EVALUATION OF LEVEE SETBACKS FOR FLOOD-LOSS REDUCTION ALONG THE MIDDLE MISSISSIPPI RIVER

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Problem

- Flood losses across the United States are widespread and continue to rise.
- Extensive development continues in areas of the U.S. with the greatest flood risk.
- Levees increase flood levels
  - Magnitude of increase varies from study to study
  - 0.3 to 1.5 m in St. Louis region
- New floodplain-management strategies are needed.

Potential Solution = Levee Setbacks

- First proposed in the Pick-Sloan Plan, a component of the Flood Control Act of 1944
- Small-scale projects have been implemented in the U.S.
  - Coyote Creek – San Jose, CA, completed in 1995
  - Bear River – Yuba County, CA, completed in 2010

- Can levee setbacks reduce flood losses?

Study Area

Modeled Levee Scenarios

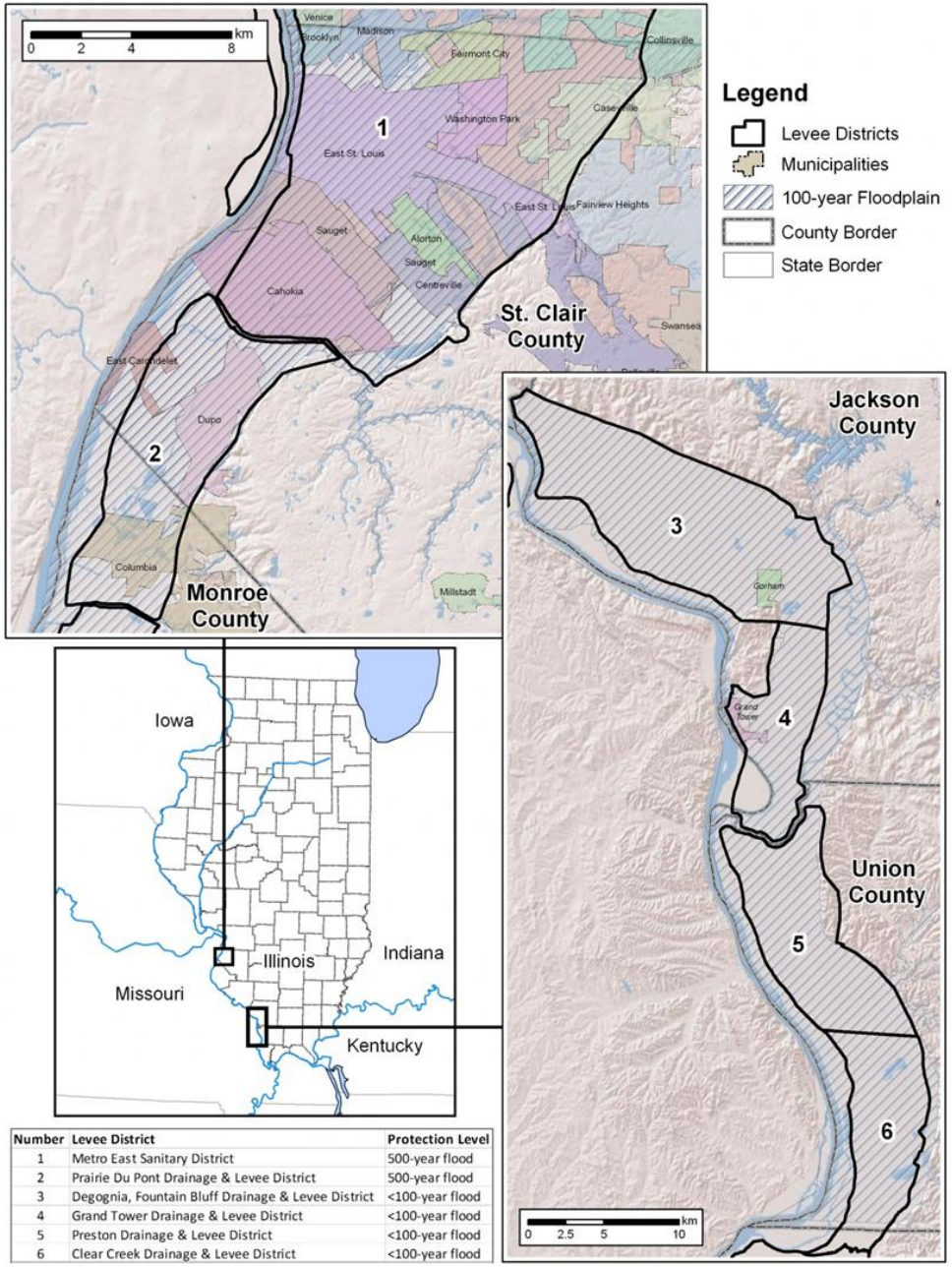
1 - Modern levees

2 - 1500 m setback

3 - 1000 m setback

4 - Planned setback

4B - Planned setback with buyouts



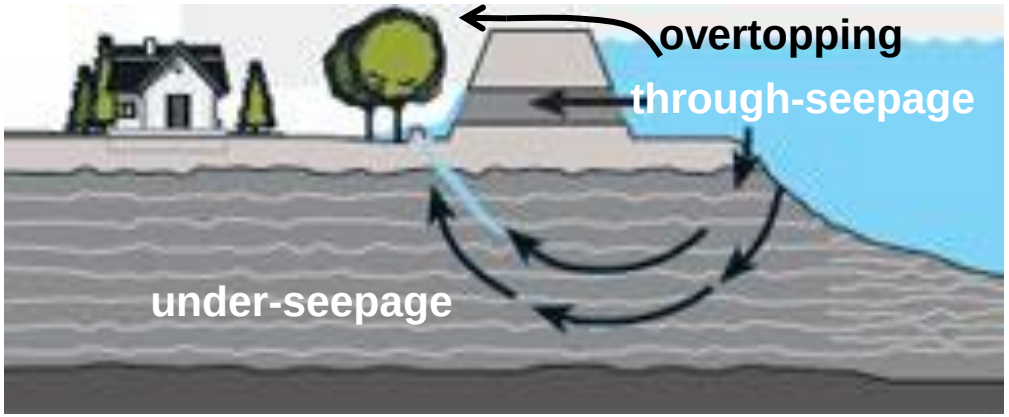
Number	Levee District	Protection Level
1	Metro East Sanitary District	500-year flood
2	Prairie Du Pont Drainage & Levee District	500-year flood
3	Degognia, Fountain Bluff Drainage & Levee District	<100-year flood
4	Grand Tower Drainage & Levee District	<100-year flood
5	Preston Drainage & Levee District	<100-year flood
6	Clear Creek Drainage & Levee District	<100-year flood

Methodology: Overview

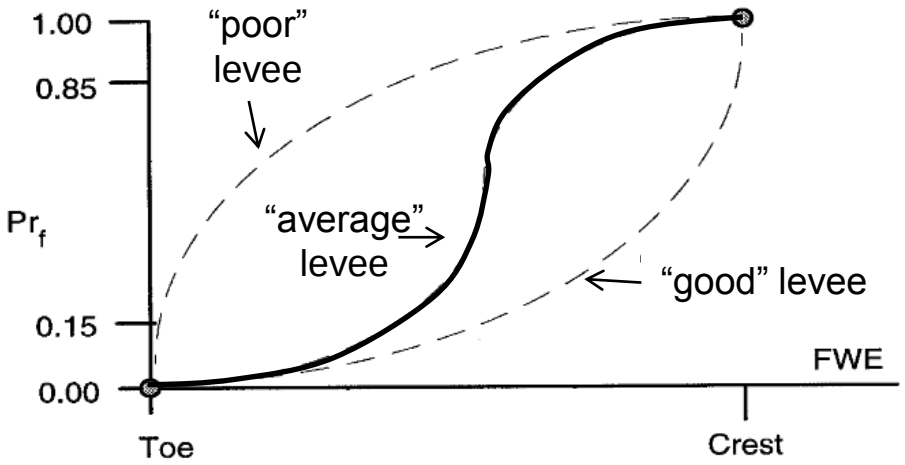
Five major methodological steps:

1. Creation of Building Inventory Databases
2. Hydraulic modeling – 1D with HEC-RAS
3. Flood-loss modeling – Hazus-MH
4. Levee-failure model
5. Calculation of Expected Annual Damage (EAD)

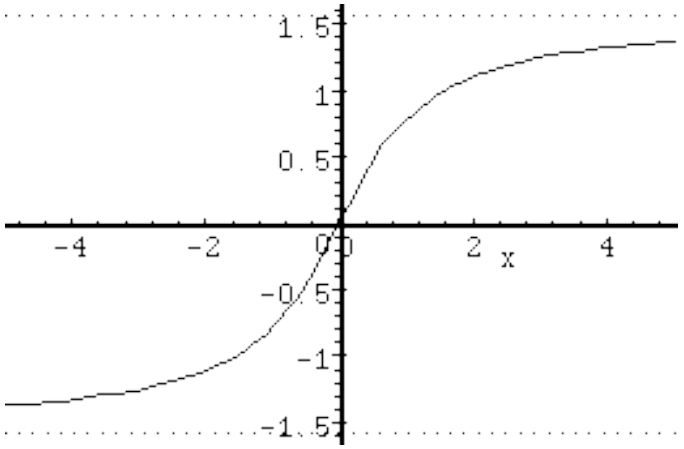
Methodology: Levee-Failure Model



Generalized stochastic levee-failure model, modified from USACE, 1999



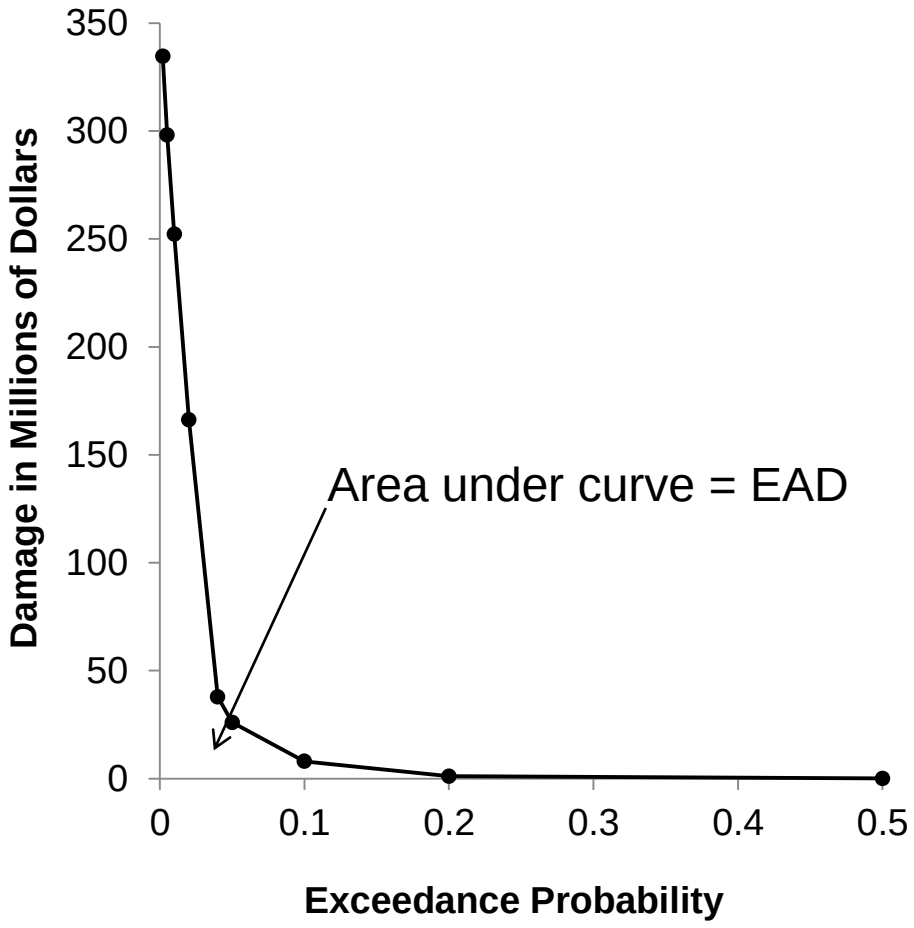
Arc tan Function



Methodology: EAD Calculation

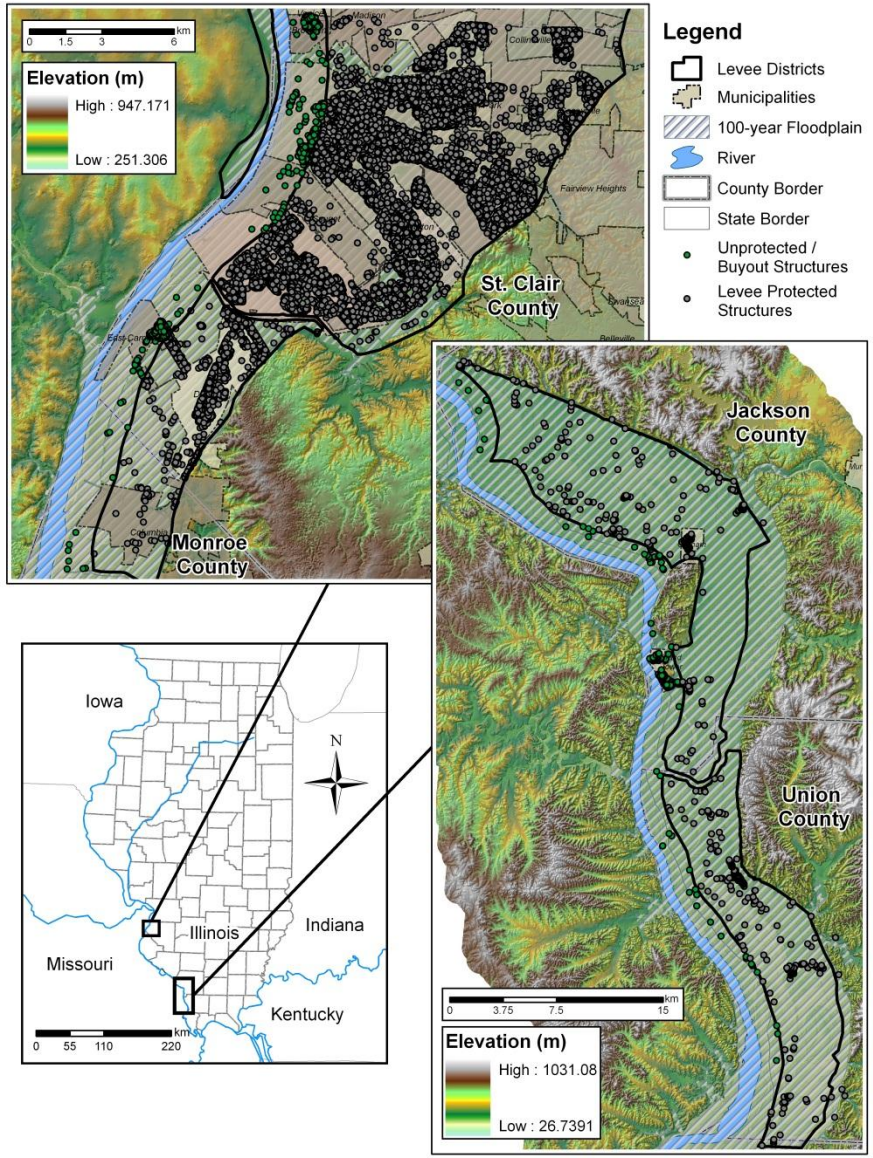
$$EAD = \sum_{i=1}^{i=n} D_i \, \Delta_p$$

- EAD (Expected Annual Flood Damage): average yearly flood damage that can be expected to occur in a reach, averaging out small and large floods over an extended period of time.



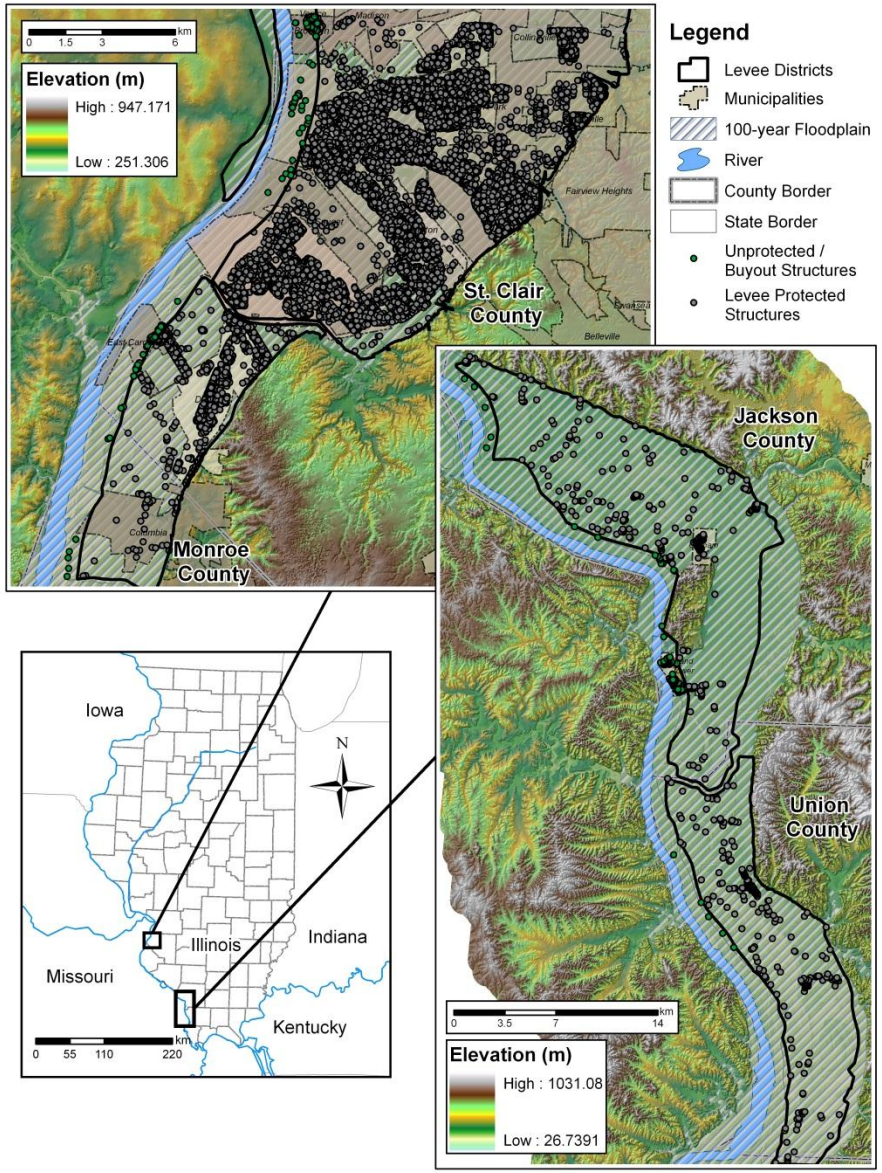
Results: 1500 m Setback

- 100-year flood elevation decreased by 0.3 m
- Flood losses increased for smaller floods (5- to 100-year) and decreased for larger floods (>100-year) in Ag Reach. Increased for all intervals in the Urban Reach.
- Urban EAD = $92.3 million
- Ag EAD = $25.0 million



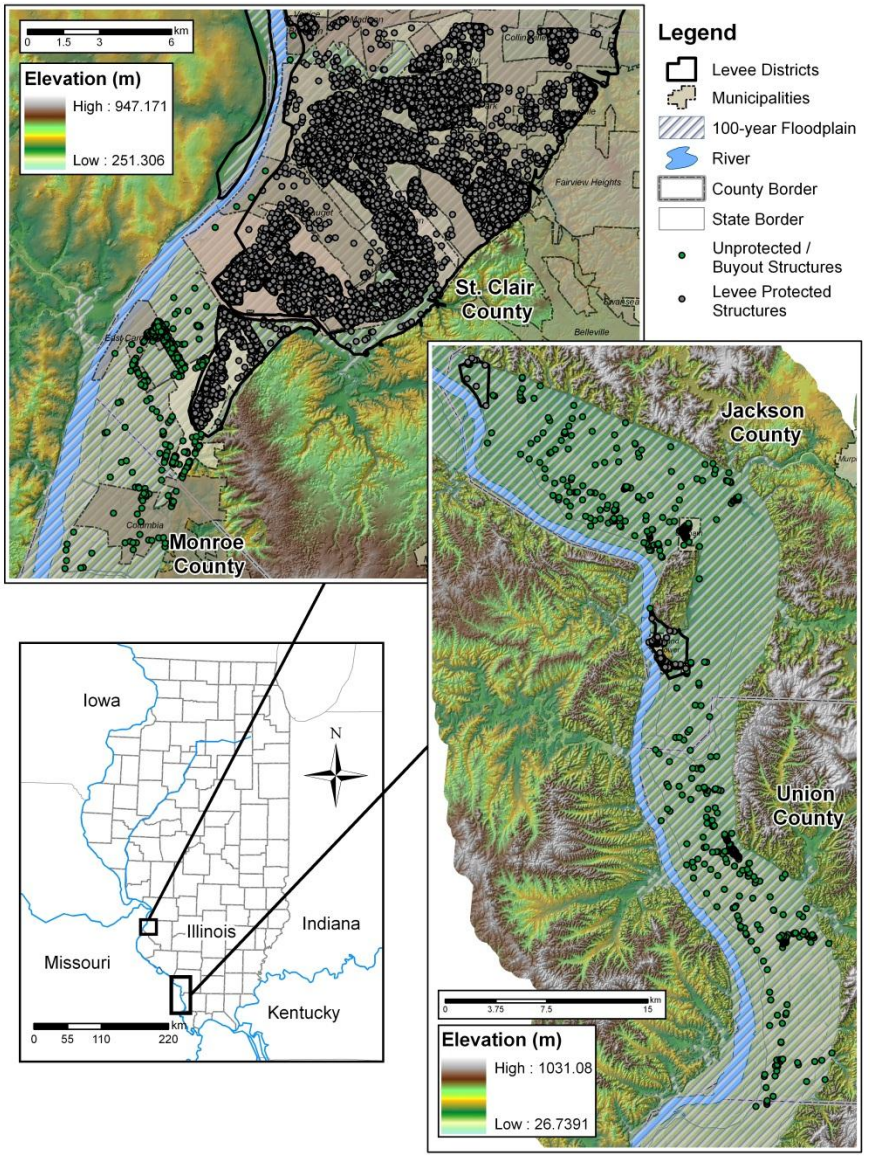
Results: 1000 m Setback

- 100-year flood elevation decreased by 0.2 m in the Urban Reach and by 0.1 m in the Ag Reach
- Flood losses increased for all recurrence intervals in both study reaches
- Urban EAD = $67.7 million
- Ag EAD = $27.3 million



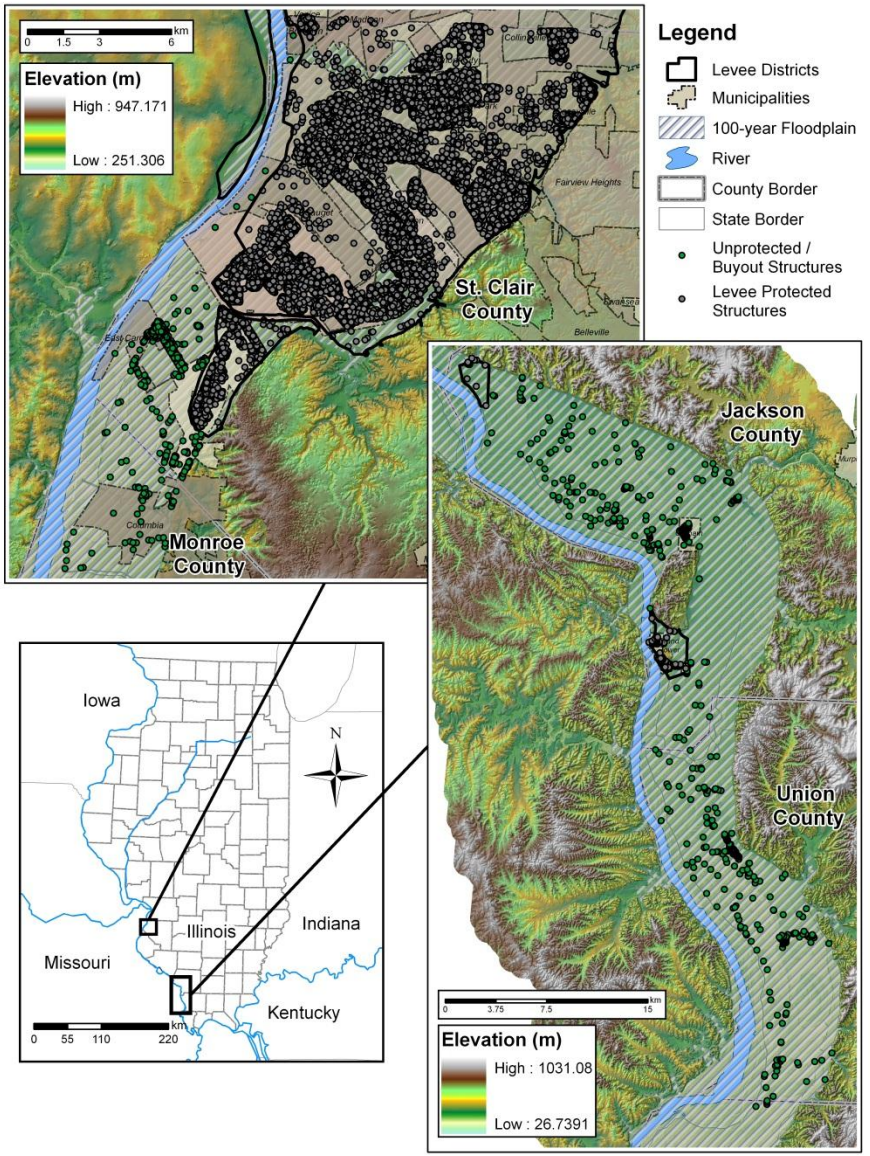
Results: “Planned” Setback

- 100-year flood elevation decreased by 0.8 m in the Urban Reach and by 1.6 m in the Ag Reach
- Flood losses decreased for floods with a recurrence intervals of more than 10 yrs.
- Urban EAD = $20.2 million
- Ag EAD = $5.1 million

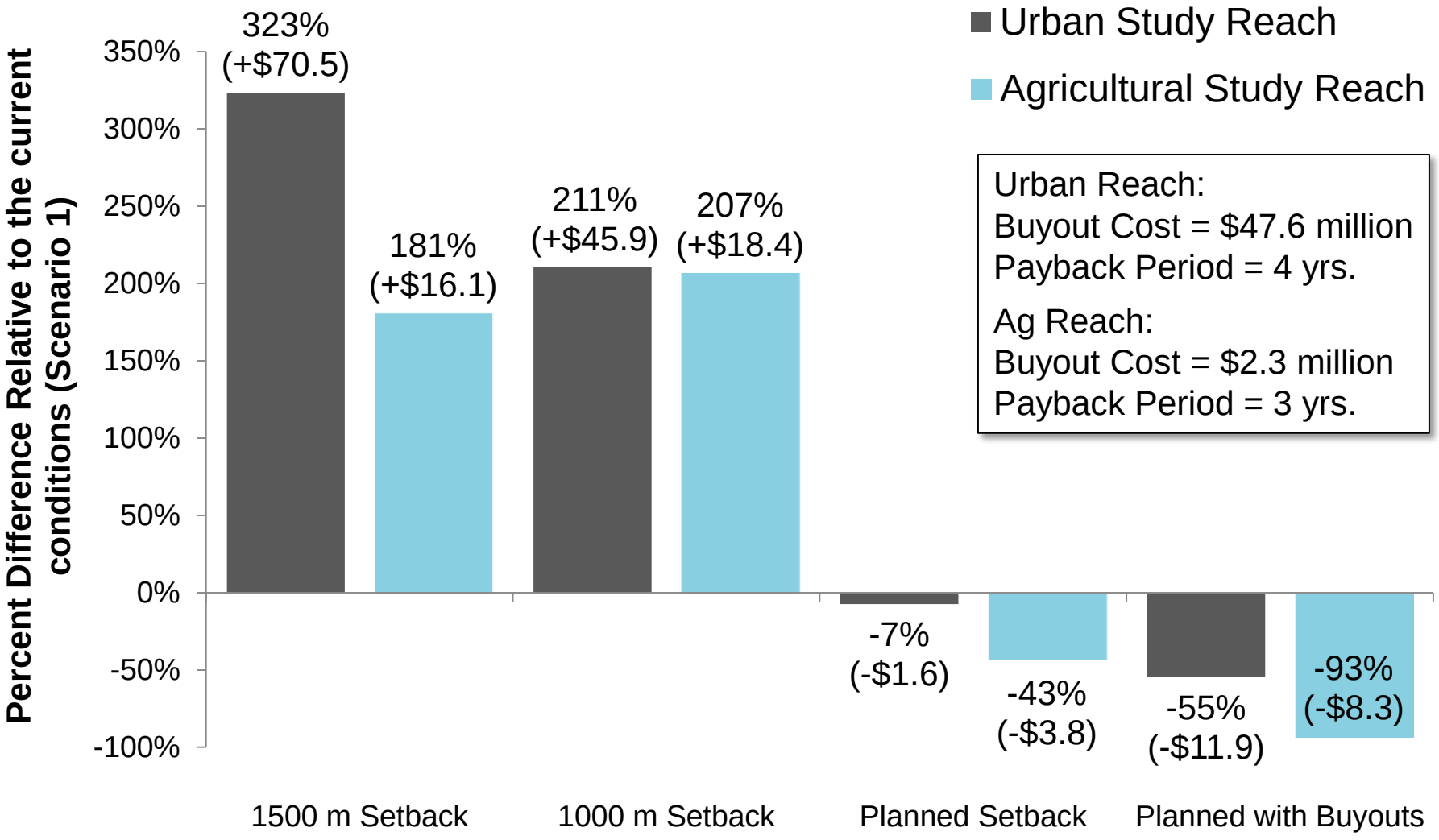


Results: “Planned” Setback with buyouts

- Buyout cost of $47.6 million in Urban Reach and $2.3 million in Ag Reach.
- Flood losses decreased for all floods.
- Urban EAD = $9.9 million
- Ag EAD = $0.6 million



Results: EAD


Urban Study Reach
Agricultural Study Reach
Percent Difference Relative to the current conditions (Scenario 1)
350%
300%
250%
200%
150%
100%
50%
0%
-50%
-100%
323% (+$70.5)
181% (+$16.1)
211% (+$45.9)
207% (+$18.4)
-7% (-$1.6)
-43% (-$3.8)
-55% (-$11.9)
-93% (-$8.3)
1500 m Setback
1000 m Setback
Planned Setback
Planned with Buyouts
Urban Reach:
Buyout Cost = $47.6 million
Payback Period = 4 yrs.
Ag Reach:
Buyout Cost = $2.3 million
Payback Period = 3 yrs.

Conclusions and Implications

- Carefully designed levee setbacks are a viable approach for flood-risk reduction.
  - Reduce flood levels
  - Discourages further floodplain development
  - Reduce flood losses:
  - EAD decreased by $11.9 million (55%) in Urban Reach and by $8.3 million (93%) in Ag Reach

Conclusions and Implications

- The “Planned” setback scenario could be used as a template for the replacement of any aging or failing levee system.
  - Alternative to expensive in-place repairs
  - Example = Metro East Levees in this study’s Urban Reach.
  - Problems with under-seepage, slope stability, and possible subsidence
  - Estimates of repair costs increased from $136-$180 million in 2007 to at least $300-$500 million in late 2009.

Questions?

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