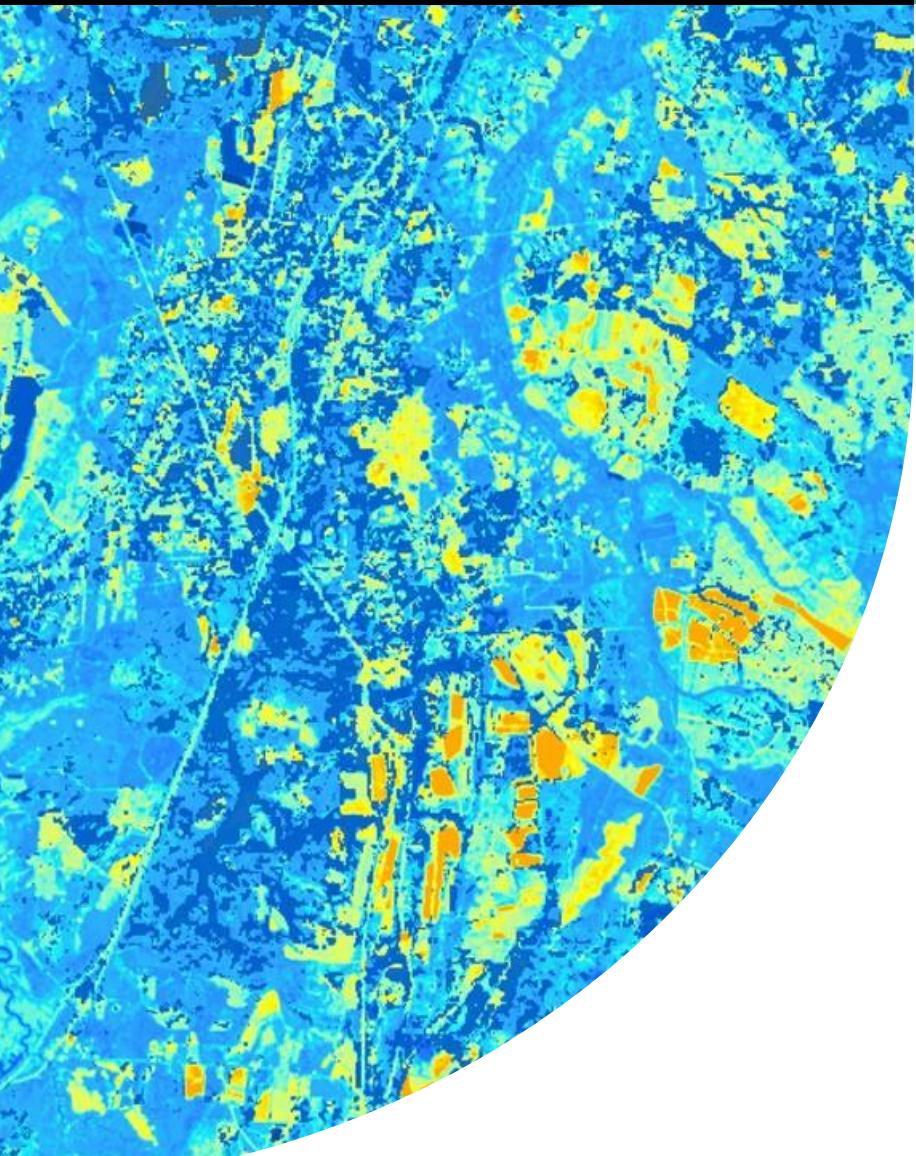




National Aeronautics and
Space Administration



Coastal South Carolina Water Resources II

Assessing Unprotected Wetlands to Identify
Priority Conservation Areas for Community
Protection Against Flood Events in South
Carolina

Asa Julien, Jake Ferus, Karen Wang, & Sydney
Brown (Analytical Mechanics Associates)

Georgia – Athens | Summer 2025



Meet the Team



Asa Julien



Jake Ferus



Karen Wang



Sydney Brown



Wetlands

Wetlands are diverse ecosystems found at the transition between aquatic and terrestrial environments. The ground is either permanently or seasonally saturated with water.



An **isolated wetland** is a wetland that is not directly connected to a navigable water of the United States **via continuous surface connection**.



Provide Habitat



Sequester Carbon



Mitigate Floods





Wetlands and Flood Impacts

Wetlands act as a **natural sponge**, storing water during wet periods, and then releasing it during dry periods.

A wetland can store around **one million gallons** of water per acre.

Image Credit: The Coastal Conservation League



Wetland Degradation

The long-term global loss of naturally occurring wetlands has been estimated to be between **54-57%**, with the rate of loss being **3.7x faster** in the 20th and 21st centuries.

The United States has lost an estimated **40%** of its inland wetland coverage since 1700.

The 2023 Sackett v. EPA ruling excludes isolated wetlands from federal protection.

Sackett v. EPA

(Slip Opinion) OCTOBER TERM, 2022 1
Syllabus

NOTE: Where it is feasible, a syllabus (headnote) will be released, as is being done in connection with this case, at the time the opinion is issued. The syllabus constitutes no part of the opinion of the Court but has been prepared by the Reporter of Decisions for the convenience of the reader. See *United States v. Detroit Timber & Lumber Co.*, 200 U. S. 321, 337.

SUPREME COURT OF THE UNITED STATES
Syllabus

SACKETT ET UX. v. ENVIRONMENTAL PROTECTION AGENCY ET AL.
CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT
No. 21-454. Argued October 3, 2022—Decided May 25, 2023

Petitioners Michael and Chantell Sackett purchased property near Priest Lake, Idaho, and began backfilling the lot with dirt to prepare for building a home. The Environmental Protection Agency informed the Sacketts that their property contained wetlands and that their backfilling violated the Clean Water Act, which prohibits discharging pollutants into “the waters of the United States.” 33 U. S. C. §1362(7). The EPA ordered the Sacketts to restore the site, threatening penalties of over \$40,000 per day. The EPA classified the wetlands on the Sacketts’ lot as “waters of the United States” because they were near a ditch that fed into a creek, which fed into Priest Lake, a navigable, intrastate lake. The Sacketts sued, alleging that their property was not “waters of the United States.” The District Court entered summary judgment for the EPA. The Ninth Circuit affirmed, holding that the CWA covers wetlands with an ecologically significant nexus to traditional navigable waters and that the Sacketts’ wetlands satisfy that standard.

Held: The CWA’s use of “waters” in §1362(7) refers only to “geographic[al] features that are described in ordinary parlance as ‘streams, oceans, rivers, and lakes’ and to adjacent wetlands that are ‘indistinguishable’ from those bodies of water due to a continuous surface connection.” *Rapanos v. United States*, 547 U. S. 715, 755, 742, 739 (plurality opinion). To assert jurisdiction over an adjacent wetland under the CWA, a party must establish “first, that the adjacent [body of water constitutes] . . . ‘water[s] of the United States’ (i.e., a relatively permanent body of water connected to traditional interstate navigable waters); and second, that the wetland has a continuous surface connection with that water, making it difficult to determine where the ‘water’ ends and the ‘wetland’ begins.” *Ibid.* Pp. 6–28.

Image Credit: The United States Supreme Court



The Coastal Conservation League

The **Coastal Conservation League** is a non-profit organization that promotes improved sustainability initiatives and aims to protect natural resources of South Carolina.

They work with different state agencies, local businesses, and citizen groups.

Currently, they work to preserve the natural landscape and assess social vulnerability impacts from natural disasters by **focusing on wetlands and their benefits to communities.**



Image Credits: The Coastal Conservation League



Coastal South Carolina Water Resources II



Image Credit: The Coastal Conservation League

Community Concerns

Isolated wetlands are **not being protected by federal law**



Potential decrease of wetlands causes an **increase in risk of flooding severity**



These flooding events negatively **impact certain communities**



Term I Project

The 2025 Spring GA Coastal South Carolina Water Resources Team mapped isolated wetlands in **Jasper, Berkeley, and Horry** South Carolina that have lost protection. They also mapped the decrease in wetlands from **2015-2025**.

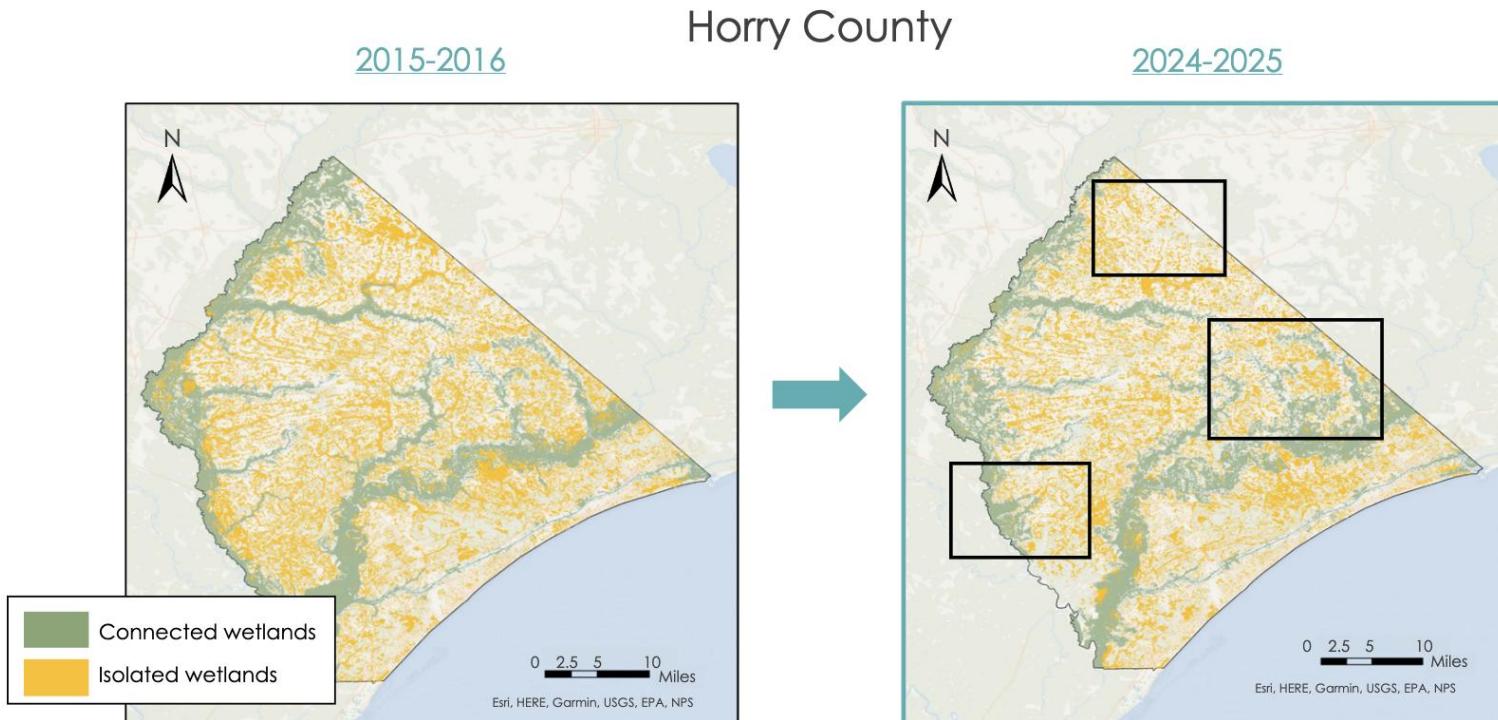


Image Credits: 2025 Spring GA Coastal South Carolina Water Resources Team

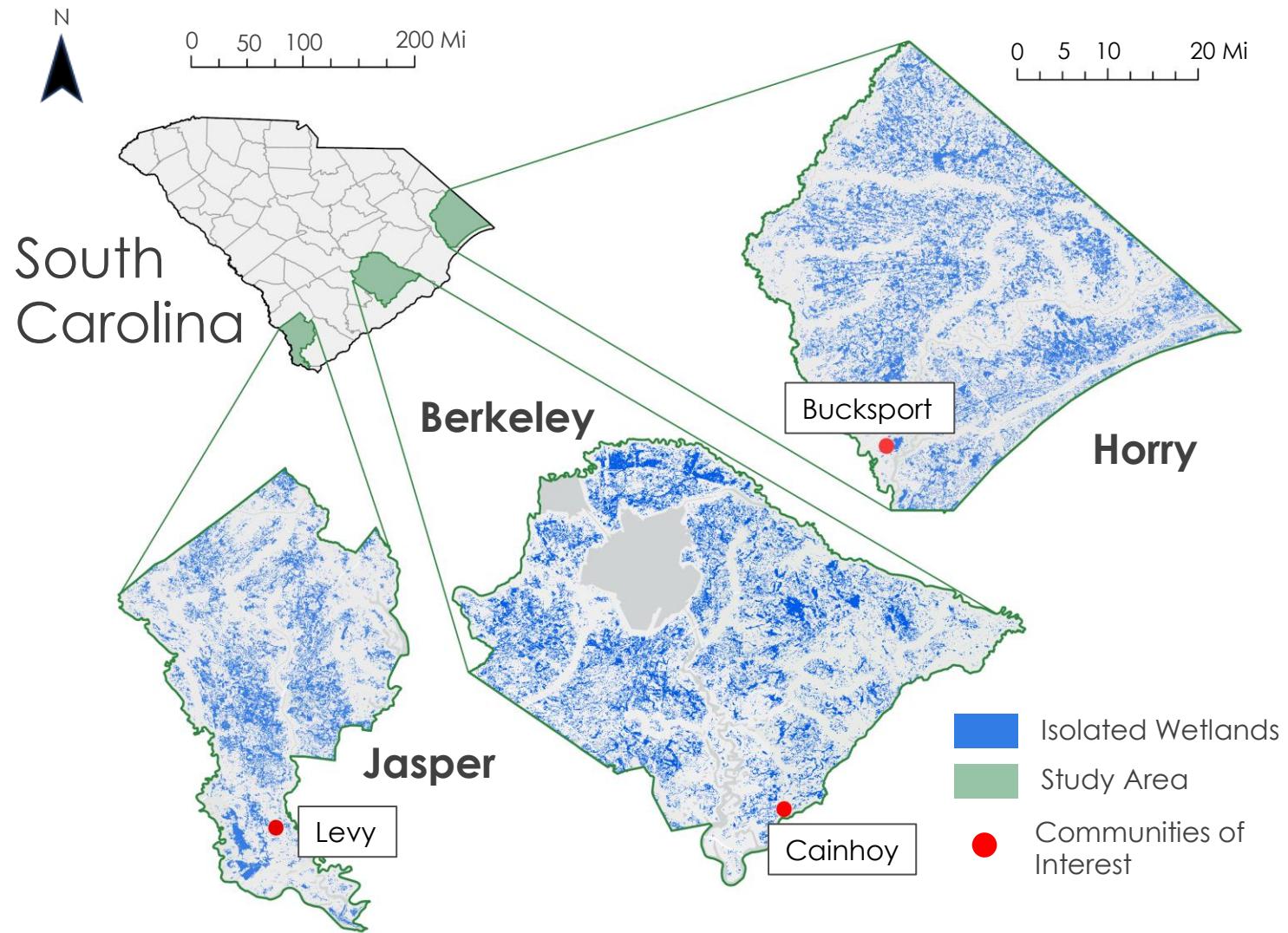


Image Credit: 2025 Spring GA Coastal South Carolina Water Resources Team

**2025 Spring GA Coastal
South Carolina Water
Resources Team**



Study Area & Time Period



Sources: ESRI, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



Coastal South Carolina Water Resources II

Study Area

- Jasper, Berkeley, & Horry Counties
- Levy, Cainhoy, & Bucksport Communities

Study Period

- 2015 – 2025
- 2018 – Hurricane Florence



Image Credit: NASA

Project Objectives

Flood Risk Prediction Analysis

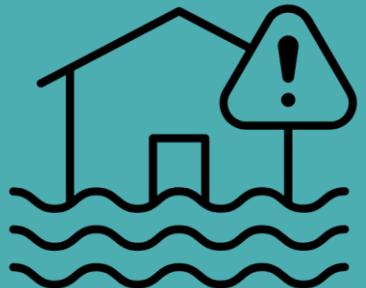


Image Credit: Savannah Vize

Implement a predictive flood model to assess the flood potential of unprotected wetland areas

Identify isolated freshwater wetlands in regions with high flood risk to highlight priority wetlands for conservation

Social Vulnerability Assessment

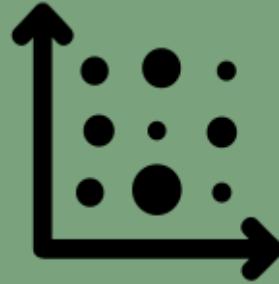


Image Credit: Ramakrishna Venkatesan

Create a bivariate map that showcases socio-environmental vulnerability crossed with flood risk predictions

Assess social vulnerability and flood risk of partner-identified communities of interest



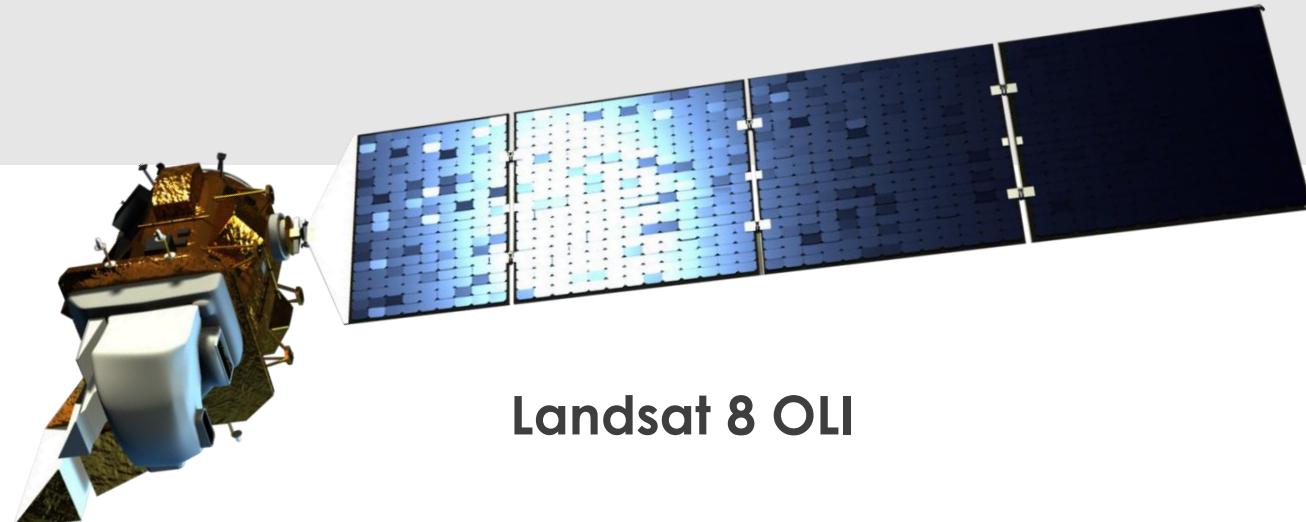
Earth Observations



Landsat 7 ETM+



Sentinel-1 C-SAR

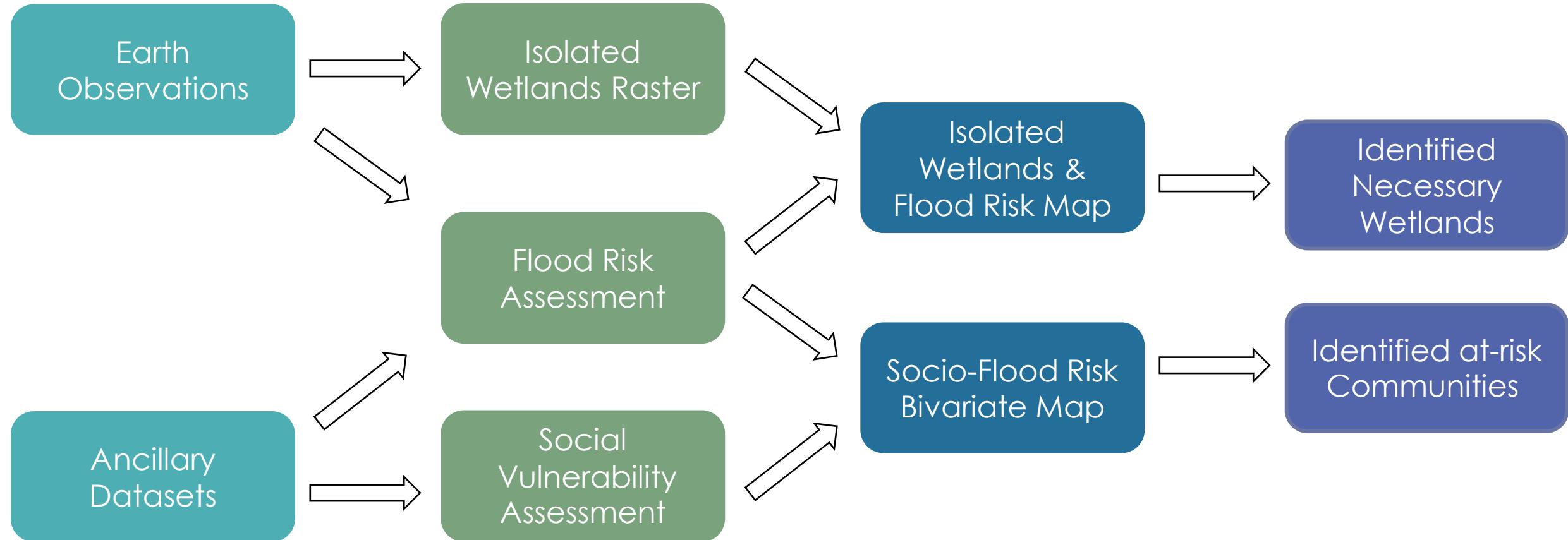


Landsat 8 OLI

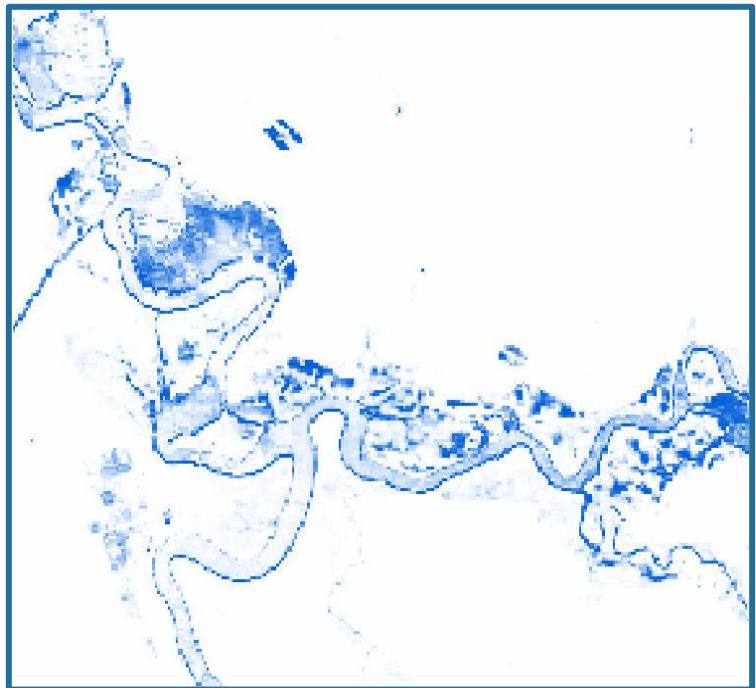
Image Credits: NASA, ESA



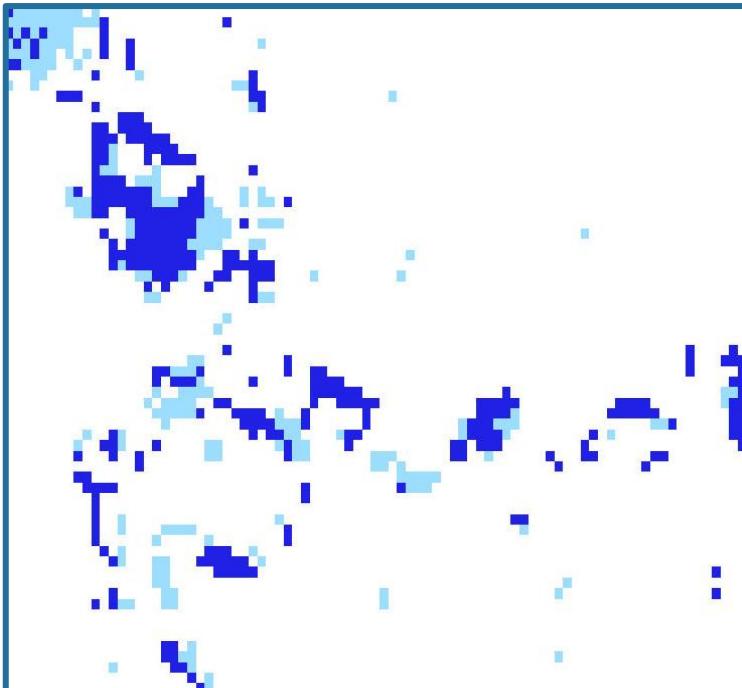
Methods – Objectives Flow Chart



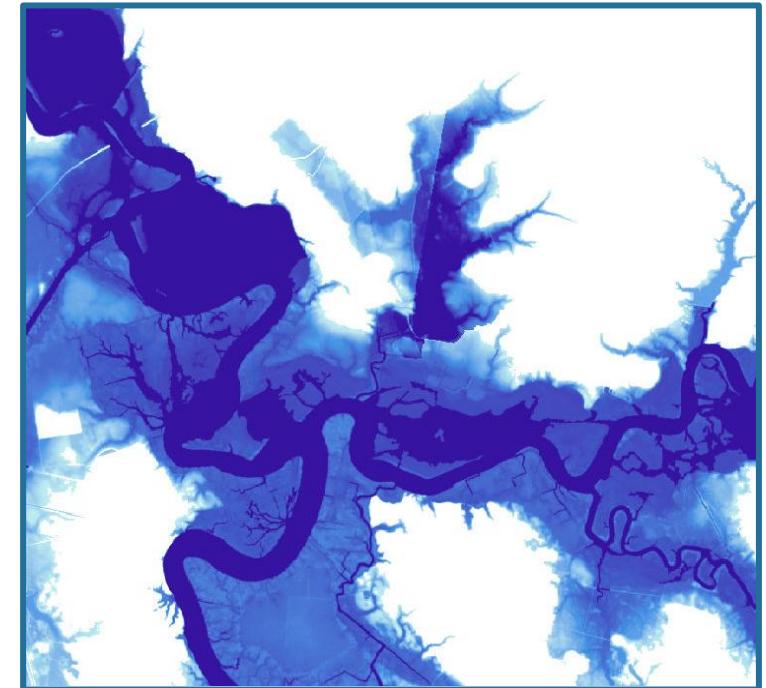
Methods – Mapping Flood Extent



FLATS
Landsat EVI + NDWI
Optical



SAR
VV Polarization
Radar



HAND
DEM + CGD
Model

All imagery retrieved from Google Earth Engine



Methods – Flood Risk Weighted Sum

Flood Extents

SAR Observation

20%

Landsat EVI and NDWI

10%

HAND Model

20%

Distance from Streams

20%

Precipitation*

0%*

Land Use Land Cover

10%

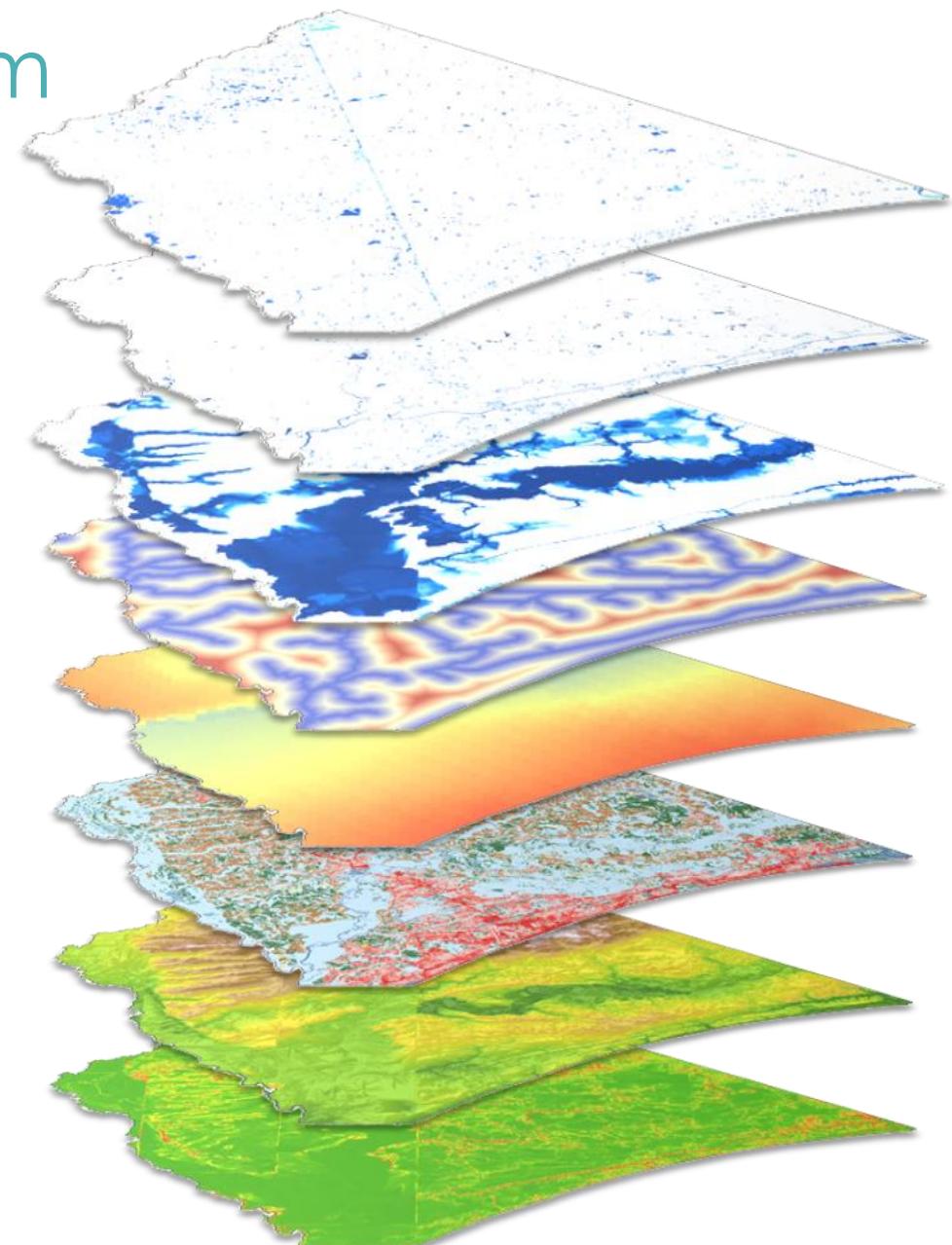
Elevation

10%

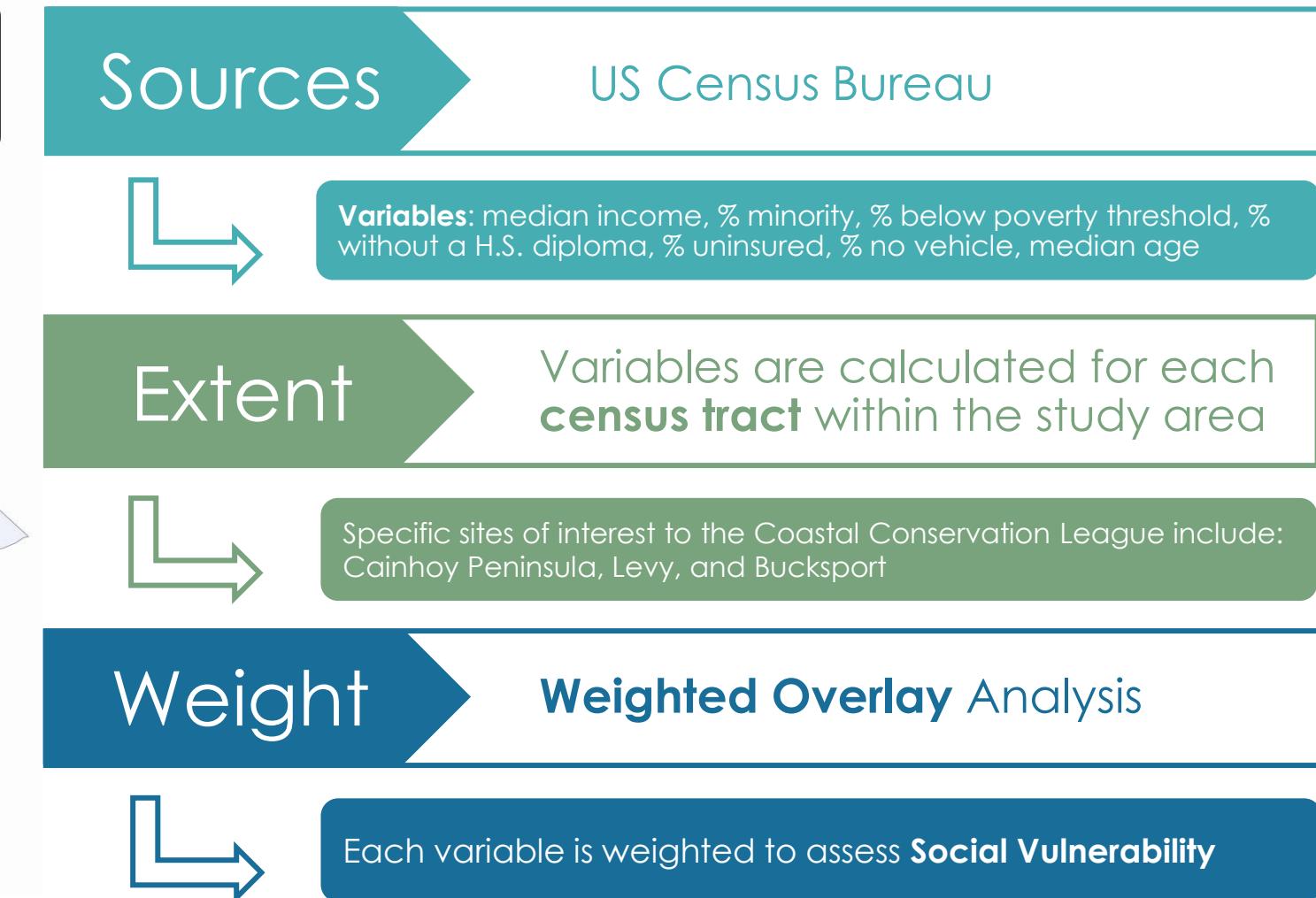
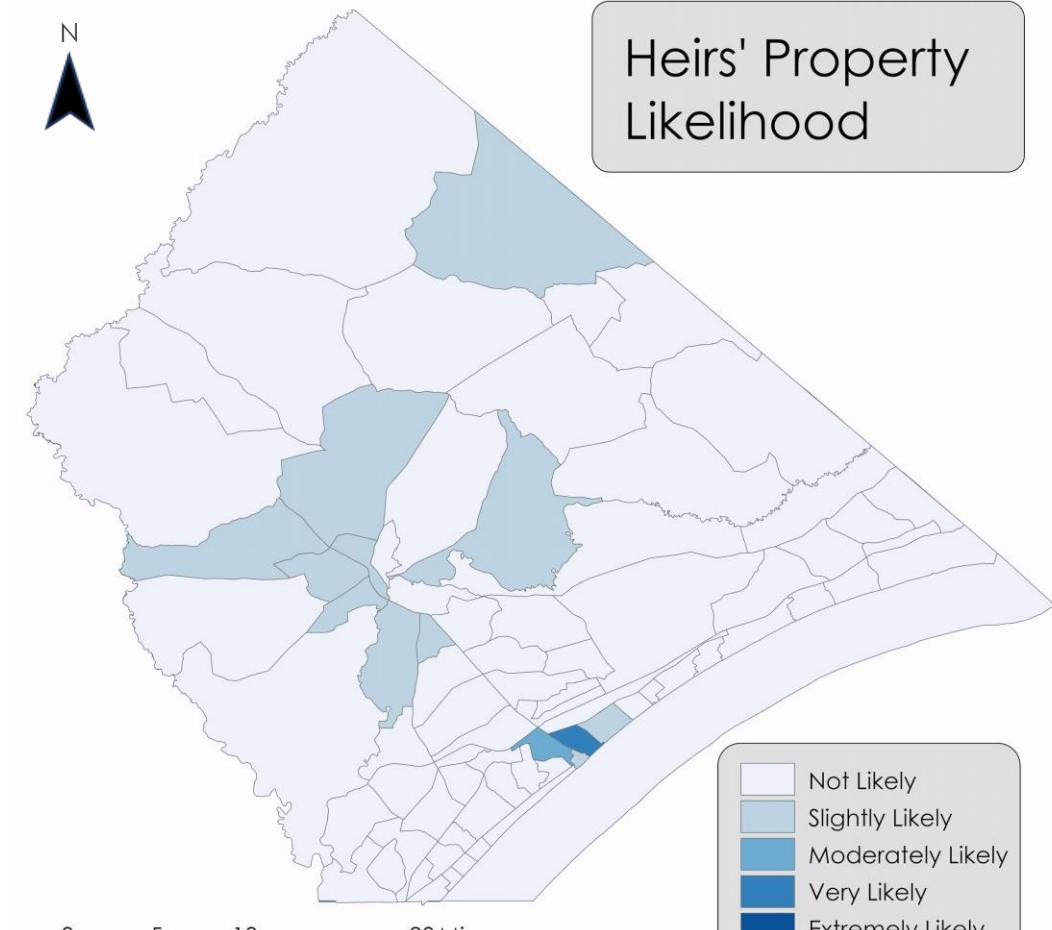
Slope

10%

Flood Predictors



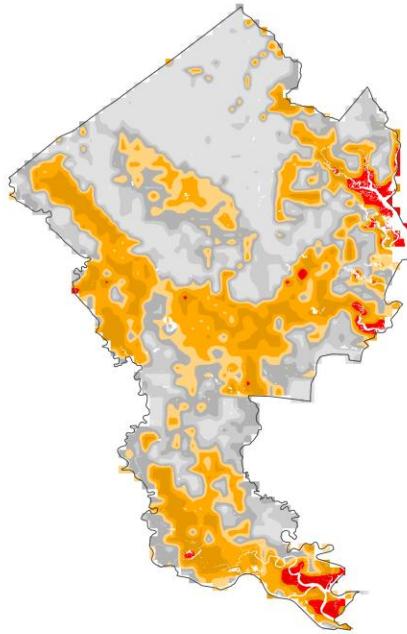
Methods – Social Vulnerability Analysis



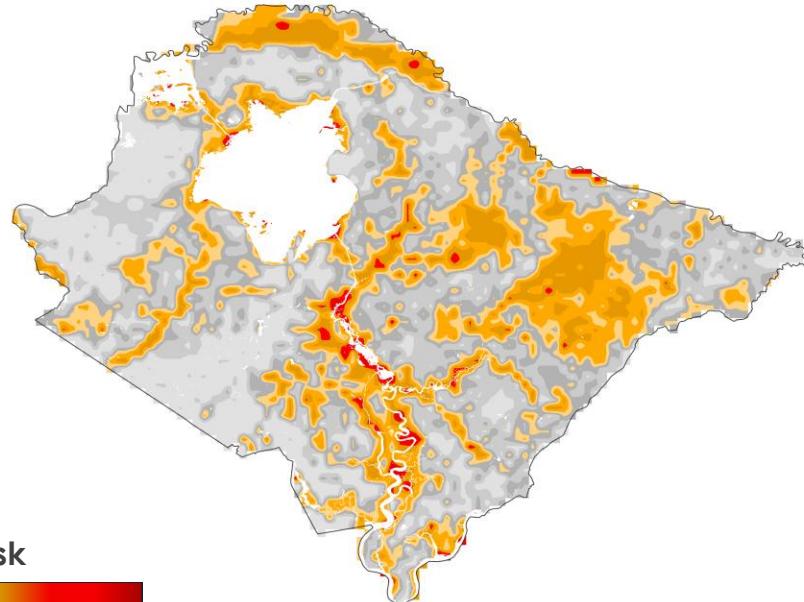
Results – Flood Risk Assessment

With Precipitation

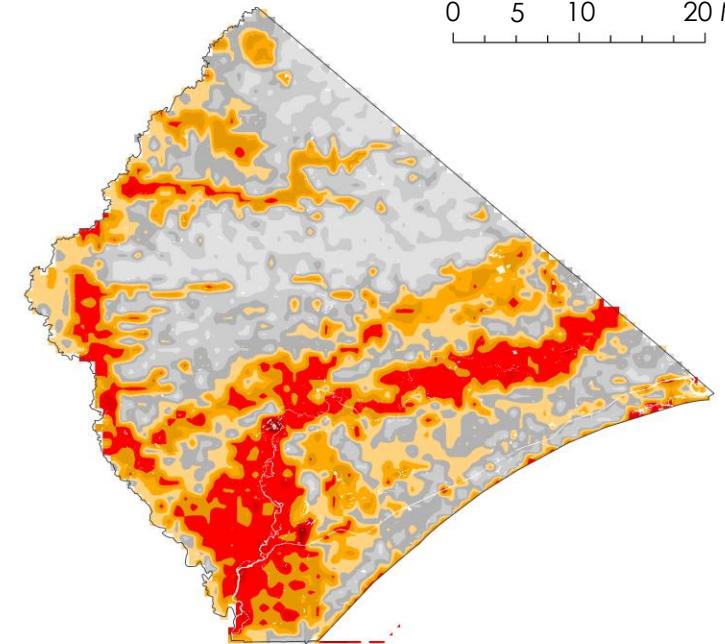
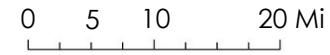
Jasper



Berkeley



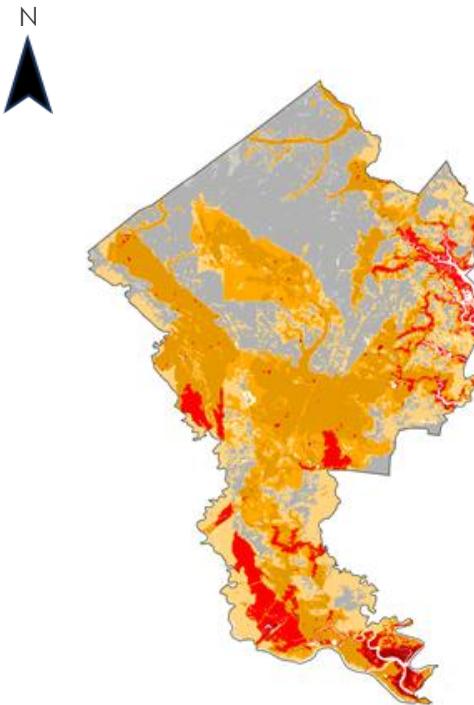
Horry



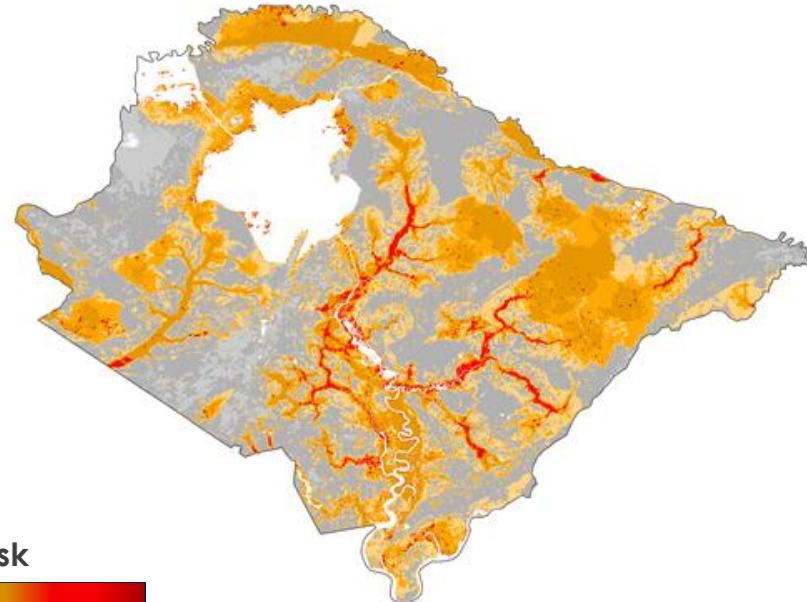
Results – Flood Risk Assessment

Without Precipitation

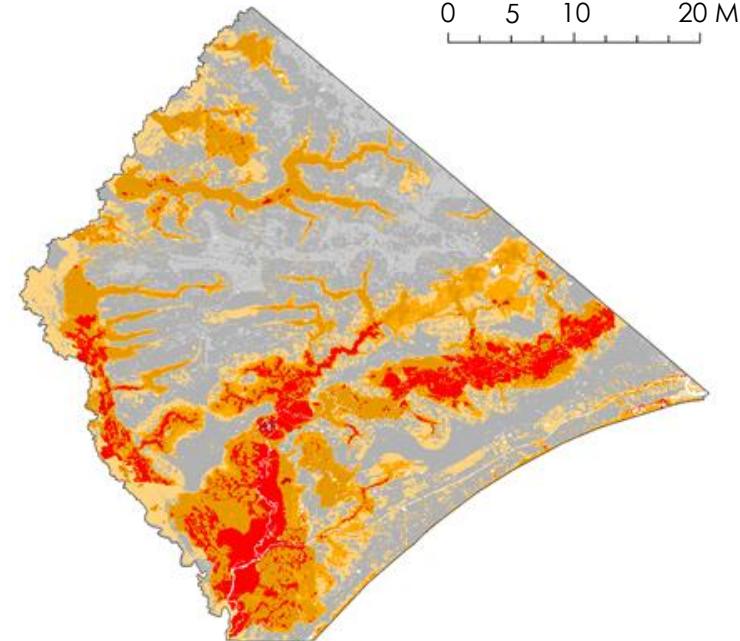
Jasper



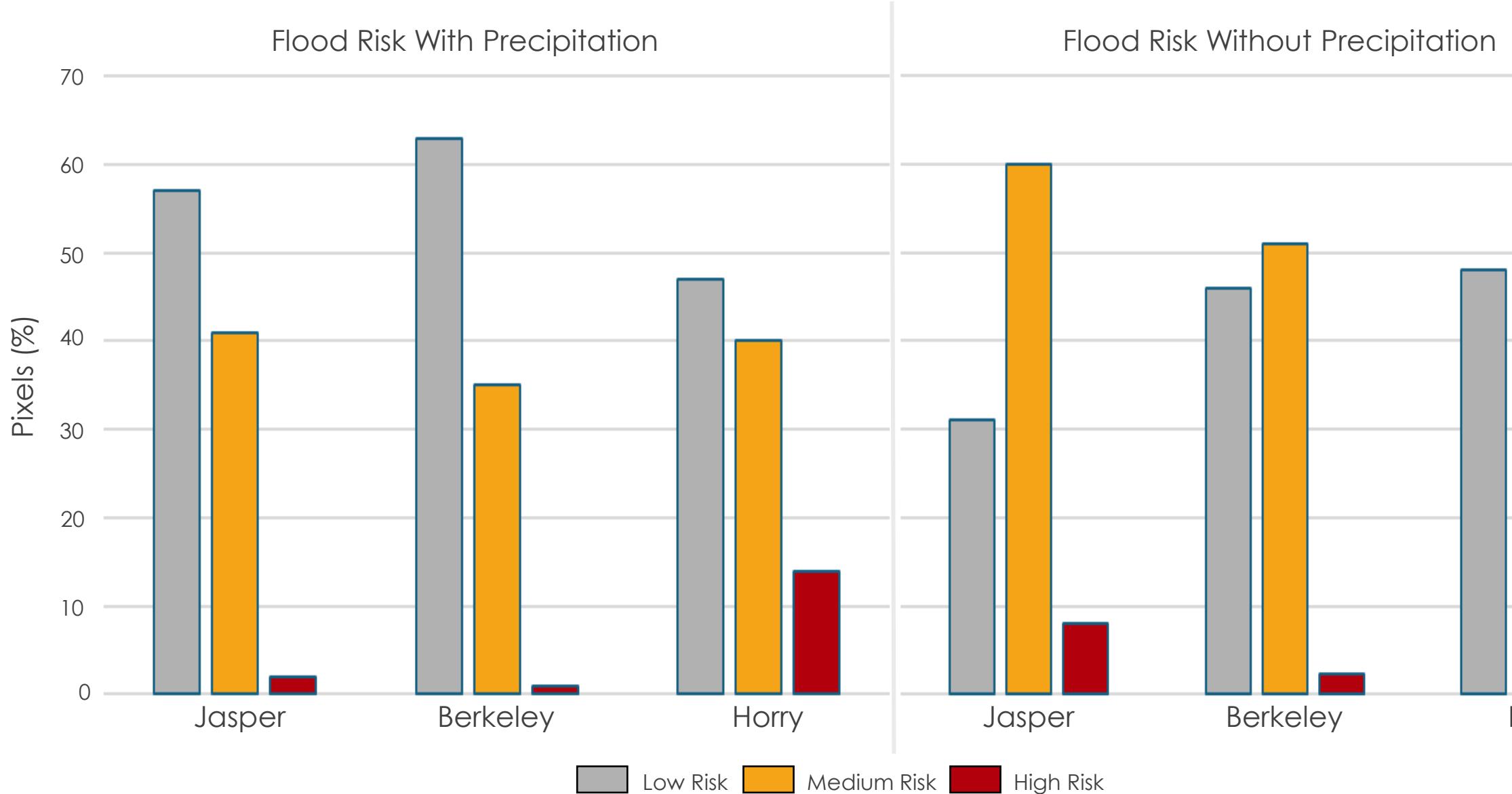
Berkeley



Horry

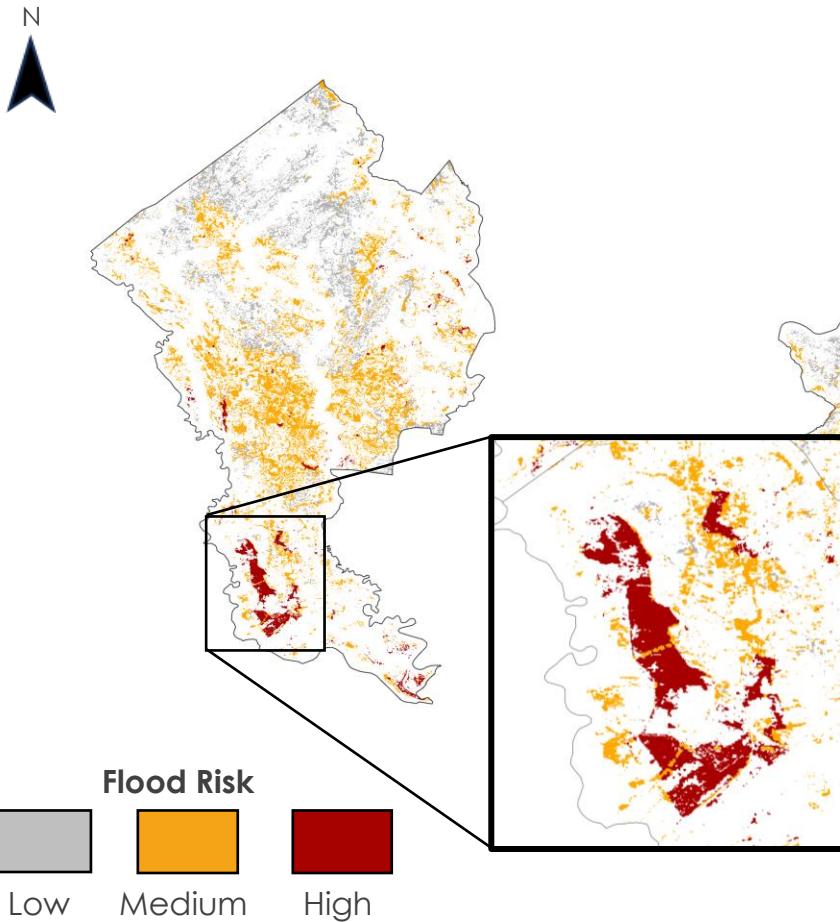


Results – Flood Risk Assessment Statistics

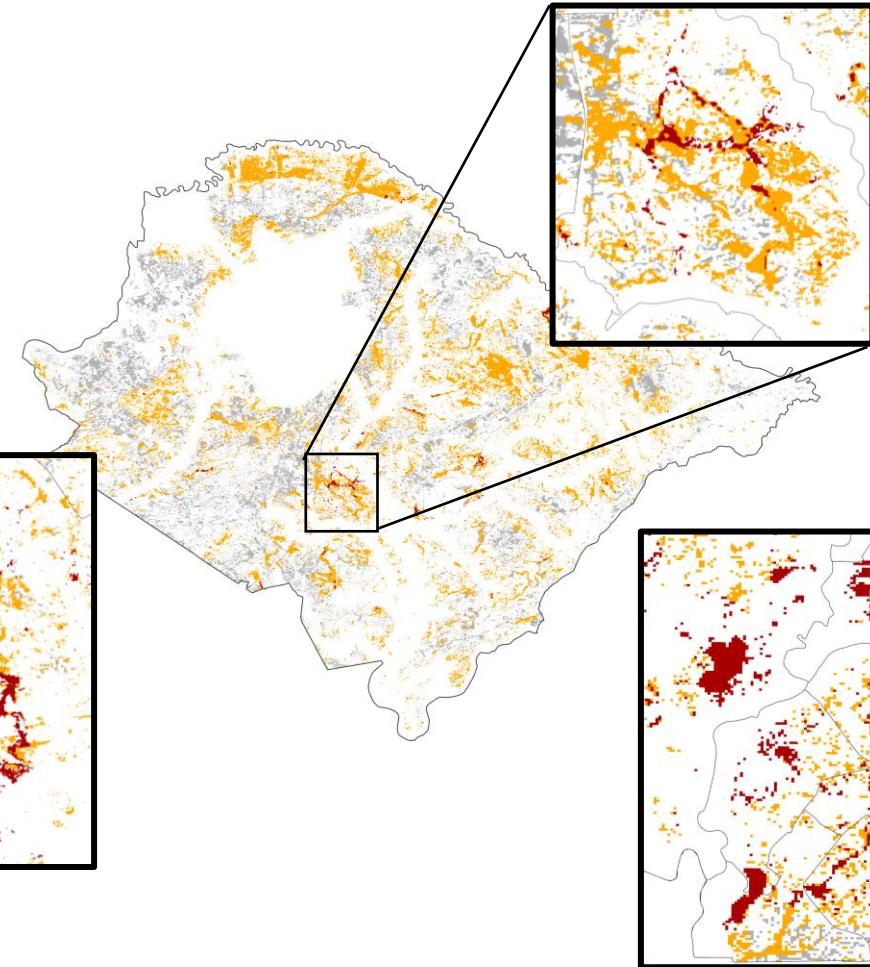


Results – Isolated Wetlands and Flood Risk

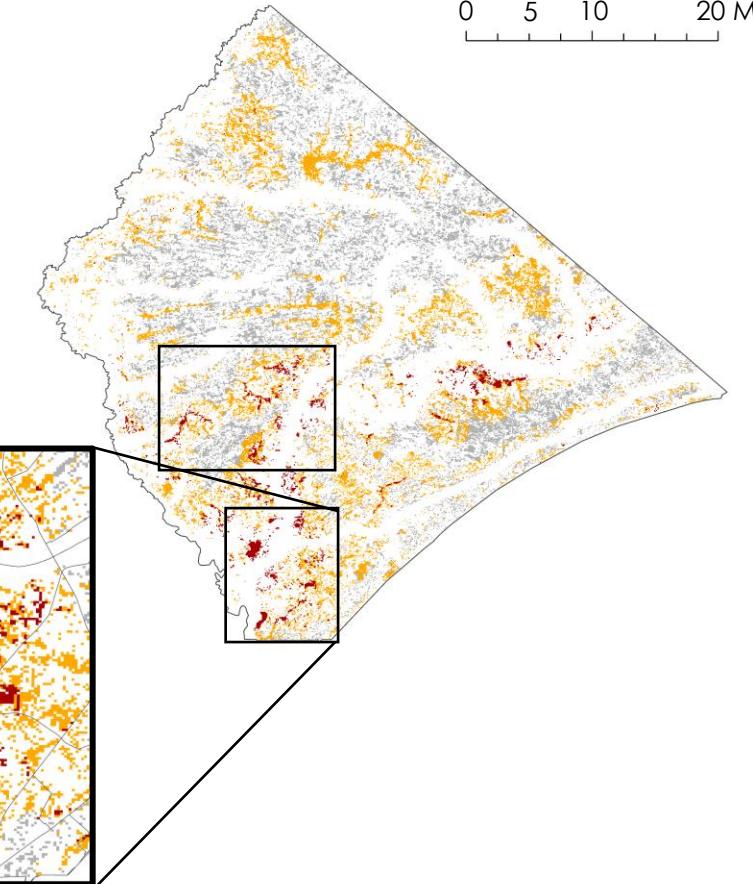
Jasper



Berkeley

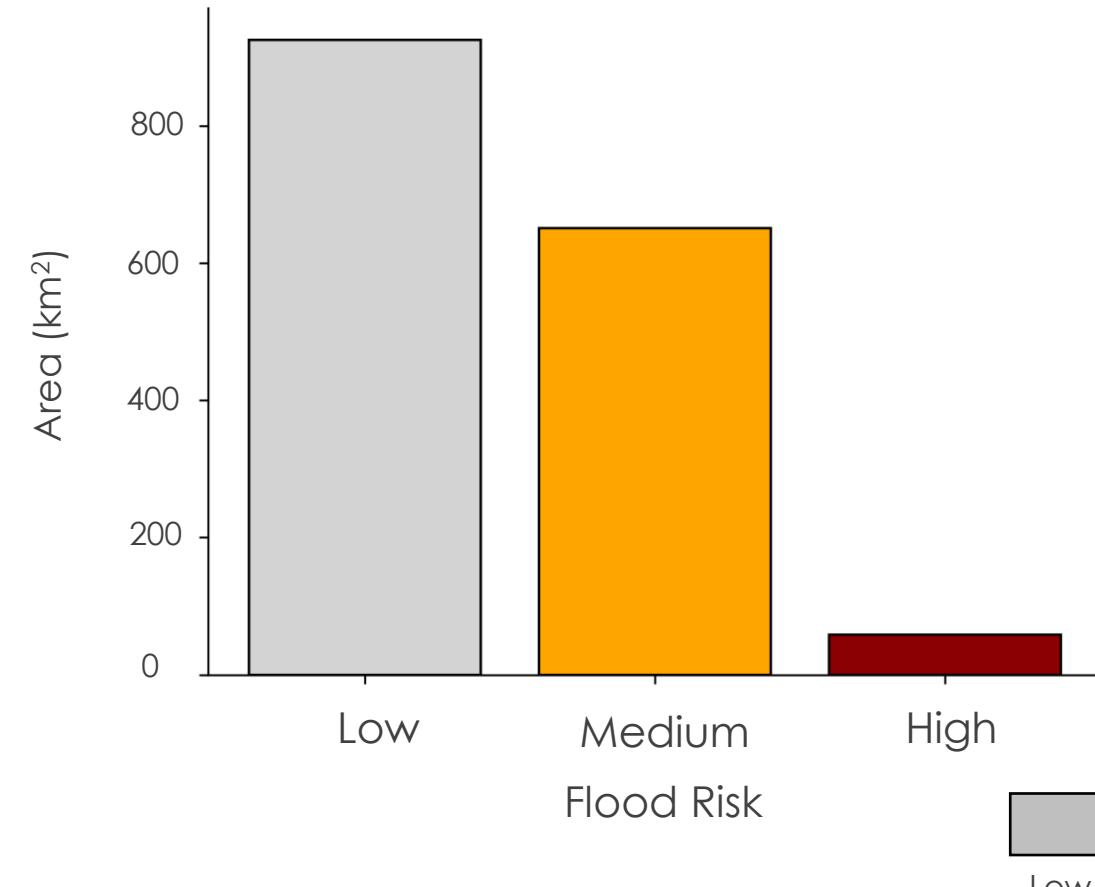


Horry

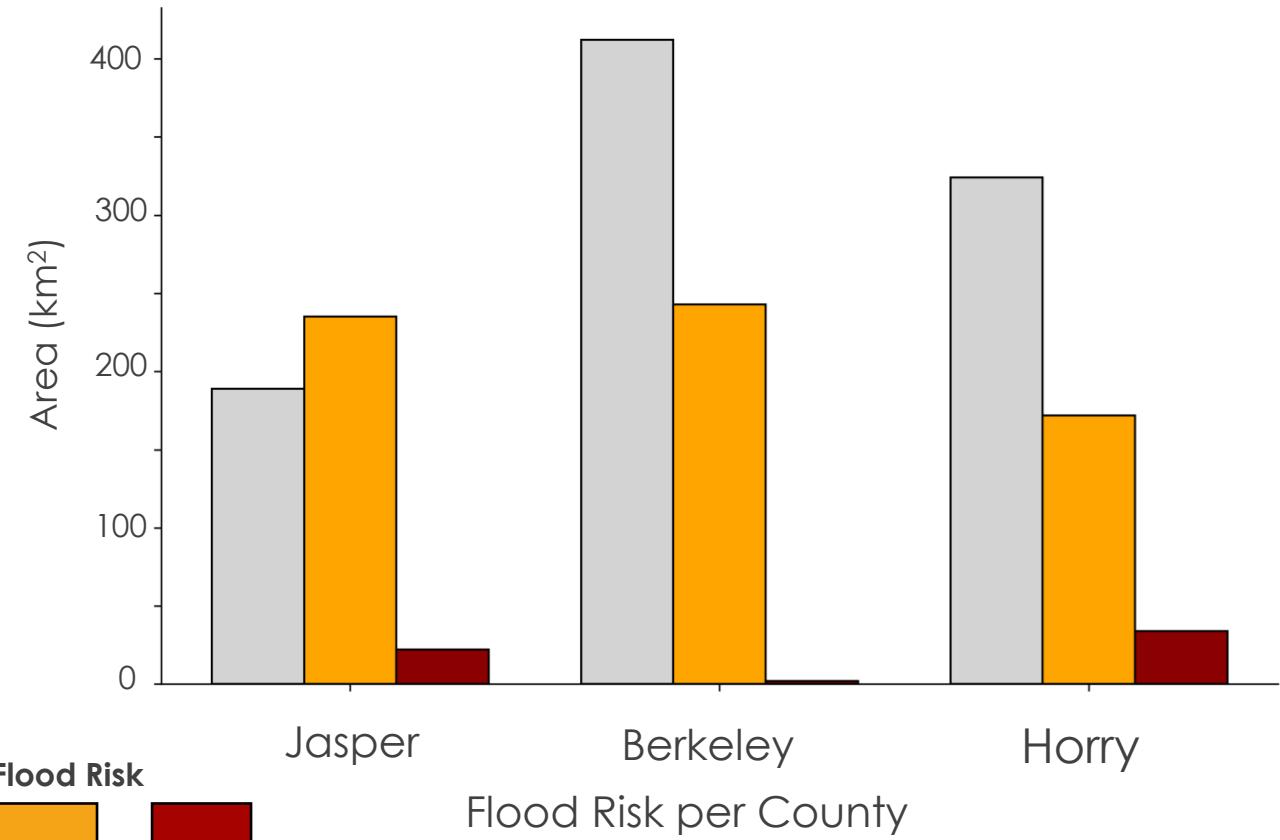


Results – Isolated Wetlands and Flood Risk Statistics

All Isolated Wetlands Combined

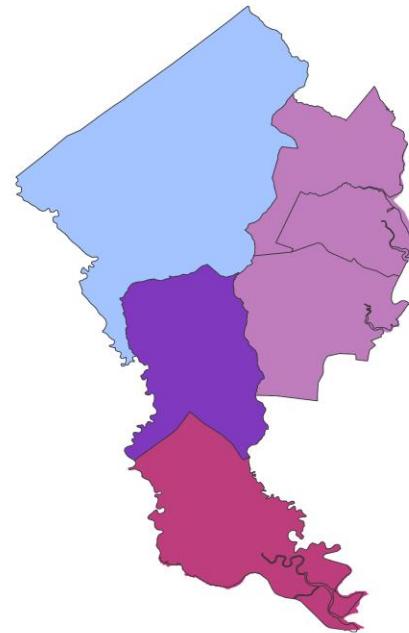


Isolated Wetlands by County



Results – Flood Risk and Social Vulnerability Bivariate Map

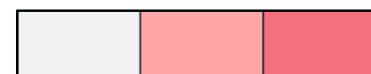
Jasper



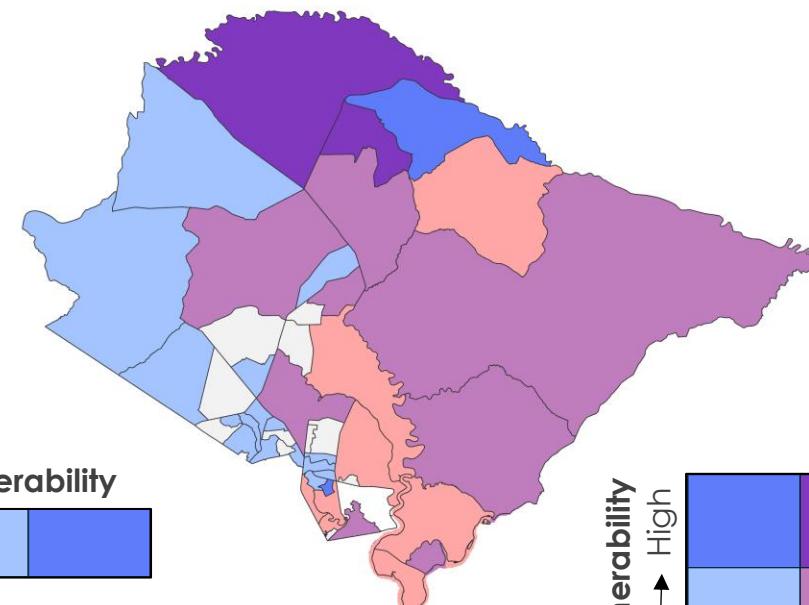
Social Vulnerability



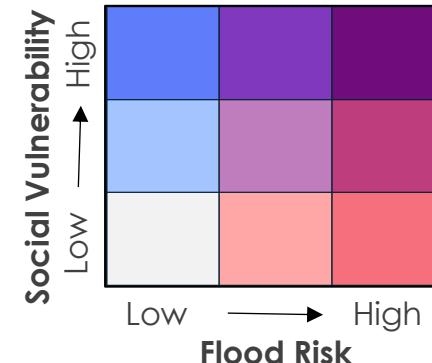
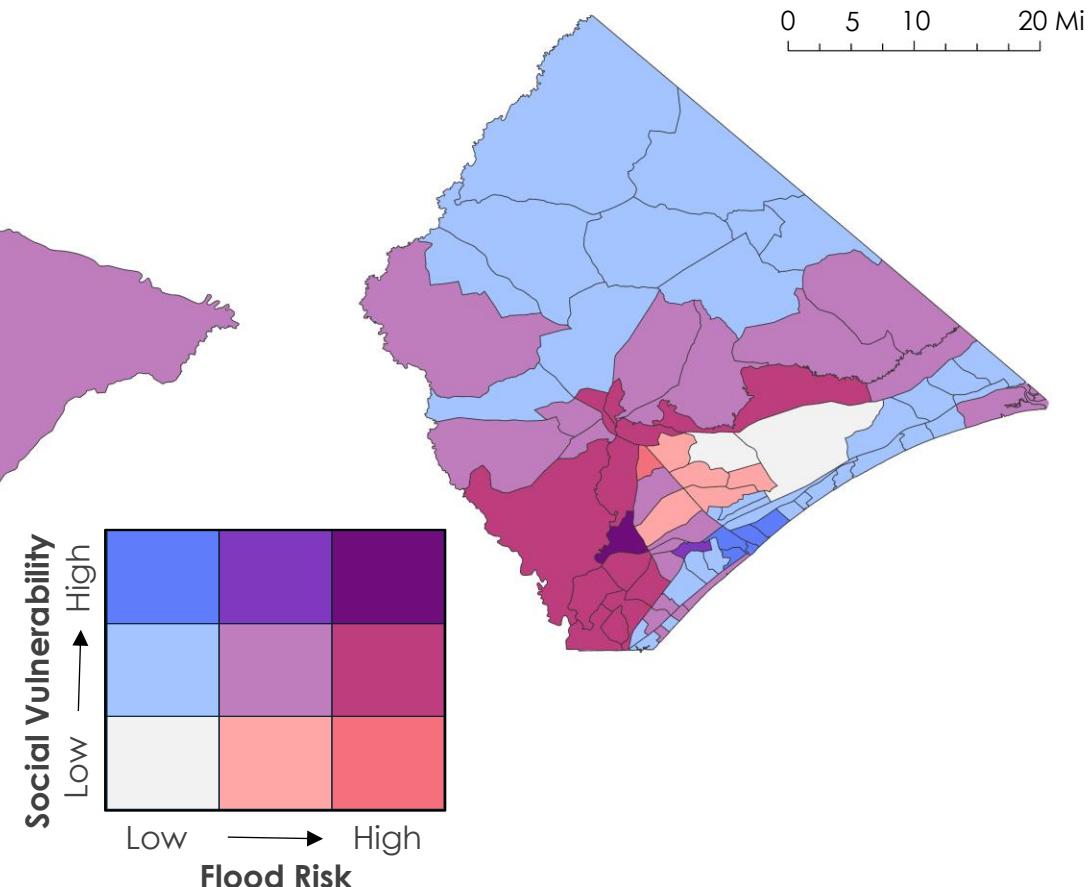
Flood Risk



Berkeley

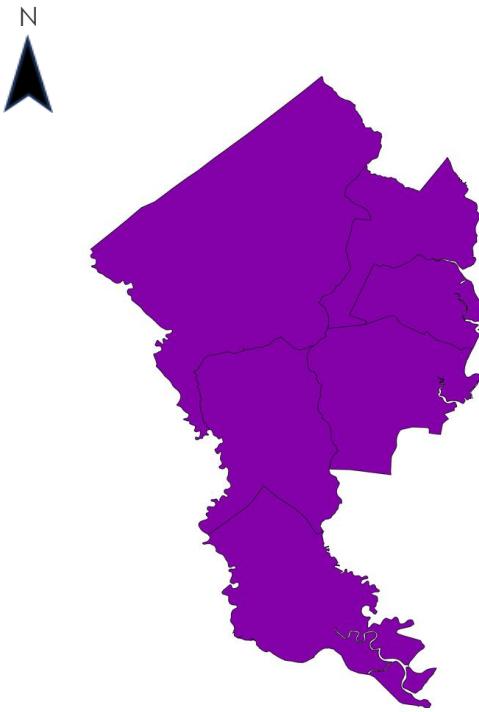


Horry

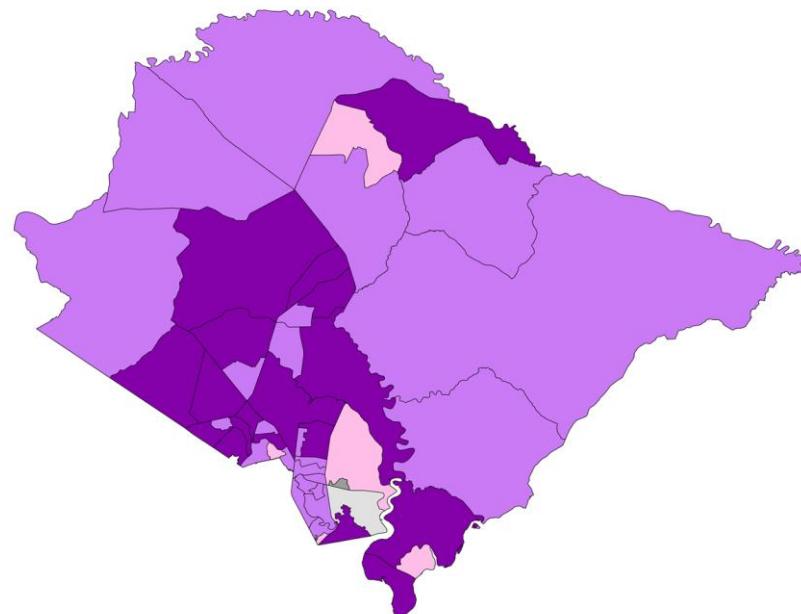


Results – FEMA National Risk Index Comparison

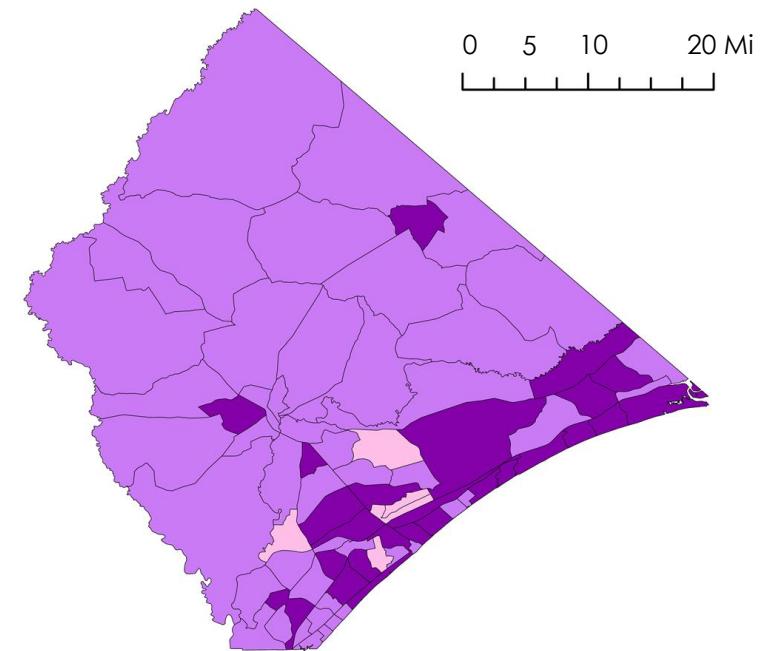
Jasper



Berkeley



Horry



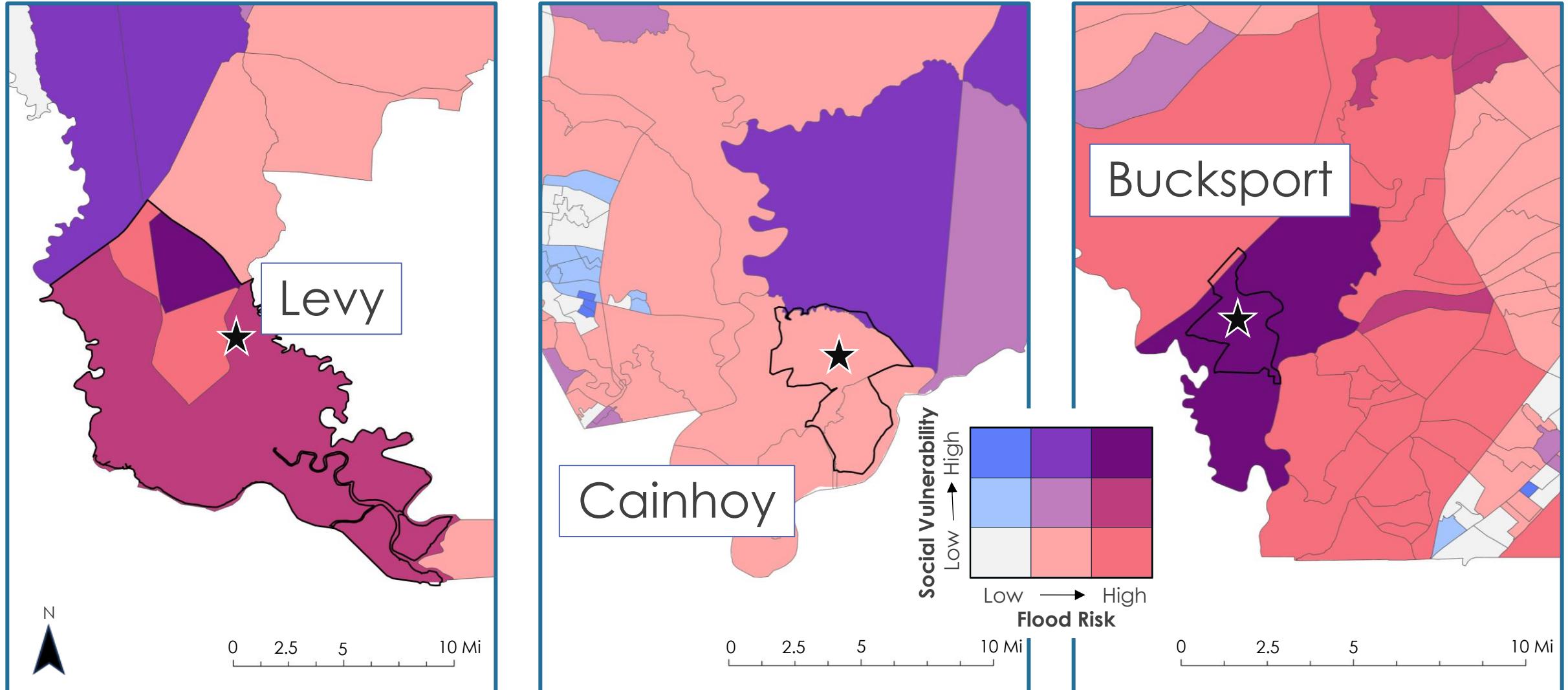
FEMA Risk Index Rating



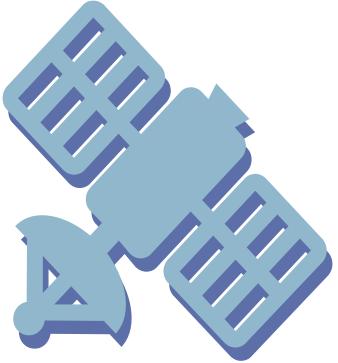
Low → High



Results – Highlighted Communities



Errors and Uncertainties



Data Acquisition

- Lack of ground-truth data
- Gaps in satellite overpass during flooding event

Mapping Flood Extent

- HANDE: relies solely on DEM data
- SAR: limited ability to detect forest flooding; backscattering

Scaling

- Subjective weighted scale
- Scale mismatch among demographic factors

Holistic Flood Risk

- Lack of multiple storm datasets
- Removing precipitation as a model factor



Feasibility – Partner Implementation

Earth Observations

Allow partners to assess flood and social vulnerability at broad scales

Partner Use

Partners will see at-risk regions where isolated wetlands should be protected

Future Application

Incorporate more data related to social vulnerability and wetland flooding



Conclusion

1

43% of isolated freshwater wetlands were in areas with medium-to-high risk flood zones. Two of the communities of interest, Levy and Bucksport, were located near isolated wetlands in high-risk flood zones.

2

Partner-identified communities of interest had medium-to-high flood risk and social vulnerability.

3

Combining optical and active radar data allows our partner to quickly prioritize wetland conservation in specific locations to address large-scale flooding resilience.



Acknowledgements

NASA DEVELOP

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DEVELOP Spring 2025 Team

- Jake Ferus, Yunjoo Cho, Sidney Eigeman, Maisunath Maliha Amin



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