

Lessons learned from Hydrodynamic Levee-Breach and Inundation Modeling

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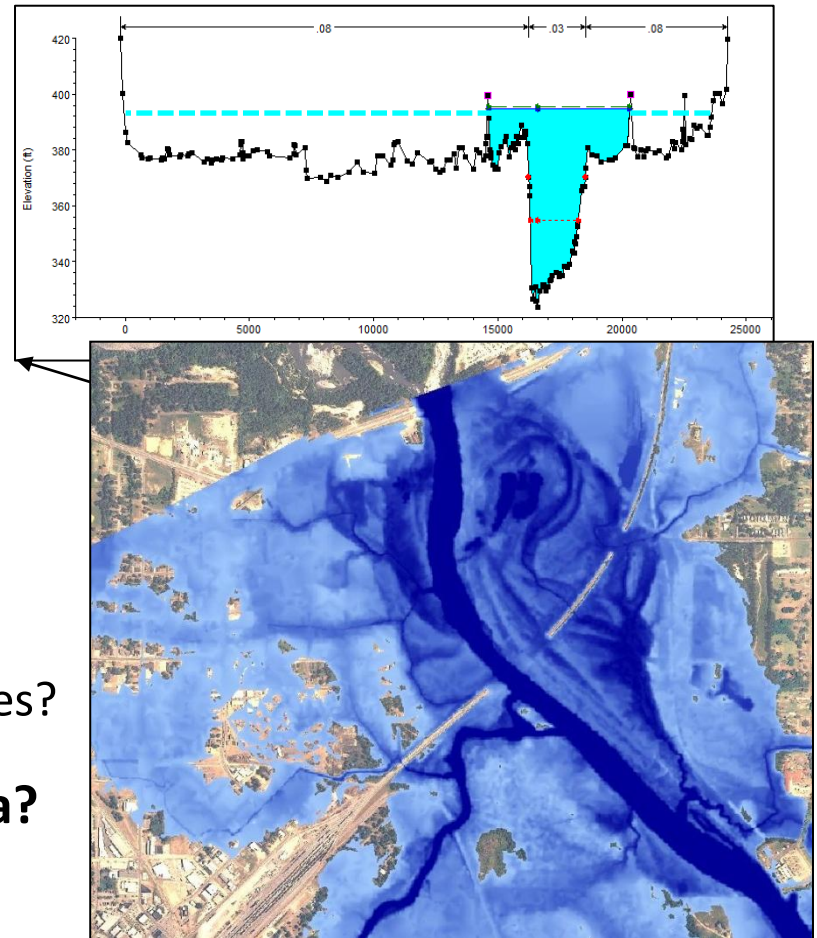
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Inundation modeling

- current practice -

- 1D River model (HEC-RAS)
 - River cross-sections
 - Extrapolate water levels
 - Project onto elevation map
- Disadvantages
 - No mass conservation of water!
 - No flow routing/barriers
- Also:
 - Difficult to model levee breaches
 - How to estimate flood arrival times?

**Should we invest in better input data?
... and another modeling concept?**



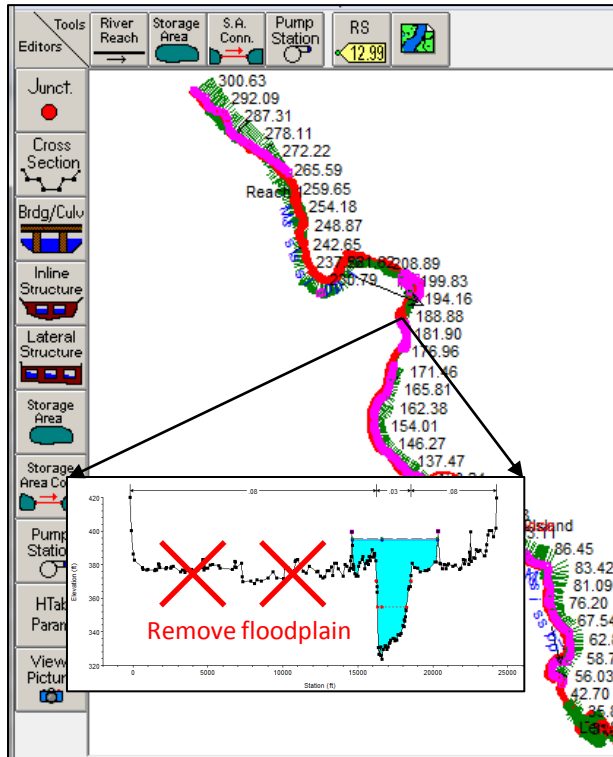
Hybrid 1D/2D approach

- model ingredients -

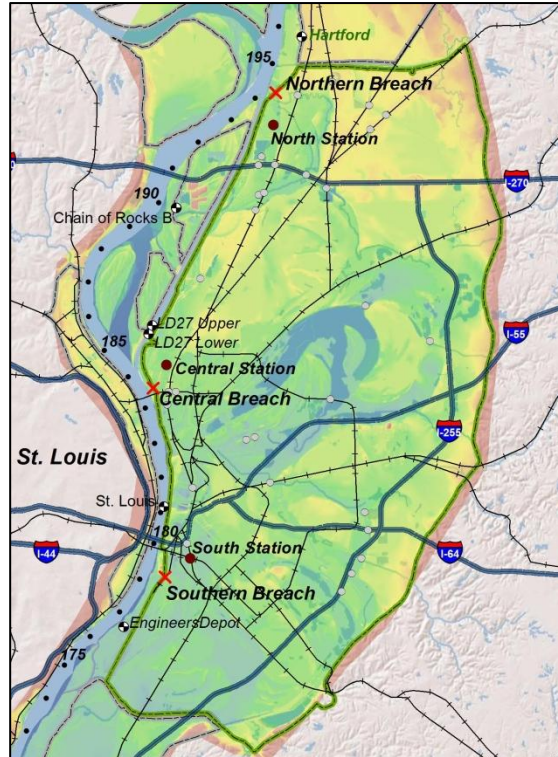
1D module

2D module

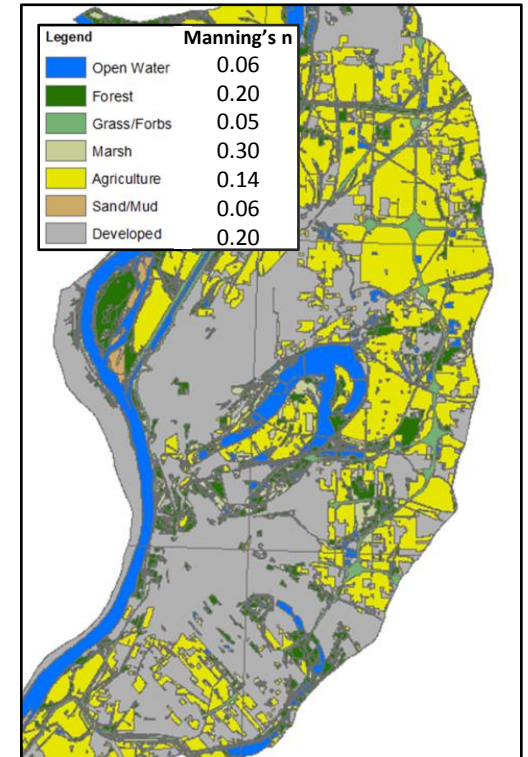
river model (HEC-RAS)



Floodplain elevation map

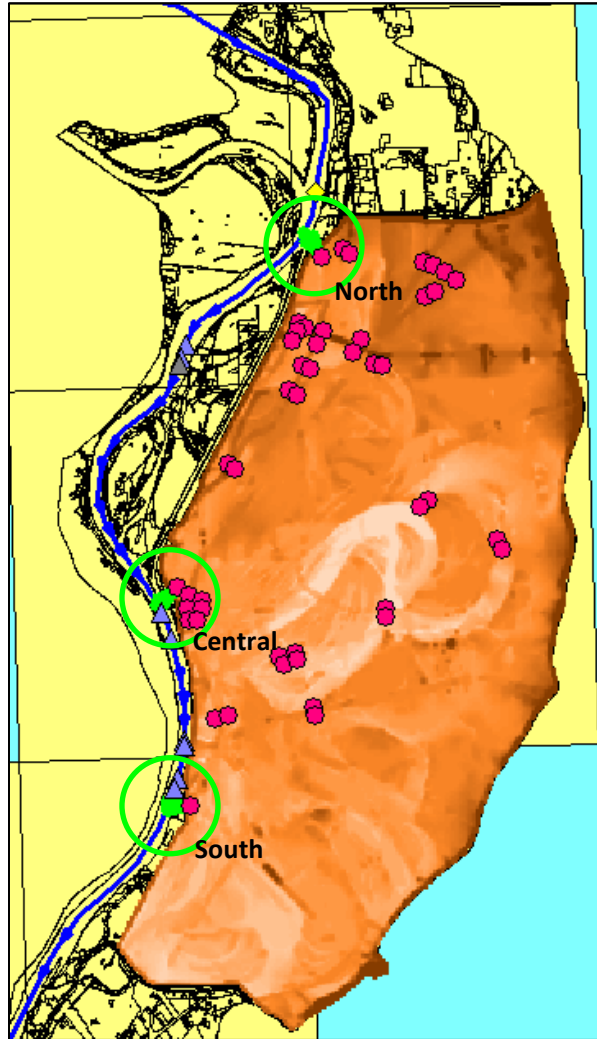


Land cover map



Hybrid 1D/2D approach

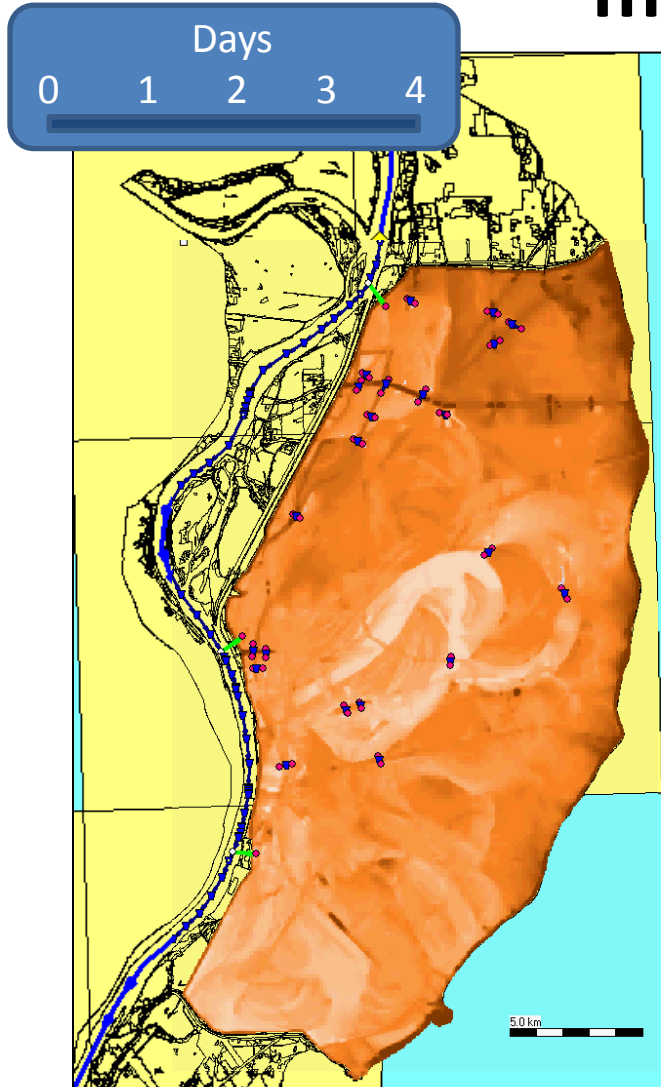
- model set-up -



1. 1D river model
 - Import HEC-RAS
2. Floodplain Elevation Model
 - Associated with roughness map
3. Include flow pass ways
 - Bridges and culverts
4. Connect 1D channel and 2D floodplain
 - Levee breach function
 - Calculate breach development

Hybrid 1D/2D approach

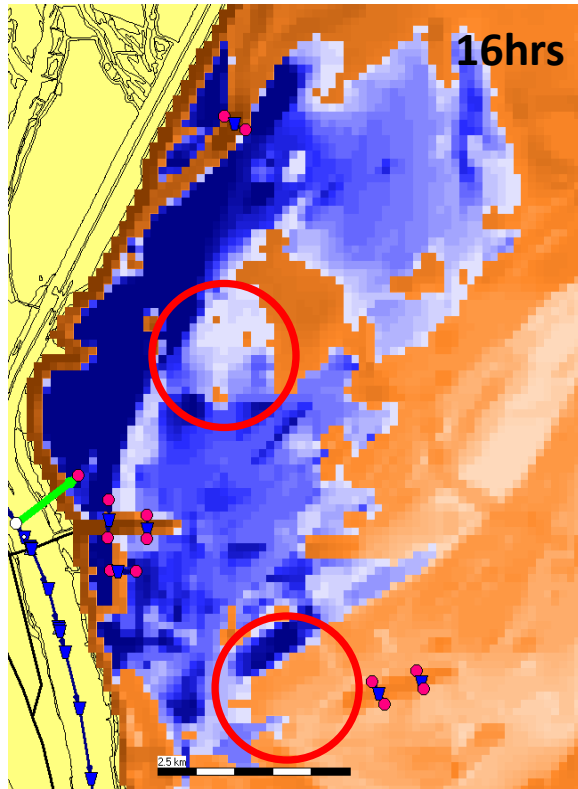
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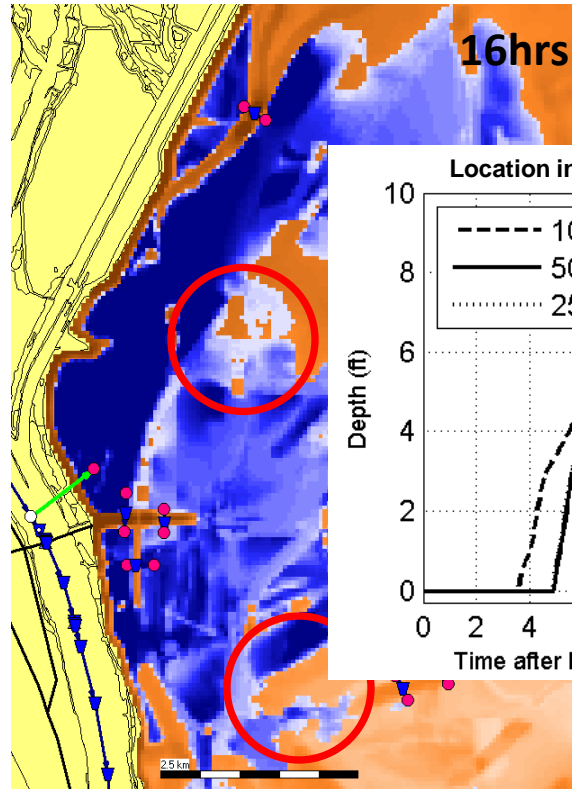
Choosing a 2D grid resolution

Cell size: 100m x 100m



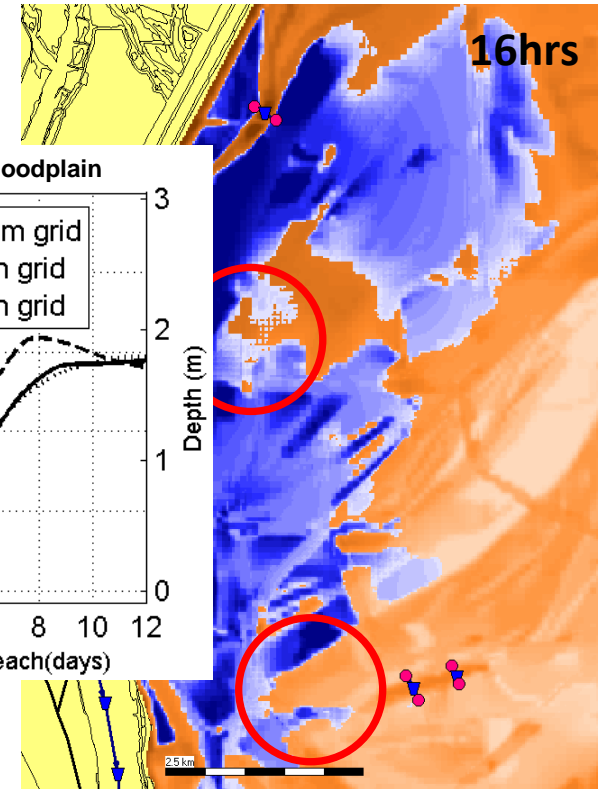
Calculation time: 10 minutes

Cell size: 50m x 50m

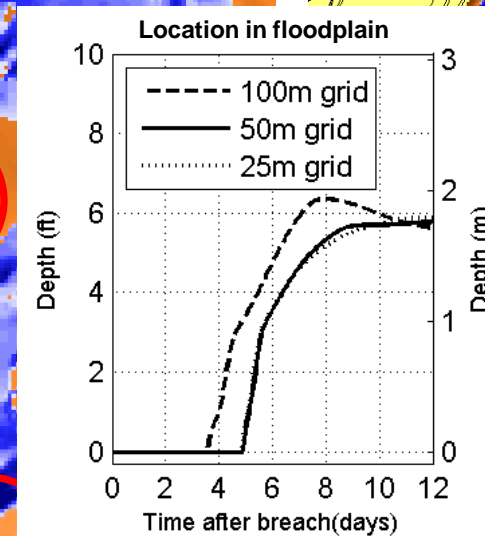


1 hour

Cell size: 25m x 25m



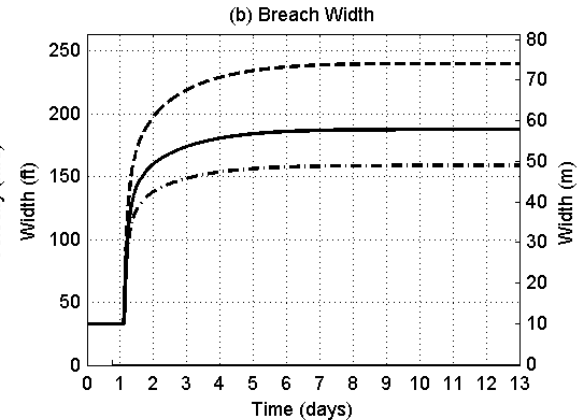
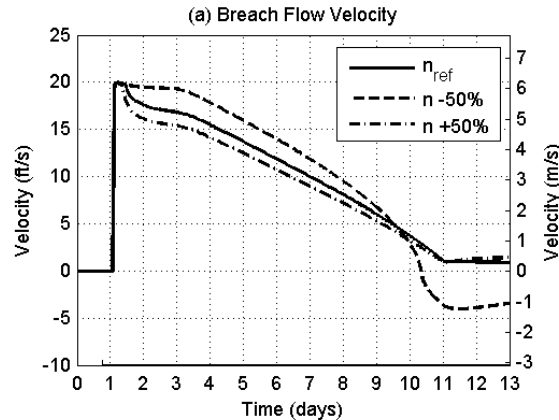
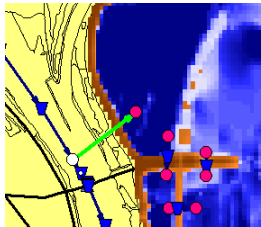
6 hours



Sensitivity to floodplain roughness

- Impact on breach growth

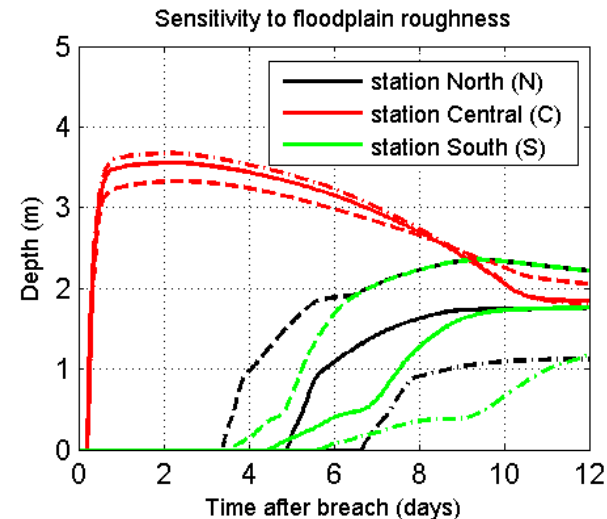
- Larger roughness:
 - smaller breach
 - less flow into floodplain



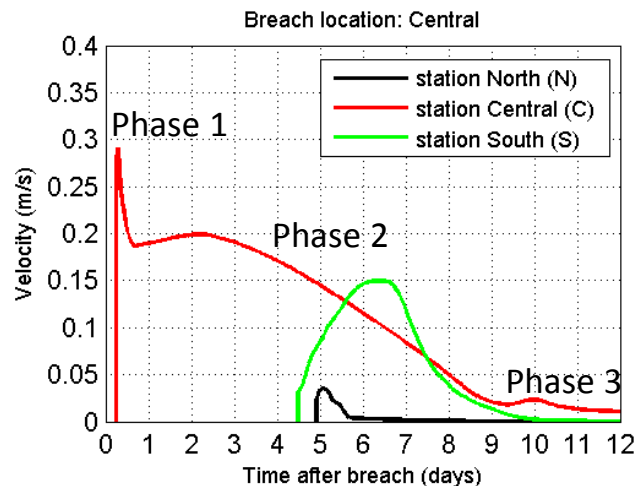
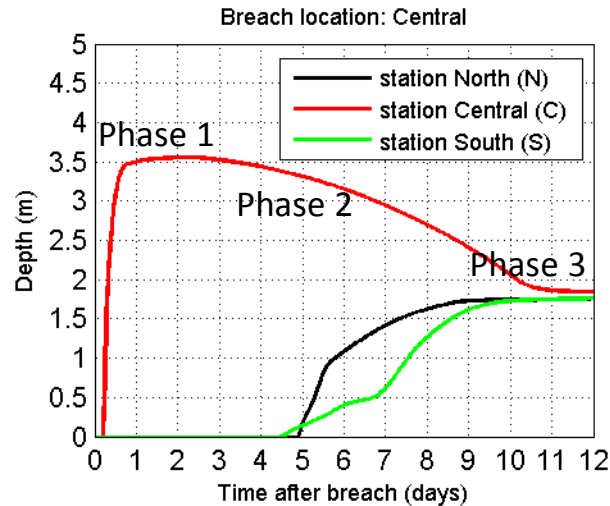
- Impact on inundation pattern

- 3 locations in floodplain
 - Larger roughness:
 - later flood arrival
 - lower flood levels

Large impact on breach growth and inundation pattern!
Potential use for flood protection?



Inundation phases



Phase 1: Flash flood phase

- Arrival of a flood front
- Rapid rise in water depths
- High flow velocities

Phase 2: Redistribution phase

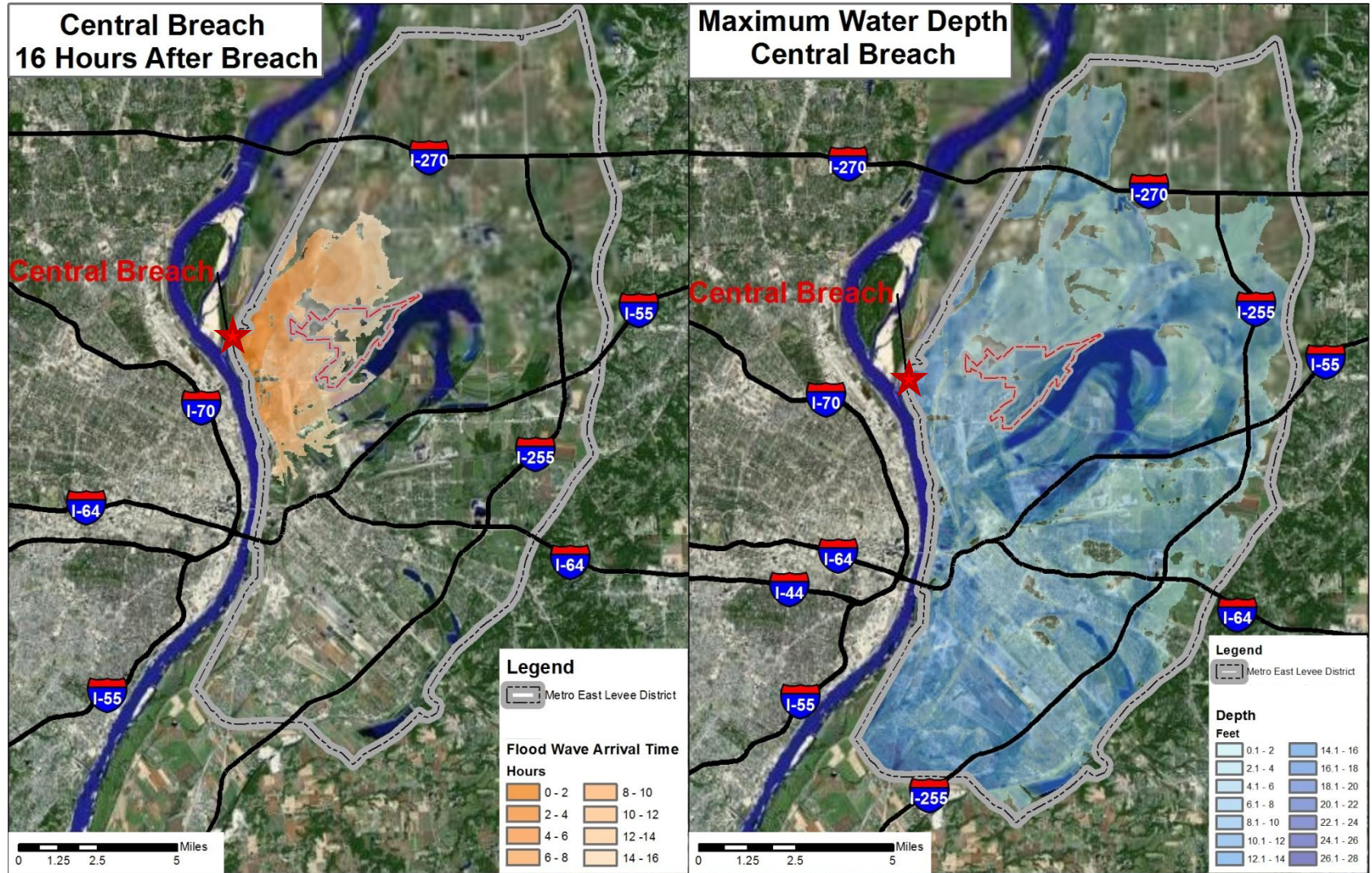
- Water at higher elevations flows to lower elevations
- Lower flow velocities
- Inundation depth decreases near breach and increases at locations further away

Phase 3: Equilibrium phase

- “Bathtub phase”
- Simultaneous changes in water depths over the entire levee cell

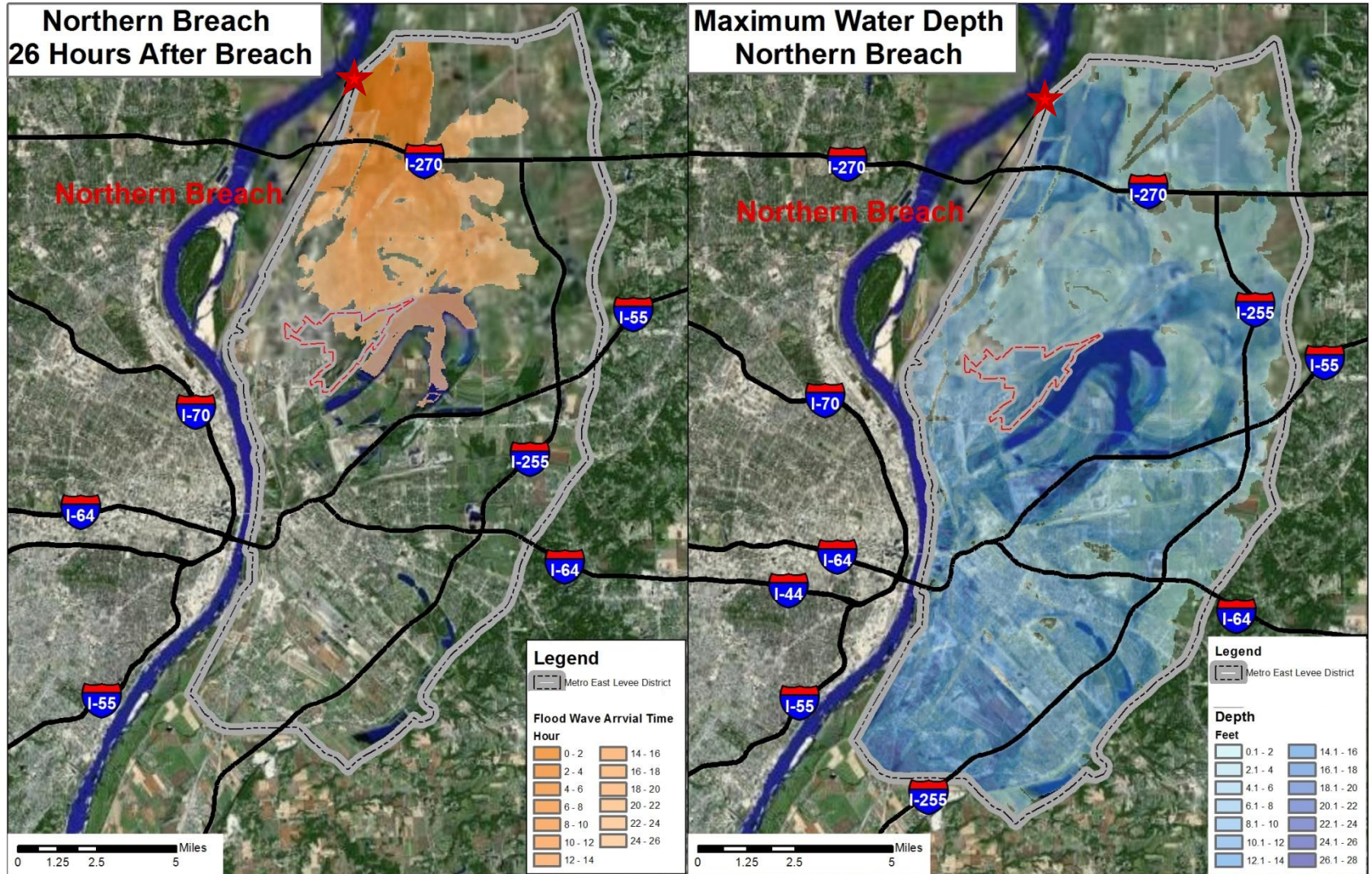
Flood maps

(500-yr flood)



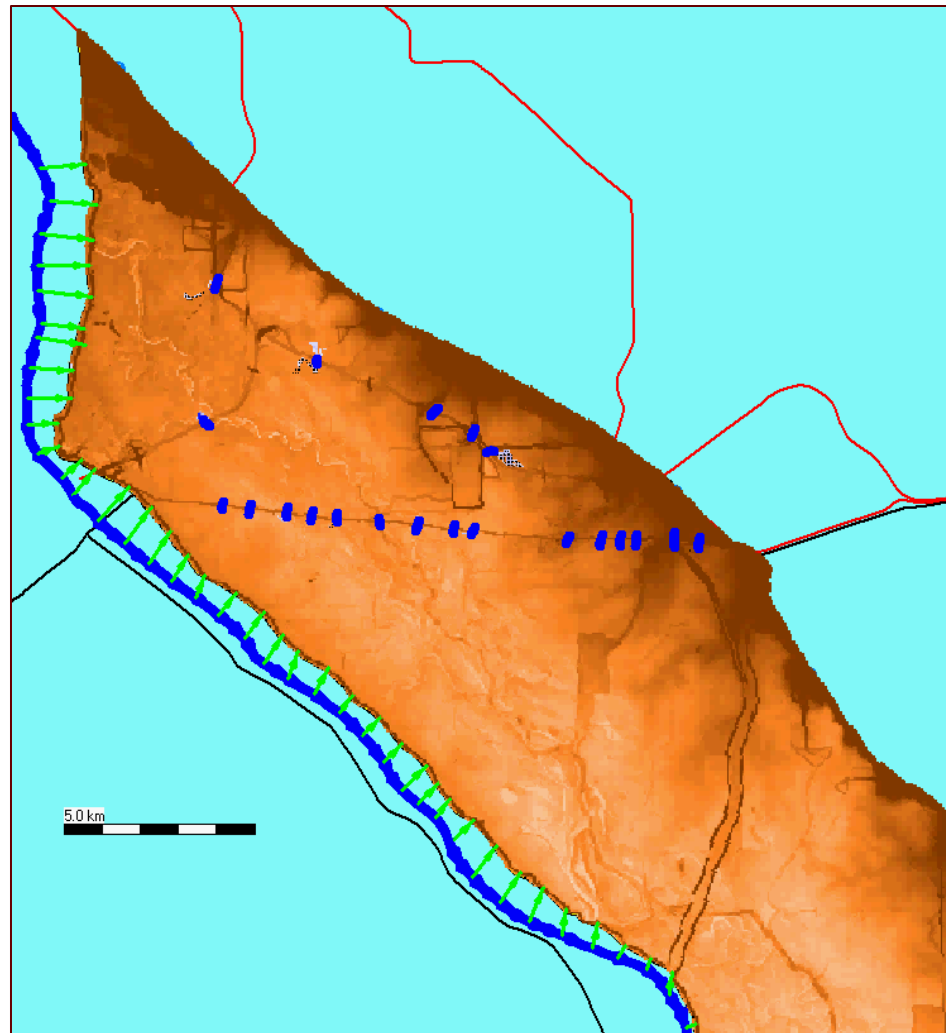
Flood maps

(500-yr flood)

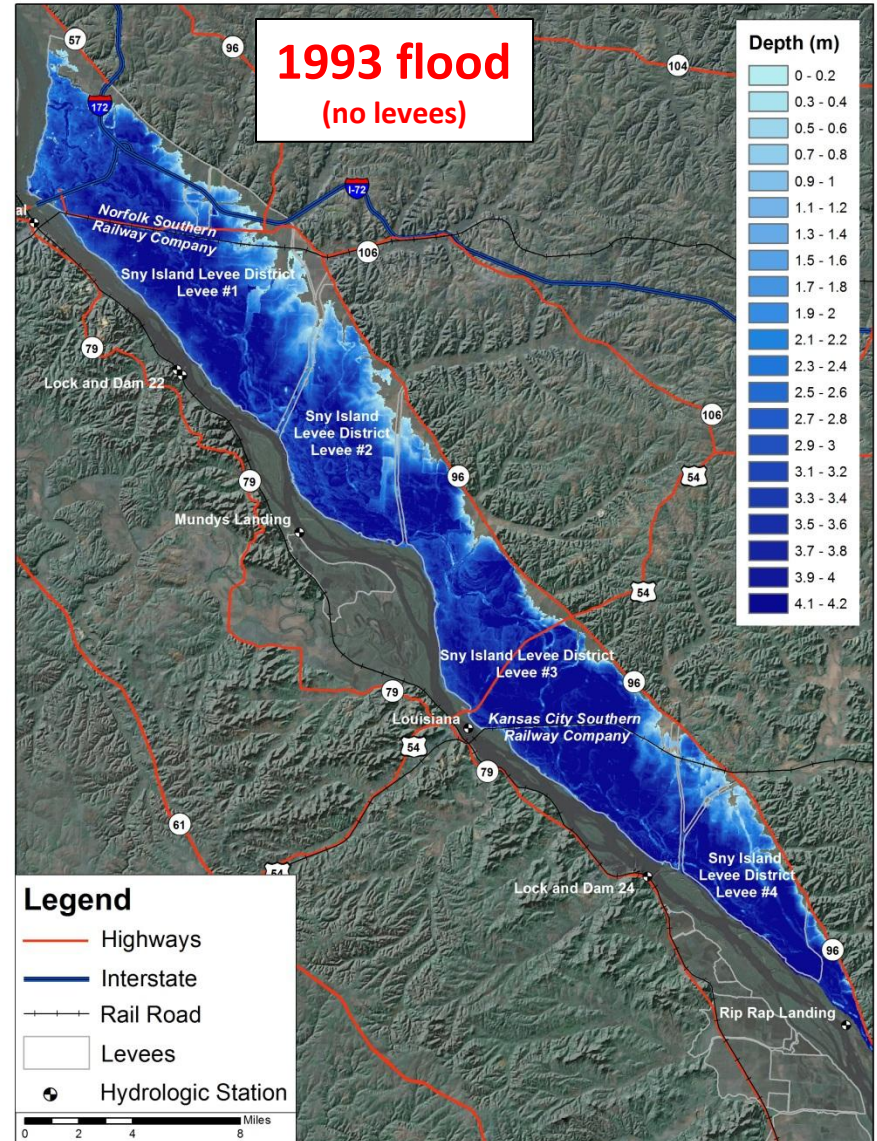
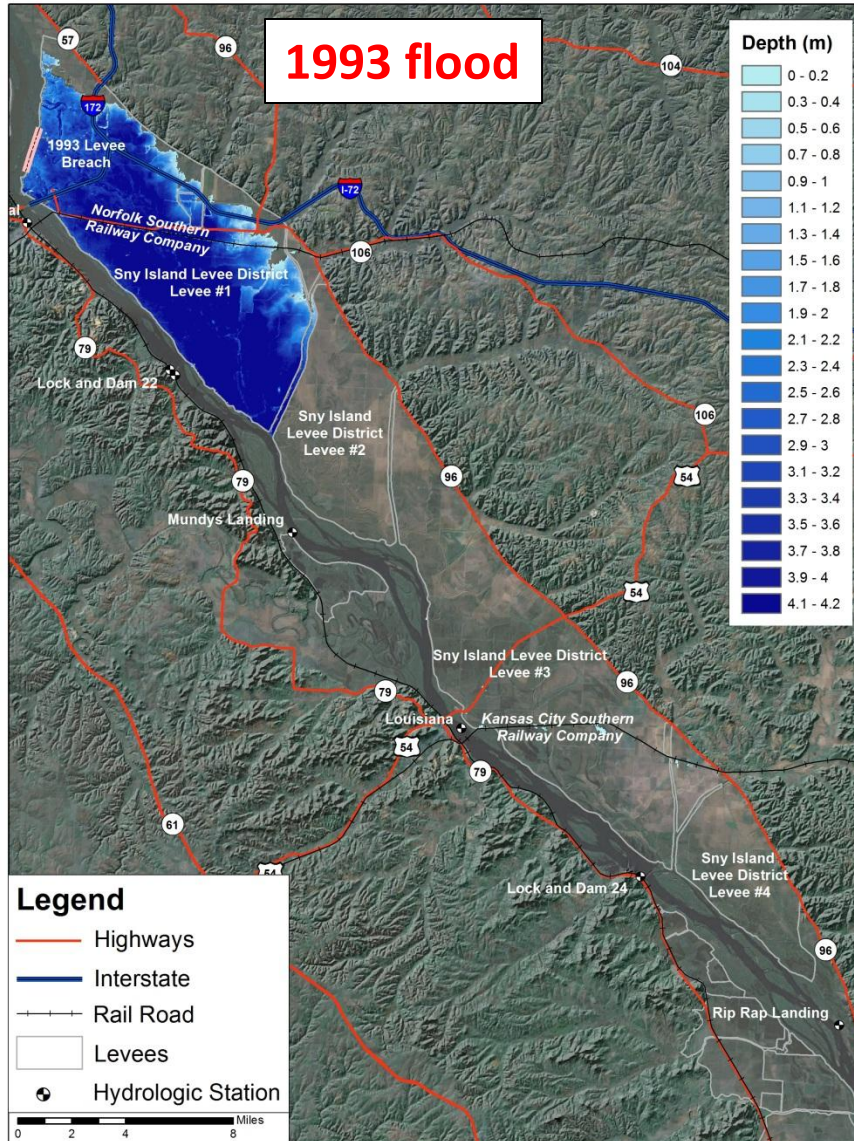


Inundation Sny Island Levee District

Flood 1993



Flood maps Sny Island Levee District

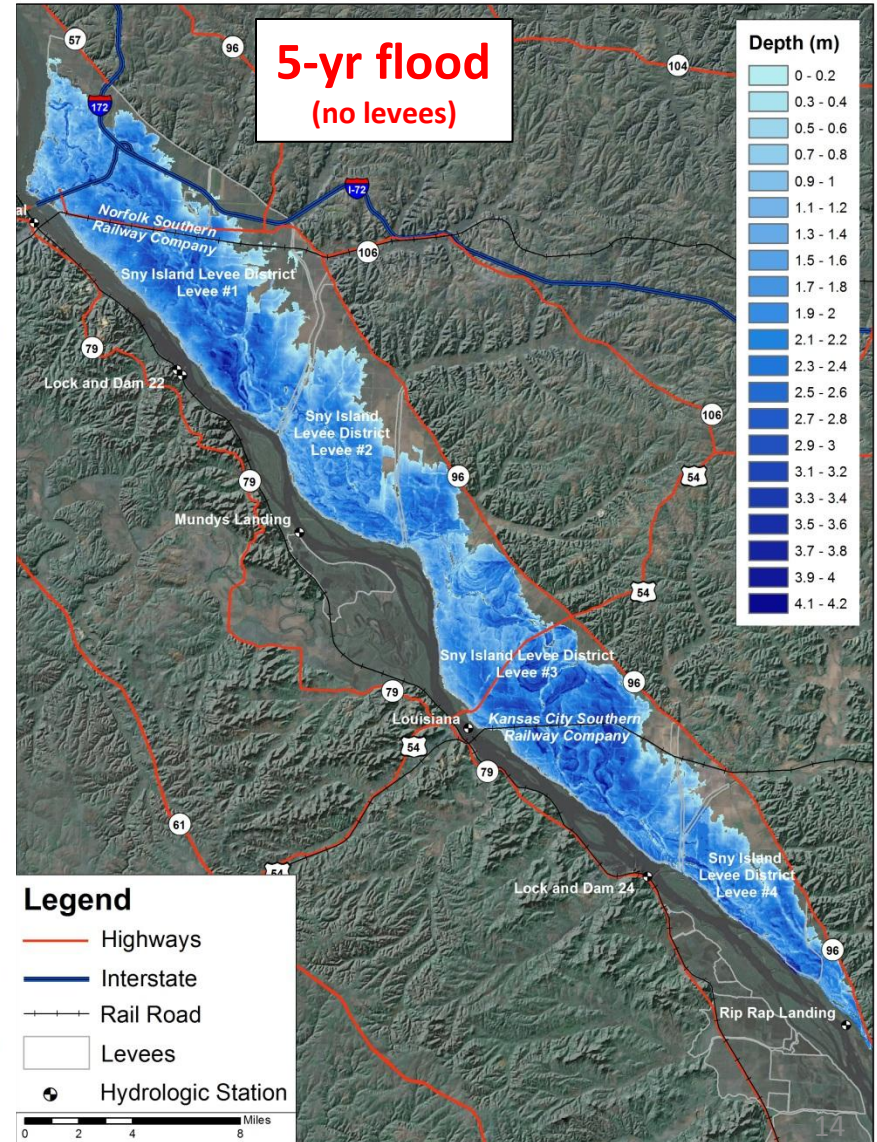
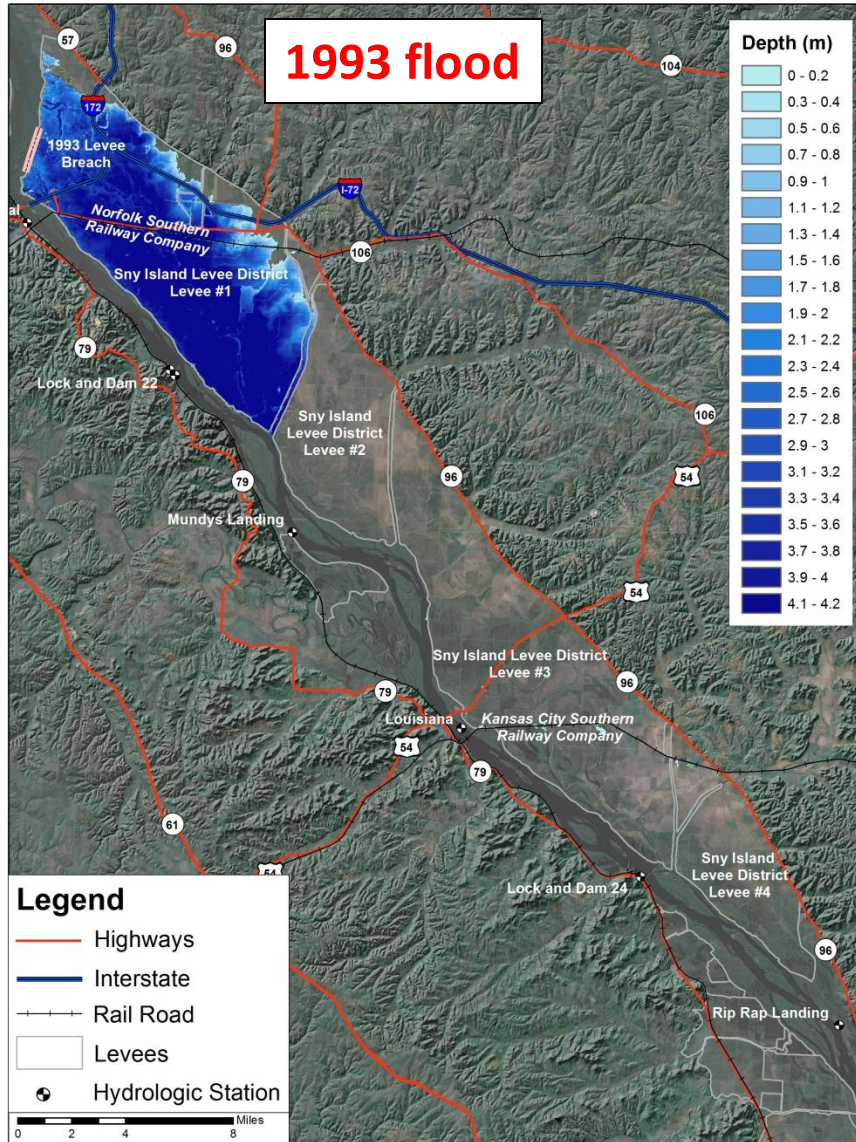


Conclusions

- 1D/2D Hybrid inundation modeling:
 - more realistic flood risk maps
(current maps mostly overestimate flood risk)
 - improve flood response plans
(flood arrival times, flood phase awareness)
 - improve flood prevention plans
(strategic vegetation placement)
- Required technology and data is available!

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Flood maps Sny Island Levee District



Flood maps Sny Island Levee District

