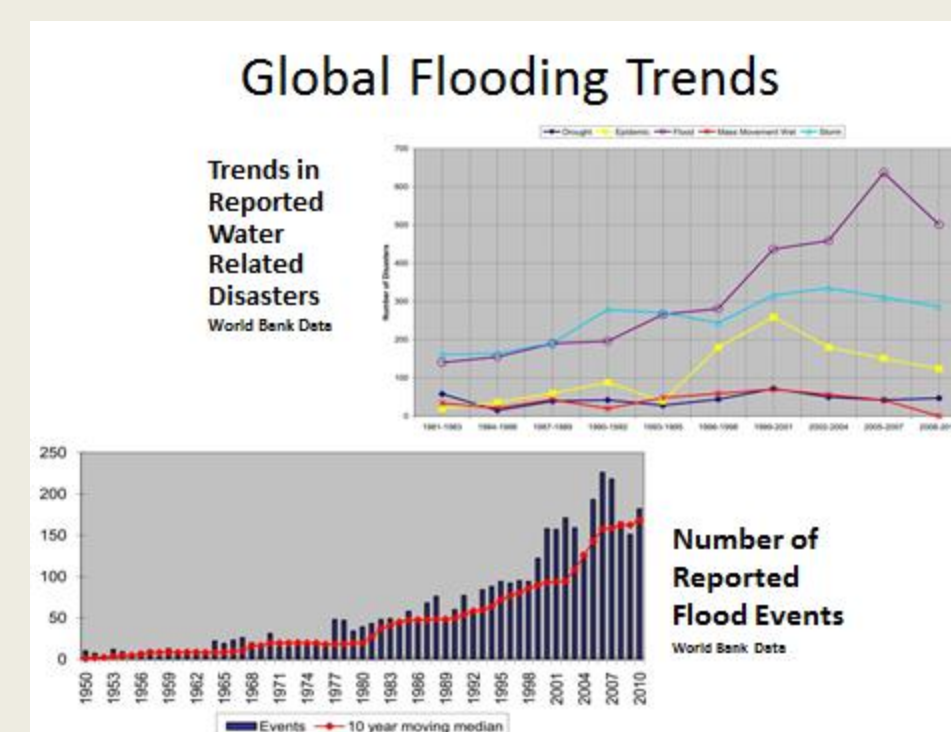


# URBAN FLOODING AND FUTURE CLIMATE: CASE STUDIES IN OKLAHOMA AND TEXAS

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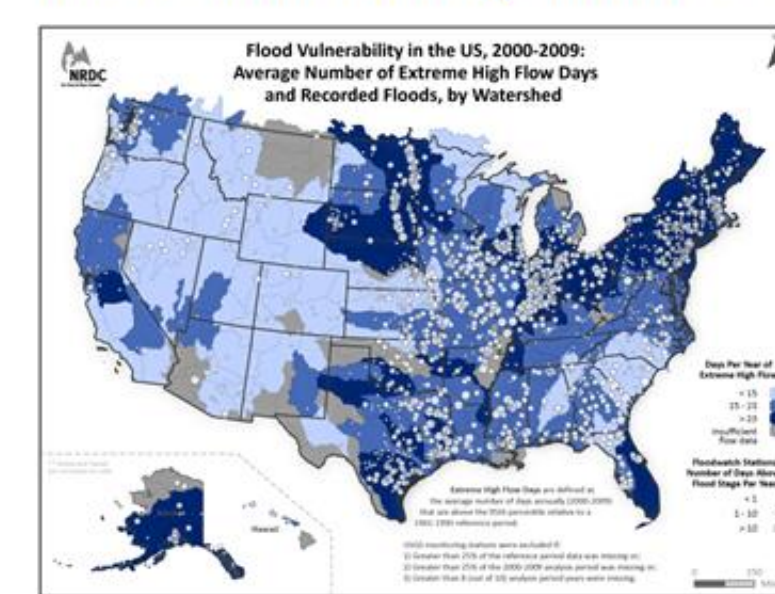
## Research Challenge



### Project Goals

- Evaluate societal impacts and adaptation strategies associated with projected flood hazards in five cities under *present* and *projected* climate scenarios.
- Given precipitation modeled by Global Climate Models (GCMs) under three assumed emission scenarios, the results of watershed model simulations will be presented to urban planners and decision makers.

### Flood Vulnerability in the US



### National Climate Assessment (2014)

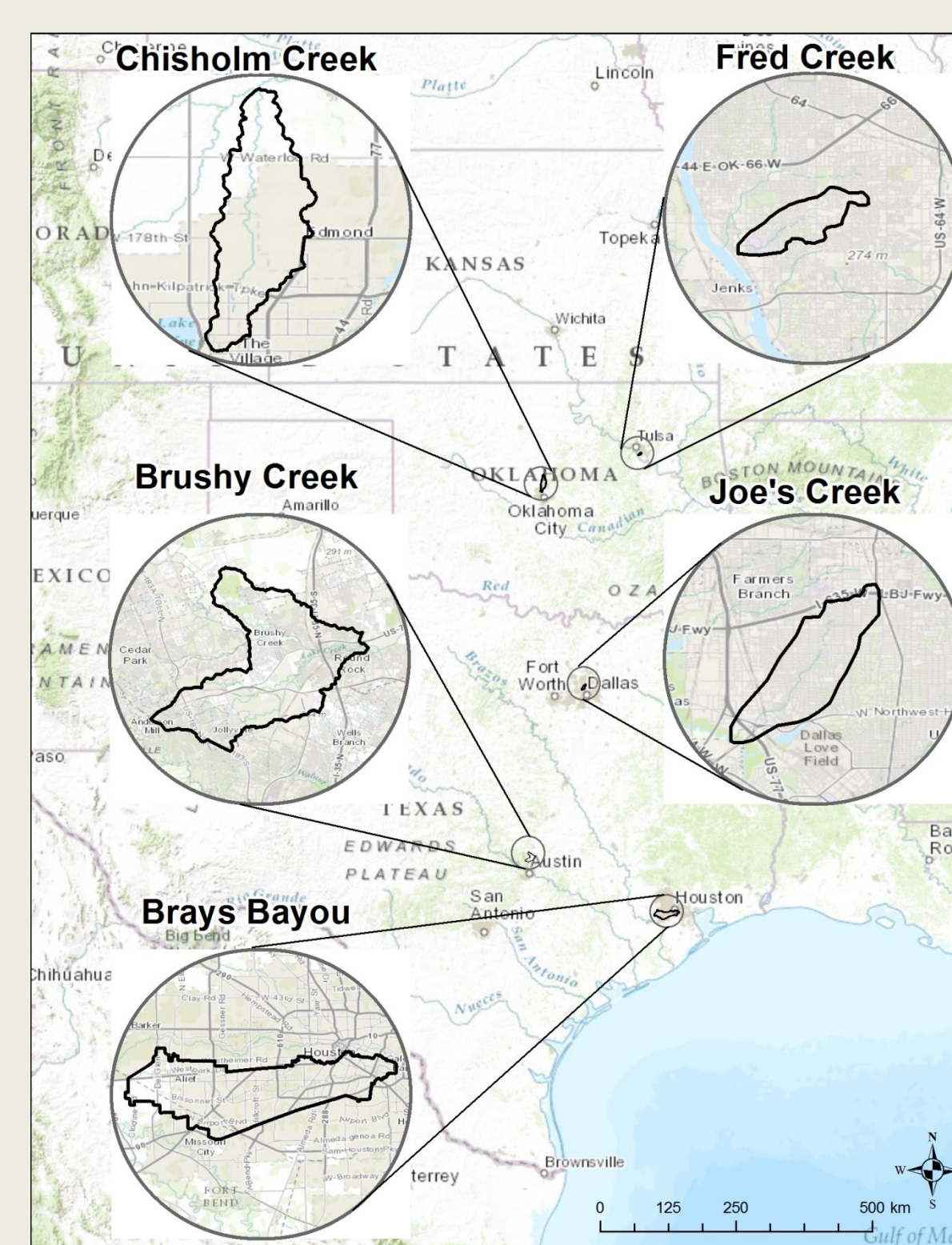
"Heavy rainfall events are projected to increase, which is expected to increase the potential for flash flooding. Land cover, flow and water-supply management, soil moisture, and channel conditions are also important influences on flood generation and must be considered in projections of future flood risks."

### NCA Recommendations

"To provide decision-makers with more timely, concise, and useful information, a sustained assessment process would include both ongoing, extensive engagement with public and private partners and targeted, scientifically rigorous reports that address concerns in a timely fashion."

### Modeling and Visualization Tasks

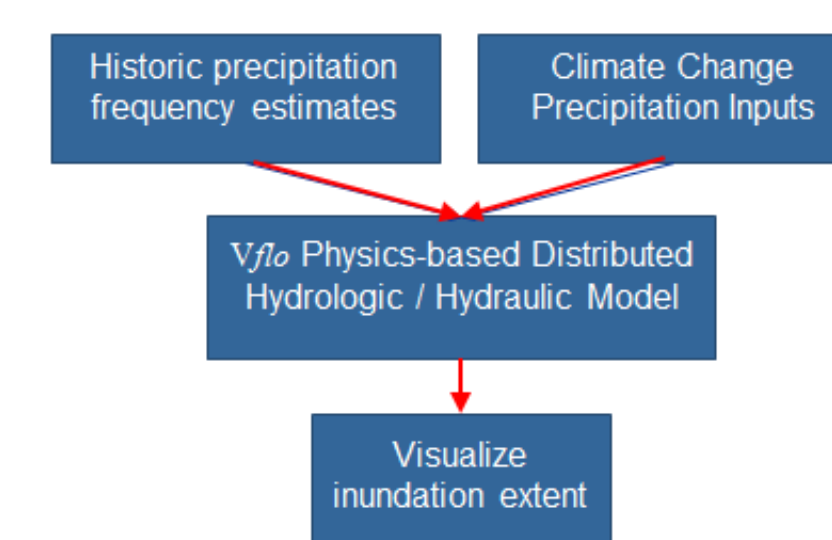
- Geospatial data defining soils, topography, land use/cover, and imperviousness are assembled into a distributed hydrologic model, and used to calculate inundation depths.
- The resulting flood depths are visualized and presented to each of the city watershed managers to determine their response and to guide planning and decision-making that could be used to adapt.
- The five urban watersheds are:
  - Chisholm Creek, OK, OK
  - Joe's Creek, Dallas, TX
  - Fred Creek, Tulsa, OK
  - Upper Brushy Creek, Austin, TX
  - Grays Bayou, Houston, TX



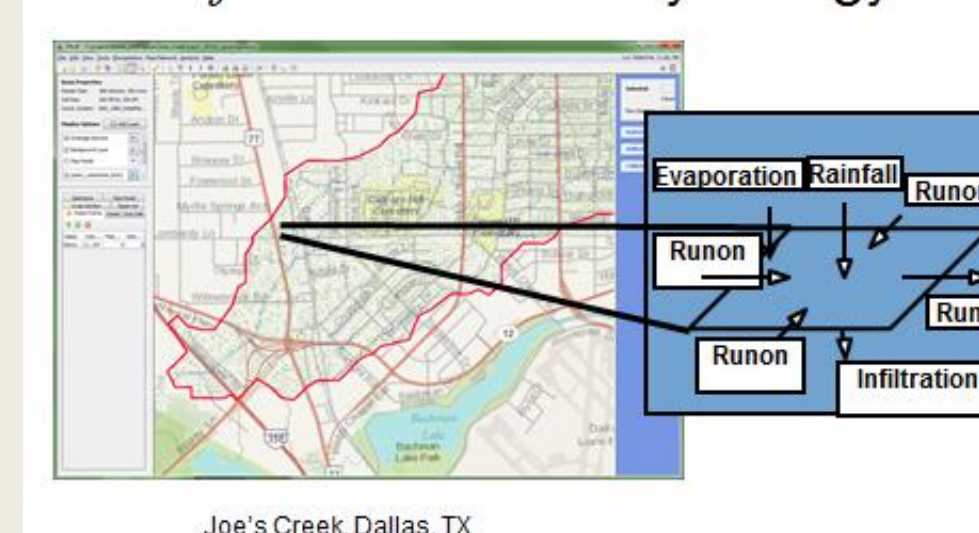
## Stakeholder Engagement



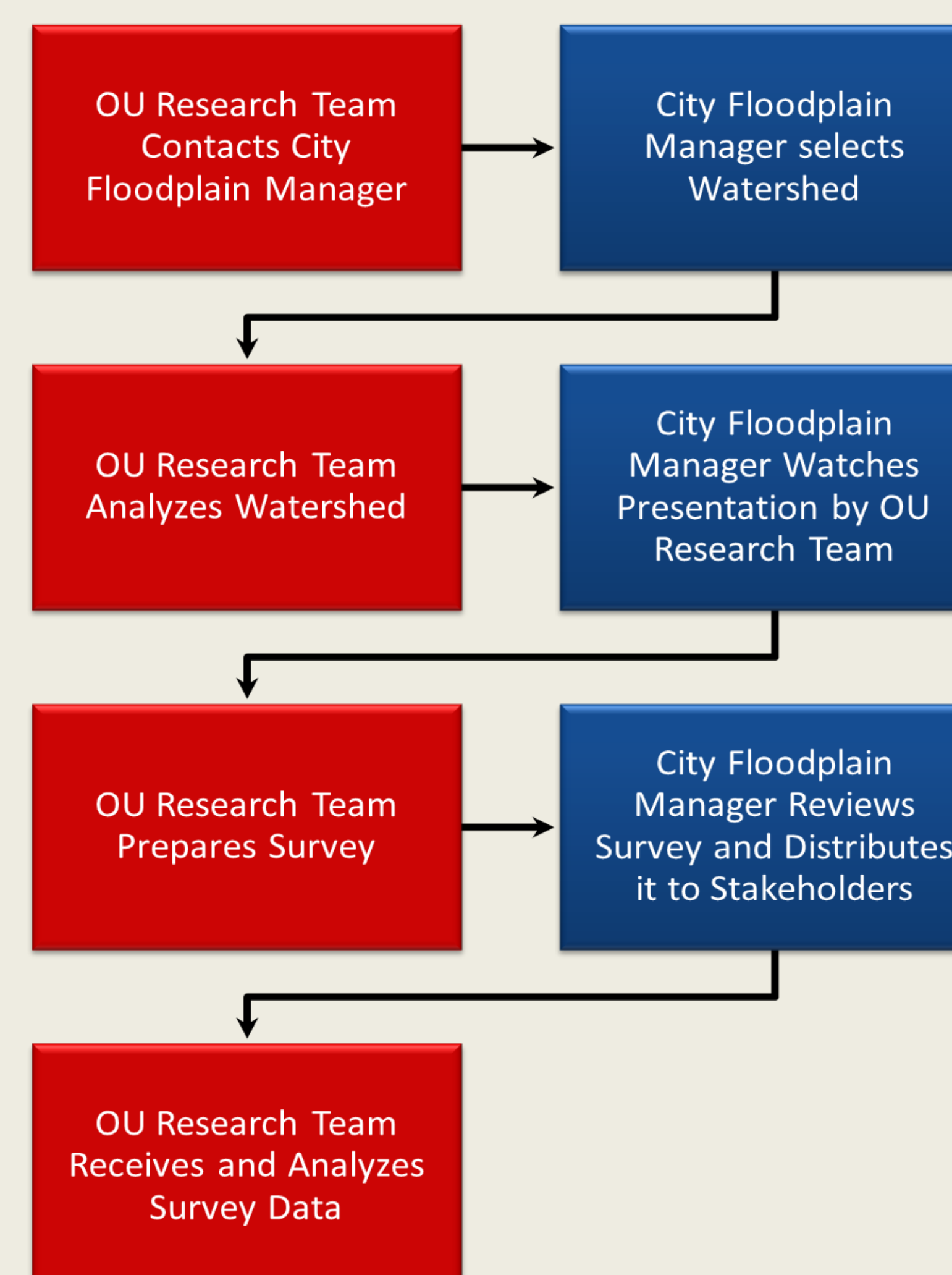
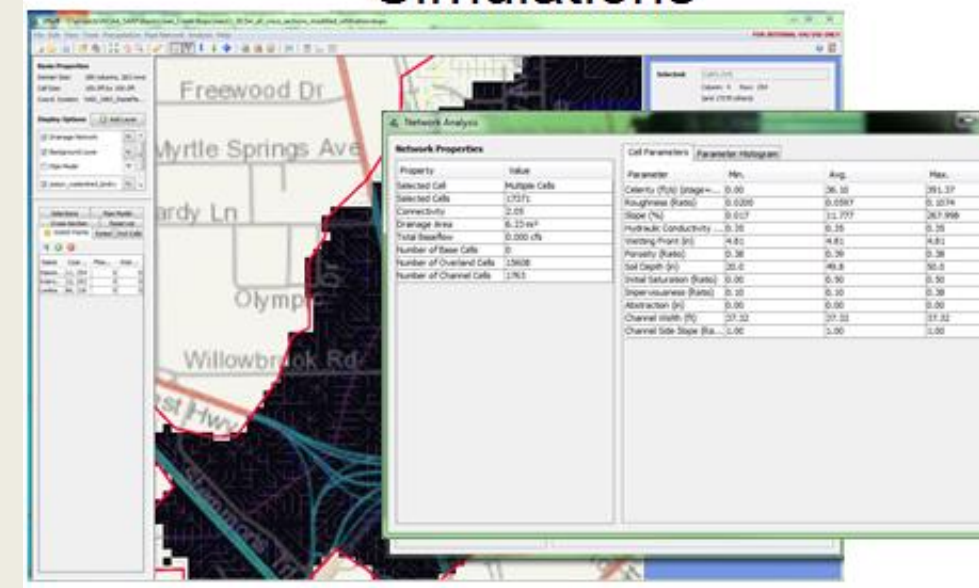
### Climate Change Approach to Flood Hazard Identification



### Vflo Distributed Hydrology



### Vflo Model Parameters and Simulations



## Results & Implications

### Survey Development

- After the city watershed manager reviewed the watershed model and animation, suggested changes were made, and a web-based survey instrument was developed.
- The survey instrument was built with *Qualtrics* software which can demonstrate visual animations quite well.
- The goal of the survey is to determine the appeal and utility of watershed models and visual animations for planning and management under conditions of climate variability and change.

### Selected Results

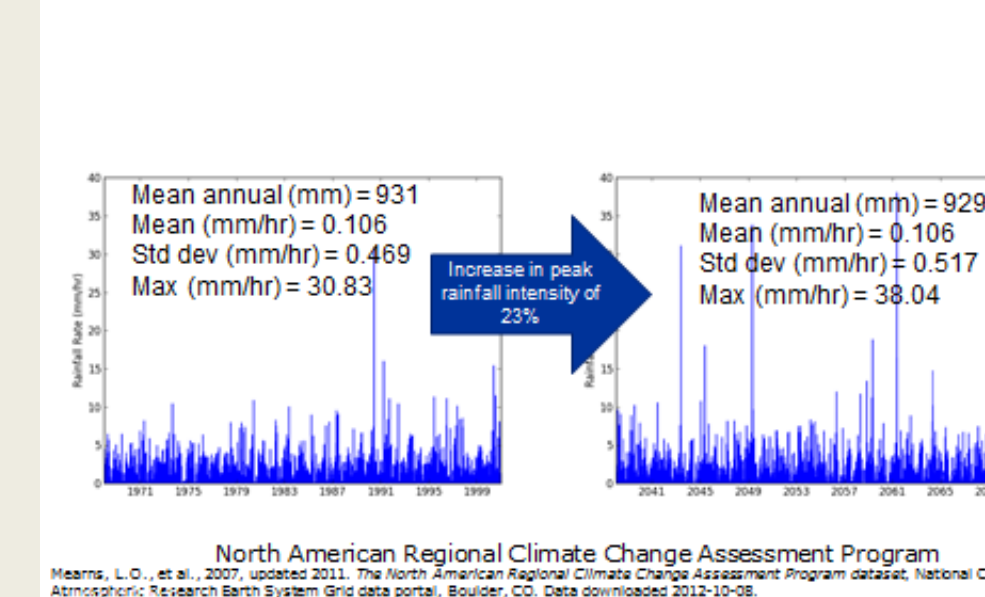
- Question 7 – 61.5% and 20.5% agreed and strongly agreed that hydrologic models and images are effective in discussions with stakeholders about capital improvement project needs
- Question 8 – 56.4% and 17.9% agreed and strongly agreed that hydrologic models enable people to understand increases in flooding due to increases in precipitation
- Question 10 – 74.3% indicated that the animation was more effective than a static map.
- Question 10 – 71.4% indicated that they would like to see more animations
- Question 11 – 29% indicated that animations were extremely useful, and 29% indicated that they were extremely informative

### Watershed Survey

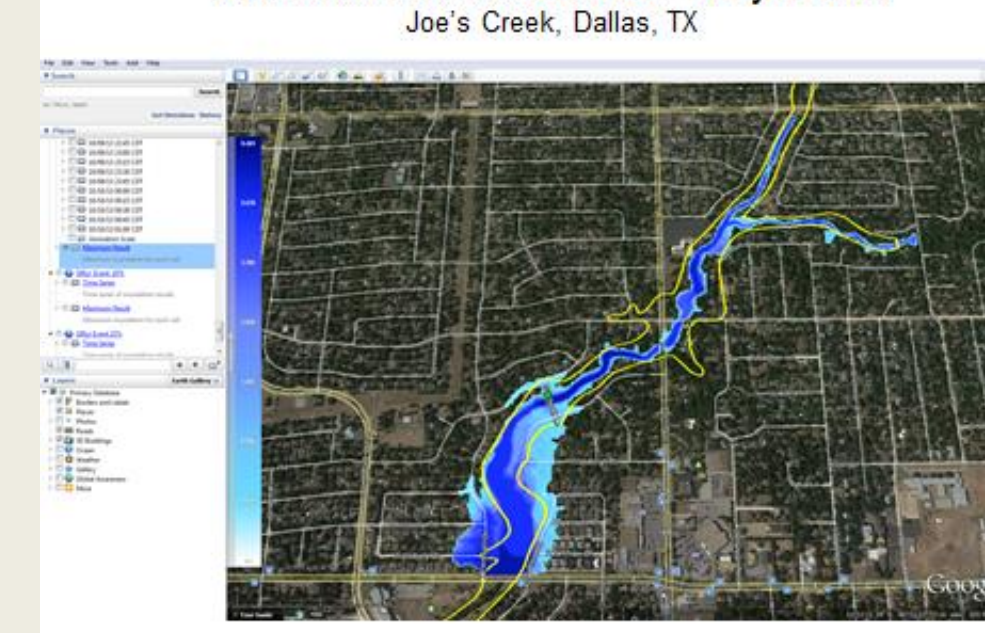
#### Twelve Questions

- Questions 1 & 2 – Historic and projected precipitation
- Question 3 – Climate models and climate change
- Question 4 – Potential impacts
- Question 5 – Maps and tables
- Question 6 – Vulnerability of drainage infrastructure
- Question 7, 8, & 9 – Evaluate hydrographs and maps
- Question 10 – Assess watershed animation
- Question 11 - Evaluate usefulness, information provided, and credibility of animation
- Question 12 –Education and professional credentials

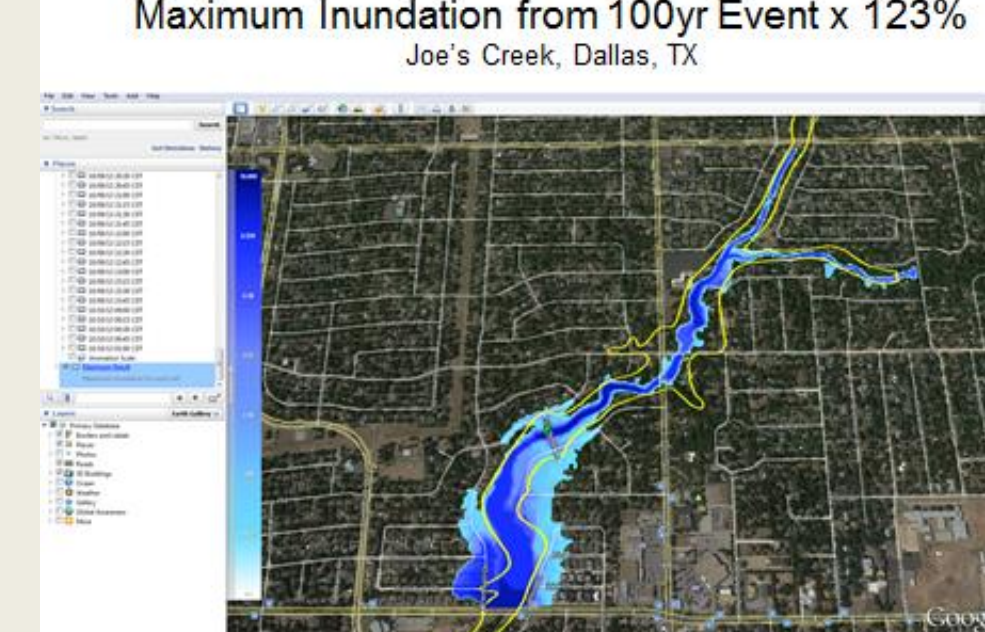
### Precipitation Frequency Climate Forecast



### Maximum Inundation from 100yr Event



### Maximum Inundation from 100yr Event x 123%



### Survey Deployment

- The target audience for the survey is a small group (~10 to 15) of knowledgeable stakeholders who are well-versed in the key issues associated with each city's watershed.
- The survey was designed to be answered in about 10 minutes.
- The URL for the web-based survey was sent to the stakeholder group by the city watershed manager. A follow-up reminder was distributed after 1 week.

### Findings

- Watershed managers were receptive to the academic initiative. A shared understanding of hydrology and policy issues associated with floodplain management was key to establishing a working relationship with cities.
- Managers were more inclined toward historic hydrological events instead of climate change projections of events.
- Credibility and professional legitimacy were achieved by the team by presenting watershed models to city technical staff and answering questions.
- The modeling and visualization approach was well received by managers and technical staff. More detailed visual imagery of flood events was requested.

### Implications

- Current technology has made interactive engagement with the research community, cities, and citizen stakeholders more feasible.
- While climate projections may lack some local credibility, familiarity with watershed hydrology is important.
- Expanded use of watershed modeling and visualization techniques can prove to be useful for adaptation planning and management.

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