

Indexing Public Health Vulnerabilities to Coastal Water Infrastructure

A Community-wide Public Health Risk
Assessment of Vulnerable Water
Infrastructure in Coastal Cities

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OLD DOMINION
UNIVERSITY

IDEA FUSION



CISA

Carolinas Integrated Sciences and Assessments
A NOAA RISA TEAM

Project Goal

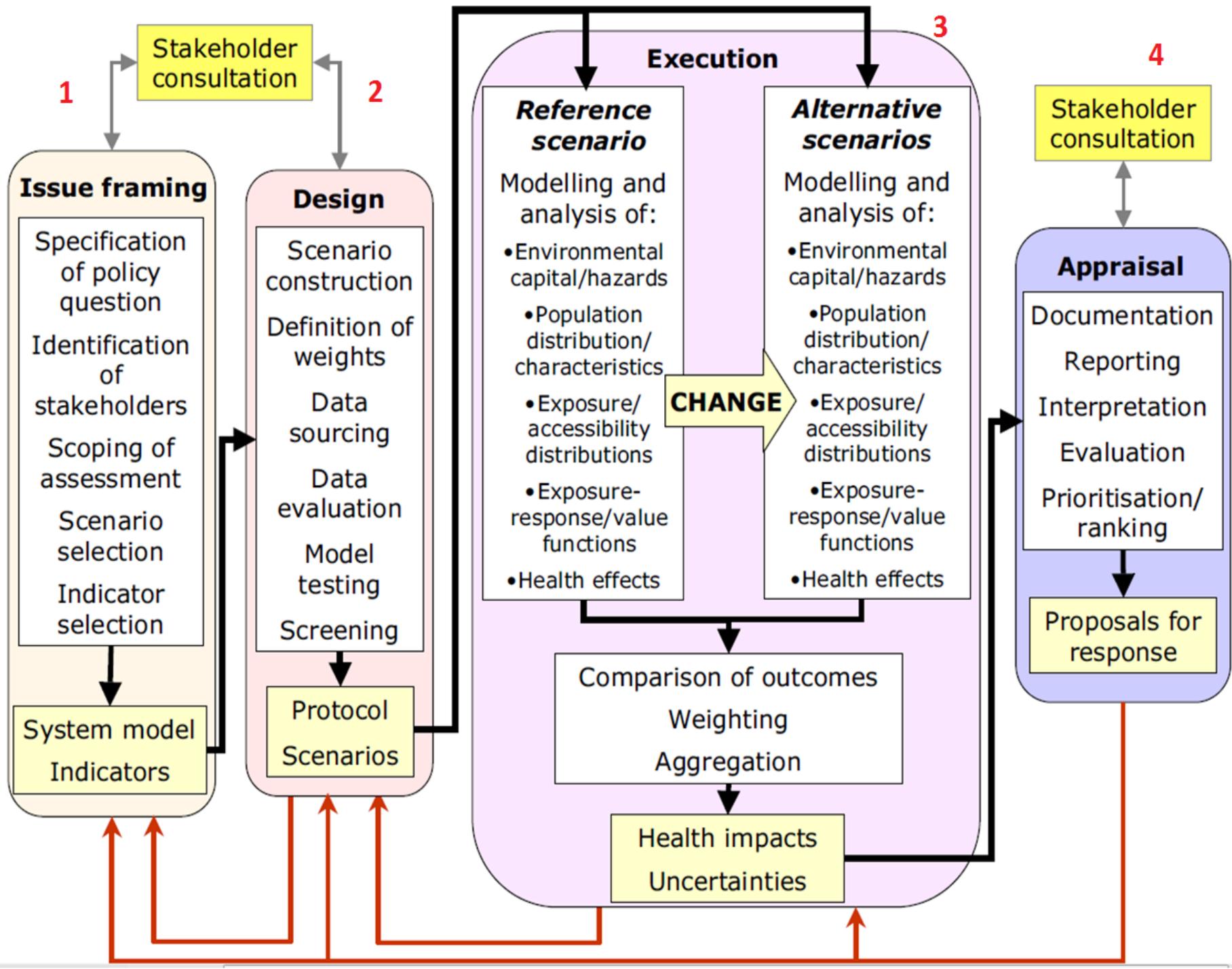
- ▶ Provide coastal decision makers with a tool to quickly assess and respond to public health impacts in urban environments.



A Four Step Process

- ▶ 1) Understanding infrastructure vulnerability to sea level rise and extreme events
- ▶ 2) Engaging stakeholders to develop a community level susceptibility index
- ▶ 3) Test the susceptibility index through workshops and a table top exercise
- ▶ 4) Develop a guidebook that can be used by communities to access their susceptibilities

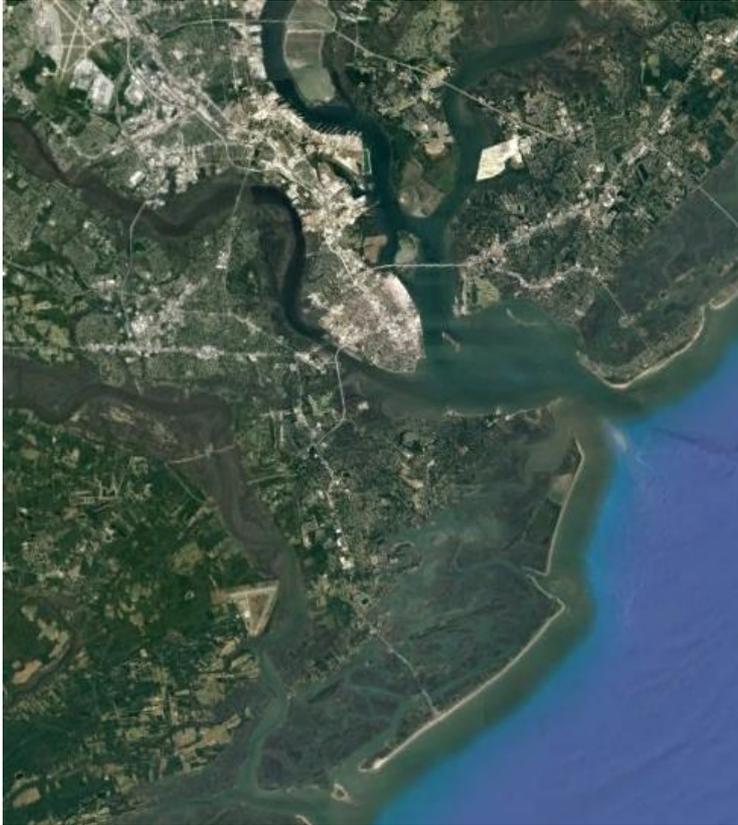




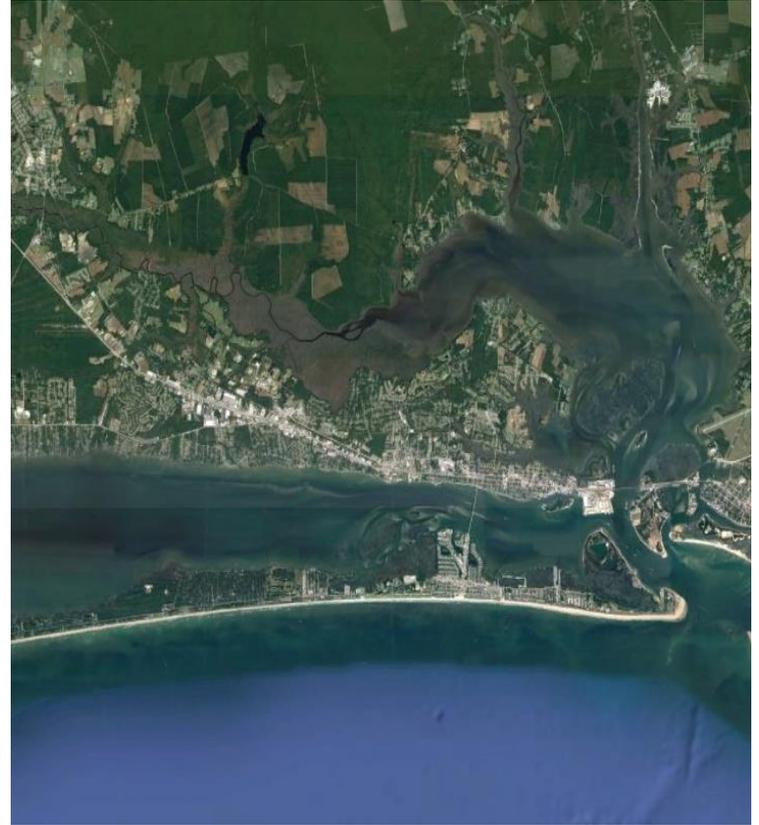


Pilot Cities

▶ Charleston, SC



▶ Morehead City, NC



Key Questions

- ▶ What are the coastal hazards that pose the greatest risk to local water infrastructure?
- ▶ In what ways are water infrastructure and public health associated?
- ▶ Are local municipal systems prepared for a natural disaster or public health based crisis?



Coastal Water Infrastructure

▶ **Types of Water Infrastructure**

- ▶ Drinking water facilities / piping
- ▶ Waste water facilities / piping
- ▶ Storm water facilities / piping
- ▶ Treatment plants

▶ **Vulnerable to:**

- ▶ Storm surge
- ▶ Increasing tides
- ▶ Failures from age or material status



Hazard – *Water and Infrastructure*

▶ Sea Level Rise and Saltwater Intrusion

- ▶ King County, WA. 2008. *Vulnerability of Major Wastewater Facilities to Flooding from Sea-Level Rise*. King County Department of Natural Resources and Parks, Wastewater Treatment Division.

▶ Antiquated Water Infrastructure

- ▶ Chughtai, F. and T. Zayed. 2008. Infrastructure condition prediction models for sustainable sewer pipelines. *J Perform Constr Fac* 22:333-341
- ▶ Doyle, M.W., E. H. Stanley, D. G. Havlick, M. J. Kaiser, G. Steinbach, W. L. Graf, G. E. Galloway, and J.A. Riggsbee. 2008. Aging infrastructure and ecosystem restoration. *Science* 319: 286-287.

▶ Remote/Low-Lying Location of Treatment Facilities

- ▶ Oyer, Z. 2014. Water infrastructure vulnerability to coastal flood hazards: A space-place analysis of Manteo, New Bern, and Plymouth, North Carolina. Master's Thesis, East Carolina University.



Hazard - *Public Health*

- ▶ There are a number of health threats that can emerge from breakdowns in water/waste water infrastructures:
 - ▶ Direct physical threats
 - ▶ Exposure to bacteria, molds, and viral infections
 - ▶ Reduced access to health services
 - ▶ Reduced access to drinking water
 - ▶ Reduced ability to maintain sanitary living conditions
 - ▶ Mental health effects from stressful events



Triple Threat

- ▶ The coastal regions of North and South Carolina are some of the fastest growing urban populations in the country
 - ▶ NOAA. 2013. National Coastal Population Report: Population Trends from 1970 to 2020. State of the Coast. <http://stateofthecoast.noaa.gov/features/coastal-population-report.pdf>
- ▶ There has also been an increase in the frequency and intensity of coastal storms over the past five decades (Kerjan 2012); as well as projected rises in sea level
 - ▶ Parris, A., Bromirski, P., Burkett, V., Cayan, D., Culver, M., Hall, J., Horton, R., Knuuti, K., Moss, R., Obeysekera, J., Sallenger, A.H., Weiss, J., 2012. *Global Sea-level Rise Scenarios for the US National Climate Assessment*. NOAA Technical Report. National Oceanic and Atmospheric Administration.
- ▶ These factors combined with an aging American infrastructure place many individuals in jeopardy, and pose a great risk to public health
 - ▶ Kessler, R. 2011. Stormwater strategies: Cities prepare aging infrastructure for climate change. *Environ Health Persp* 119:A514–A519



Local Interviews

- ▶ Using a standardized set of questions, we interviewed stakeholders in Morehead City and Charleston to gain their perspective on the current state of public health susceptibilities from water infrastructure failures.
- ▶ The interviews also revealed complex patterns of geospatial vulnerability as well as insight into the underlying connections between hospitals, utility specialist, and agents of municipal emergency management



Interview Summary

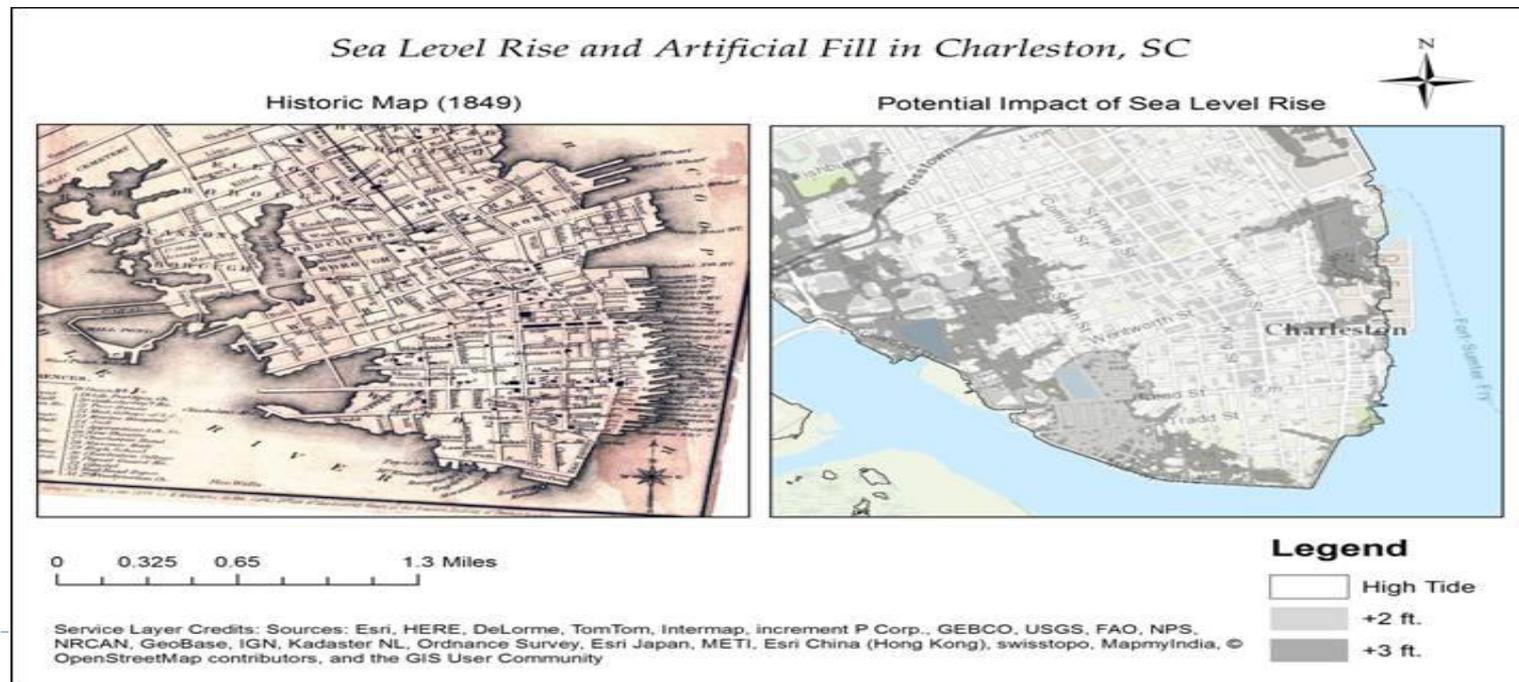
- ▶ Currently completing interviews with stakeholders from Charleston's emergency, city, infrastructure, and hospital management sectors.
- ▶ Questions were standardized in order to assess stakeholder opinions on hazardous scenarios, infrastructure vulnerability, mitigation plans, susceptible neighborhoods, and expected outcomes from systemic breakdowns
- ▶ Results were varied, but provided valuable information in terms of capacity building



Interview Summary (Cont'd)

▶ KEY POINTS:

- ▶ A major area of concern (*from an infrastructure and public health perspective*) identified through these interviews was Charleston's hospital district on the south west portion of the peninsula.



Interview Summary (Cont'd)

▶ KEY POINTS:

- ▶ Coastal storms and precipitation are serious hazards for the area, however earthquakes were also repeatedly mentioned as potential threats to water based infrastructure.
- ▶ The factor most associated with resistance / susceptibility to health impacts from failed water infrastructure was individual preparedness
- ▶ Many organizations are moving from awareness of climate change impacts towards steps of action

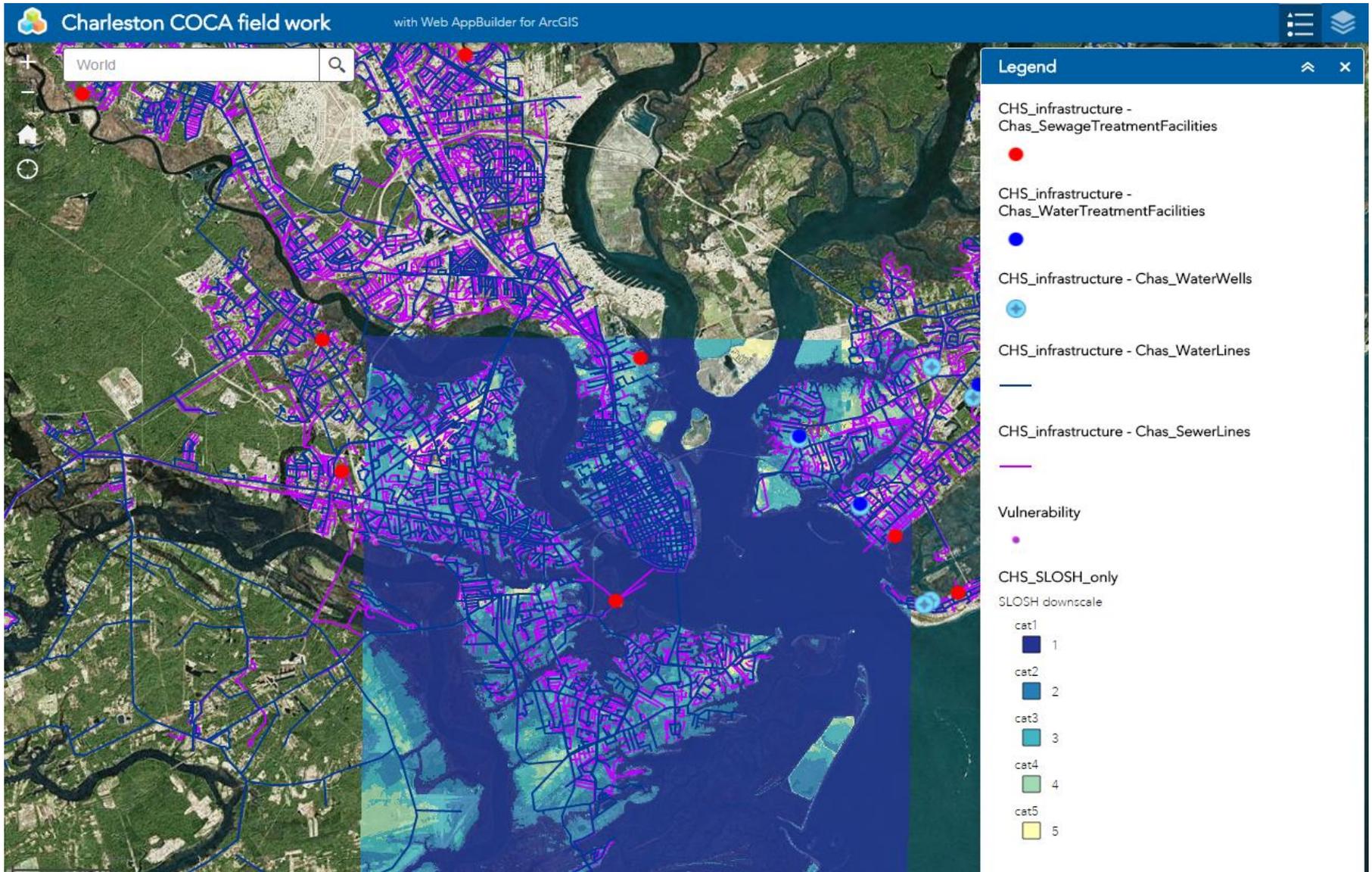


Drinking Water

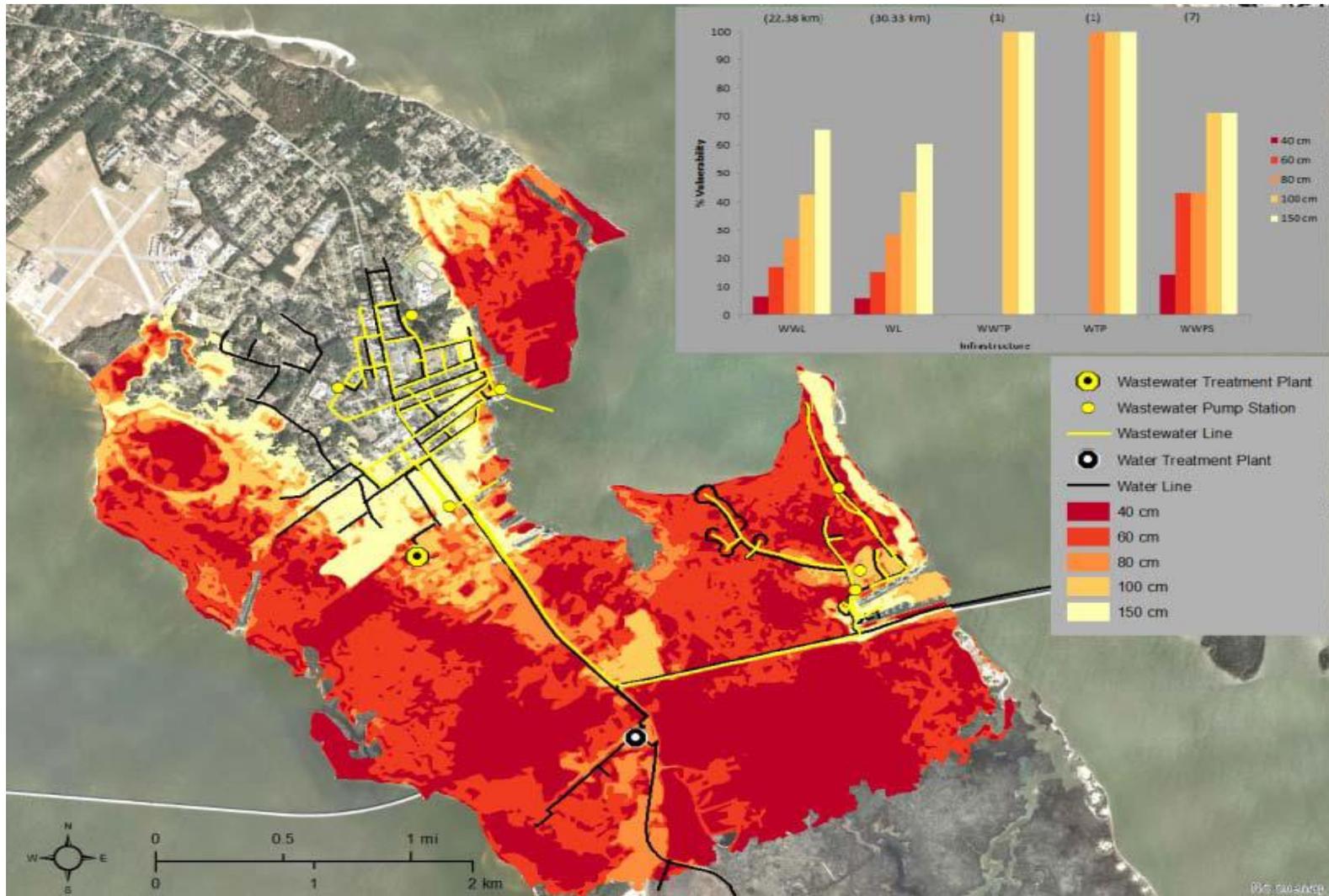
- ▶ A primary concern for city employees, infrastructure specialist, hospital liaisons, and emergency managers.
- ▶ Most drinking water qualms involve:
 - ▶ Access
 - ▶ Contamination
 - ▶ Preservation of source
- ▶ Clean drinking water is highly associated with positive public health outcomes
 - ▶ Hospital & emergency managers more concerned with contaminated drinking water than exposure to waste water
 - ▶ Many city and hospital managers are pushing for redundant drinking water infrastructure



GIS Modeling



GIS Modeling



Susceptibility Assessment

- ▶ We defined vulnerability (broadly) as – *existing in a state or condition which increases the likelihood of a negative outcome from failures in water infrastructure*
- ▶ Indicators used to assess vulnerability could possibly include – *geographic location, education, income, age, etc*



Vulnerability Index

- ▶ We're still deciding on a framework for our vulnerability assessment
- ▶ Workshop planning in progress
- ▶ Table top exercises



Conclusion

- ▶ Breakdowns in water infrastructure pose a number of public health consequences
- ▶ Municipal stakeholders and decision makers are invaluable sources of information for assessing regional vulnerabilities
- ▶ Tackling public health crises requires a great deal of coordination, cooperation, and communication between stakeholders from various backgrounds

