Opportunities for Risk-Based Asset Management in Flood Resilience

A Retrospective on the October 2015 South Carolina Flooding

TRB 11th National Conference on Transportation Asset Management

July 11, 2016

Agenda

- **Post-Event Assessment of Resilience (PEAR) in South Carolina – October 2015**
- **Vulnerability Assessment Scoring Tool: Using an indicator-based approach to screen vulnerability**
- **Aligning desk-based reviews with actual conditions**
- **Implications for asset management**
  - What's missing in our data sets?
  - Where do we go from here?

Project Overview

Post-Event Assessment of Resilience (PEAR)

- Retrospective analysis of resilience in the wake of disasters
- Seeks to overcome deficiencies of model-based and indicator-based approaches for understanding vulnerability, resilience, and effectiveness of adaptation
- ICF used the Richland County, SC, transportation system as an area of analysis to test PEAR

Cane Bay subdivision, Summerville, SC (Photo credit: U.S. National Weather Service)

October 2015 Flooding, South Carolina

- From October 2-5, between 10 and 20 inches of rain fell across Richland County
- Columbia, SC, had the largest rainfall reported of any urban area in South Carolina

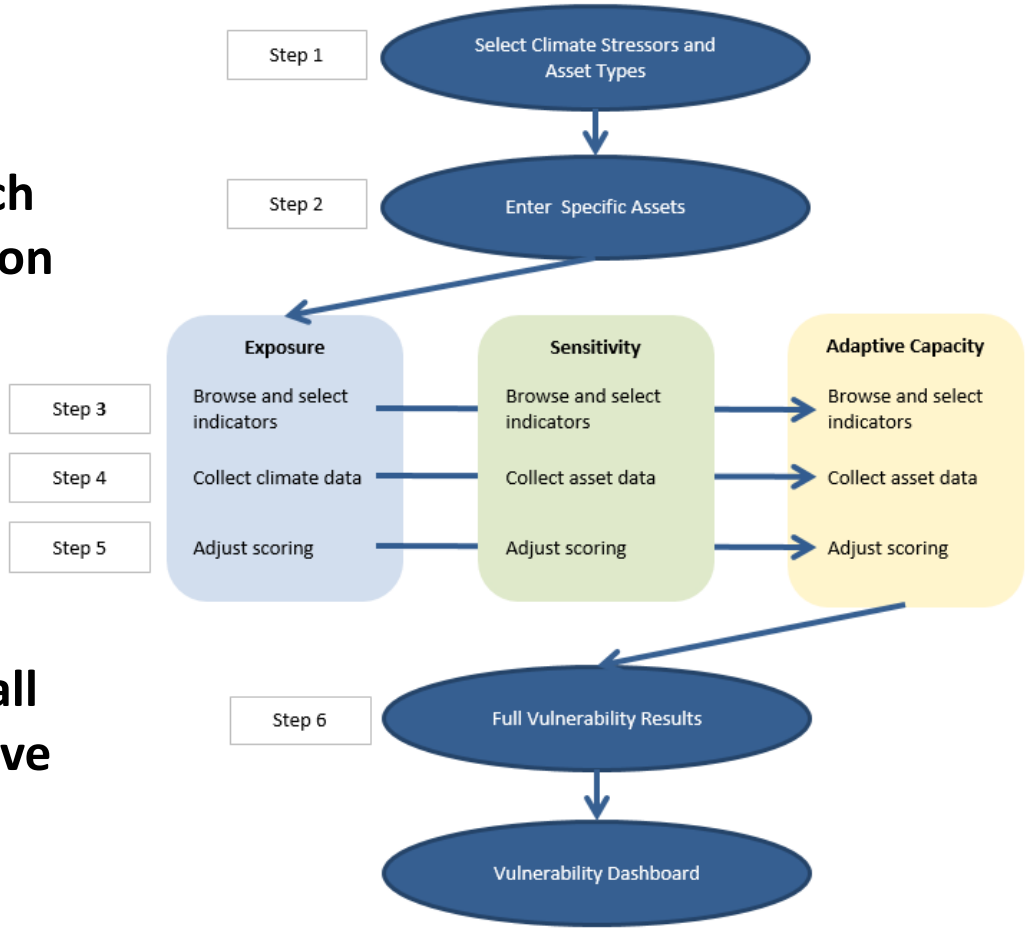
Photo Credits: U.S. National Weather Service (left); Jake Keller, Parsons Brinckerhoff (right)

PEAR in Richland County, SC

- **PEAR sought to…**
  - Assess the adaptive capacity of the transportation system in Richland County, SC
  - Use a desk-based vulnerability scoring tool to retroactively screen transportation assets for climate vulnerabilities and compare results with on-the-ground impacts

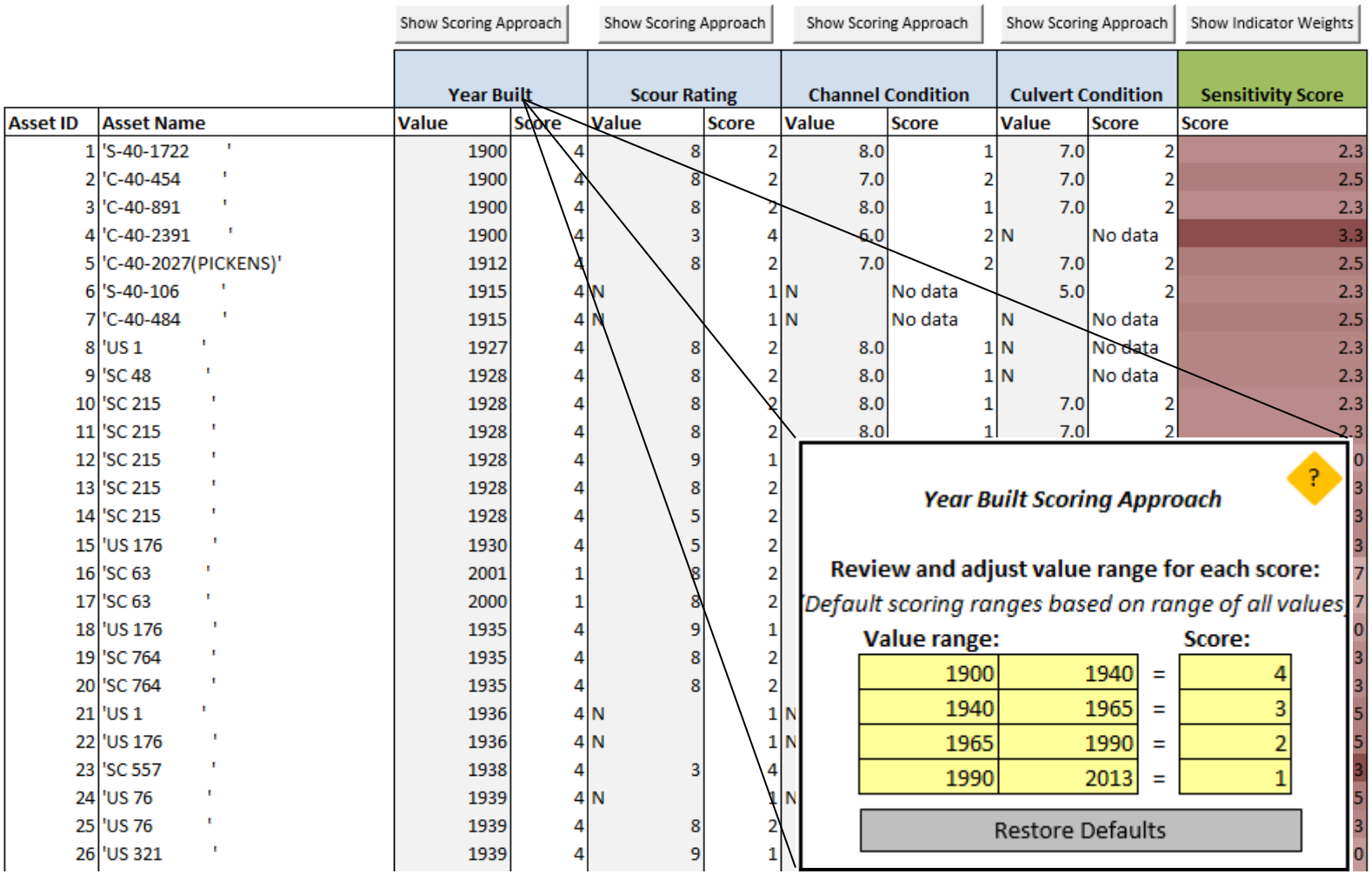
Vulnerability Assessment Scoring Tool (VAST)

- **Developed for U.S. DOT and publicly available online**
- **Uses an indicator-based approach to determine which transportation assets require a closer look at their particular climate vulnerabilities**
- ***Indicators*** **– representative data elements that can be used as a proxy measurement of the overall exposure, sensitivity, and adaptive capacity of specific assets**



VAST Process

Sample Indicators Used in VAST



		Show Scoring Approach		Show Scoring Approach		Show Scoring Approach		Show Scoring Approach		Show Indicator Weights
		Year Built		Scour Rating		Channel Condition		Culvert Condition		Sensitivity Score
Asset ID	Asset Name	Value	Score	Value	Score	Value	Score	Value	Score	Score
1	'S-40-1722 '	1900	4	8	2	8.0	1	7.0	2	2.3
2	'C-40-454 '	1900	4	8	2	7.0	2	7.0	2	2.5
3	'C-40-891 '	1900	4	8	2	8.0	1	7.0	2	2.3
4	'C-40-2391 '	1900	4	3	4	6.0	2	N	No data	3.3
5	'C-40-2027(PICKENS)'	1912	4	8	2	7.0	2	7.0	2	2.5
6	'S-40-106 '	1915	4	N	1	N	No data	5.0	2	2.3
7	'C-40-484 '	1915	4	N	1	N	No data	N	No data	2.5
8	'US 1 '	1927	4	8	2	8.0	1	N	No data	2.3
9	'SC 48 '	1928	4	8	2	8.0	1	N	No data	2.3
10	'SC 215 '	1928	4	8	2	8.0	1	7.0	2	2.3
11	'SC 215 '	1928	4	8	2	8.0	1	7.0	2	2.3
12	'SC 215 '	1928	4	9	1					0
13	'SC 215 '	1928	4	8	2					3
14	'SC 215 '	1928	4	5	2					3
15	'US 176 '	1930	4	5	2					3
16	'SC 63 '	2001	1	8	2					7
17	'SC 63 '	2000	1	8	2					7
18	'US 176 '	1935	4	9	1					0
19	'SC 764 '	1935	4	8	2					3
20	'SC 764 '	1935	4	8	2					3
21	'US 1 '	1936	4	N	1	N				5
22	'US 176 '	1936	4	N	1	N				5
23	'SC 557 '	1938	4	3	4					3
24	'US 76 '	1939	4	N	1	N				5
25	'US 76 '	1939	4	8	2					3
26	'US 321 '	1939	4	9	1					0

Year Built Scoring Approach

Review and adjust value range for each score:

Default scoring ranges based on range of all values

Value range:			Score:
1900	1940	=	4
1940	1965	=	3
1965	1990	=	2
1990	2013	=	1

Restore Defaults

Our Analysis

- **Predicted Vulnerability**
  - Located in a floodplain
  - Proximity to dams
  - Flood stage
  - Year built
  - Scour rating
  - Channel condition
  - Culvert condition
  - Functional classification
  - Annual average daily traffic
  - Detour length
  - Replacement cost
  - Evacuation route
- **Actual Vulnerability**
  - Flood depth
  - Closure duration

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Data sources:
- FEMA
- National Bridge Inventory
- SCDOT

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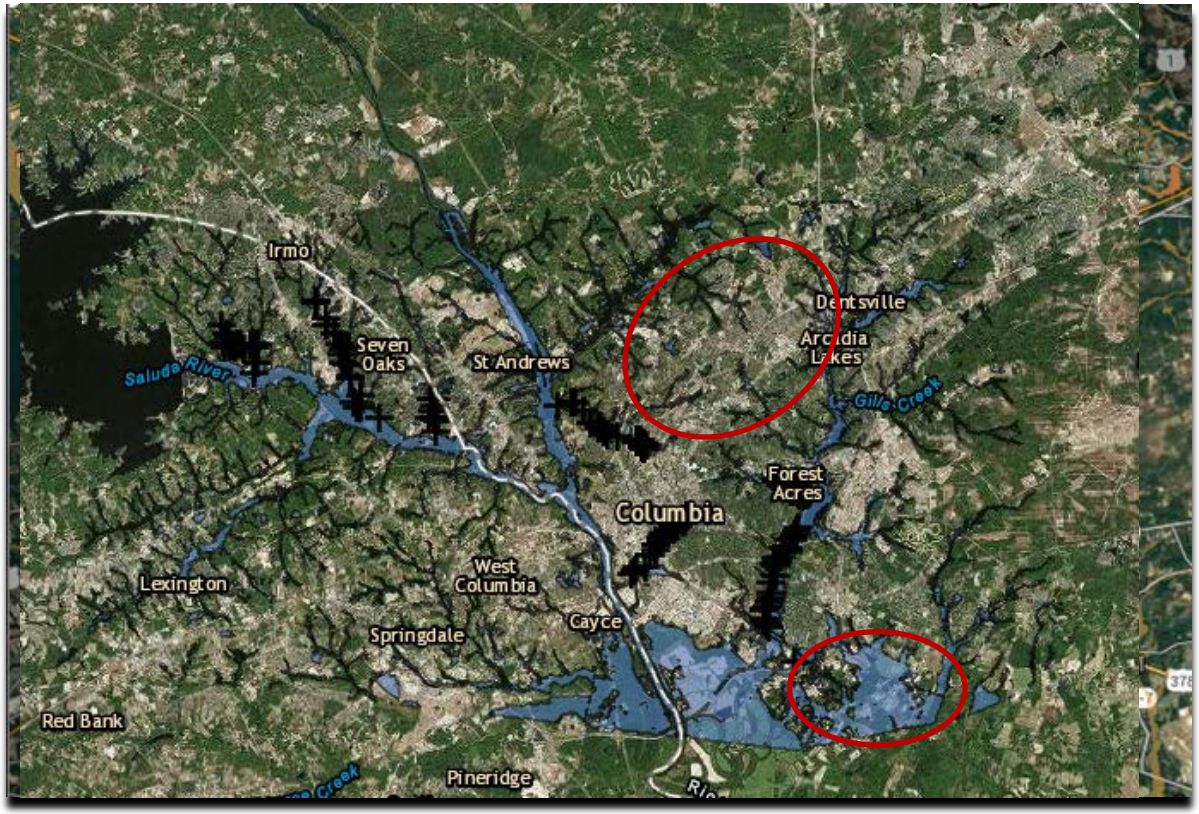
Findings

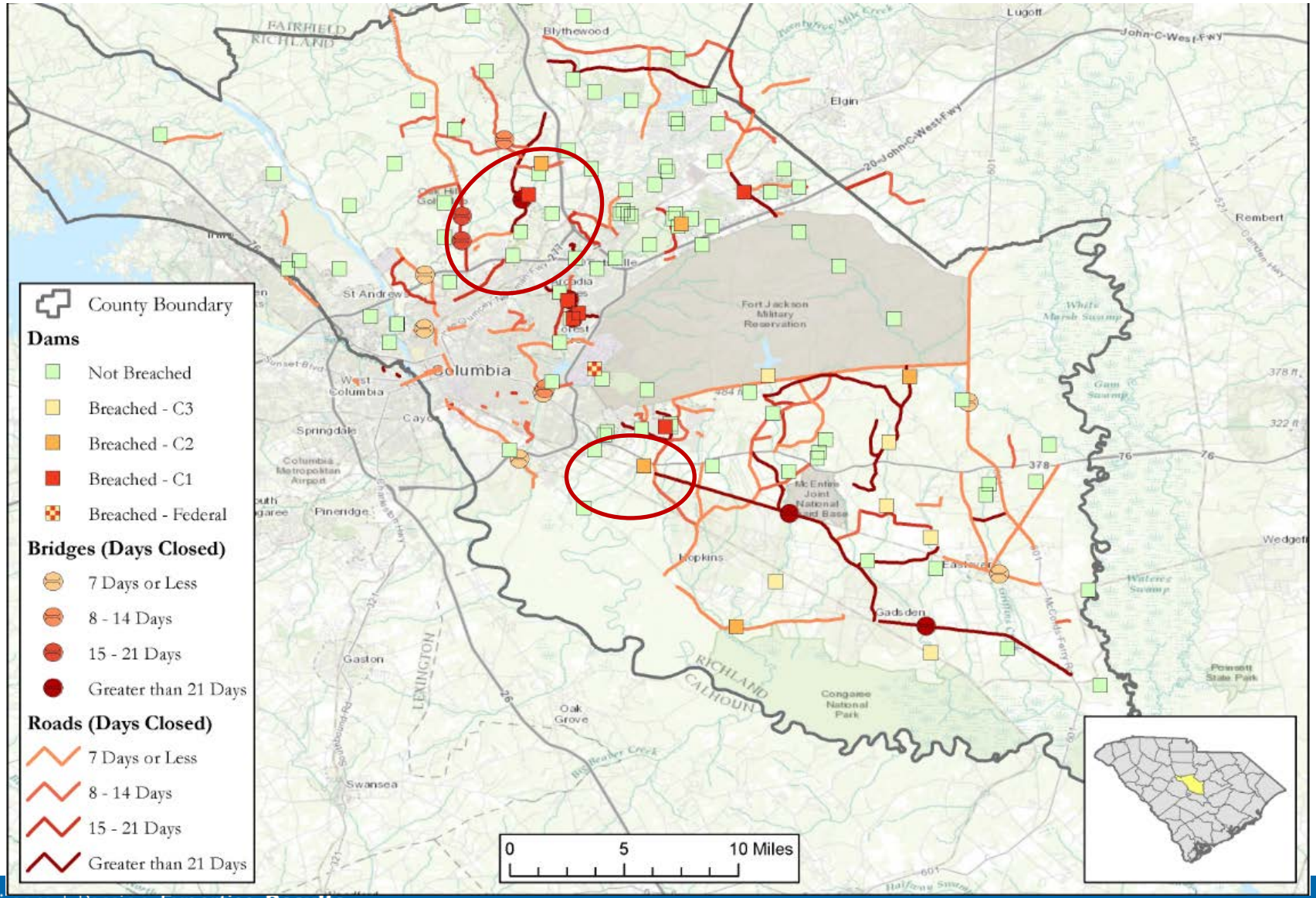
How well could we estimate exposure?

- **FEMA Floodplain generally good indicator of actual flood extent for bridges, but not for roads:**



Source: FEMA Preliminary Flood Extents (left/blue); Richland County GIS (right/orange)

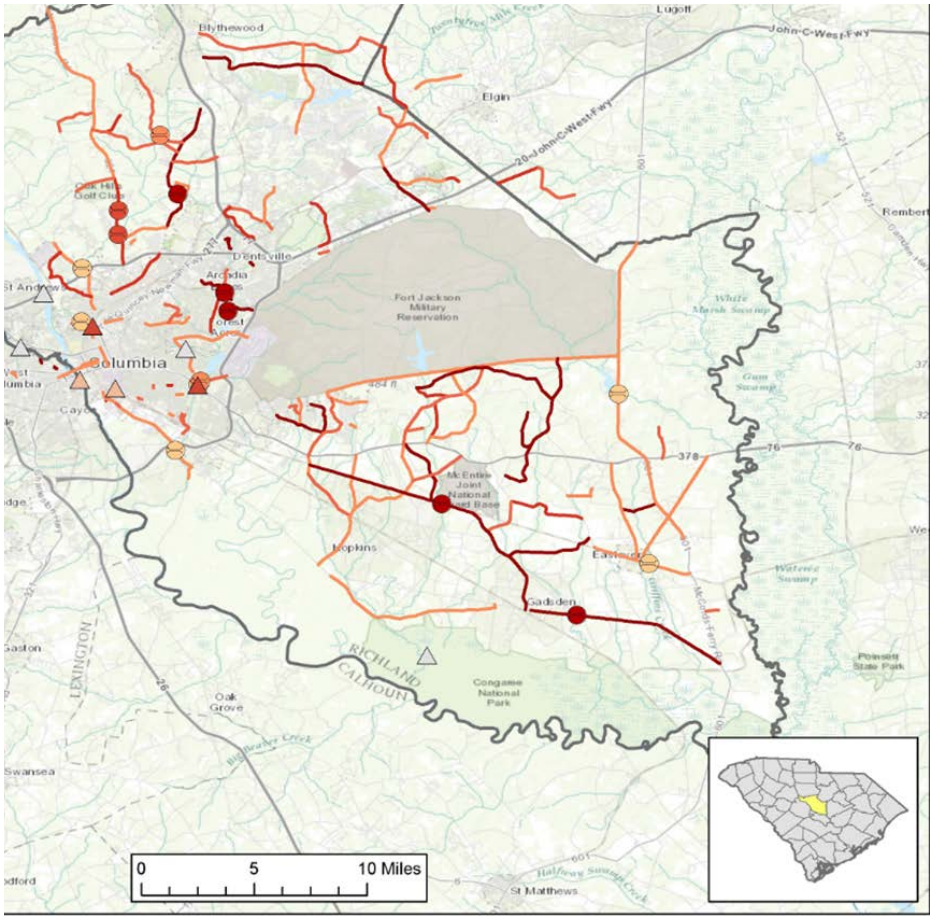
Dam breaches explain much of the difference



How well could we estimate sensitivity?

Bridges

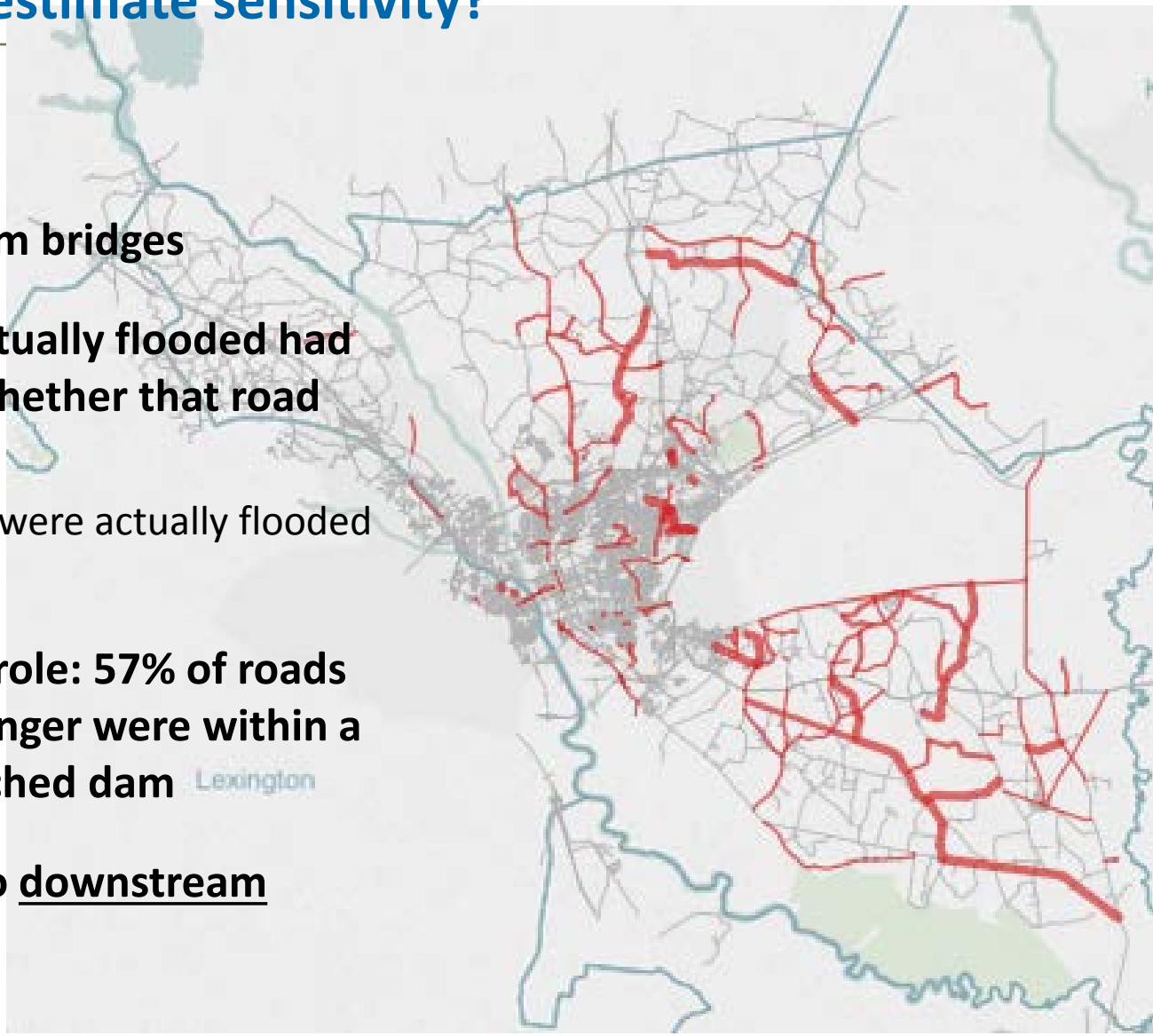
- **Only two statistically significant indicators of closure duration:**
  - Location in a FEMA floodplain (i.e., exposure)
    - 40% of flooded bridges were closed
  - Functional Classification
    - Question: Is this because higher FC bridges are built to a higher design standard and experienced less damage, or because higher FC bridges were prioritized for re-opening? Both?



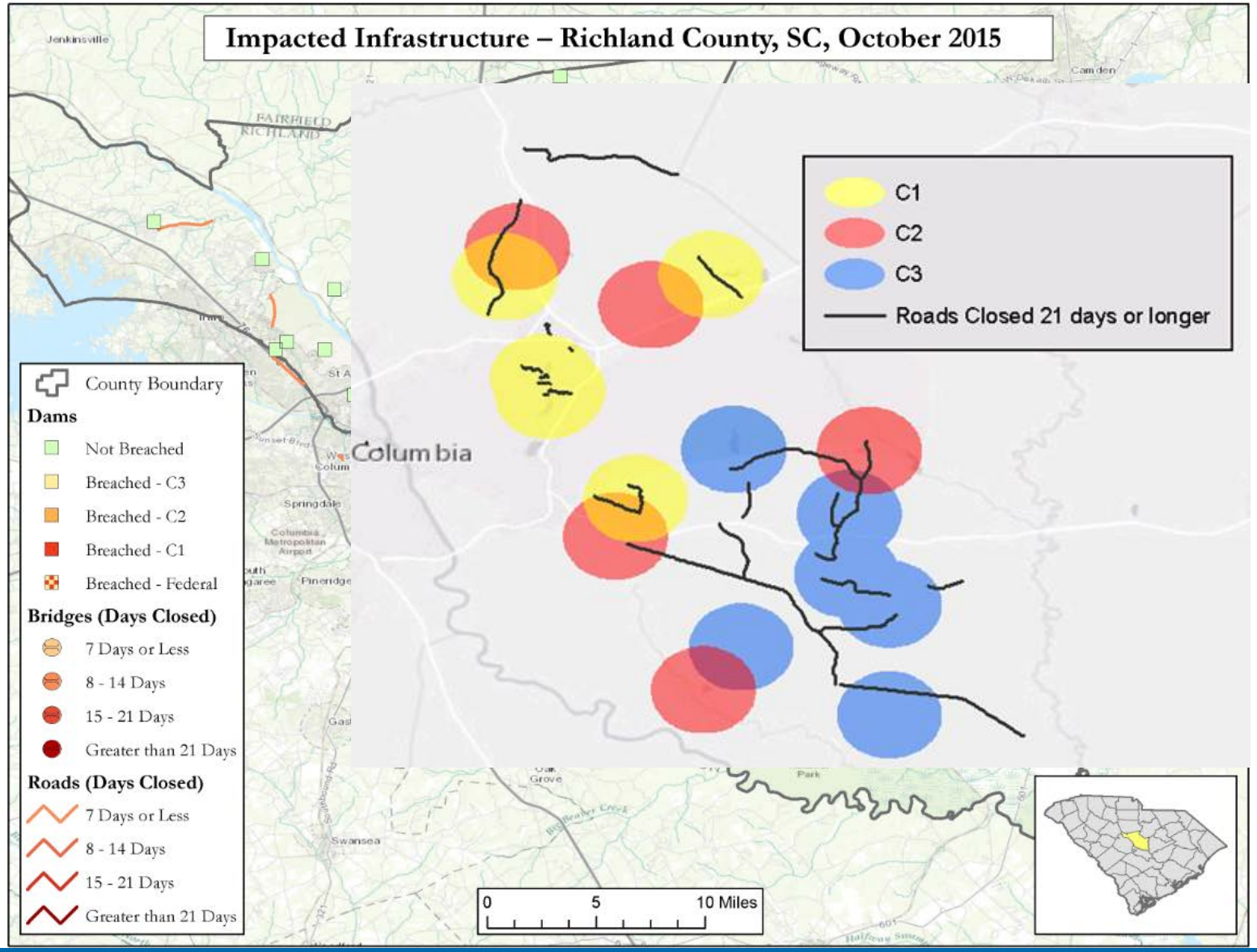
How well could we estimate sensitivity?

Roads

- **Very different story from bridges**
- **Whether a road was actually flooded had very little bearing on whether that road was closed**
  - Only 11% of roads that were actually flooded were closed
- **Dams played a greater role: 57% of roads closed for 21 days or longer were within a 2-mile radius of a breached dam**
- **Anecdotally: damage to <u>downstream</u>**



Proximity to Dams



Implications for Asset Management

Several Data Points Could Improve Flood Damage Predictability

- **Important to get exposure right**
  - Flood control structures/dams
  - Updated floodplain mapping
- **Important to better capture likelihood of damage**
  - Indicators may be inconsistent or vary by asset type or within region– work with engineers and managers to identify indicators
  - Mine institutional knowledge – may prove more valuable than indicators evaluated in a vacuum (e.g., floodplain)

Thank You!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Case Studies

- **SC 769 at Cedar Creek**
  - Not located in FEMA 100-year flood zone
  - Built in 1944
  - Scour rating: Stable
  - Channel Condition: Bank protection in need of minor repairs (7)
  - Culvert Condition: Shrinkage cracks, light scaling, and insignificant spalling (7)
  - Major Collector
  - **Full Bridge Replacement Needed. Reopened May 11, 2016 (216 days)**

SCDOT @SCDOTPress · May 11
Congaree Rd over Cedar Creek @RichlandSC. The bridge replaces a bridge that washed out in the October flood.

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Case Studies

- **SC 48 at Gills Creek**
  - Located in FEMA 100-year flood zone
  - Built in 1900
  - Scour rating: Scour Critical
  - Channel Condition: Bank beginning to slump (6)
  - Local Road
  - **Not closed or damaged**