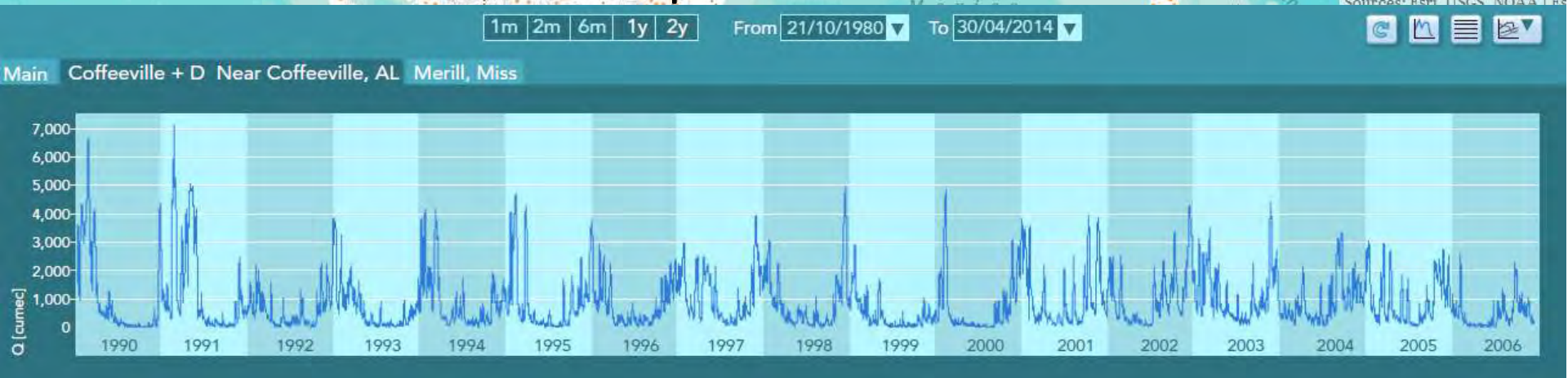
National Flood Interoperability Experiment

David R. Maidment,

University of Texas at Austin

Catchment-based Hydrological Data Assimilation (CAHMDA) VI Conference

8 September 2014



Overview: National Water Center (NWC)

- Located on Tuscaloosa Campus of University of Alabama
- Operated by National Weather Service to support IWRSS partners (NWS, USGS, Corps of Engineers, FEMA)

INTEGRATED WATER RESOURCES SCIENCE AND SERVICES (IWRSS)

SUMMIT TO SEA

Integrated Water Resources Science and Services (IWRSS)

Aligns multiple agencies with complimentary water related missions to:

- Integrate services and service delivery
- Improve river and flood forecasts
- Provide new summit-to-sea water resources analyses and forecasts
- Enable more effective use of resources

Roadmap Document (February 2009)

Slide: Ed Clark, NWS

http://www.nohrsc.noaa.gov/~cline/IWRSS/IWRSS_ROADMAP_v1.0.pdf

NWS River Forecast Centers

Nationally Synthesize Operations of Regional River Forecast Centers

Inaugural Meeting – May, 2014

Overview: National Water Center (NWC)

- Operations Center with Situation Rooms — Temporal information
  - Establish common operating picture for floods to droughts; begin demonstration of hourly summit-to-sea analyses and forecasts of soil moisture, evapotranspiration, and snow pack; and expand demonstration of Real-Time Dynamic Flood Inundation Mapping portraying the extent, depth, and impacts of flood waters to enhance community resiliency and enable decision makers to mitigate the impacts of floods.
- Geo-Intelligence Laboratory — Geospatial information
  - Develop, implement and maintain state-of-the science enterprise Geographic Information Systems (GIS) to support NWS operations

National Water Data Infrastructure

Transformative Research (NSF)

Transformative research involves ideas, discoveries, or tools that radically change our understanding of an important existing scientific or engineering concept or educational practice or leads to the creation of a new paradigm or field of science, engineering, or education. Such research challenges current understanding or provides pathways to new frontiers.

http://www.nsf.gov/about/transformative_research/definition.jsp

How to move from evolutionary change to transformative change?

National Flood Interoperability Experiment (NFIE)

- Will be led by the academic community in collaboration with the IWRSS partners through the National Water Center
- Run from September 2014 to August 2015
  - Preparatory phase to May 2015
  - Summer Institute at the National Water Center, June to August 2015

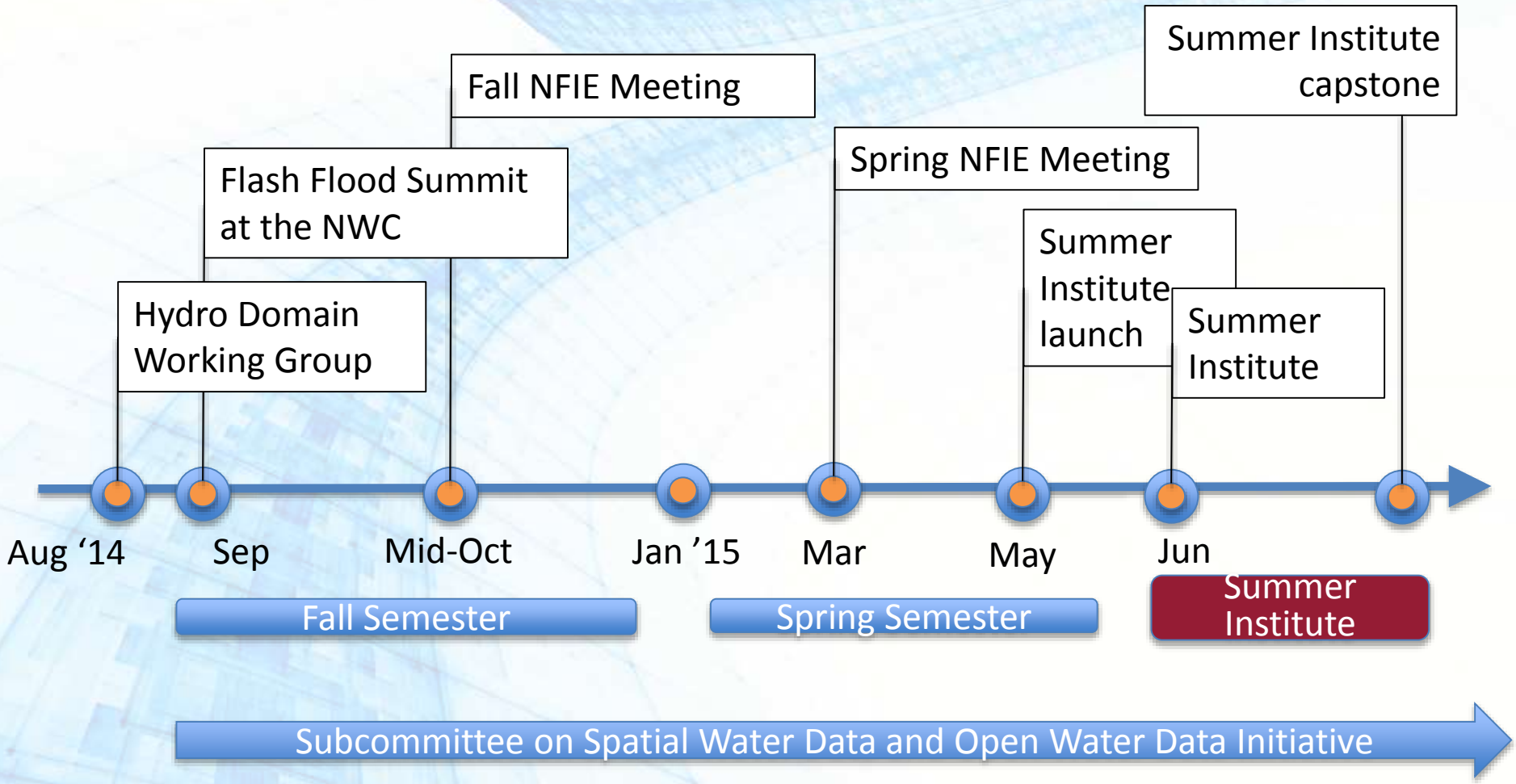
NFIE Goal: Connect National Scale Flood Modeling with Local emergency planning and response

1. How can near-real-time hydrologic simulations at high spatial resolution, covering the nation, be carried out using the NHDPlus or next generation *hydro-fabric* (e.g. data structure for hillslope, watershed scales)?
2. How can this lead to improved emergency response and community resilience?
3. How can an improved interoperability framework support the first two goals and lead to sustained innovation in the research to operations process?

Slide: Ed Clark, NWS

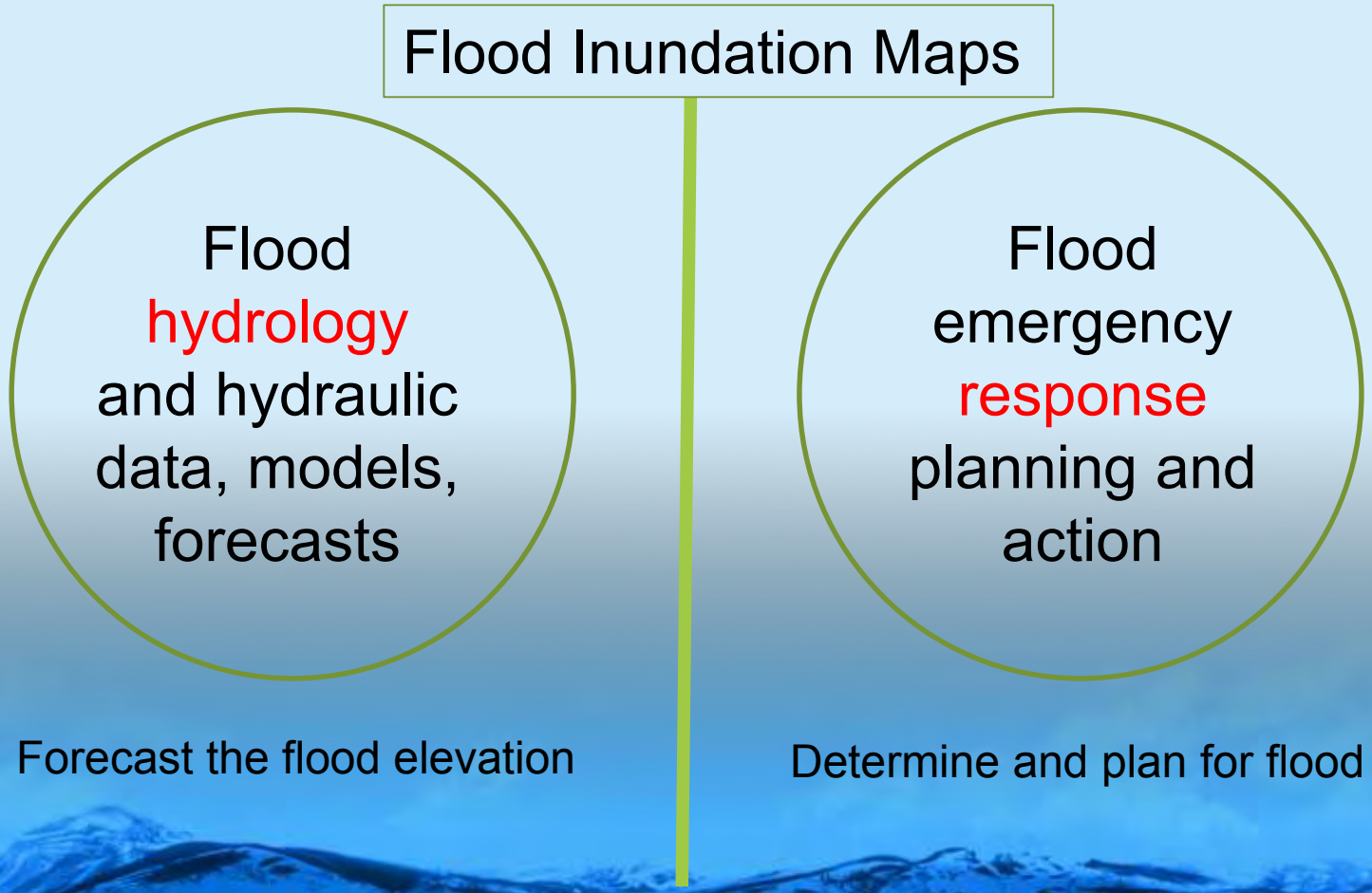
NFIE Academic Centers (as at present)

NFIE: Proposed Timeline



Slide: Ed Clark, NWS
(pre-decisional)

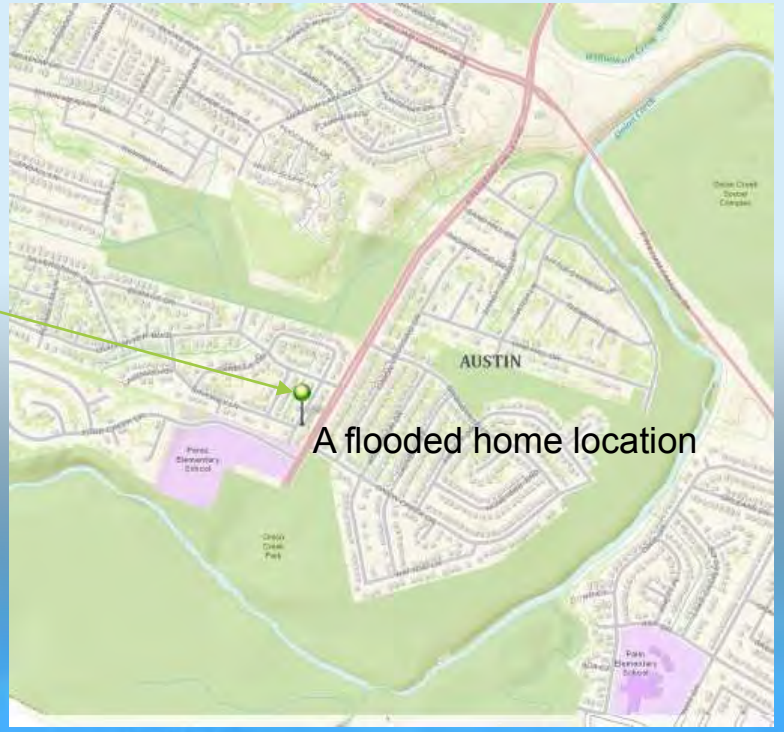
Flood hydrology and response



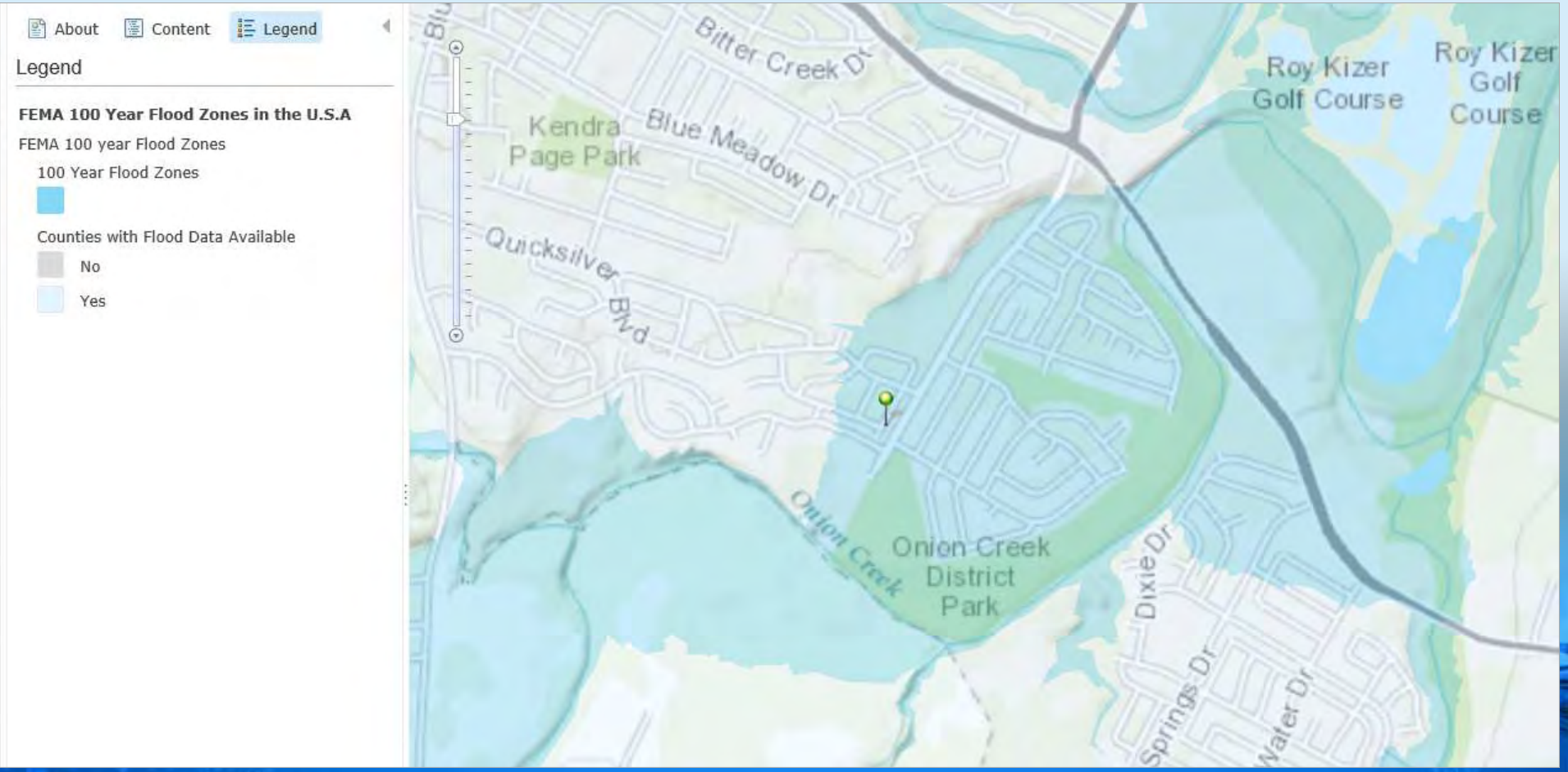
Halloween Flood, Onion Creek, Austin, Texas, October 2013

Upstream watershed 280 mi^2
(larger than the City of Austin)

Watershed delineated using
ESRI terrain services



FEMA Flood Hazard Zone



Mitigation and Response Flood Levels

(FEMA)

Mitigation (ft above NAVD88)

(NWS)

Response (Stage Height, ft)

Onion Creek at US 183, TX (ATIT2)

Data Type
- Inundation Levels
- Flood Categories
- Current/Forecast

Inundation Levels

NAVD88	Stage
Record Crest: 40.15 ft	
482.4	39.3
481.4	38.3
480.4	37.3
479.4	36.3
478.4	35.3
477.4	34.3
476.4	33.3
475.4	32.3
474.4	31.3
473.4	30.3
472.4	29.3
471.4	28.3
470.4	27.3
469.4	26.3
468.4	25.3
467.4	24.3
Major Flooding Begins	
466.4	23.3
465.4	22.3
464.4	21.3
463.4	20.3
Moderate Flooding Begins	
462.4	19.3
461.4	18.3
460.4	17.3
Minor Flooding Begins	
459.4	16.3
458.4	15.3

* = Extended rating

500 yr	490.34
200 yr	487.88
100 yr	484.82
50 yr	481.24
25 yr	477.09
10 yr	471.01
5 yr	466.62
2 yr	460.30

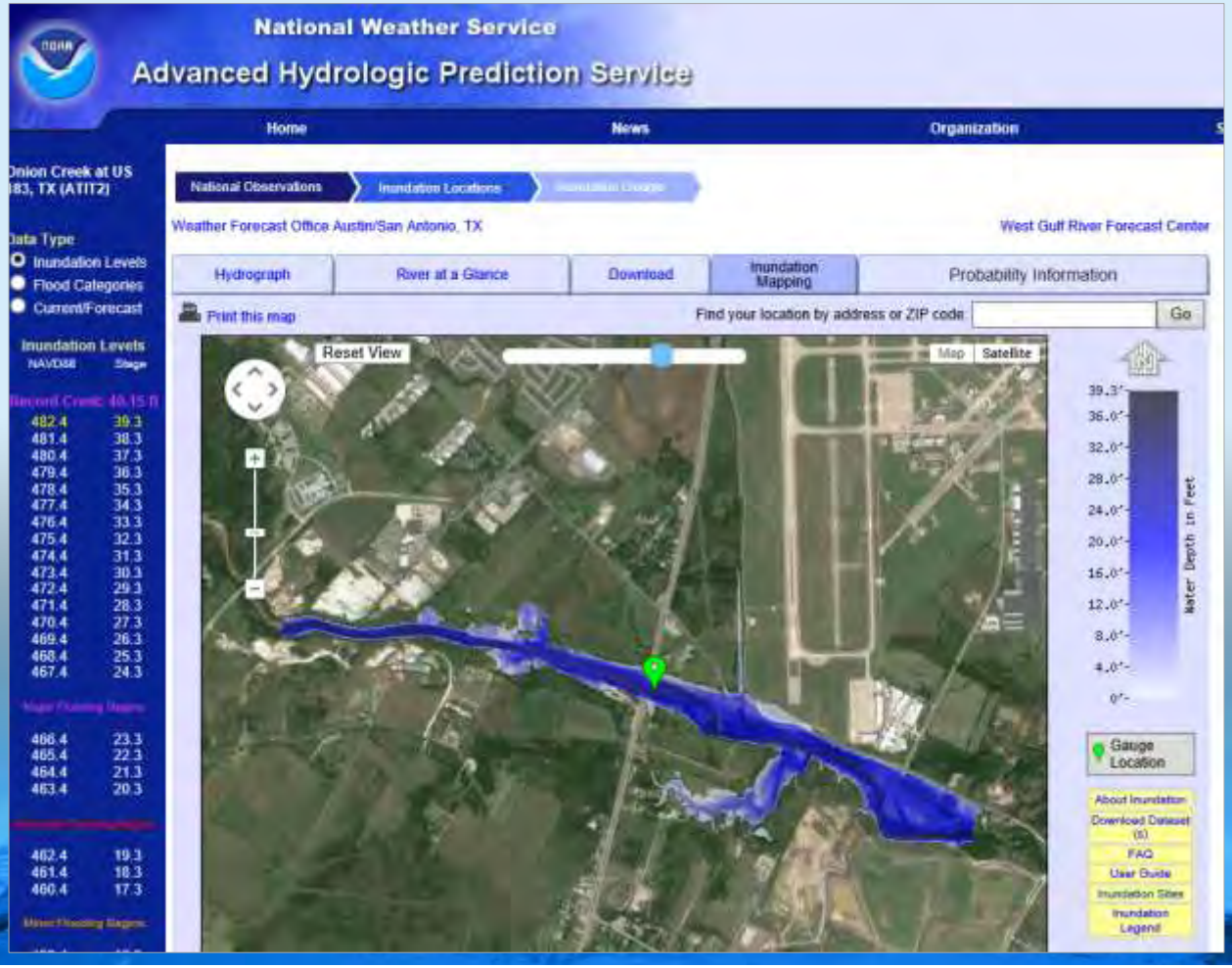
Major Flood Stage: 24

Moderate Flood Stage: 20

Flood Stage: 17

Action Stage: 15

Real-Time Flood Inundation Mapping (USGS/NWS)

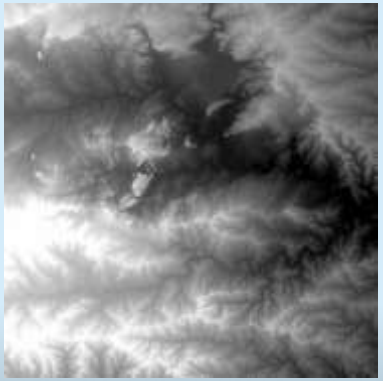


Use modeling to extend this concept to the whole country

http://water.weather.gov/ahps2/inundation/inundation_google.php?gage=atit2

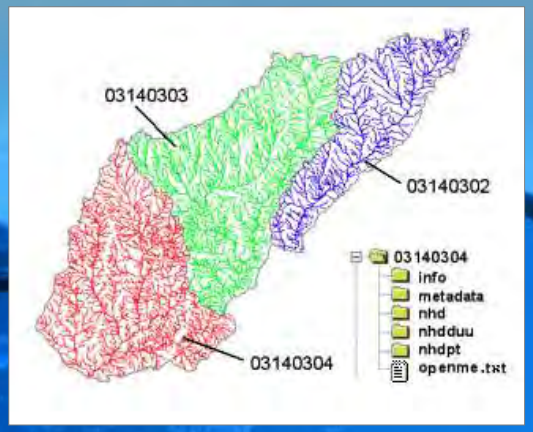
NHDPlus

Geospatial base for National Water Data Infrastructure



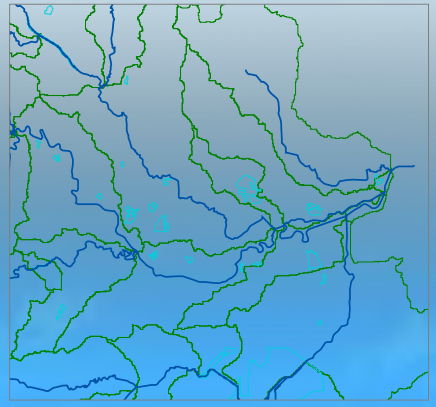
National Elevation Dataset

National Hydrography Dataset



NHDPlus

(built 2004-2014)



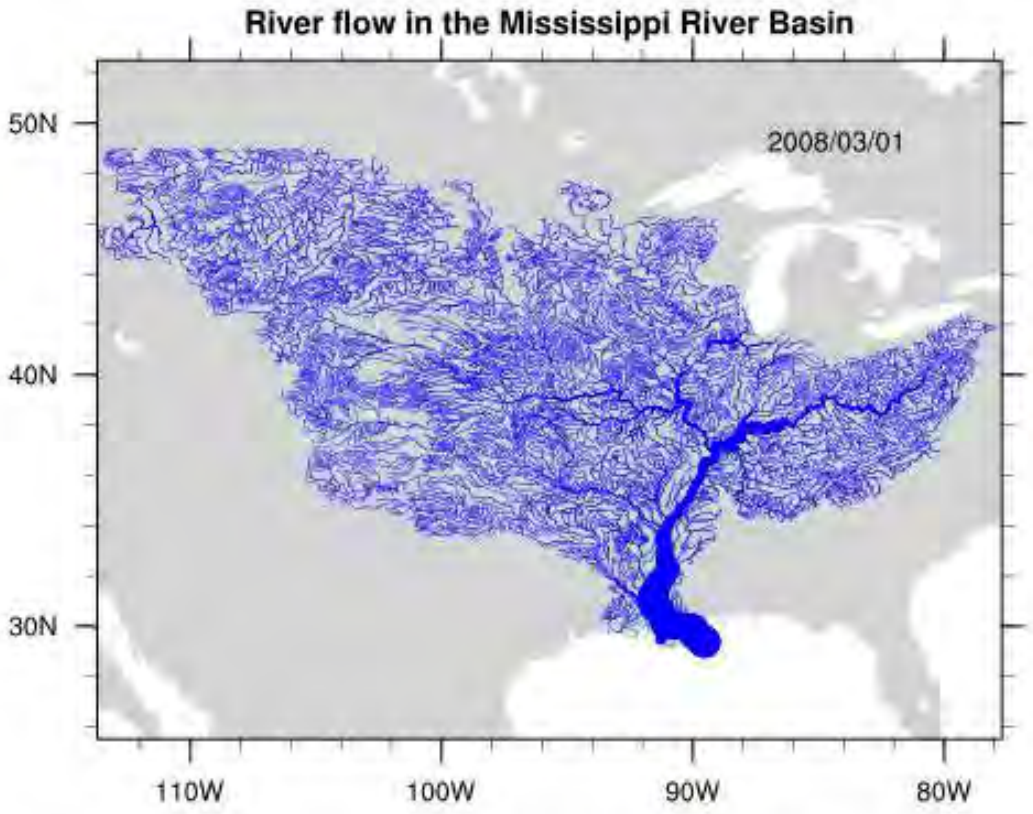
3 million catchments
average area 3 km^2,
reach length 2 km

Watershed Boundary Dataset

National Land Cover Dataset

Rapid Model for flow on NHDPlus

March to May 2008, 3 hour time steps

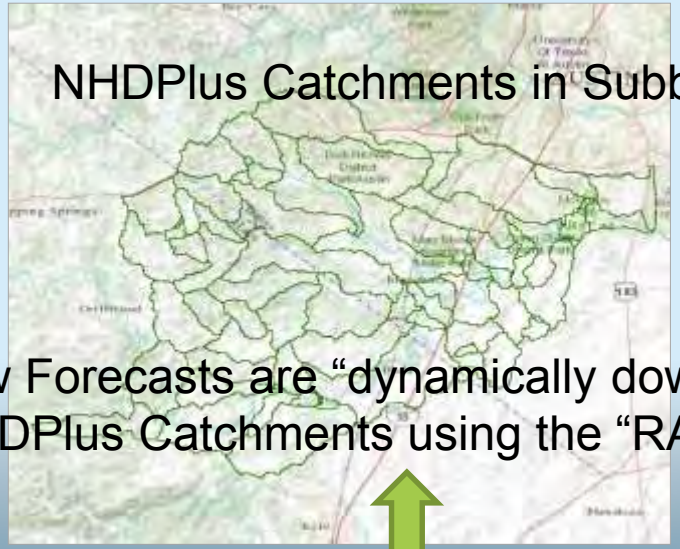


David et al. (2011) DOI: 10.1175/2011JHM1345.1

GIS data describes 1.2 million river reaches . . .

. . . simulate flow in each reach in each time step

Dynamic downscaling of NWS River Forecasts

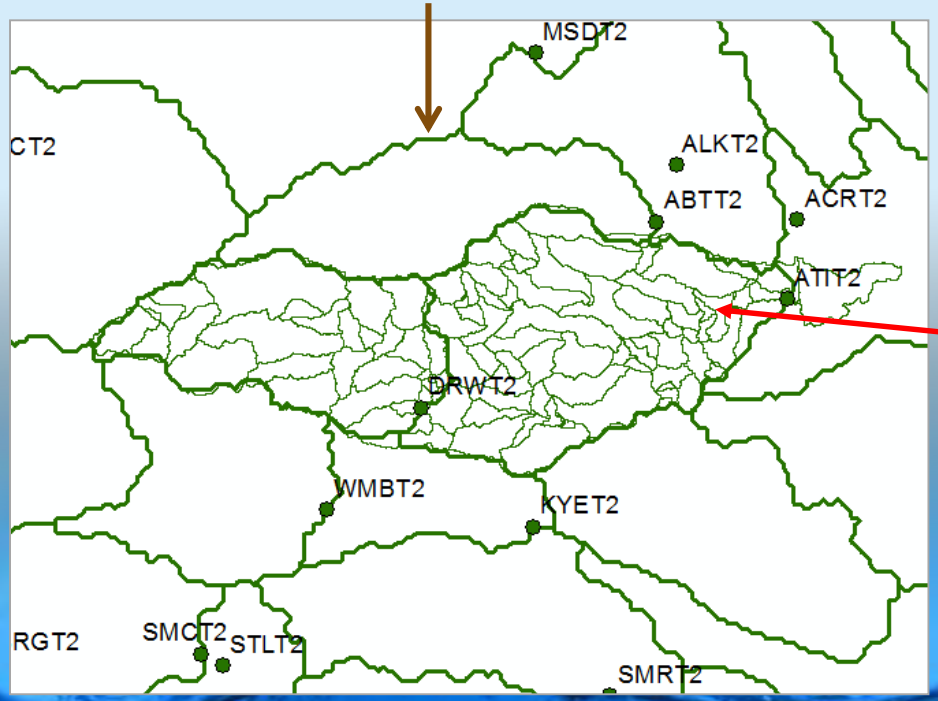


NWS Flow Forecasts are “dynamically downscaled” onto the NHDPlus Catchments using the “RAPID” mode

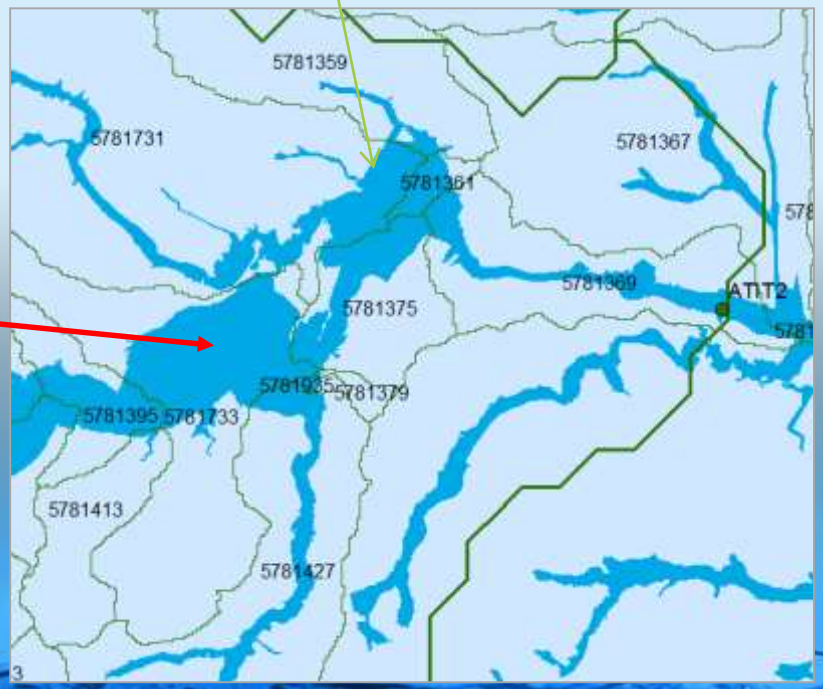
Forecast Subbasins for
West Gulf River Forecast Center

Linking NWS Flood Forecasts to FEMA National Flood Hazard Layer

National Weather Service
River Forecast Subbasins

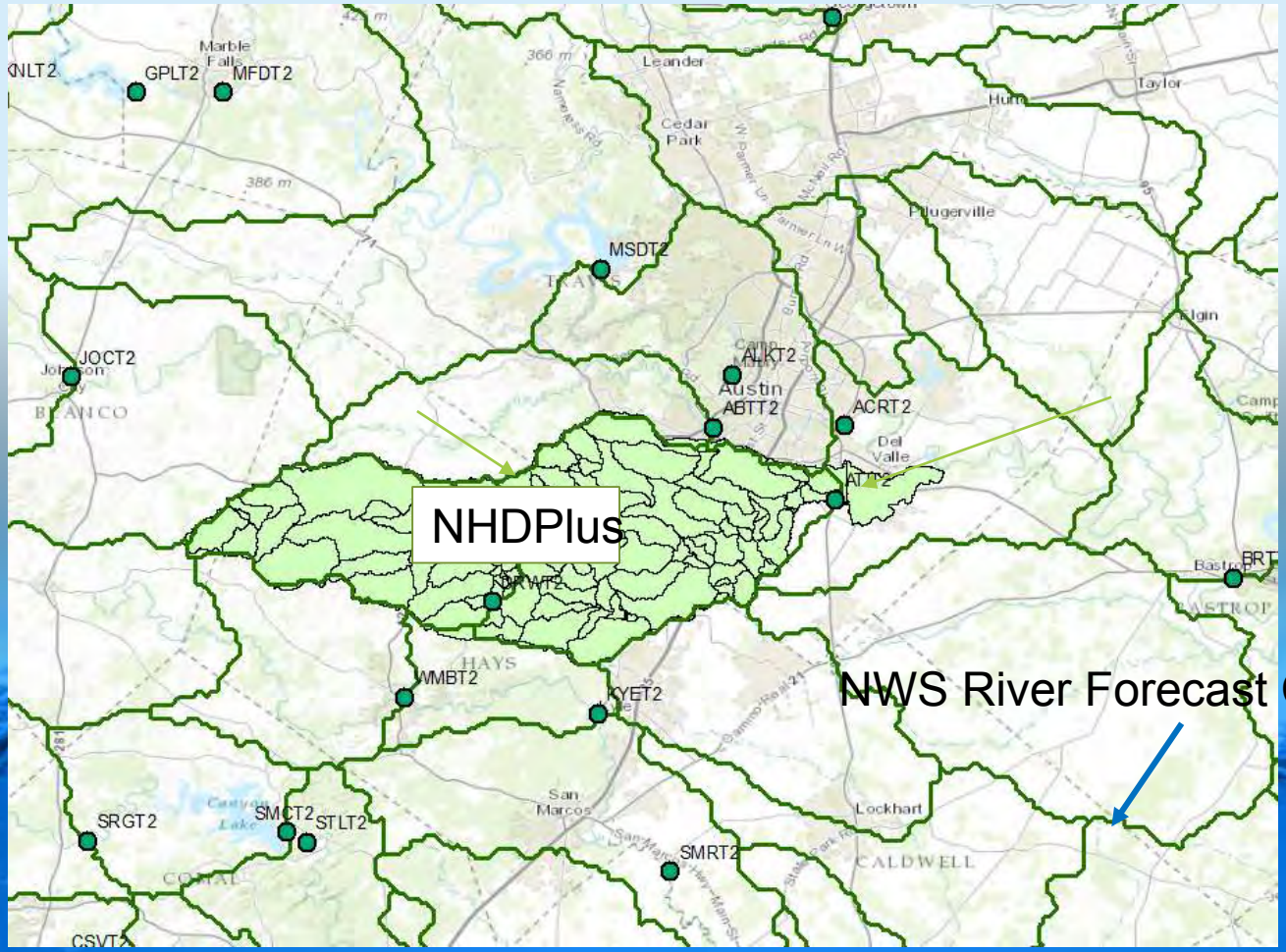


National Flood Hazard Layer



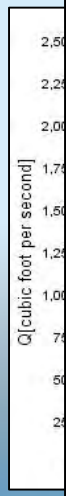
Intersect NHDPlus Catchments with Flood Hazard Layer to get a flood warning zone for each catchment

“Dynamic Downscaling” of NWS River Forecasts to NHDPlus for Onion Creek



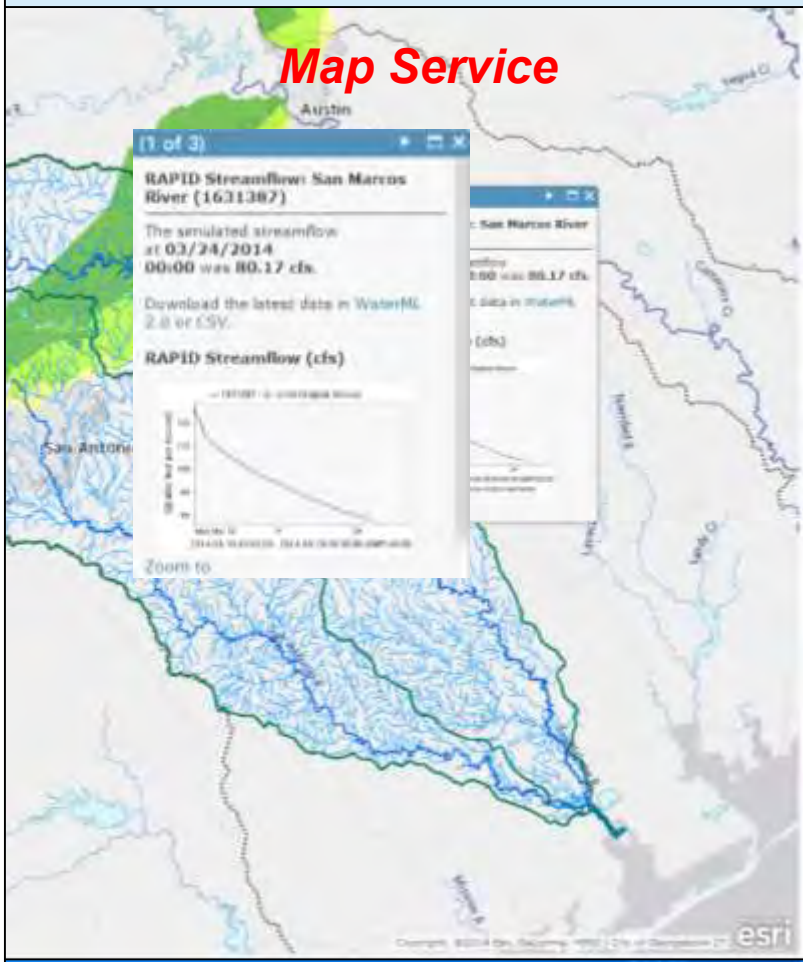
Water Map and Data Services

RAPID Streamflow Calculations – 47 NWS River Forecast basins downscaled to 5,175 NHDPlus catchments in San Antonio and Guadalupe basins



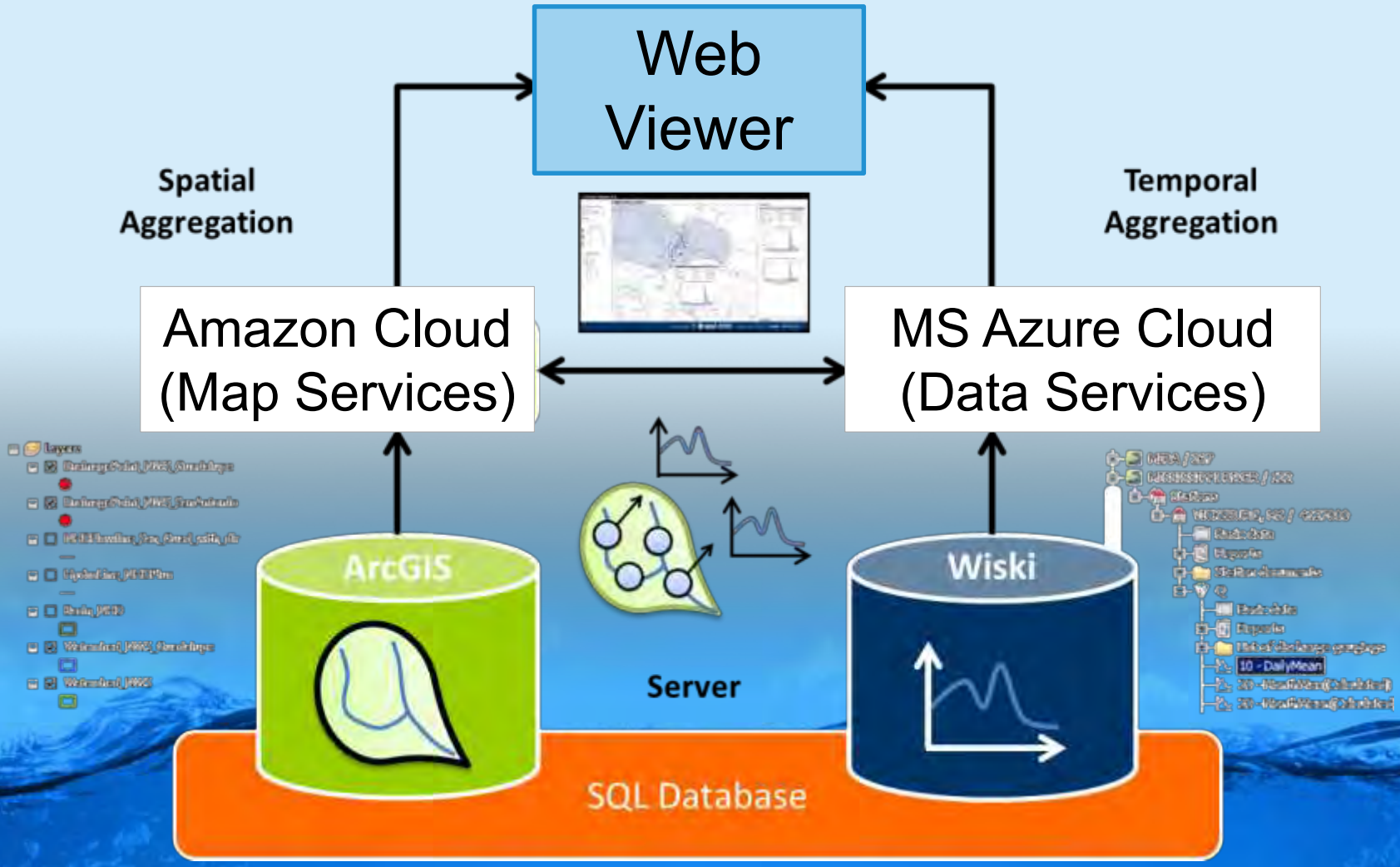

```
▼<wml2:point>
  ▼<wml2:MeasurementTVP>
      <wml2:time>2014-03-25T06:00:00.000-06:00</wml2:time>
      <wml2:value>78.41391019532672</wml2:value>
    </wml2:MeasurementTVP>
  </wml2:point>
▼<wml2:point>
  ▼<wml2:MeasurementTVP>
      <wml2:time>2014-03-25T09:00:00.000-06:00</wml2:time>
      <wml2:value>78.28605746596666</wml2:value>
    </wml2:MeasurementTVP>
  </wml2:point>
▼<wml2:point>
  ▼<wml2:MeasurementTVP>
      <wml2:time>2014-03-25T12:00:00.000-06:00</wml2:time>
      <wml2:value>78.21303364497622</wml2:value>
    </wml2:MeasurementTVP>
  </wml2:point>
▼<wml2:point>
  ▼<wml2:MeasurementTVP>
      <wml2:time>2014-03-25T15:00:00.000-06:00</wml2:time>
      <wml2:value>78.15977921539424</wml2:value>
    </wml2:MeasurementTVP>
  </wml2:point>
▼<wml2:point>
  ▼<wml2:MeasurementTVP>
      <wml2:time>2014-03-25T18:00:00.000-06:00</wml2:time>
      <wml2:value>78.12700984939693</wml2:value>
    </wml2:MeasurementTVP>
  </wml2:point>
▼<wml2:point>
  ▼<wml2:MeasurementTVP>
      <wml2:time>2014-03-25T21:00:00.000-06:00</wml2:time>
      <wml2:value>78.11474238632958</wml2:value>
    </wml2:MeasurementTVP>
  </wml2:point>
```

Data Service



https://ut-austin.maps.arcgis.com/home/webmap/viewer.html?webmap=d107aa9260534ddbb96db302e3643a93

Integration of Map and Data Services

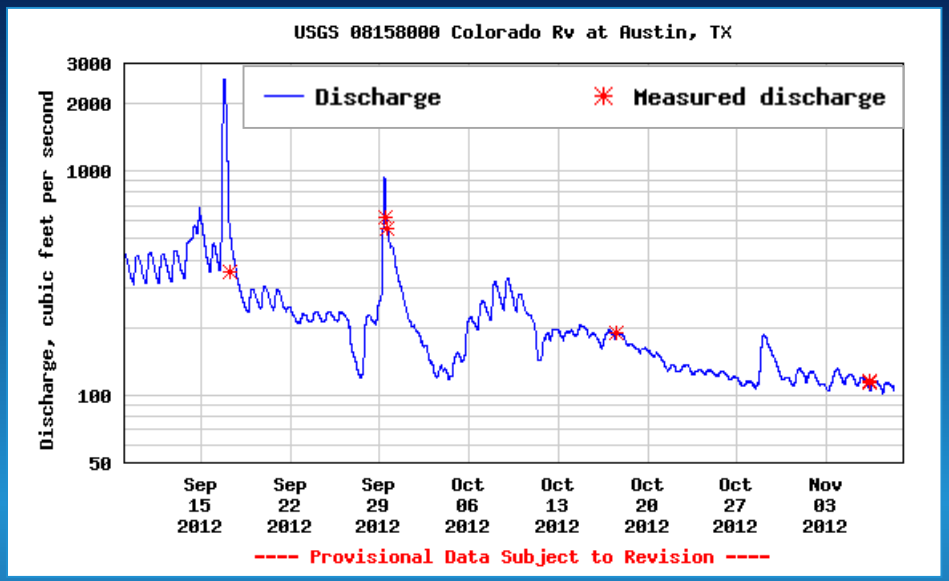


Open Geospatial Consortium

More than 400 companies and agencies globally

WaterML Web Services – CUAHSI, USGS, OGC, WMO …..

Water time series data on the internet



```
- <wml2:point>
    - <wml2:MeasurementTVP>
        <wml2:time>2014-05-11T21:30:00-05:00</wml2:time>
        <wml2:value>262.0</wml2:value>
      </wml2:MeasurementTVP>
  </wml2:point>
- <wml2:point>
    - <wml2:MeasurementTVP>
        <wml2:time>2014-05-11T21:35:00-05:00</wml2:time>
        <wml2:value>264.0</wml2:value>
      </wml2:MeasurementTVP>
  </wml2:point>
```

24/7/365 service
For daily and real-time data

. . . Operational water web services system for the United States

http://waterservices.usgs.gov/nwis/iv/?format=waterml,2.0&sites=08158000&period=P1D&parameterCd=00060

Water Data Distribution by US Geological Survey

Open Water Data Initiative

- Subcommittee on Spatial Water Data will lead this effort
- This reports to both FGDC and ACWI

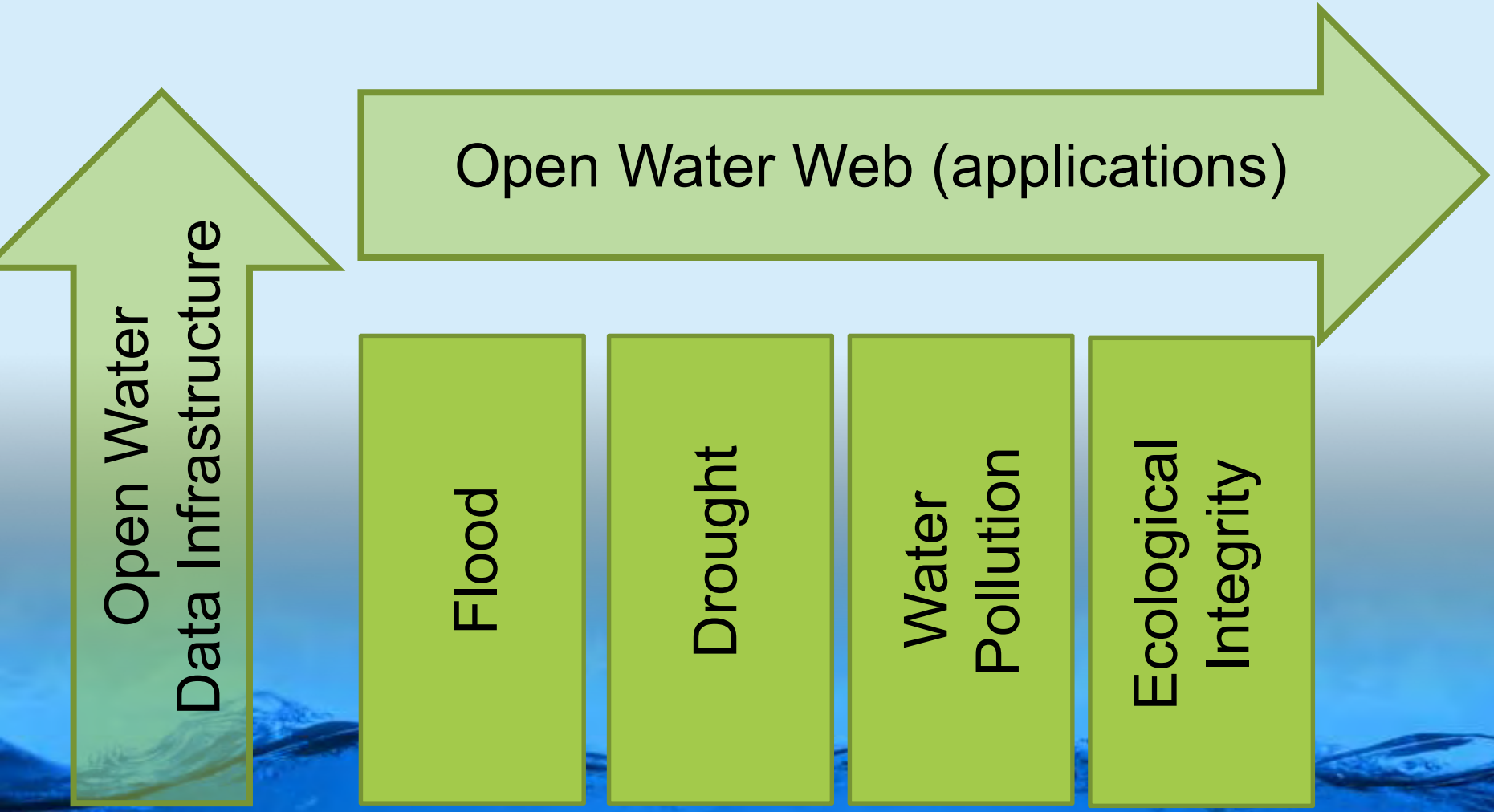
Anne Castle, Asst Secretary for Water and Science, Dept of Interior

Chair

fgdc Federal Geographic Data Committee

ACWI Advisory Committee on Water Information

Open Water Data Components



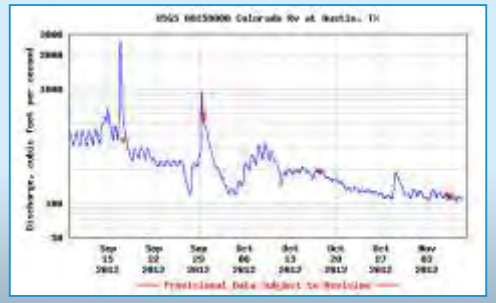
Concept: Nate Booth, USGS

National Flood Interoperability Experiment
Data Framework

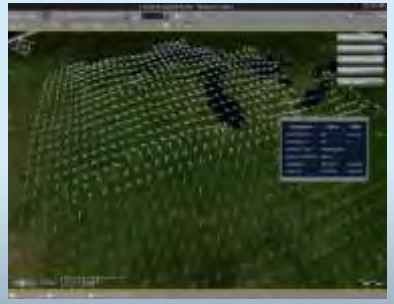
Temporal

Geospatial

Time Series
(WaterML2 and .csv)



Multidimensional Arrays
(WCS and netCDF)

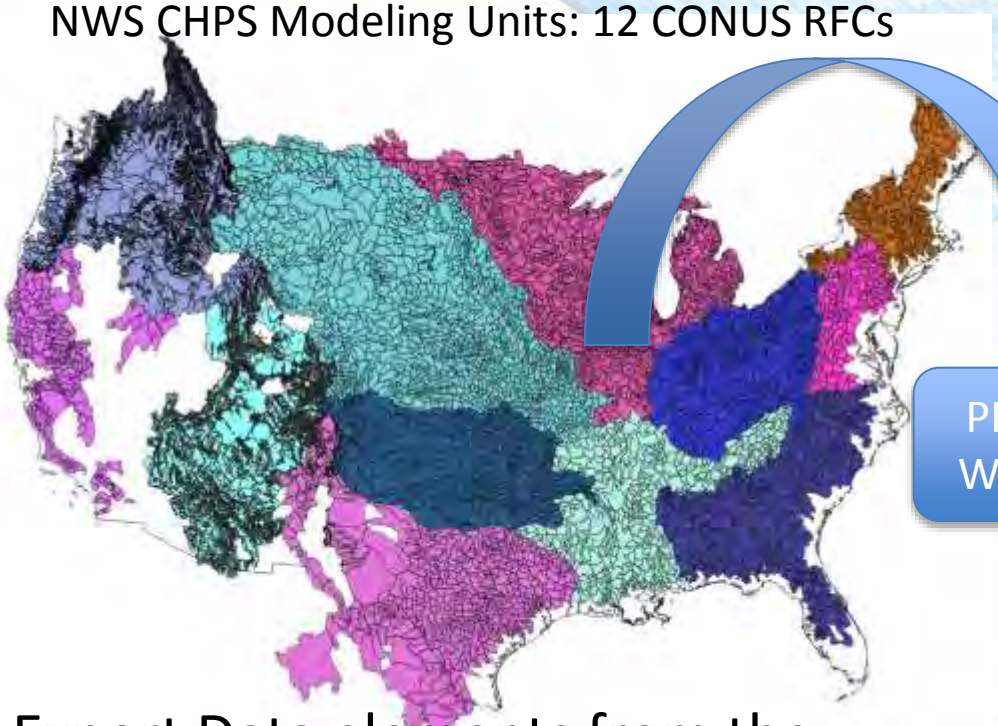


Hydrology
(RFC Basins,
NHDPlus Catchments)

Hydraulics
(National Flood Hazard Layer,
Flood Inundation Map Libraries)

Develop NWS Experimental Data Services

NWS CHPS Modeling Units: 12 CONUS RFCs



Experimental distributed model (SAC-HTET)

PI-XML to WaterML2

XMRG to NetCDF

Data Services – local runoff

Export Data elements from the simulation workflow including:

- INFW – Inflow to the "Channel"
- Mean Areal Precipitation (MAP)
- Reservoir Outflow (QINE)

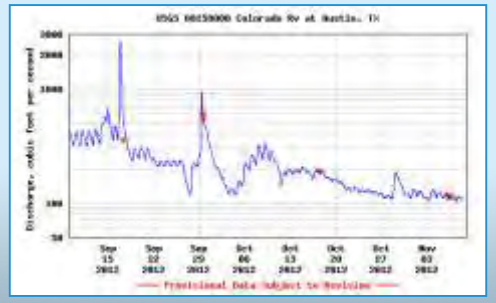
Slide: Ed Clark, NWS
(pre-decisional)

National Flood Interoperability Experiment
Data Framework

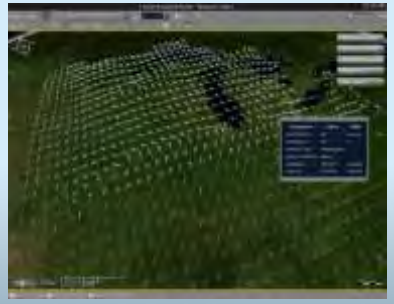
Temporal

Geospatial

Time Series
(WaterML2 and .csv)



Multidimensional Arrays
(WCS and netCDF)

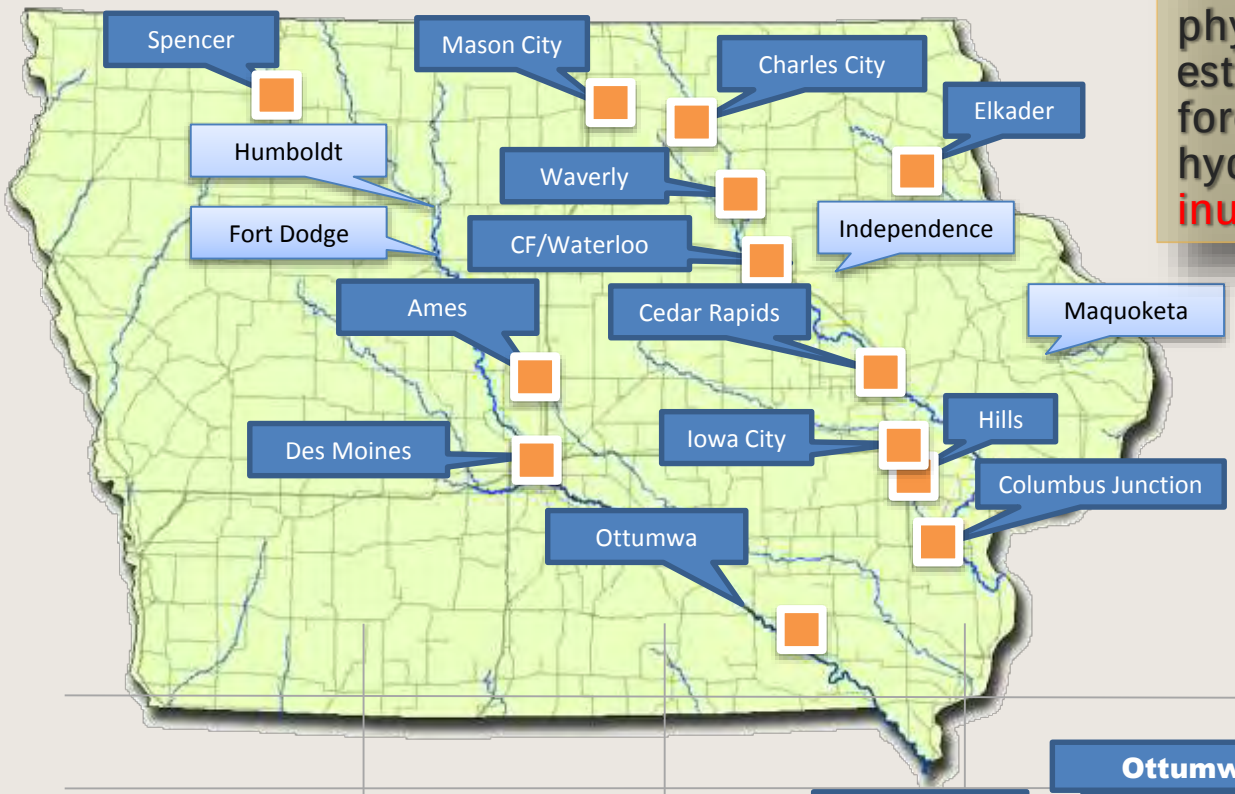


Hydrology
(RFC Basins,
NHDPlus Catchments)

Hydraulics
(National Flood Hazard Layer,
Flood Inundation Map Libraries)

Iowa Flood Information System Established after 2008 Iowa Flood

To develop hydrologic models for physically based flood frequency estimation and real-time forecasting of floods, including hydraulic models of flood plain inundation mapping.



Iowa Flood Center

Iowa City

Charles City

Cedar Falls & Waterloo

Des Moines

Cedar Rapids

Hills

Mason City

Elkader

Ames

Spencer

Ottumwa

Columbus Junct

Waverly

Maquoketa

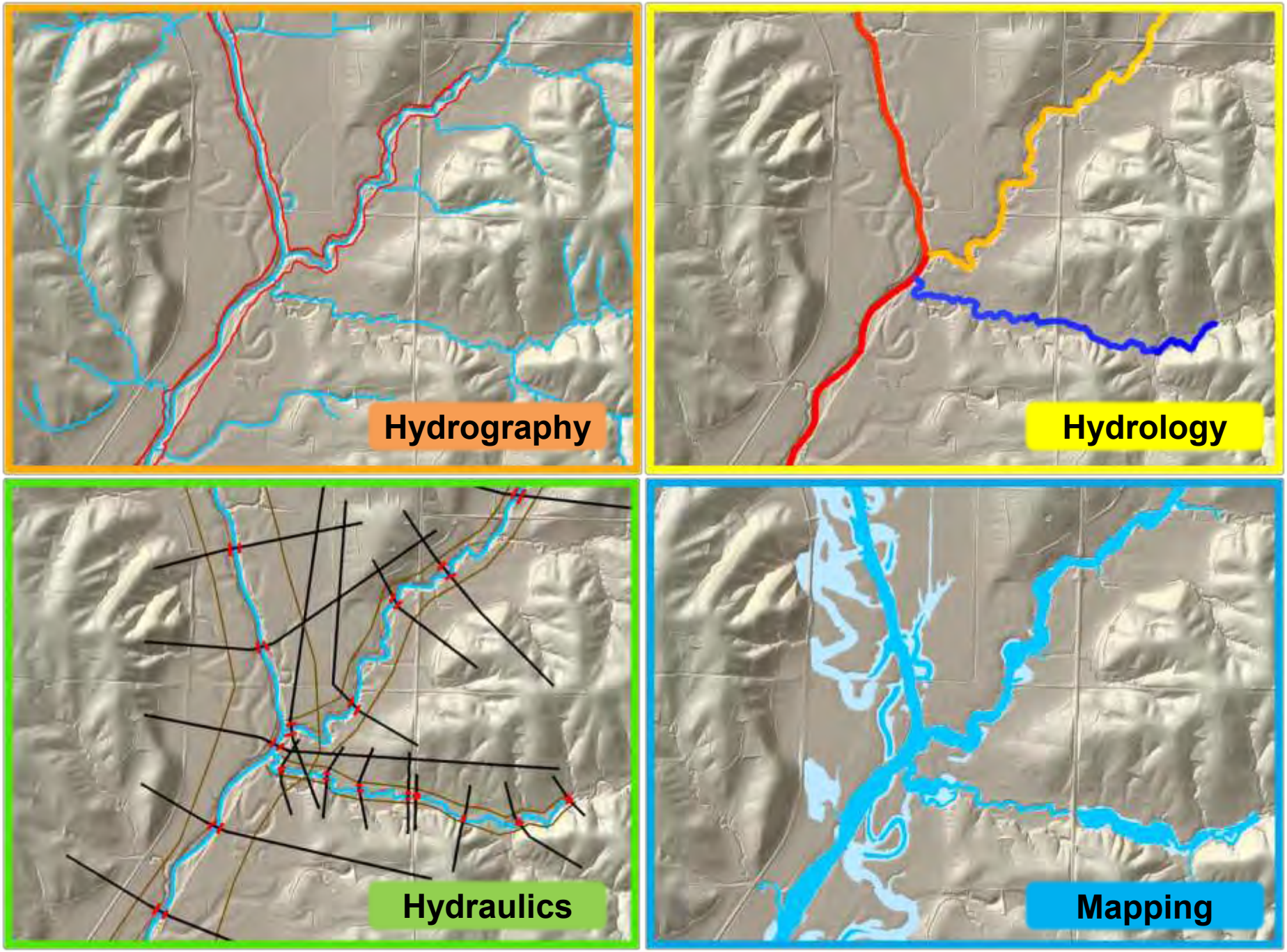
Independence

Fort Dodge

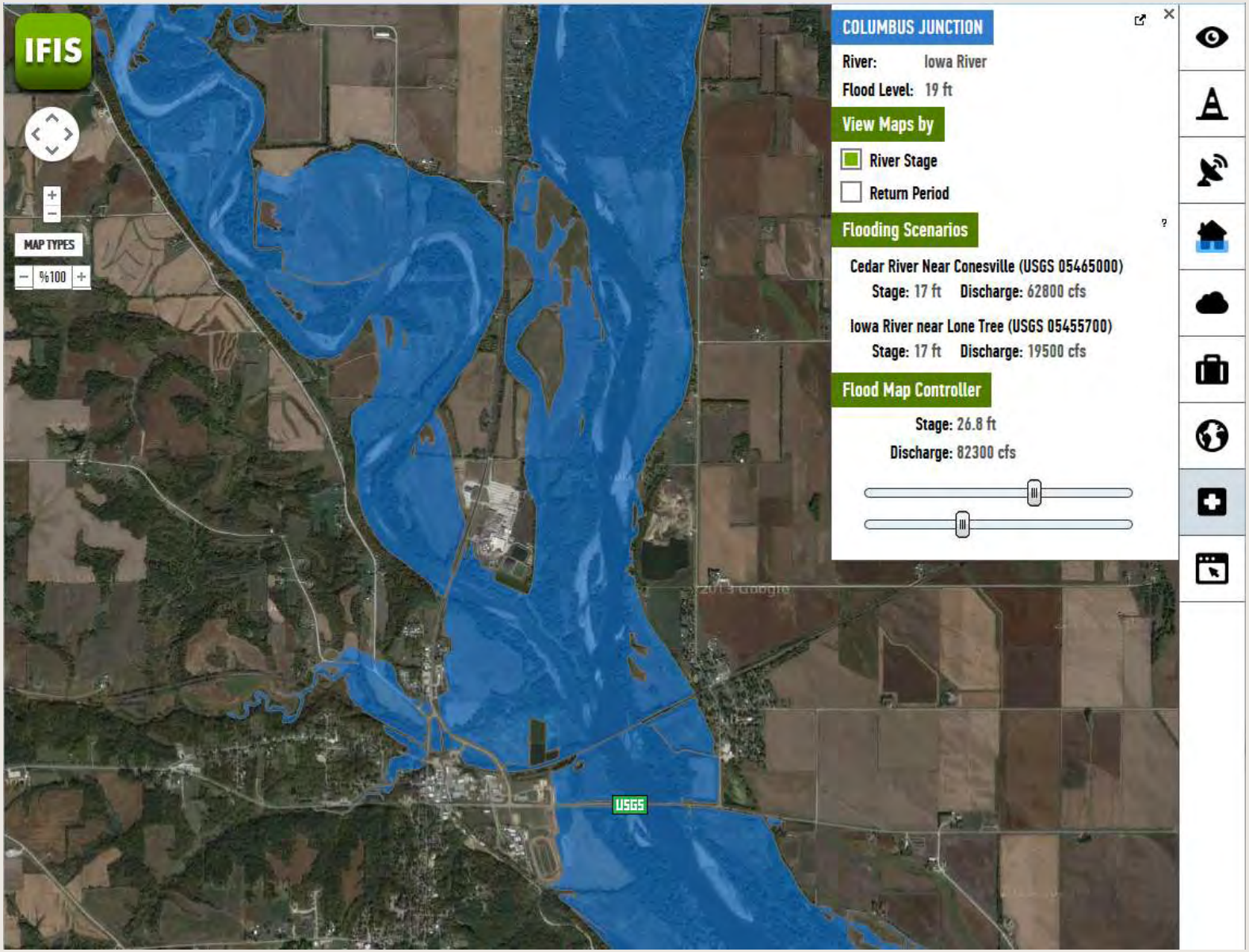
Humboldt

Today

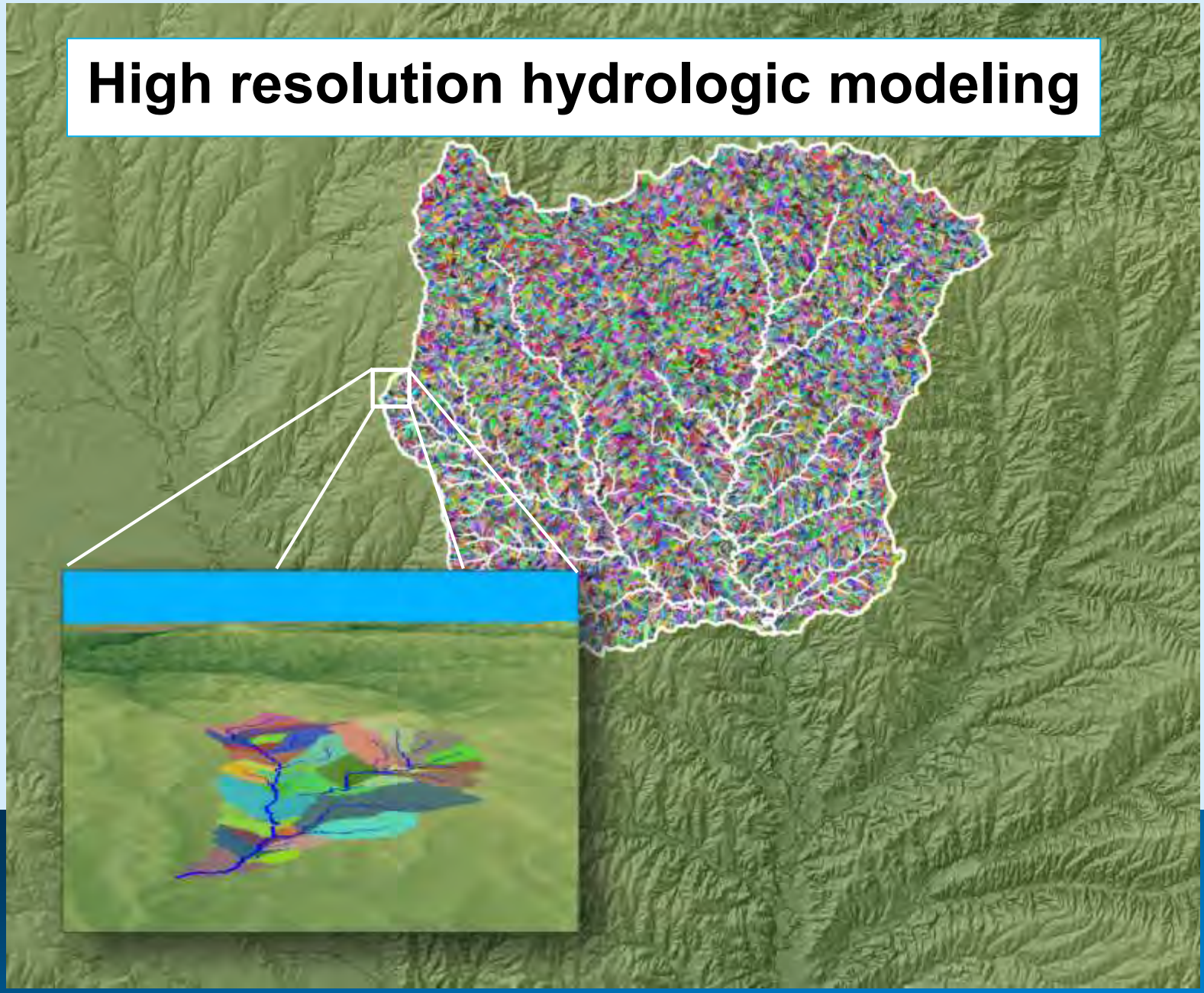
2009 2010 2011 2012 2013 2014


Hydrography
Hydrology
Hydraulics
Mapping

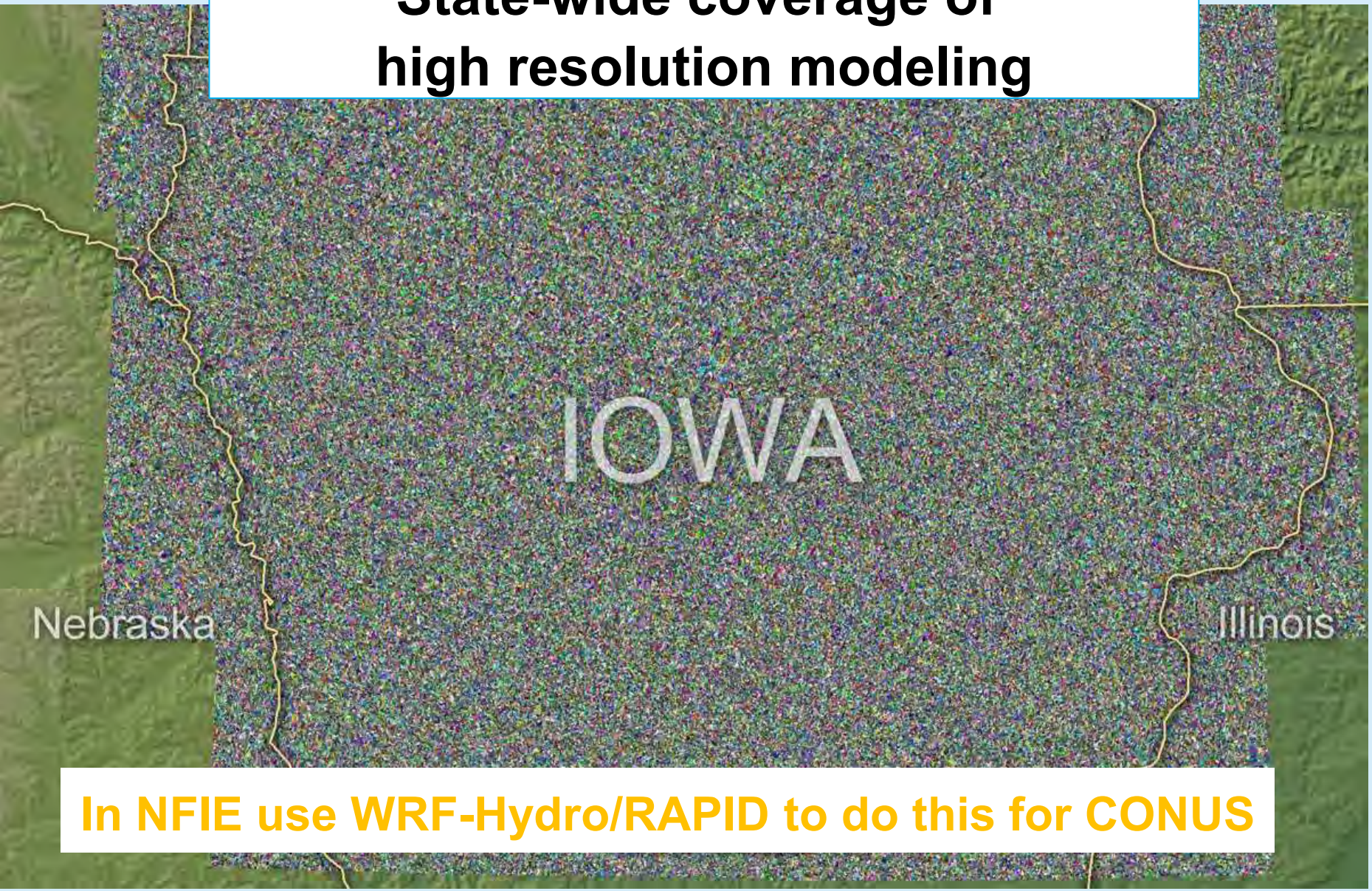
New Maps – Columbus Junction



High resolution hydrologic modeling

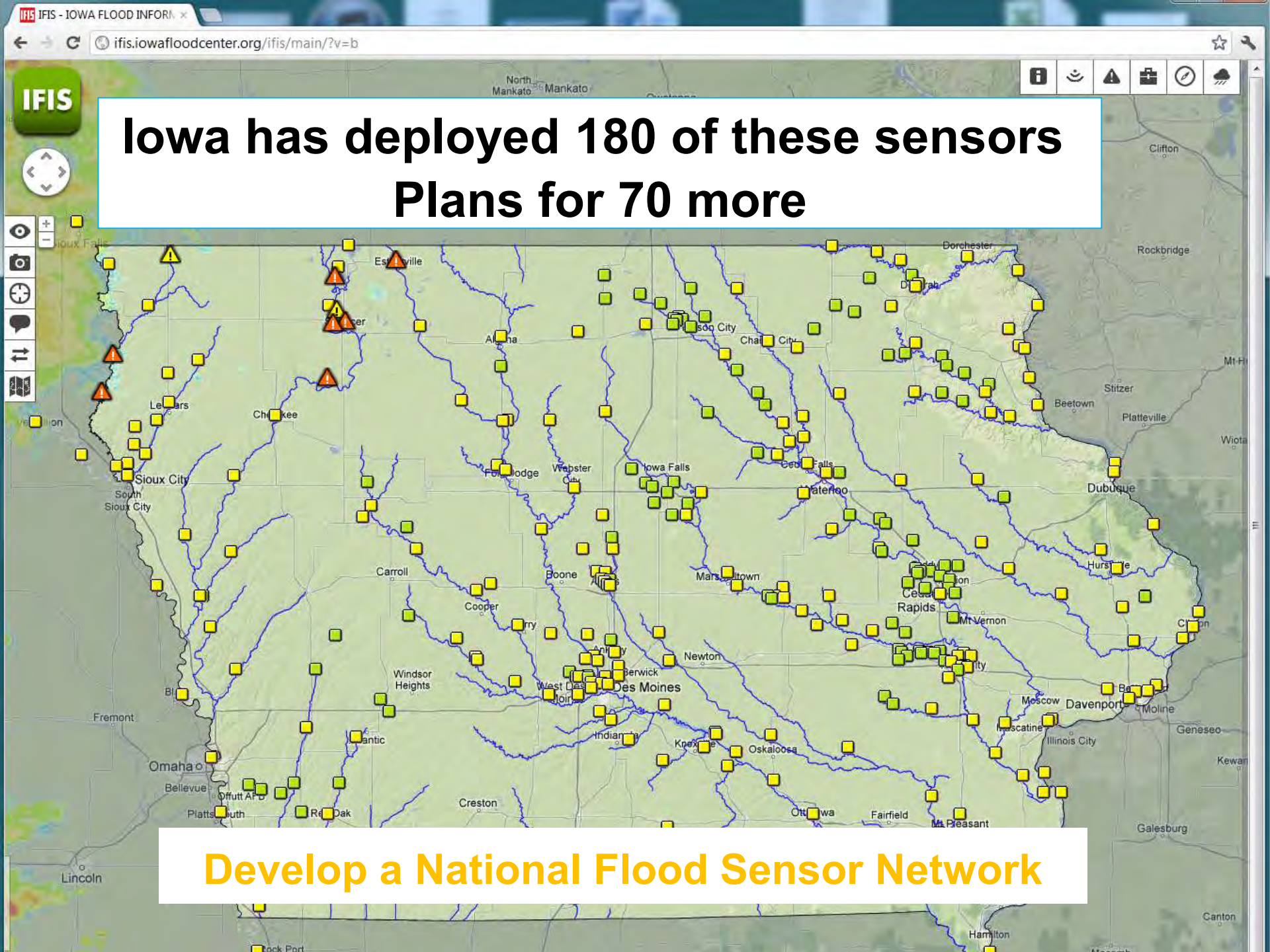


State-wide coverage of high resolution modeling



In NFIE use WRF-Hydro/RAPID to do this for CONUS

Install water level sensors on the back of bridges ($3000 per site)


IFIS - IOWA FLOOD INFORM
ifis.iowafloodcenter.org/ifis/main/?v=b
IFIS
Iowa has deployed 180 of these sensors
Plans for 70 more
Develop a National Flood Sensor Network
Sioux City
Des Moines
Cedar Rapids
Davenport
Dubuque
Waterloo
Iowa Falls
Omaha
Lincoln
Council Bluffs
Carroll
Boone
Newton
Oskaloosa
Fairfield
Creston
Fremont
Bellevue
Clinton
Rockbridge
Galesburg
Geneseo
Moline
Illinois City
Mt Vernon
Marshalltown
Webster City
Windsor Heights
Platteville
Beetown
Stitzer
Hamilton
Canton

Conclusions

- National Water Center is being established in Tuscaloosa, Alabama
- Offers an opportunity to do things differently in the future than in the past
- National Flood Interoperability Experiment (Sept 2014 to August 2015) to explore how to do this for flooding
- All are welcome to participate
- Possible National Drought Interoperability Experiment in 2015-2016