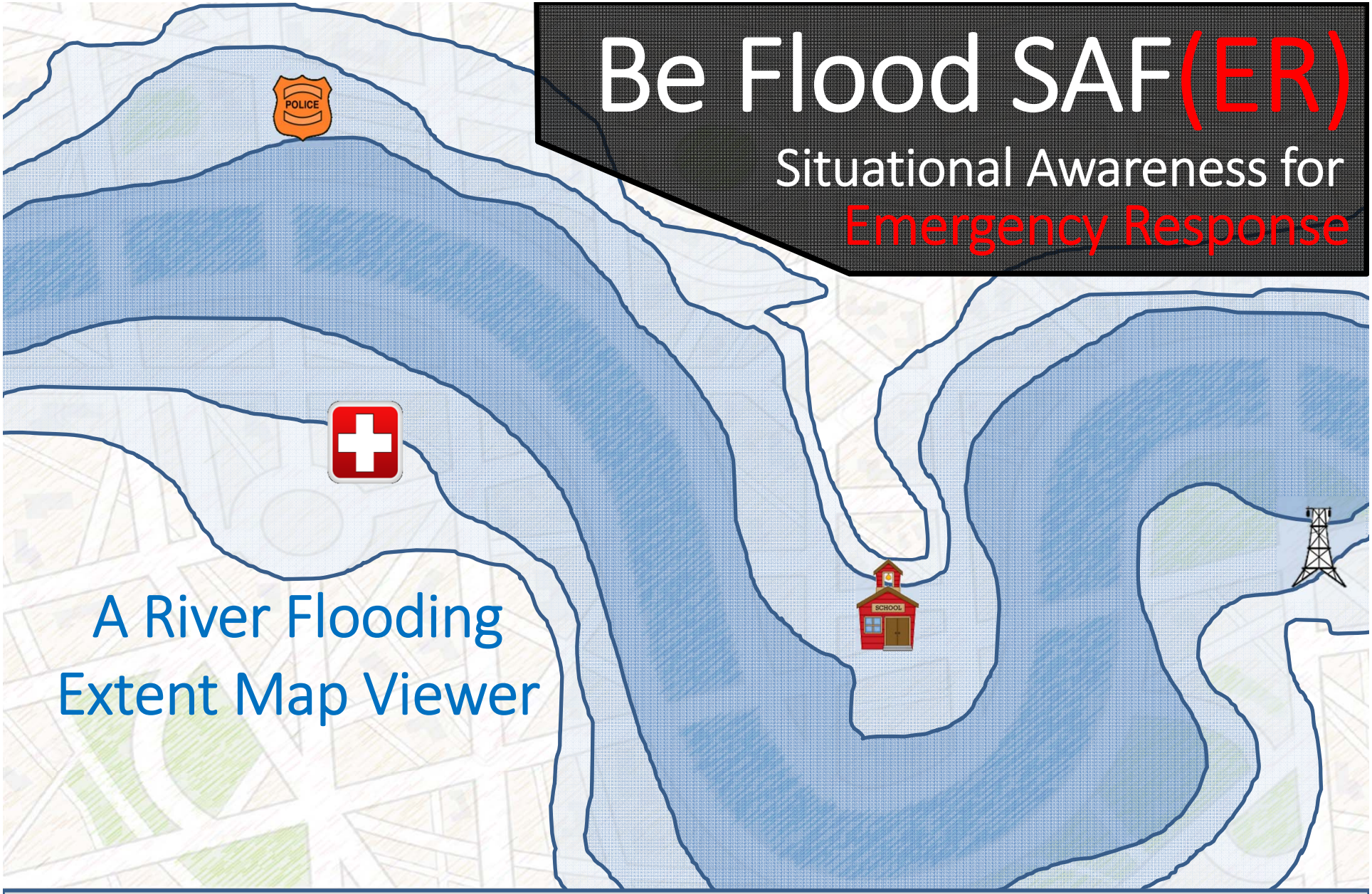
Be Flood SAF(ER)

Situational Awareness for Emergency Response



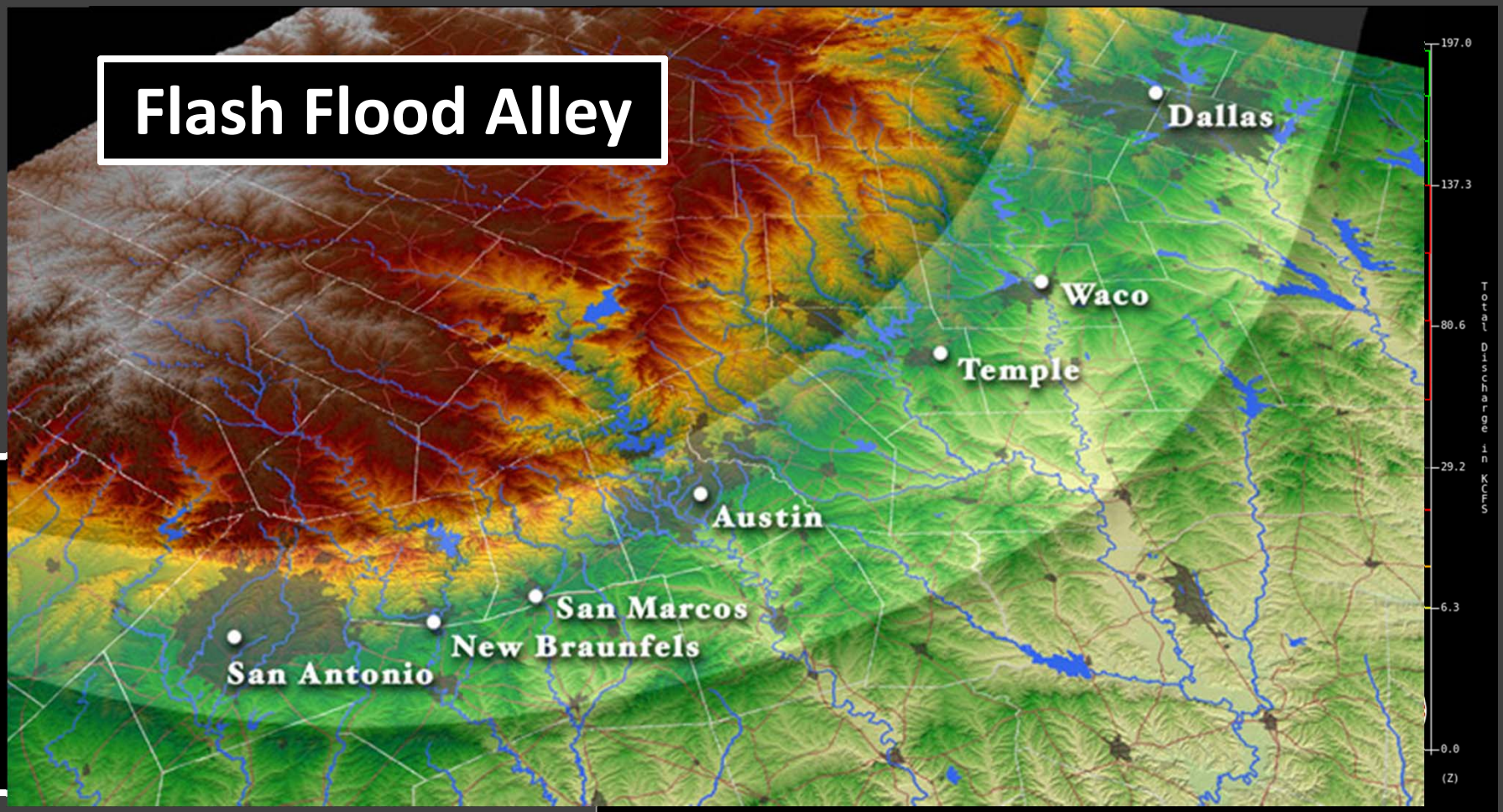
A River Flooding Extent Map Viewer

Jared Allen
NOAA/NWS
Austin/San Antonio, TX

26th Annual SCAUG Conference – Corpus Christi

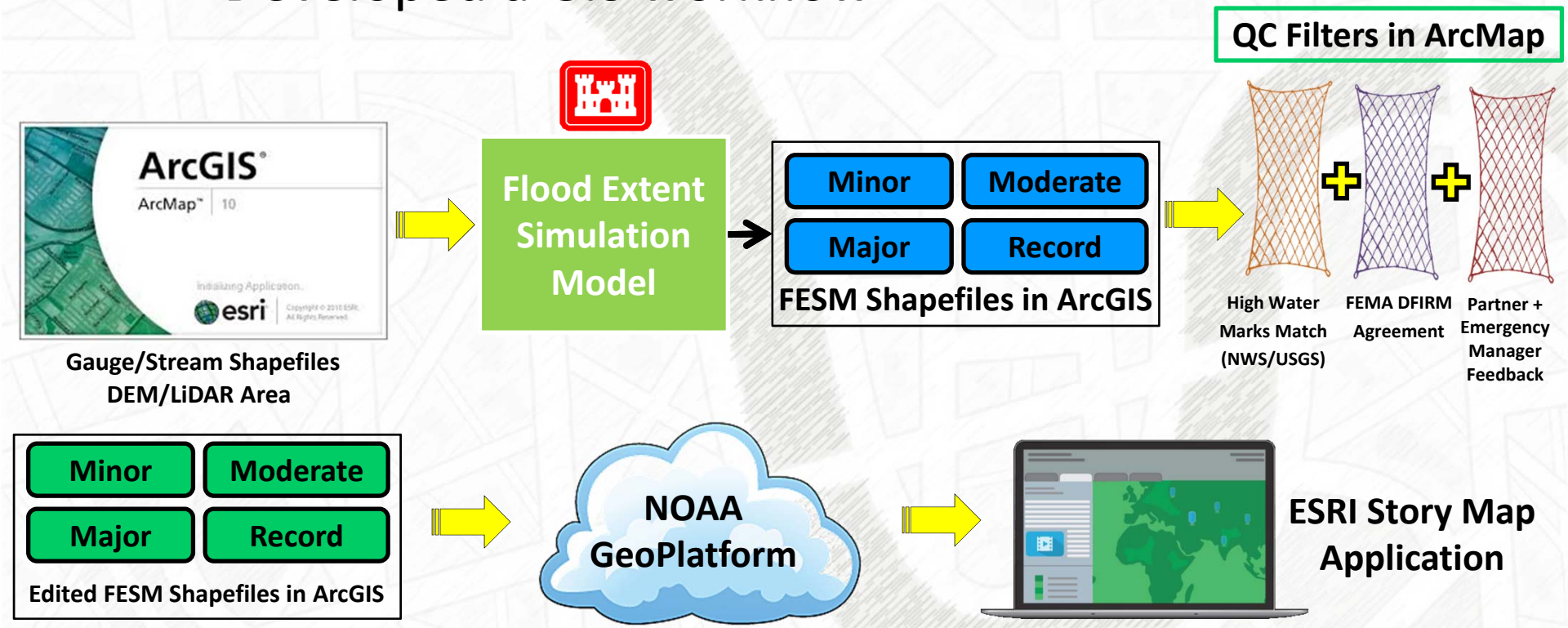
April 21th, 2016

River & Creek Flash Flooding Reality

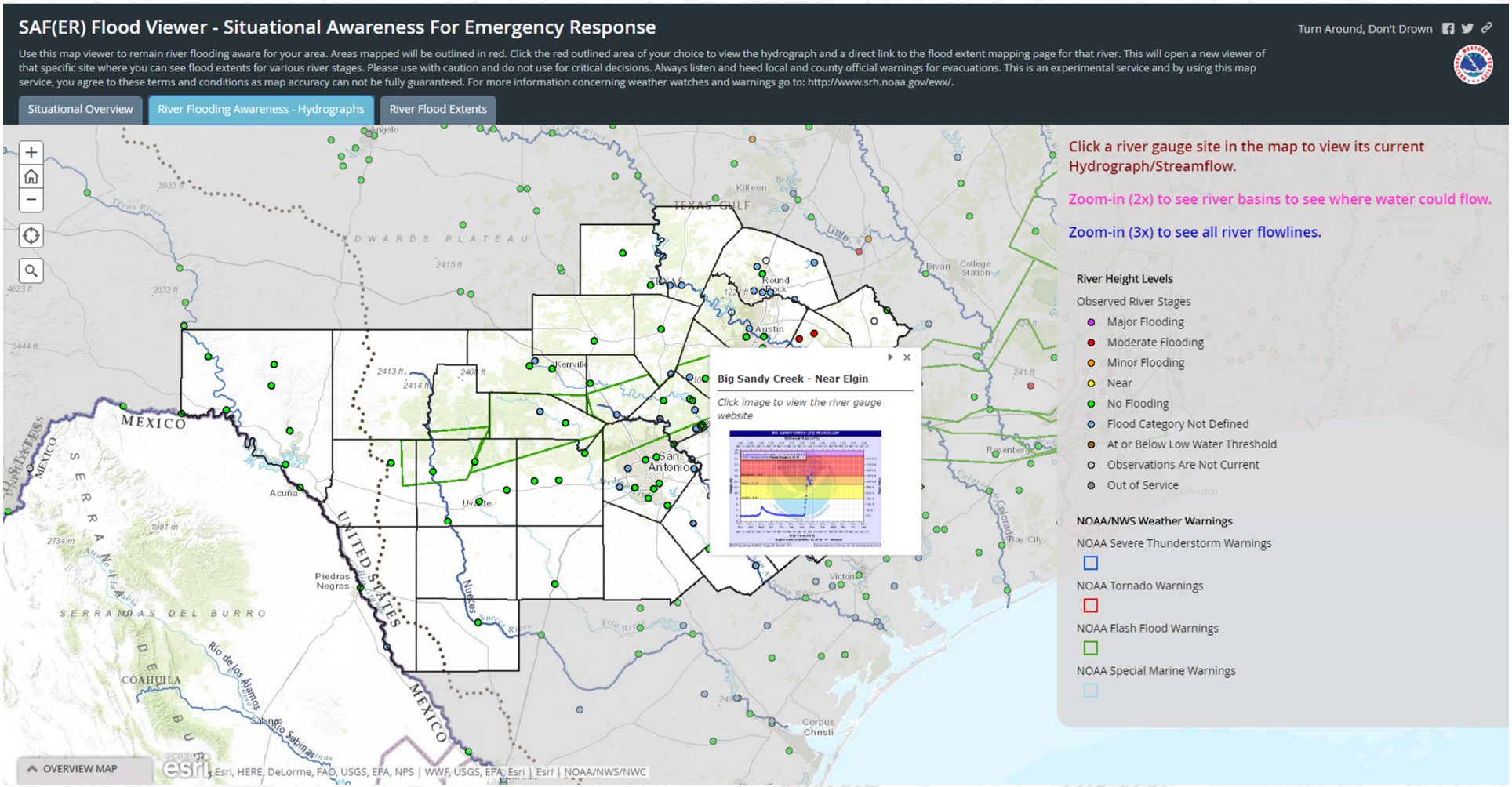


Flood SAF(ER) Development

- NWS & U.S. Corps of Engineers Partnership
  - Flood Extent Simulation Model (FESM)
  - Developed a GIS workflow

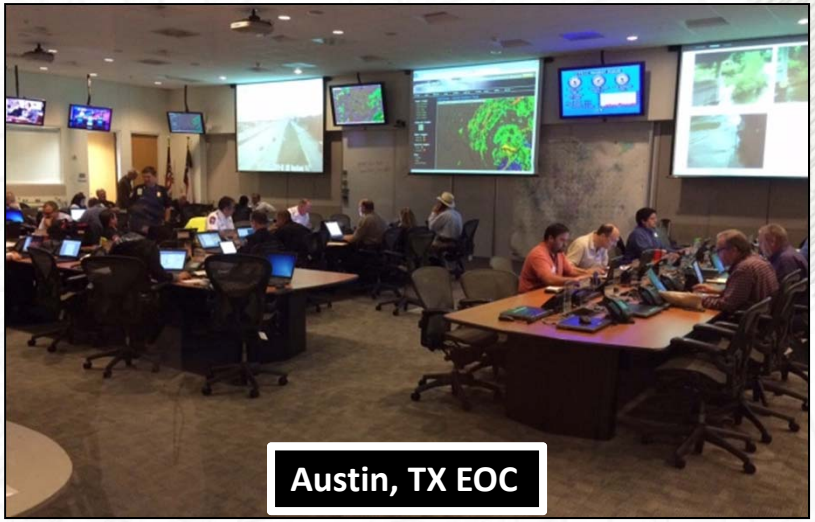


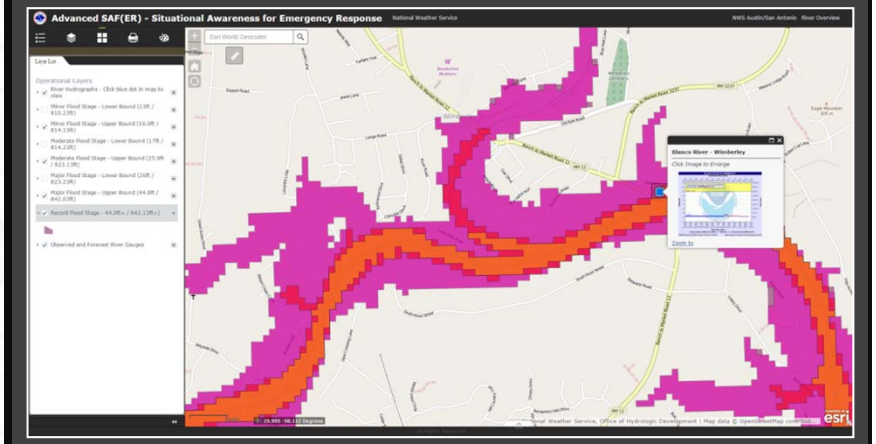
Flood SAF(ER) Application



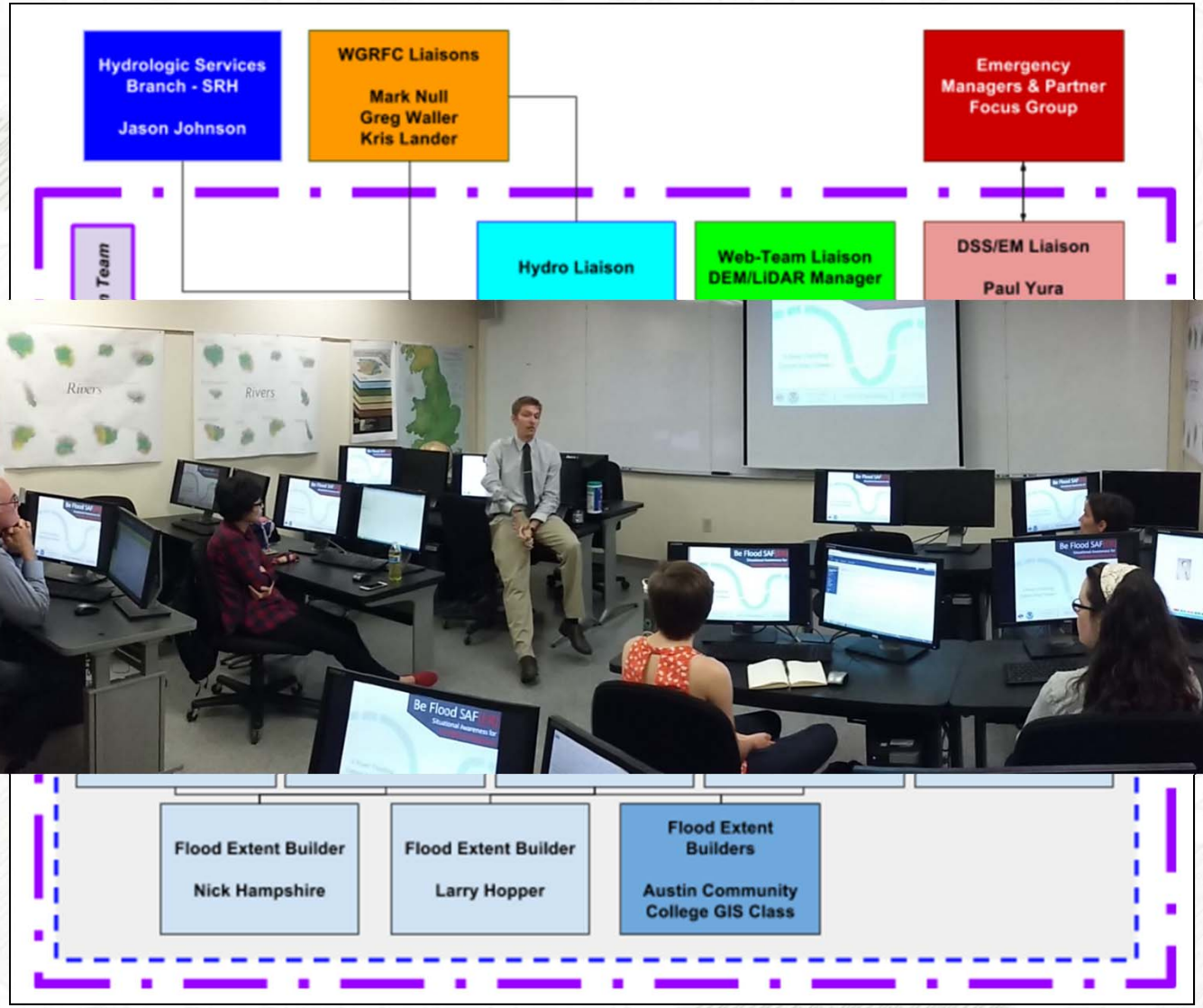
Critical for:

- Preparation:
  - NWS sharing data before the next flood to GIS & EM partners
- Planning:
  - Key decision timelines
  - People and resource allocation
- Response & Recovery:
  - EOC awareness and service





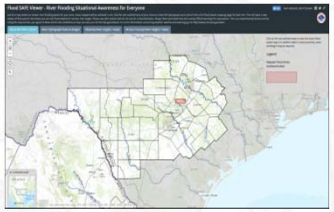
Project Scope



Phase 1: Development

- Develop GIS river flood methodology
- Statistical review of methodology
- Develop web-app prototype

Flood SAFE Viewer



Phase 2a: Internal Feedback

- 100% Get feedback from GIS team and other GIS Professionals
- 100% Make suggested edits to Flood SAFE Viewer

Phase 2b: Partner Feedback

- 90% Get feedback from GIS partners & EMs
- 80% Make suggested edits to Flood SAFE Viewer

Finalize layout

Phase 3: Local Team Building

- 60% Train and develop GIS team skills to produce flood extents

Phase 4: River Stretch Selection

- 35% Identify high-impact river stretches to map

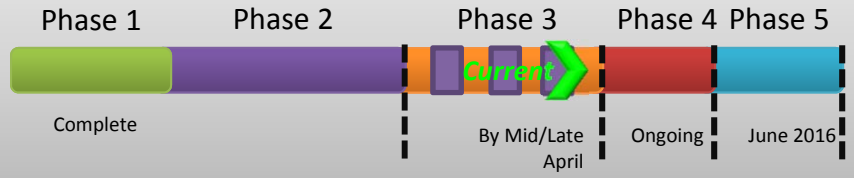
Phase 5: River Extent Development

- 25% EWX GIS Performance Team Developing River flood Extents

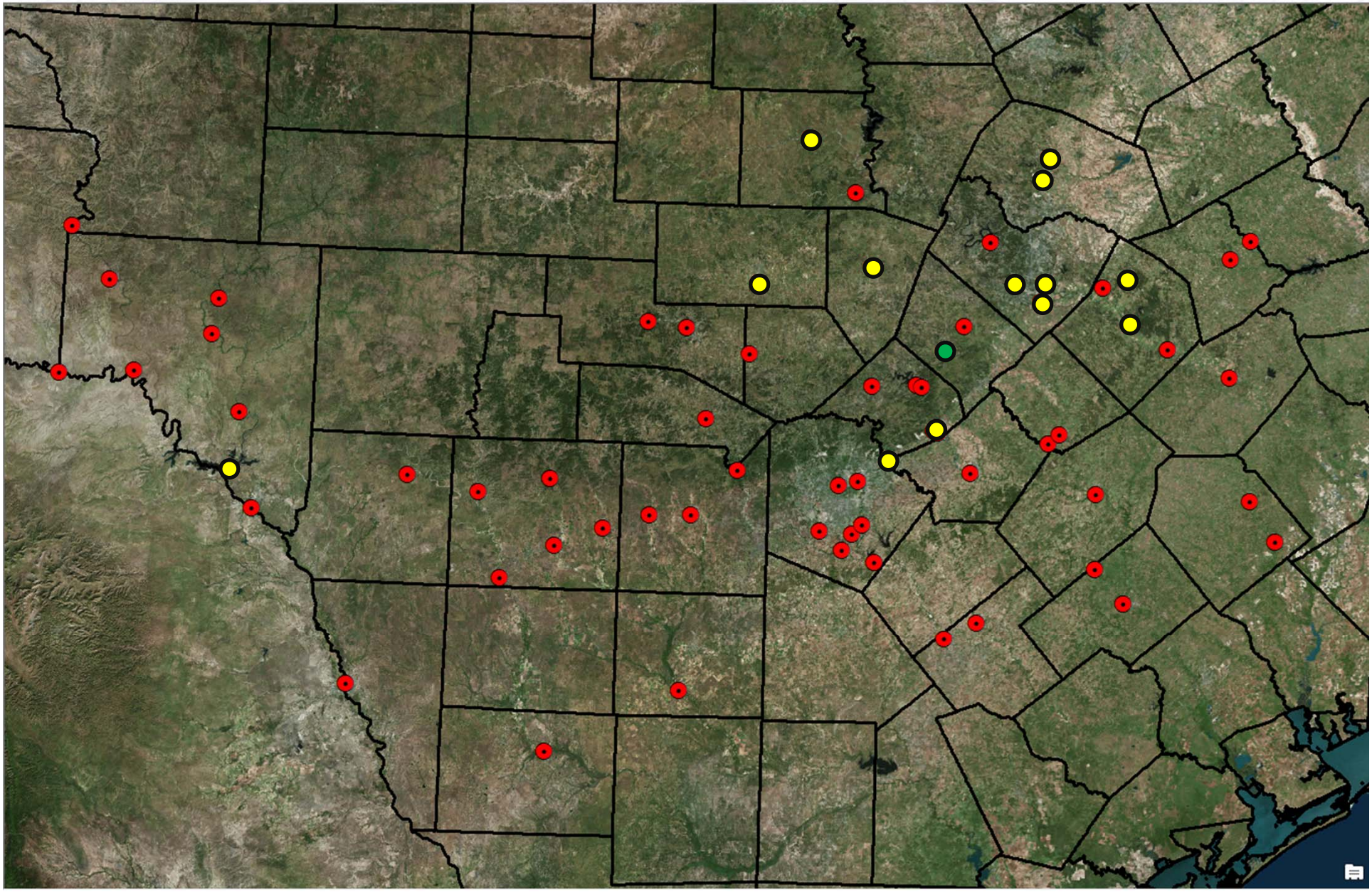
DEM/LiDAR Data Acquisition:

- Ongoing through Phases 2-5

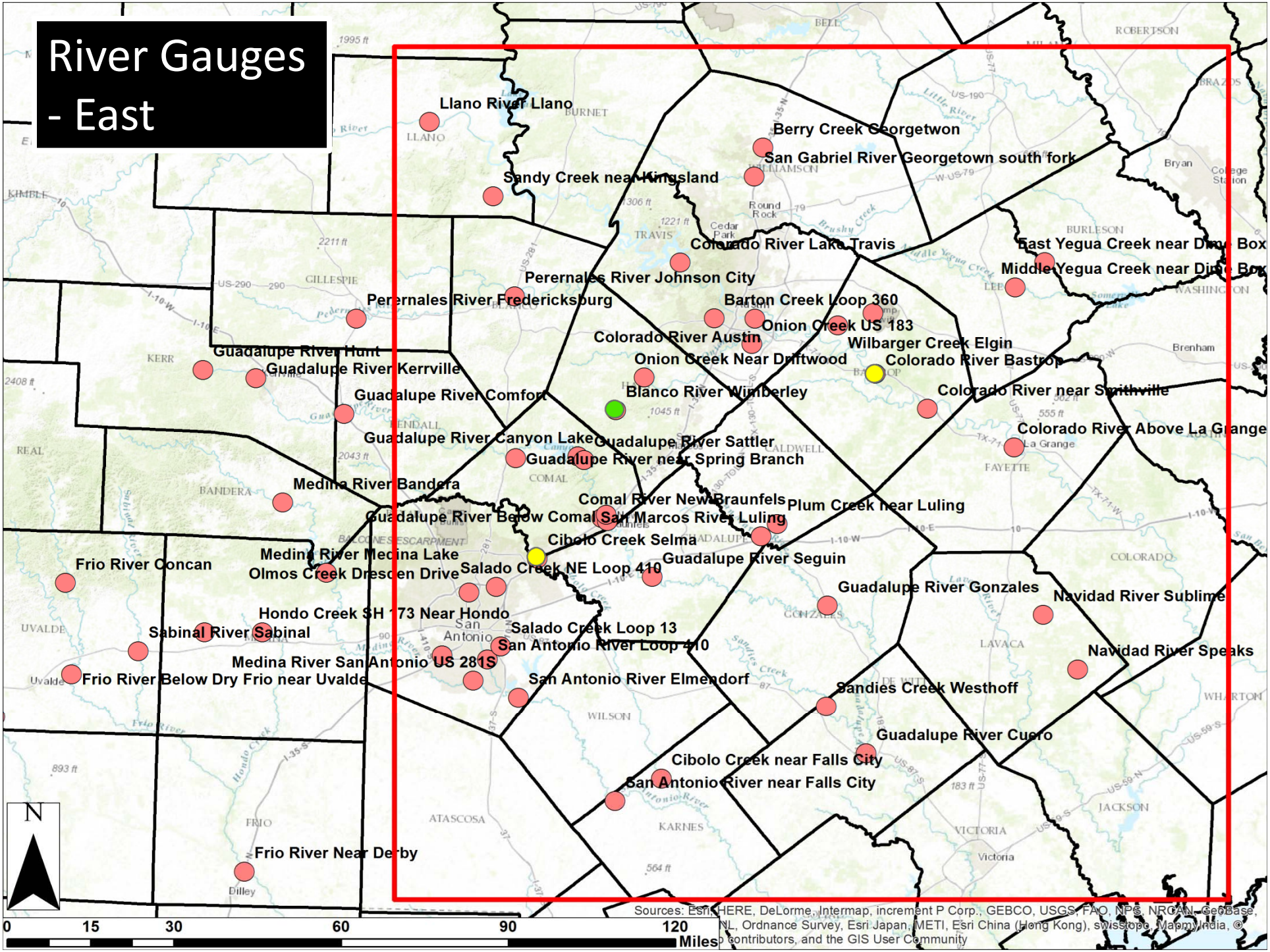
GIS River Flood Extent Project Timeline:

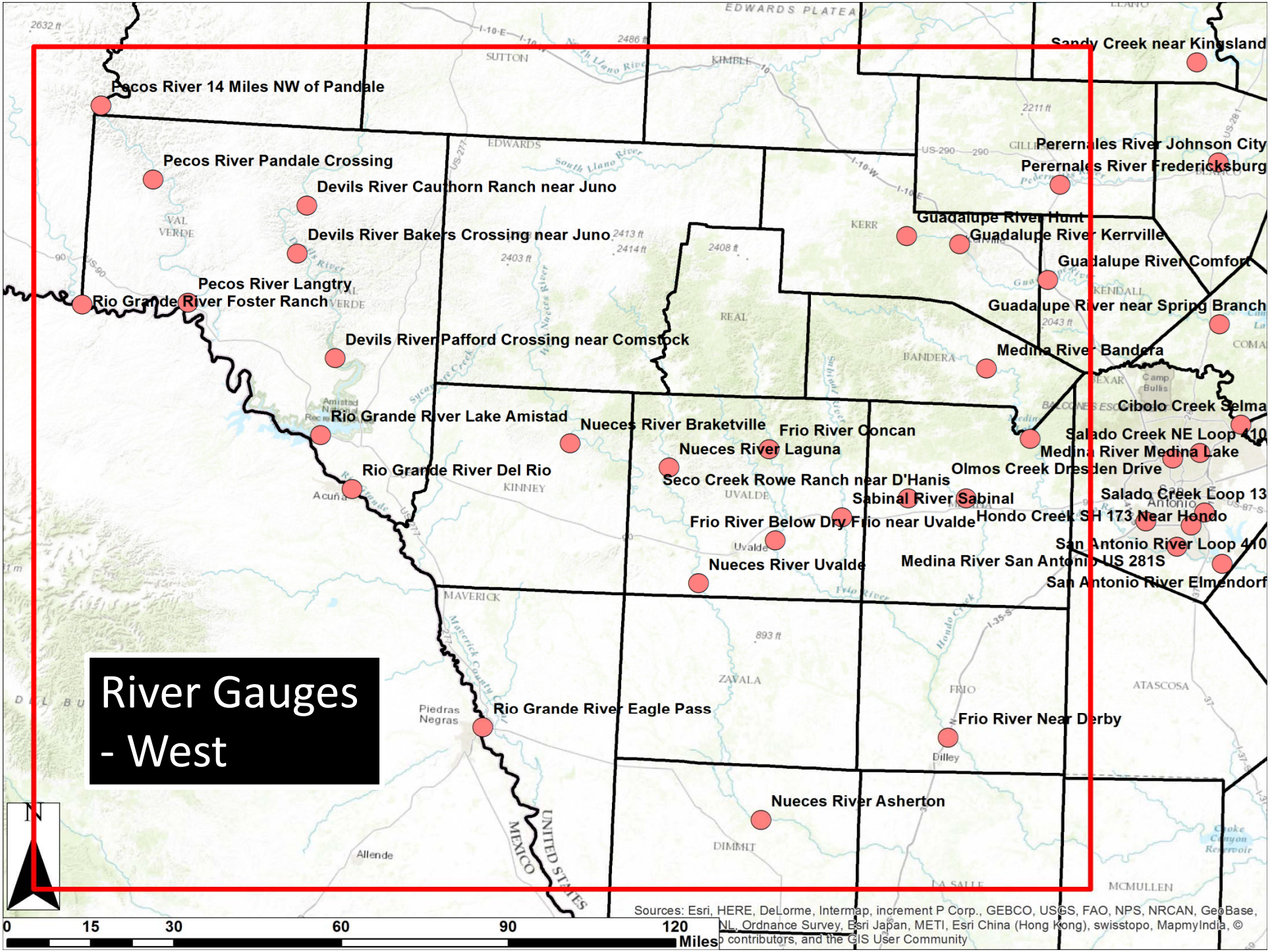


Active sites being modeled

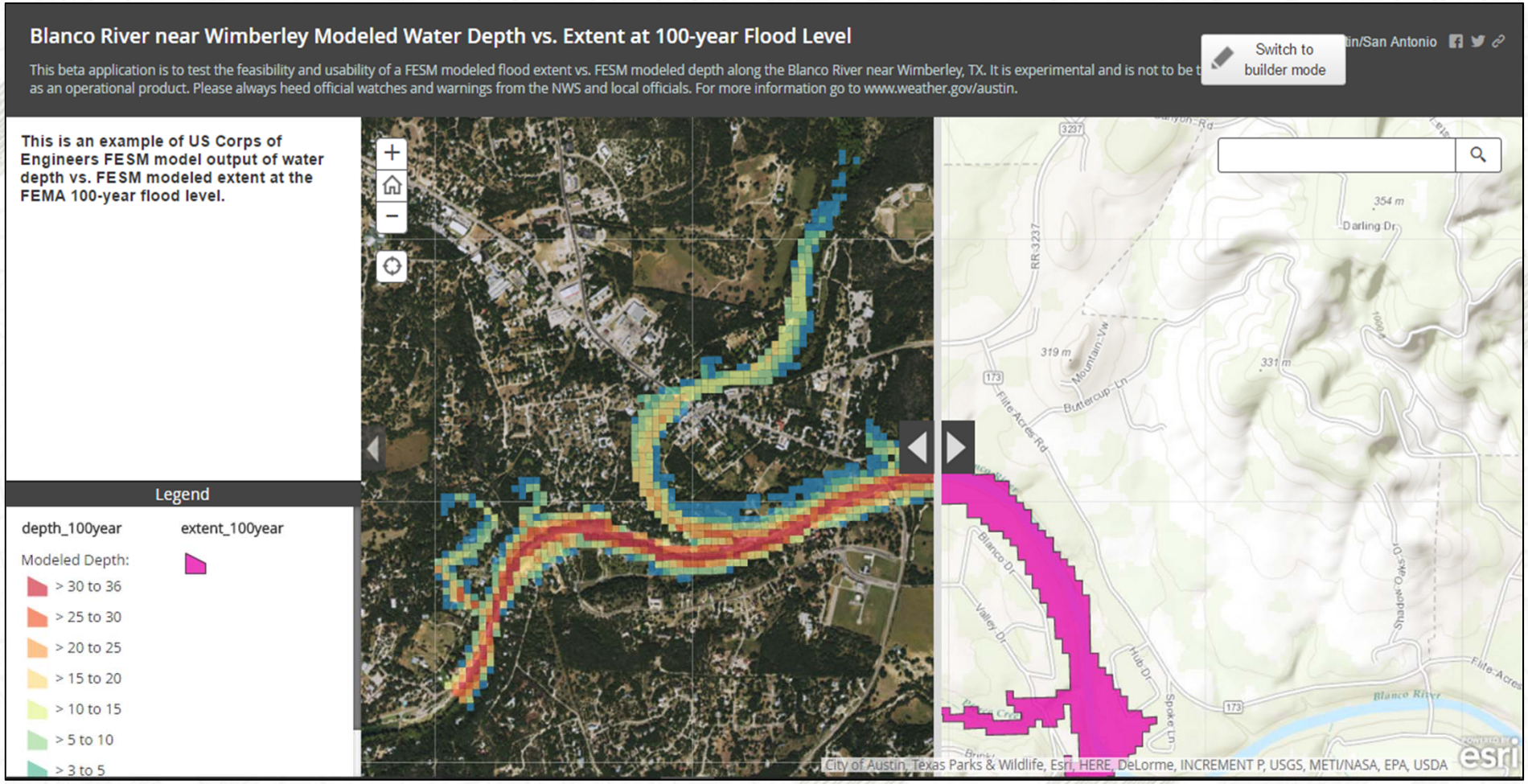


River Gauges - East




River Gauges - West
Pecos River 14 Miles NW of Pandale
Pecos River Pandale Crossing
Devils River Cauthorn Ranch near Juno
Devils River Bakers Crossing near Juno
Pecos River Langtry
Rio Grande River Foster Ranch
Devils River Pafford Crossing near Comstock
Rio Grande River Lake Amistad
Rio Grande River Del Rio
Rio Grande River Eagle Pass
Nueces River Braketville
Nueces River Laguna
Frio River Concan
Seco Creek Rowe Ranch near D'Hanis
Sabinal River Sabinal
Frio River Below Dry Frio near Uvalde
Nueces River Uvalde
Nueces River Asherton
Frio River Near Derby
Sandy Creek near Kingsland
Perernales River Johnson City
Perernales River Fredericksburg
Guadalupe River Hunt
Guadalupe River Kerrville
Guadalupe River Comfort
Guadalupe River near Spring Branch
Medina River Bandera
Cibolo Creek Selma
Salado Creek NE Loop 410
Medina River Medina Lake
Olmos Creek Dresden Drive
Salado Creek Loop 13
Hondo Creek SH 173 Near Hondo
San Antonio River Loop 410
Medina River San Antonio US 281S
San Antonio River Elmendorf
EDWARDS PLATEAU
SUTTON
KIMBLE
EDWARDS
VAL VERDE
KERR
KENDALL
REAL
BANDERA
BEXAR
COMAL
KINNEY
UVALDE
MAVERICK
ZAVALA
FRIO
ATASCOSA
DIMMIT
LA SALLE
MCMULLEN
Acuña
Piedras Negras
Allende
Uvalde
Dilley
MEXICO
UNITED STATES
N
0 15 30 60 90 120 Miles
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Future Developments



Thank You

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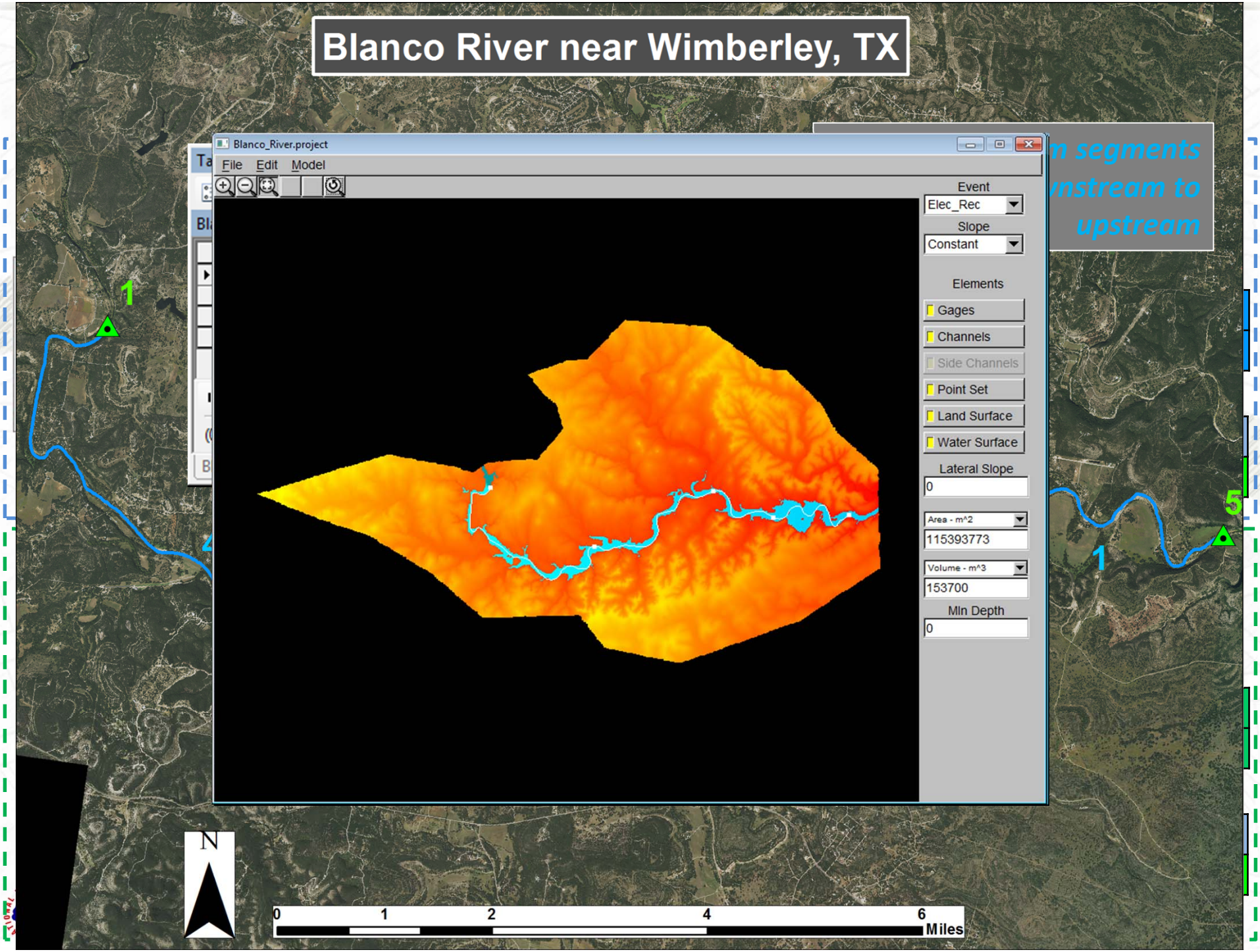
Blanco River near Wimberley, TX



Sites Modeled and Statistics

- Six river sites tested at various elevation data resolutions:

River Site	LiDAR/DEM Resolution
Leaf River at Hattiesburg, MS	~ 9 Feet (3 Meter) LiDAR
Susquehanna River at Binghamton, NY	~ 6 Feet (2 Meter) LiDAR
Red River at Alexandria, LA	20 Feet LiDAR
Susquehanna River at Harrisburg, PA	30 Feet (10 meter) DEM
Kentucky River at Frankfort, KY	5 Feet LiDAR
Onion Creek at Austin, TX	30 Feet (10 Meter) DEM

- Spatial Statistical tests performed:
  - Cohen's Kappa Coefficient[2,4]
  - Overall pixel classification accuracy[6]
    - Computed for: ***Minor***, ***Moderate***, ***Major***, and ***Record*** stages

Cohen's Kappa Coefficient

- Assess inter-model reliability between two or more spatially observed/coded qualitative or categorical variables[2].

$$\kappa = \frac{Pr(a) - Pr(e)}{1 - \mathrm{Pr}(e)}$$

$Pr(a)$ = Relative Observed Agreement

20 + 15 = 35 35/50 = 0.7

$Pr(e)$ = Probability of Random Agreement

[(30/50) * (25/50)] + ([20/50) * (25/50)] = 0.5

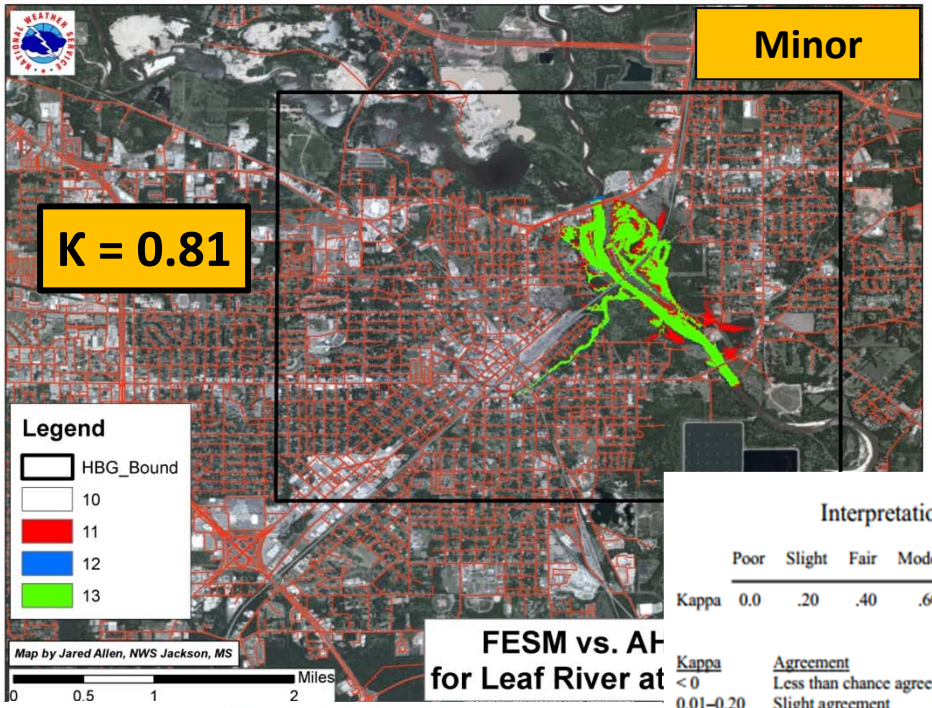
$$\kappa = \frac{0.7 - 0.5}{1 - 0.5} = 0.40$$

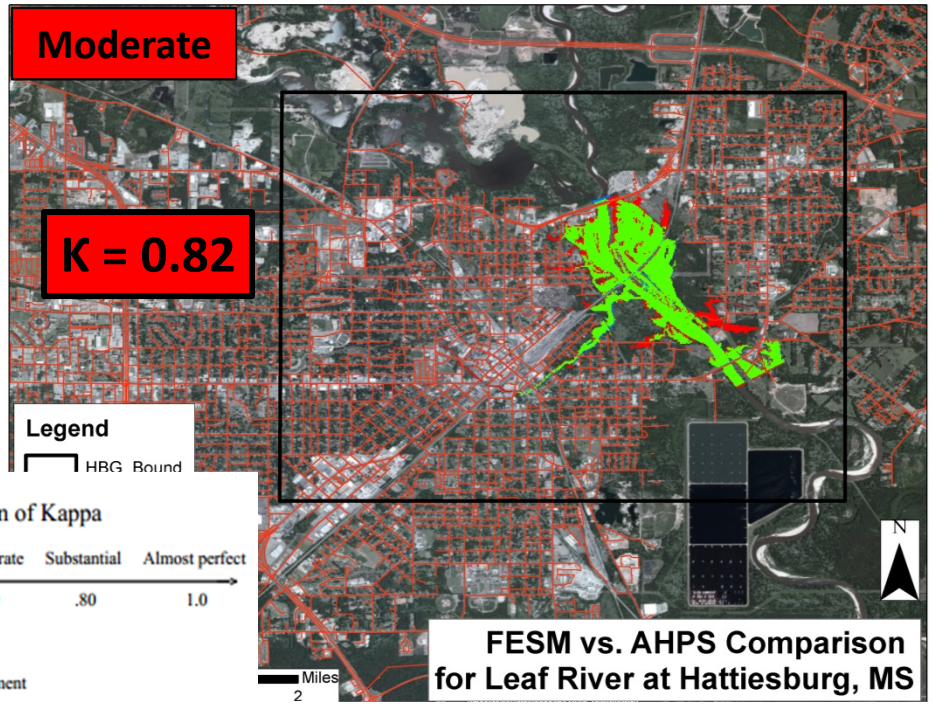
B

Interpretation of Kappa

	Poor	Slight	Fair	Moderate	Substantial	Almost perfect
Kappa	0.0	.20	.40	.60	.80	1.0

Kappa	Agreement
< 0	Less than chance agreement
0.01–0.20	Slight agreement
0.21– 0.40	Fair agreement
0.41–0.60	Moderate agreement
0.61–0.80	Substantial agreement
0.81–0.99	Almost perfect agreement





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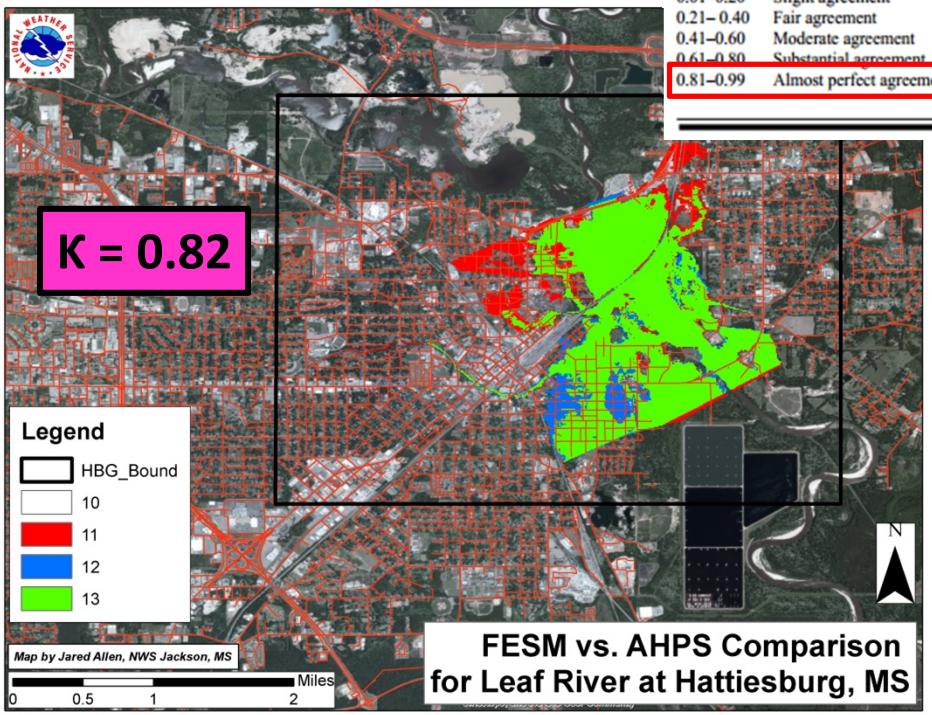
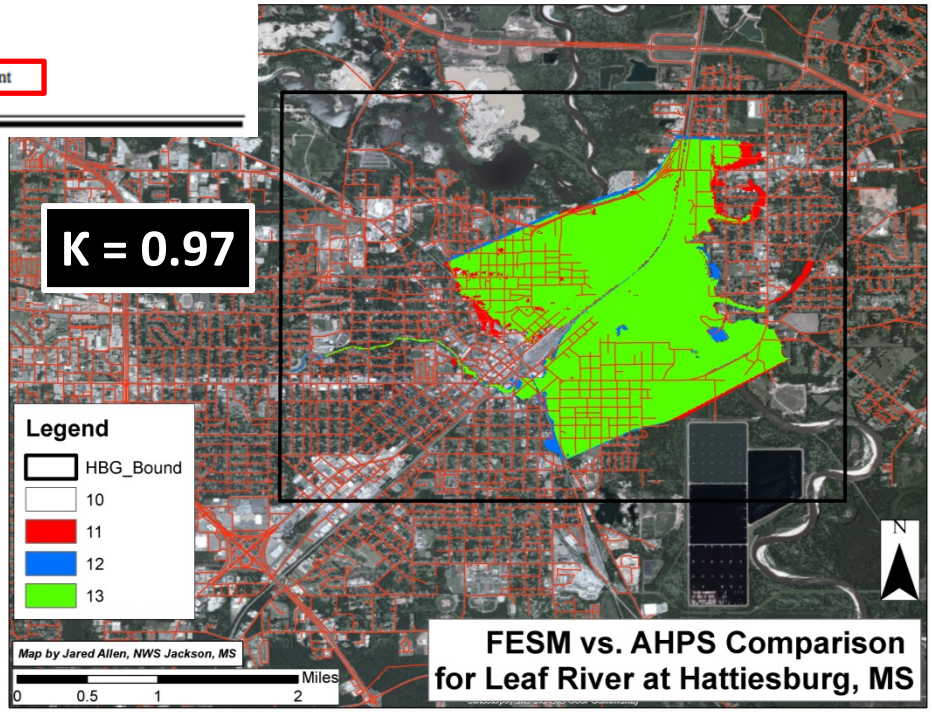
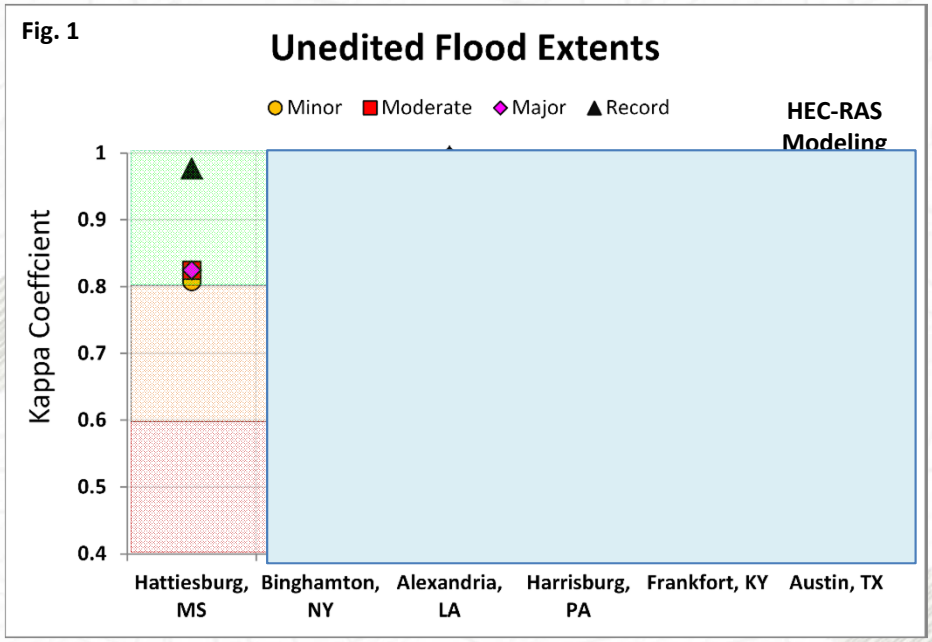
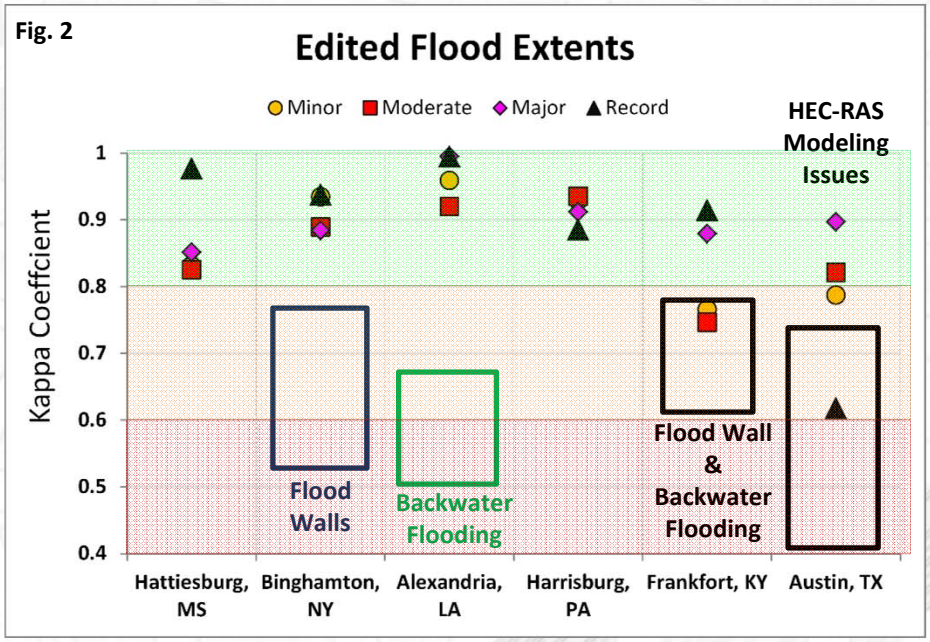




Results





- Unedited FESM Flood Extents had substantial to near perfect agreement.
  - Record Stage performed the strongest on average across all sites (Austin, TX outlier)
  - Moderate Flood Stage was weakest on average across all 6 sites (moderate agreement)
- Using water impact location descriptions & FEMA DFIRM maps, edited flood extents (Fig. 2) had near perfect to substantial agreement.
  - Excluding the minor and moderate stages for Frankfort, KY *(High substantial agreement)*
    - Kappa could be raised further with local knowledge of Trumbo Bottom Area.
  - Significant improvement for Alexandria, LA site in Bayou Maria Basin
  - Moderate Flood Stage still lowest on average but above 0.8 (near perfect)

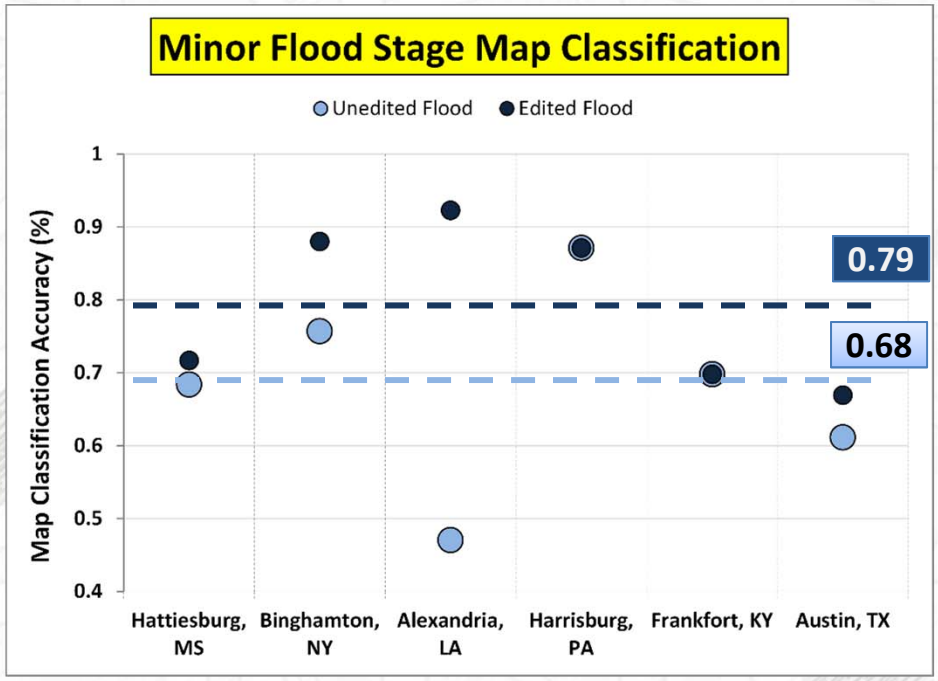
Flood Pixel **C**lassification **A**ccuracy

- FCA = $\dfrac{\textit{Pixels of Flood}_{Correct}}{(\textit{Pixels of Flood}_{Correct} + \textit{Pixels of Flood}_{Omission} + \textit{Pixels of Flood}_{Commission})}$

$$FCA = \frac{\sum 13PixelCount}{(\sum 13PixelCount + \sum 12PixelCount + \sum 11PixelCount)}$$

A series of flood classification accuracy graphs comparing <u>unedited FESM Extents</u> and <u>edited FESM Extents</u> against the accepted AHPS Extents were generated for:

- ***Minor*** - ***Moderate*** - ***Major*** - ***Record***


Minor Flood Stage Map Classification
Unedited Flood
Edited Flood
Map Classification Accuracy (%)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.79
0.68
Hattiesburg, MS
Binghamton, NY
Alexandria, LA
Harrisburg, PA
Frankfort, KY
Austin, TX

Conclusions

- FESM/ArcGIS Methodology deemed spatially accurate
  - Effort vs. Cost Analysis
    - ***70-98% FCA accurate and acceptable statistically***
    - ***Completed in a week or less (starting from scratch)***
    - ***With data in place & practice, can be as fast as 1-3 hours for raw flood area output & no QC***
- Mapping Accuracy & Kappa can be successfully increased through quality control measures:
  - Set to match current Impact Statements – E19s
  - FEMA DFIRM Data
  - River Forecast Center Agreement
  - Emergency Manager & Local Water Authority Agreement
- Future Work
  - Test more sites with current methodology
    - Quantify QC improvements thru Classification and Kappa values
  - ***Develop internal AGOL website for critical partner access.***

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http://arcg.is/1L00Wvm