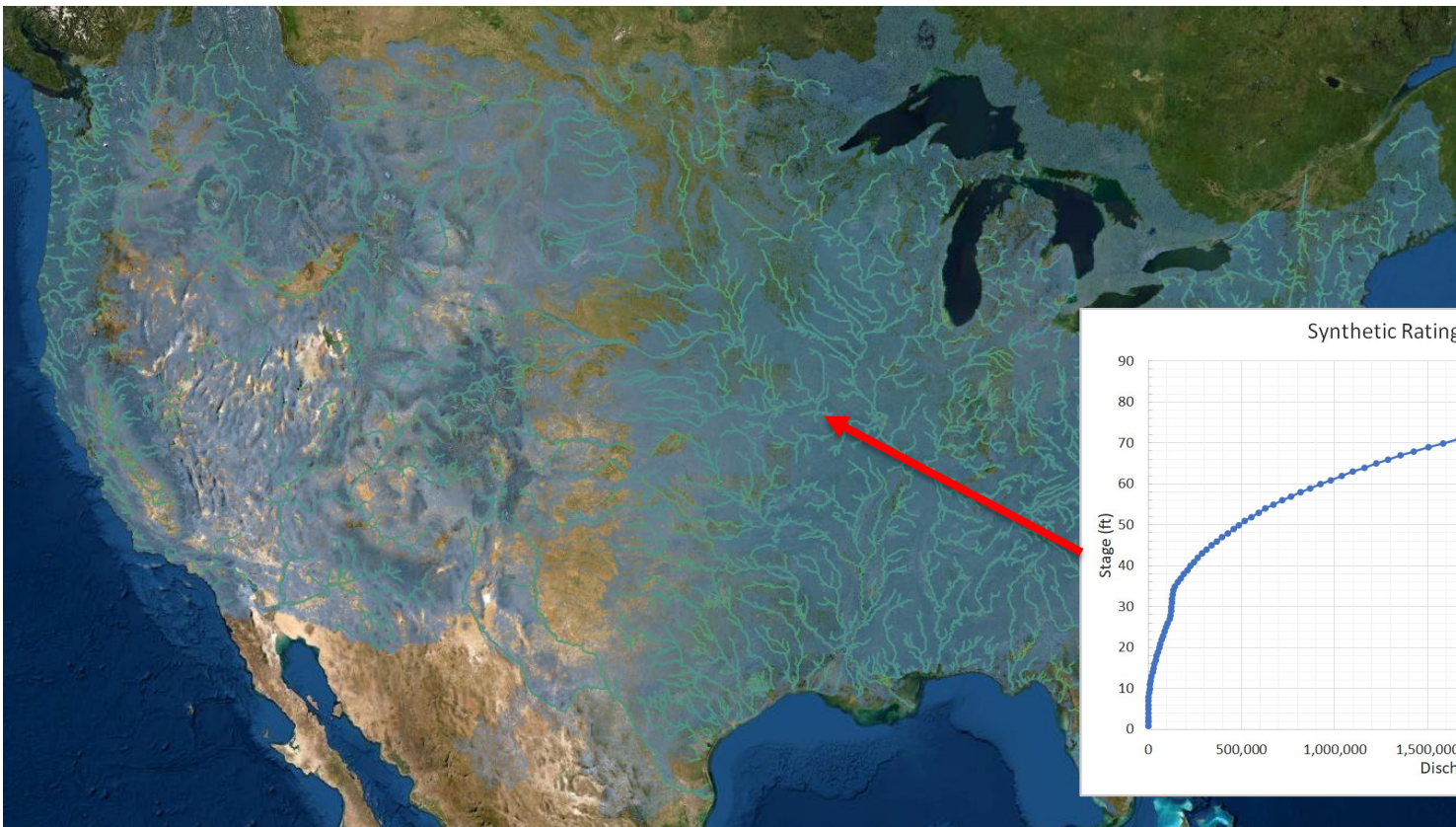
HydroID	stage	discharge_cms
17770001	0	0
17770001	0.3048	5.204117583
17770001	0.6096	16.52204345
17770001	0.9144	32.47500239
17770001	1.2192	52.45421831
17770001	1.524	76.08466062
17770001	1.8288	103.1017059
17770001	2.1336	133.3042003
17770001	2.4384	166.5317627
17770001	2.7432	202.6521814
17770001	3.048	241.5537406
17770001	3.3528	283.1402269
17770001	3.6576	327.3275129
17770001	3.9624	374.0411249
17770001	4.2672	423.2144556
17770001	4.572	474.7874152

$$Q(y) = \left(\frac{1.00}{n}\right)AR^{\frac{2}{3}}S^{\frac{1}{2}}$$



Synthetic Rating Curve

Synthetic Rating Curve generated for each stream segment in the NWM network (2.7+ million)

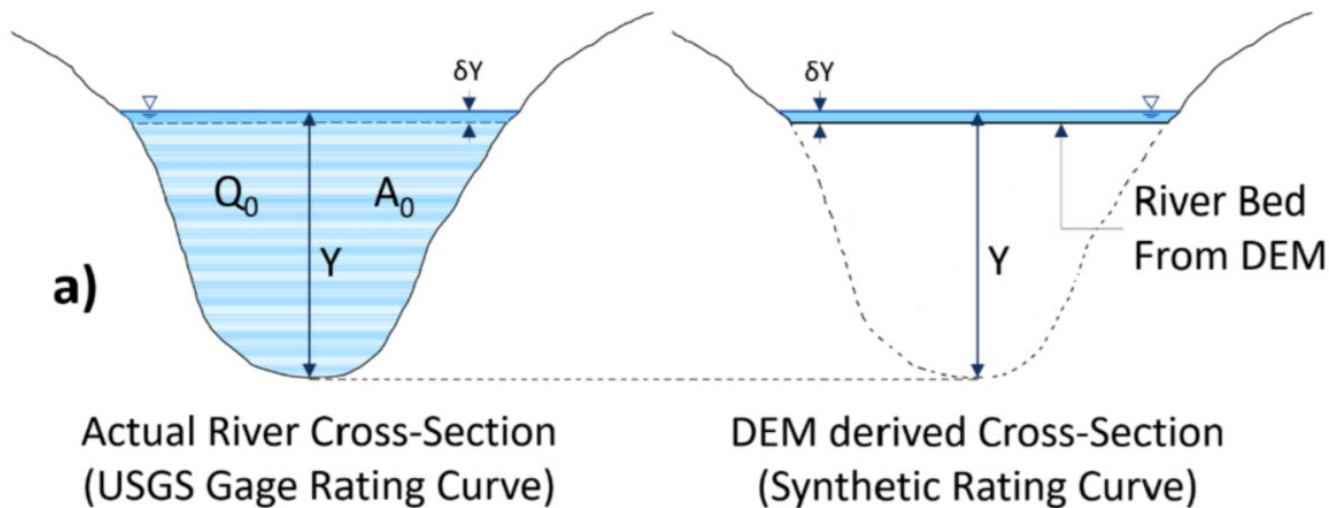




Estimating Bathymetry



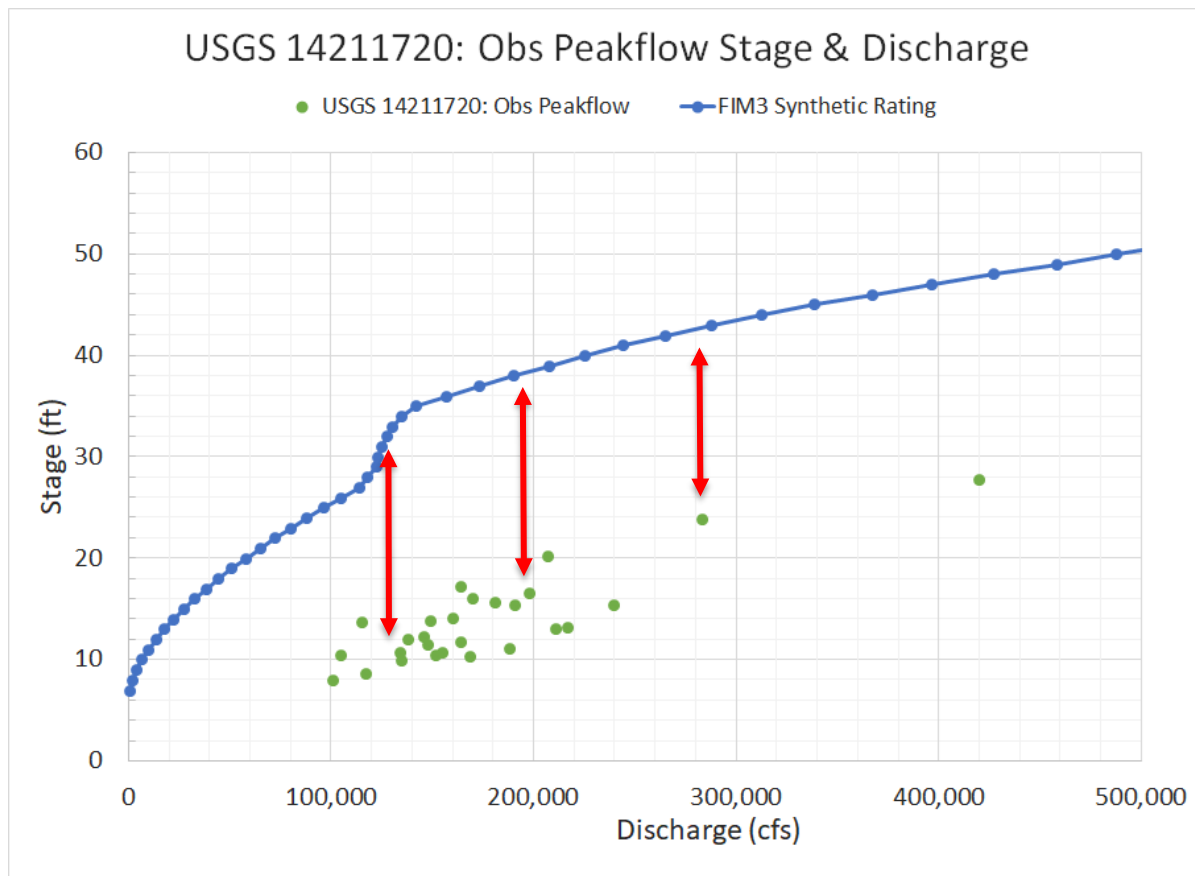
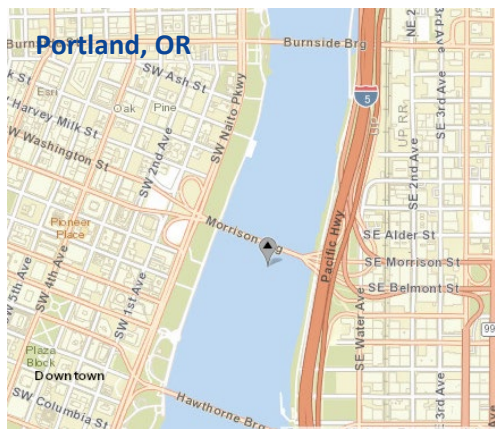
- **Problem:** DEM's typically do not portray channel bathymetry (volume below water surface)
- **Solution:** Estimate the missing bathymetry area and add it to channel cross section area. Bathymetry Adjusted Rating Curve (BARC)



Ghanghas et. al, 2021



Summary: unaccounted for bathymetry results in a substantial “shift” in the SRC





Bathymetry Adjusted Rating Curve



- Input: regression equation derived estimates of “bankfull” properties

- Source: Bieger et. al 2015



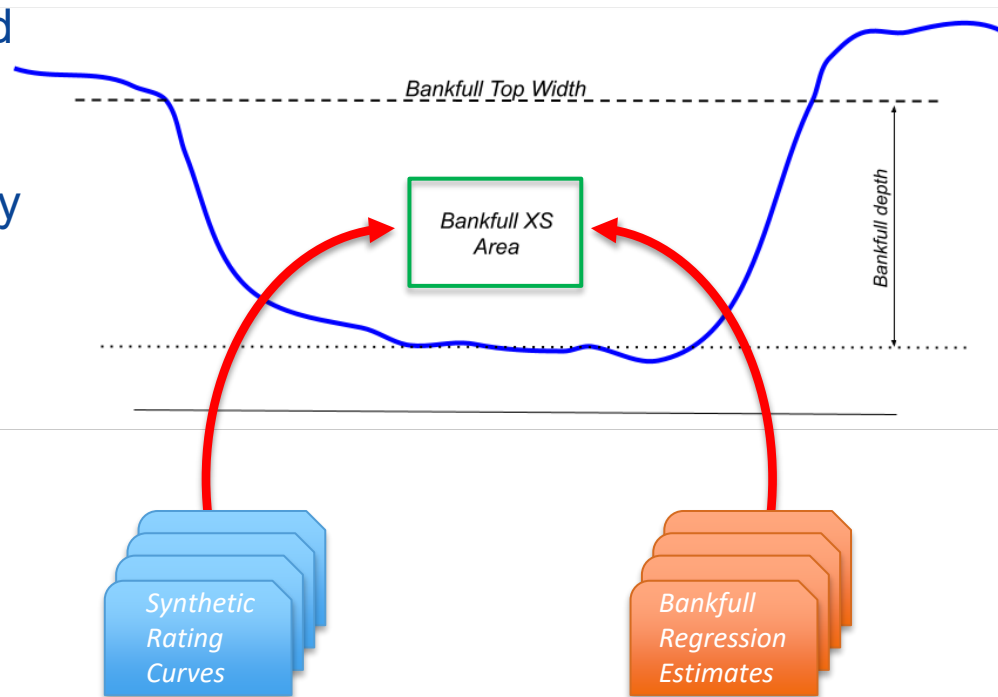
- Compute the “missing” bathymetry component of the SRC cross-section area



- Output: New SRC computed with modified XS Area and Manning’s equation



- Currently implemented for medium-large streams



$$XS\ Area\ (Bathy) = A_{Reg} - A_{SRC}$$



Optimizing SRCs with “Observed” Data



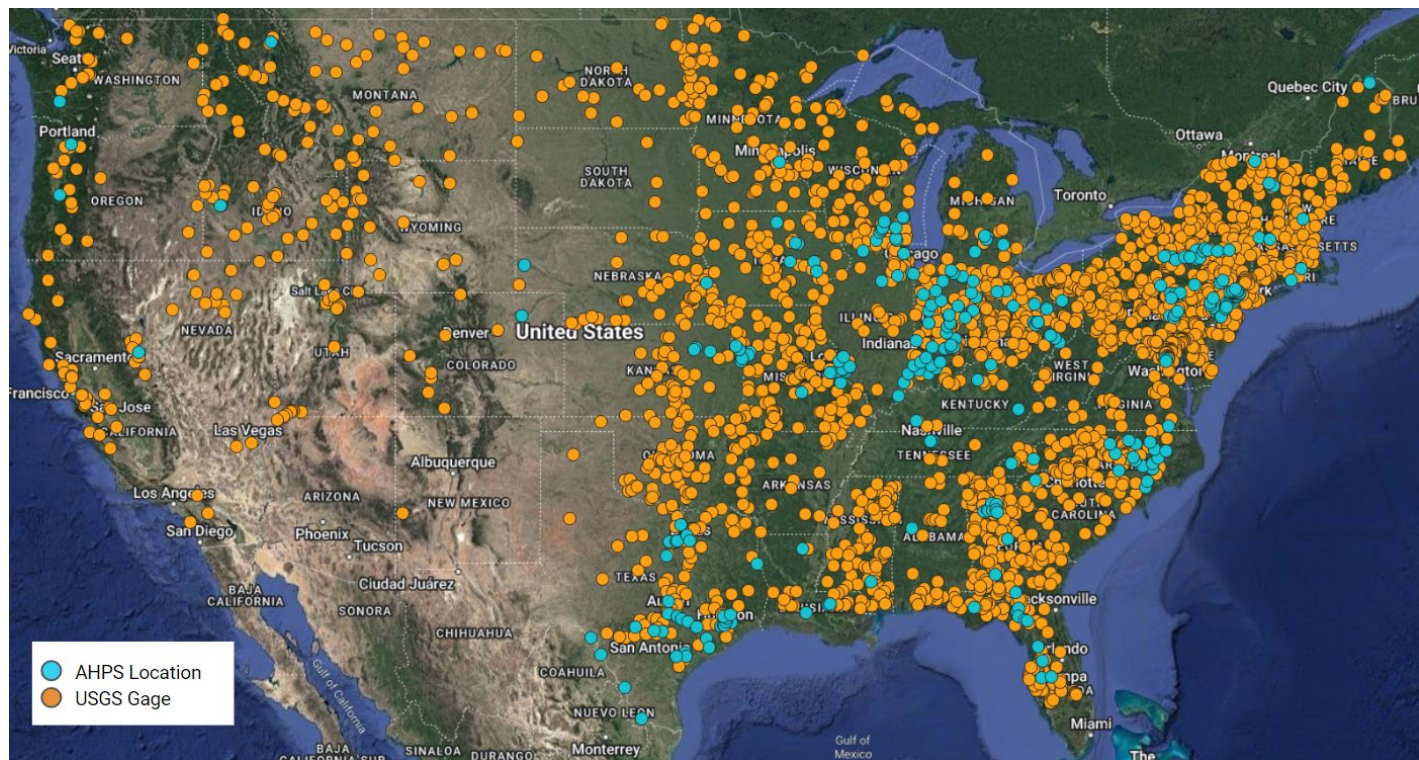
NWS and USGS Benchmark FIM Library Locations & USGS Gages with Rating Curves



283 AHPS sites
with NWS/USGS
FIM benchmark
library



2508 USGS gage
rating curve
locations

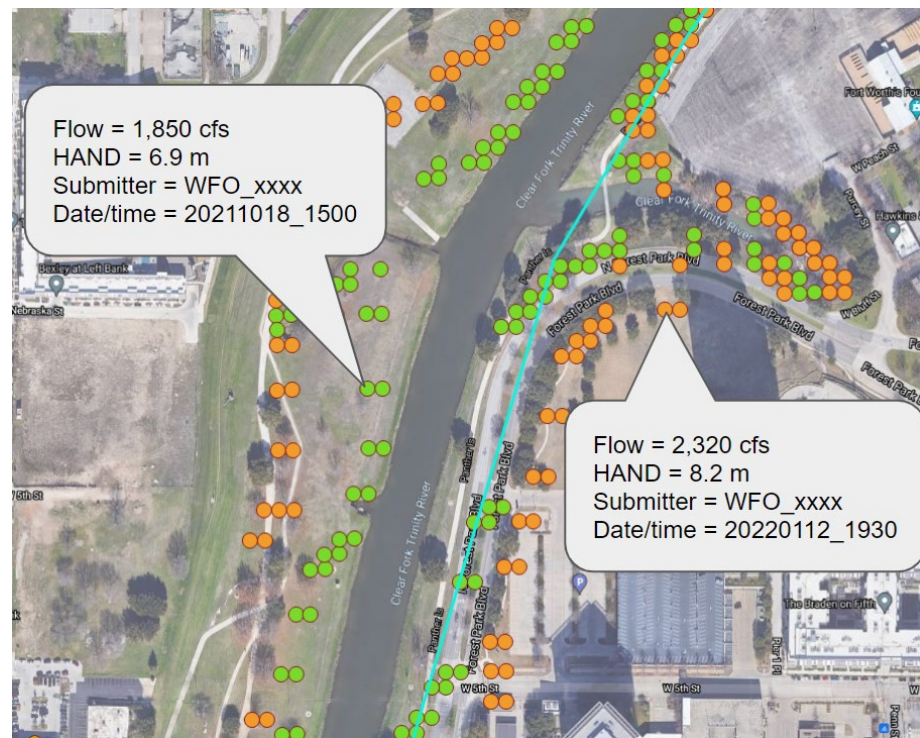
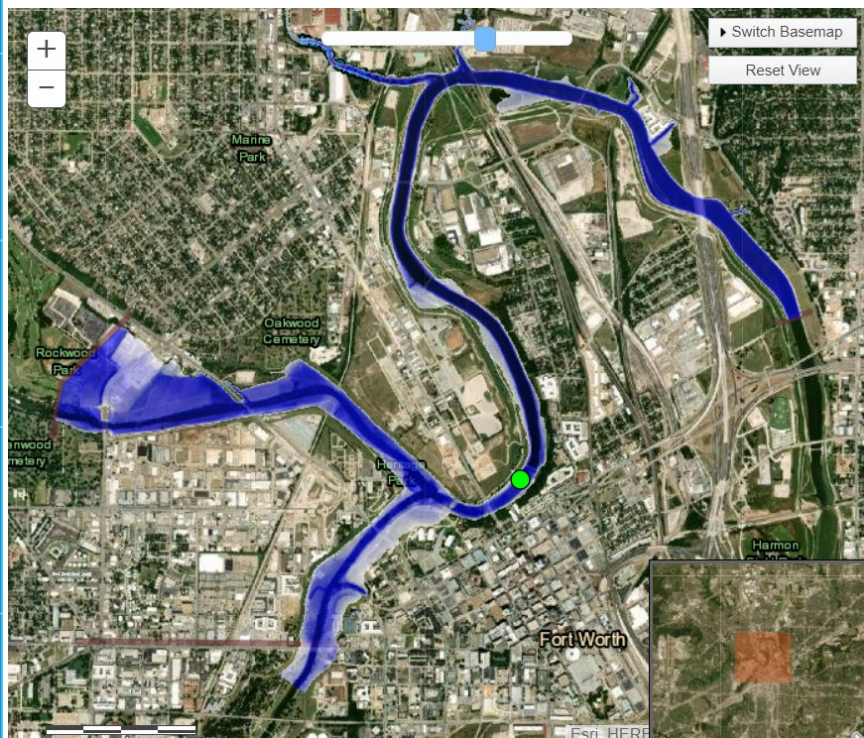




Optimizing SRCs with “Observed” Data



West Fork Trinity River at Fort Worth, TX (HEC-RAS inundation library location)

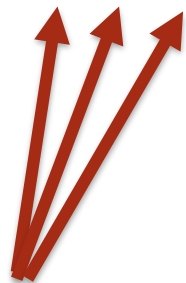




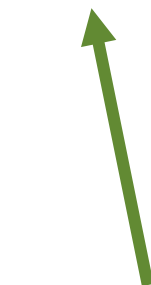
Calculating Manning's Roughness



$$n = A R^{2/3} S^{1/2} Q^{-1}$$

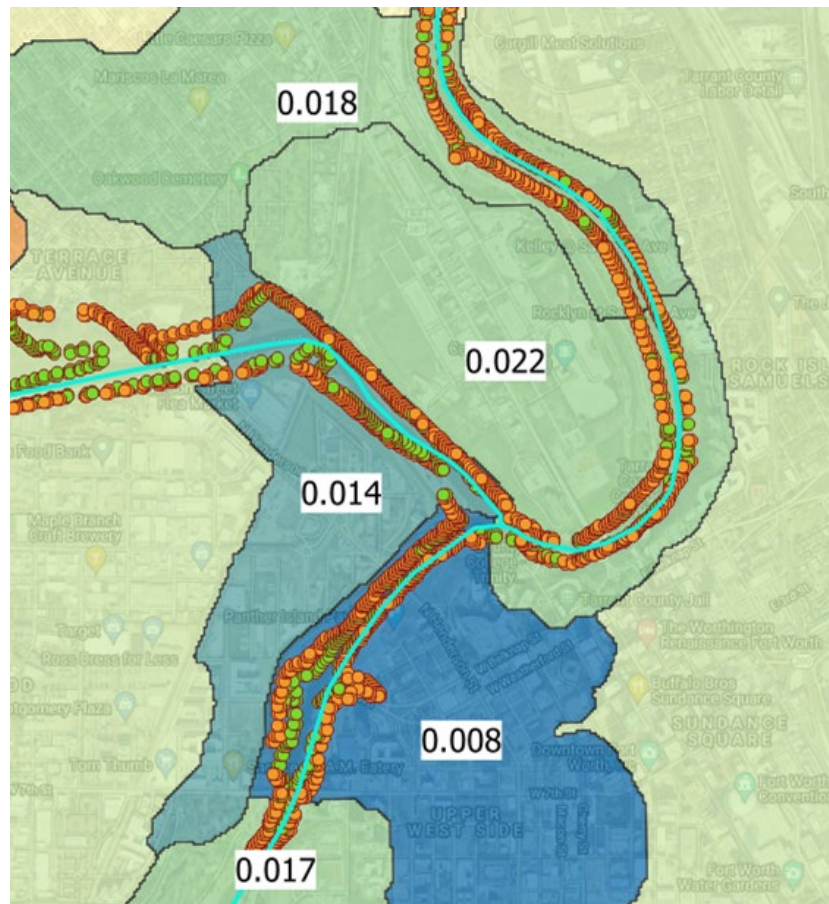


Extracted from
default SRC for
matching
HAND value



Obs discharge
(provided)

n = Manning's roughness coefficient
 A = Cross section Area
 R = Hydraulic radius
 S = Channel slope
 Q = Discharge

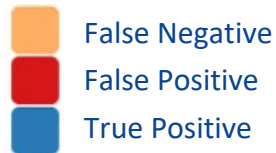
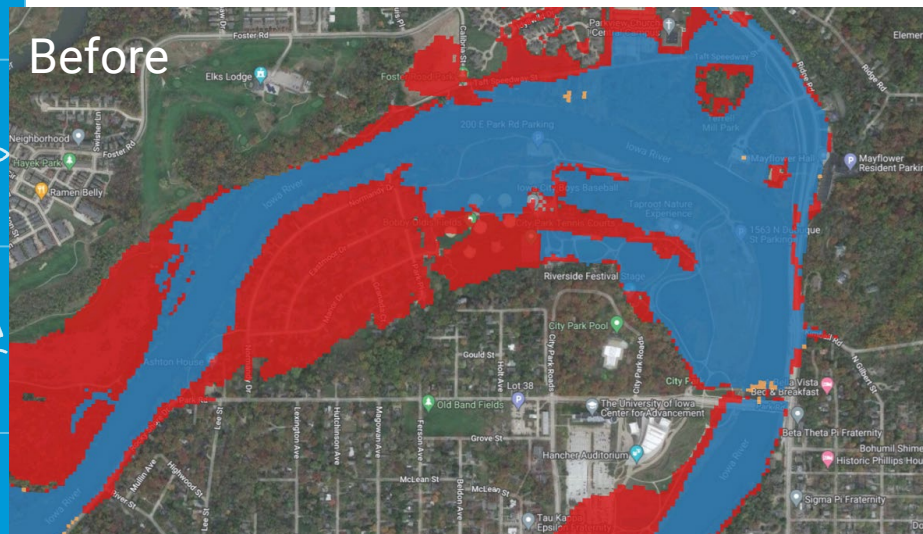




Results – Spatial Analysis



IOWI4: Iowa River @ Iowa City, IA → Moderate Flood Stage

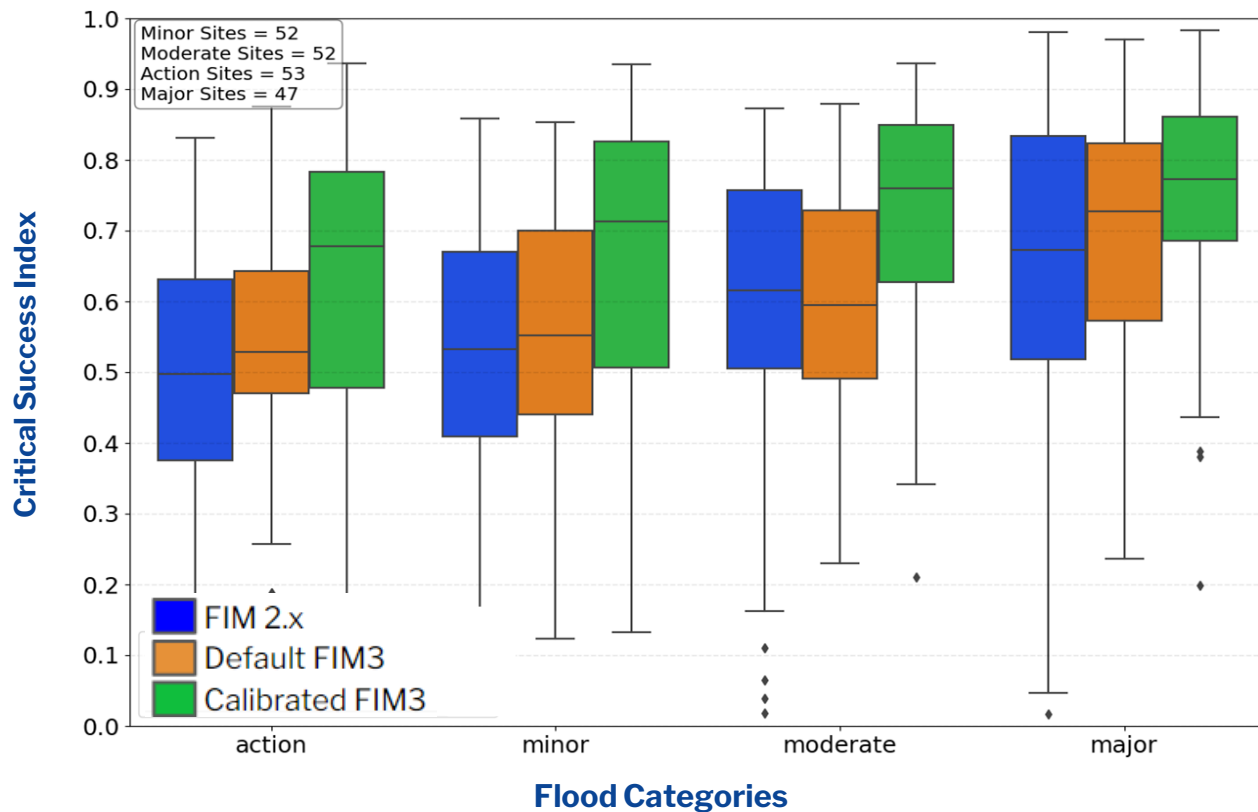




Statistical Results



Critical Success Index: USGS Evaluation Sites



Note: Calibrated results only reflect enhanced skill around AHPS forecast points and some USGS gages. Not representative of skill at watershed scale.

Future Opportunities

FIM user observes overprediction for
given flow



FIM user provides **true extent** for
given flow



Future FIM better aligns with **true extent** for
given flow



Thank you for participating!

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Trevor Grout, Fernando Aristizabal & Fernando Salas



GitHub

NOAA-OWP/inundation-mapping

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