Enabling Smart Cities in Coastal Regions of Environmental and Industrial Change: Building Adaptive Capacity through Sociotechnical Networks on the Texas Gulf Coast

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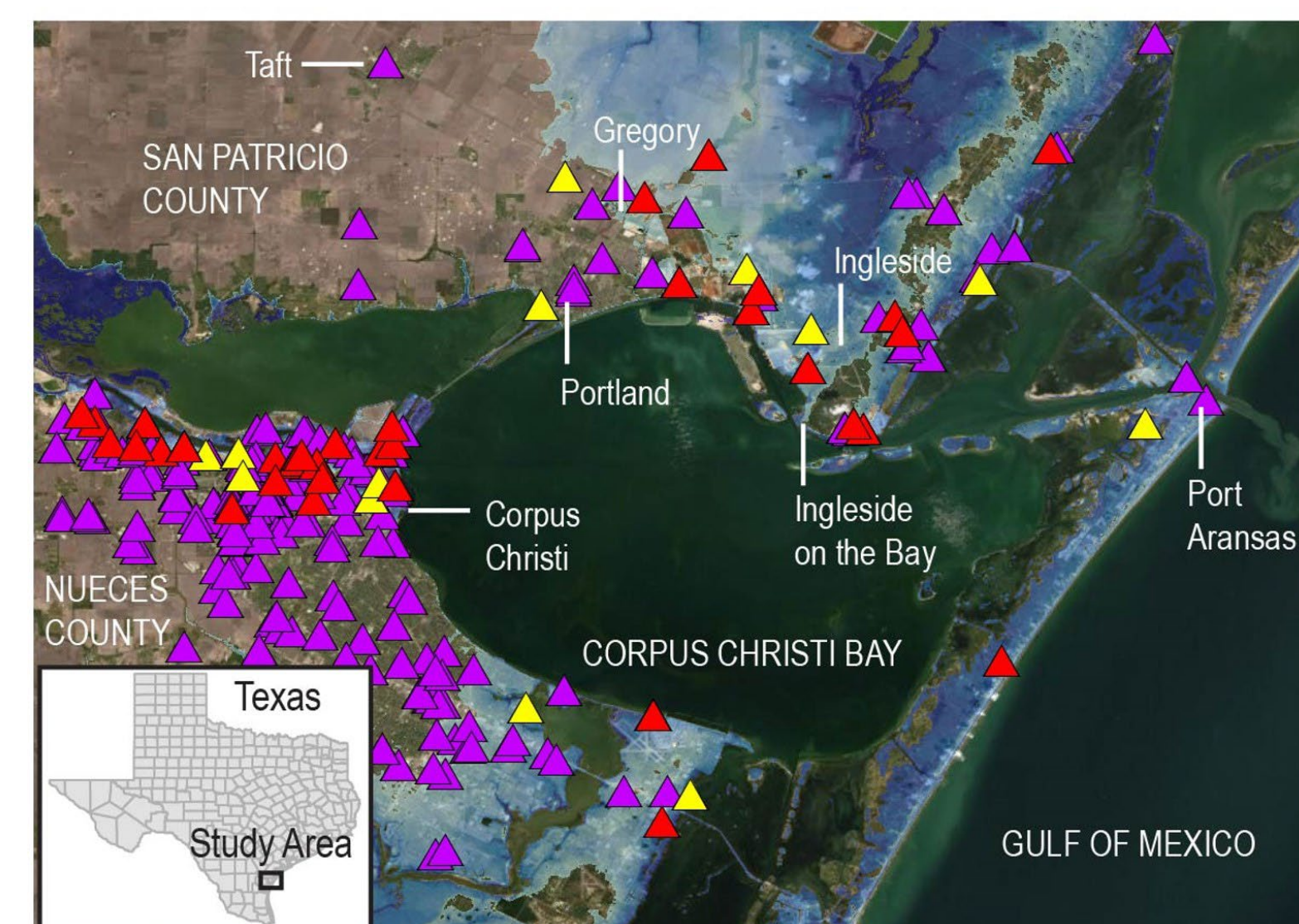
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Study Region and Partners

- Texas Coastal Bend: Nueces and San Patricio Counties
- Population: over 420,000 residents
- Partners and advisory board members from: community-based organizations, city/county governments, port, and regional planning partnerships

Community-Identified Challenges

- Impacts of climate change and industrial development on air and water quality and shoreline flooding.
- Lack of monitoring data to inform decisions about risk reduction.

Legend:
- ▲ Major air polluter
- ▲ Wastewater discharge facility
- ▲ Other contaminated site/toxic facility
- Cat. 5 hurricane storm surge (m) 0 – 20

Project Vision

- Examine how smart and connected technologies can be integrated into regional communication networks to:
  - Increase knowledge and awareness of environmental and industrial hazards.
  - Provide regional partners with real-time data to inform decision-making and advocacy efforts.
  - Build community adaptive capacity equitably among the diverse residents in the region.
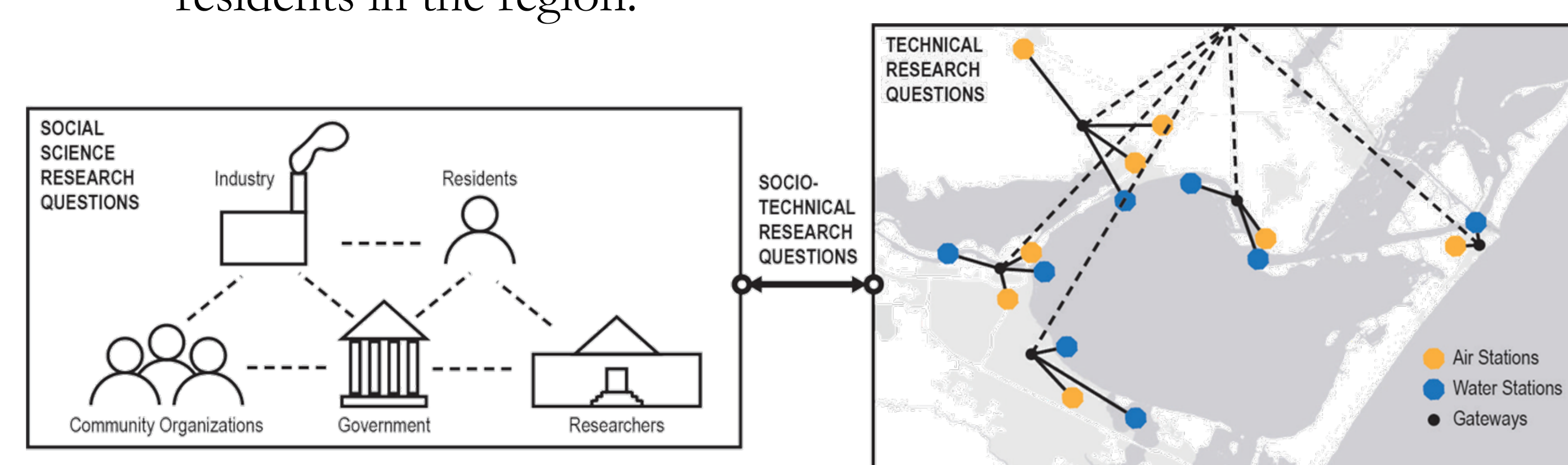
Major Outcomes/Progress

Examining the role of nonprofits in adaptive capacity building

- Found that community-based nonprofits have been integral in initiatives to develop adaptive capacity to coastal flooding.
- Identified several gaps in the regional planning networks that have limited the ability to influence policies that safeguard residents from coastal hazards.
- Paper in *Environmental Science & Policy*: 10.1016/j.envsci.2023.103599.
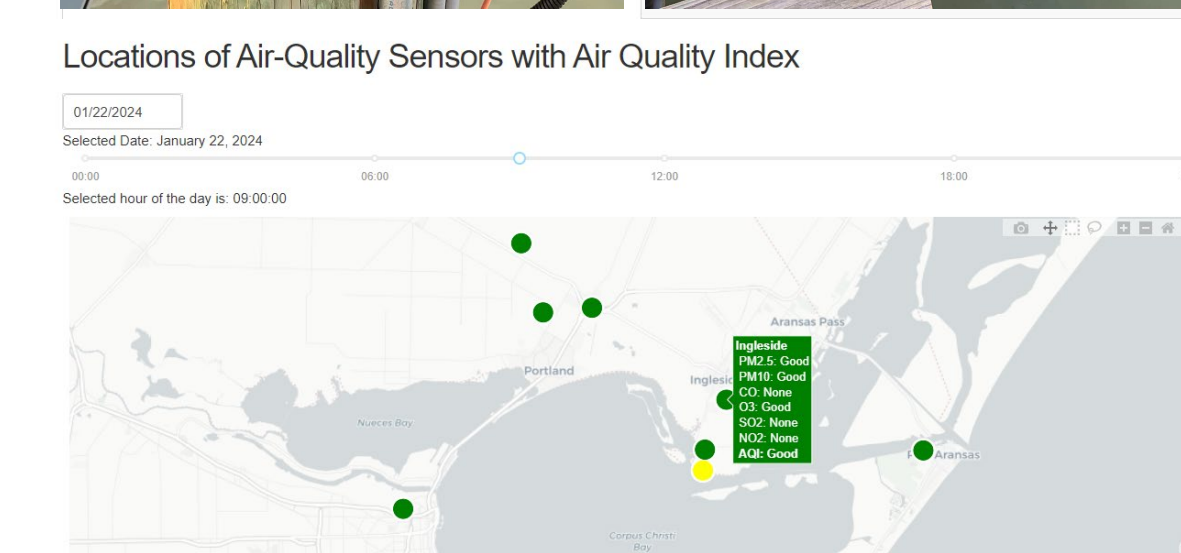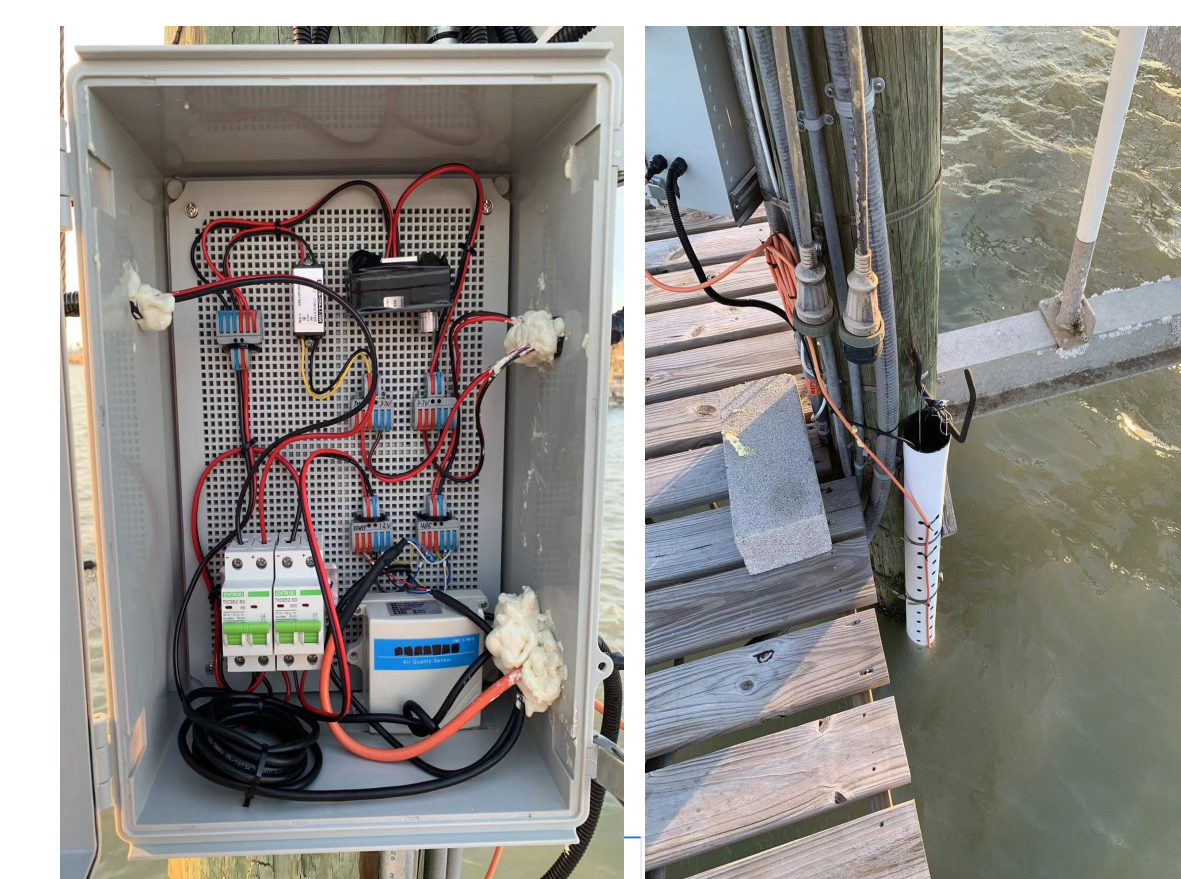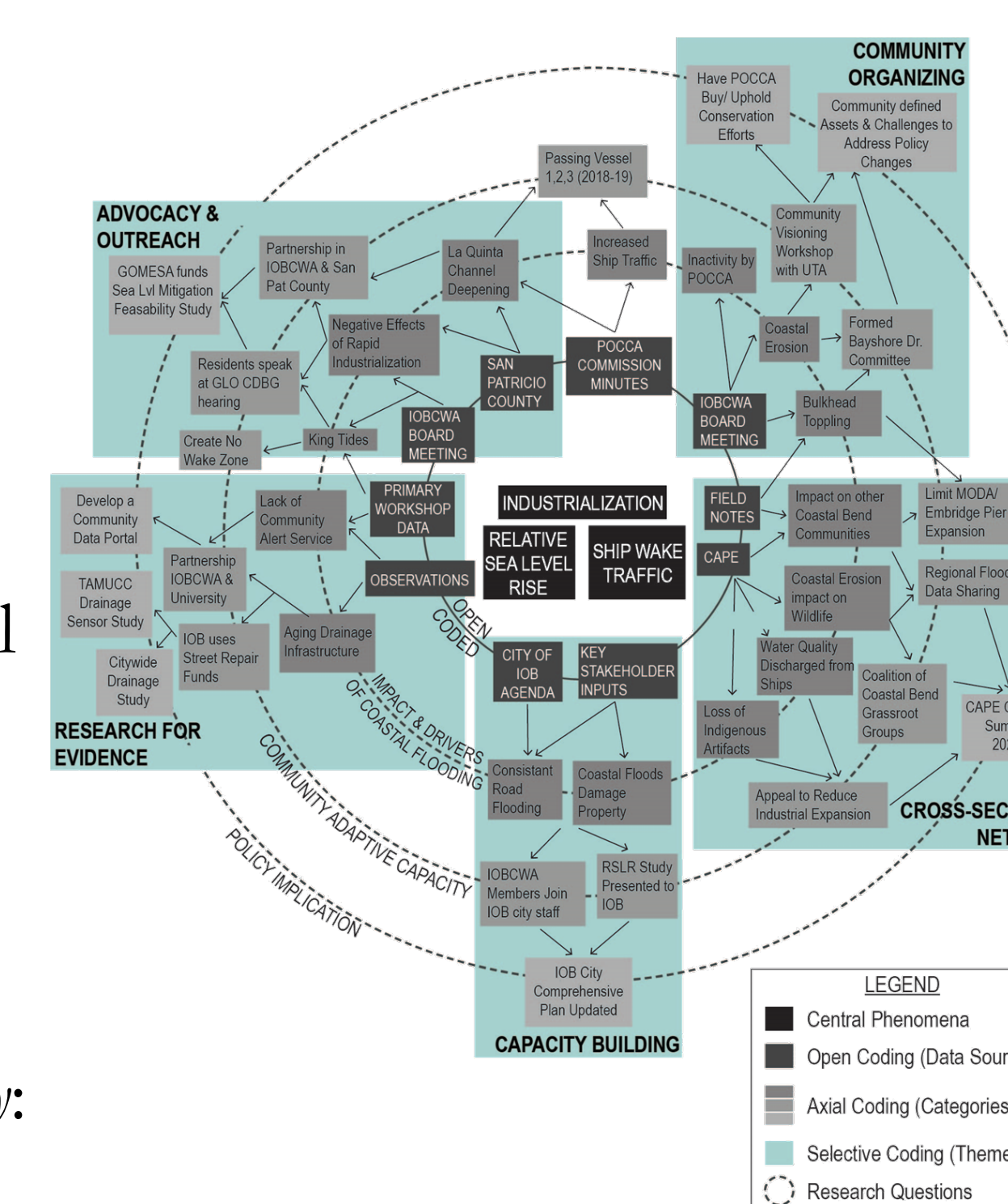
Enhancing local-level environmental monitoring capabilities

- Developed and deployed a wireless network of air quality, water quality, and water level sensors.
- Built partnerships with local organizations (e.g., Texas State Aquarium) to host sensors and share data.
- Developed an online dashboard that displays the collected sensor data in real-time.

Locations of Air-Quality Sensors with Air Quality Index

Advancing data post-processing and analysis frameworks to improve hazard detection

- Developed novel post-processing algorithms to enhance how potential hazards are detected and evaluated based on sensor data.
- Image processing technique that allows for reliable camera-based monitoring of coastal water levels in adverse conditions.
- Multi-modal data integration model that combines readings from low-cost and regulatory-grade sensors to enable uncertainty-aware predictions of air quality.
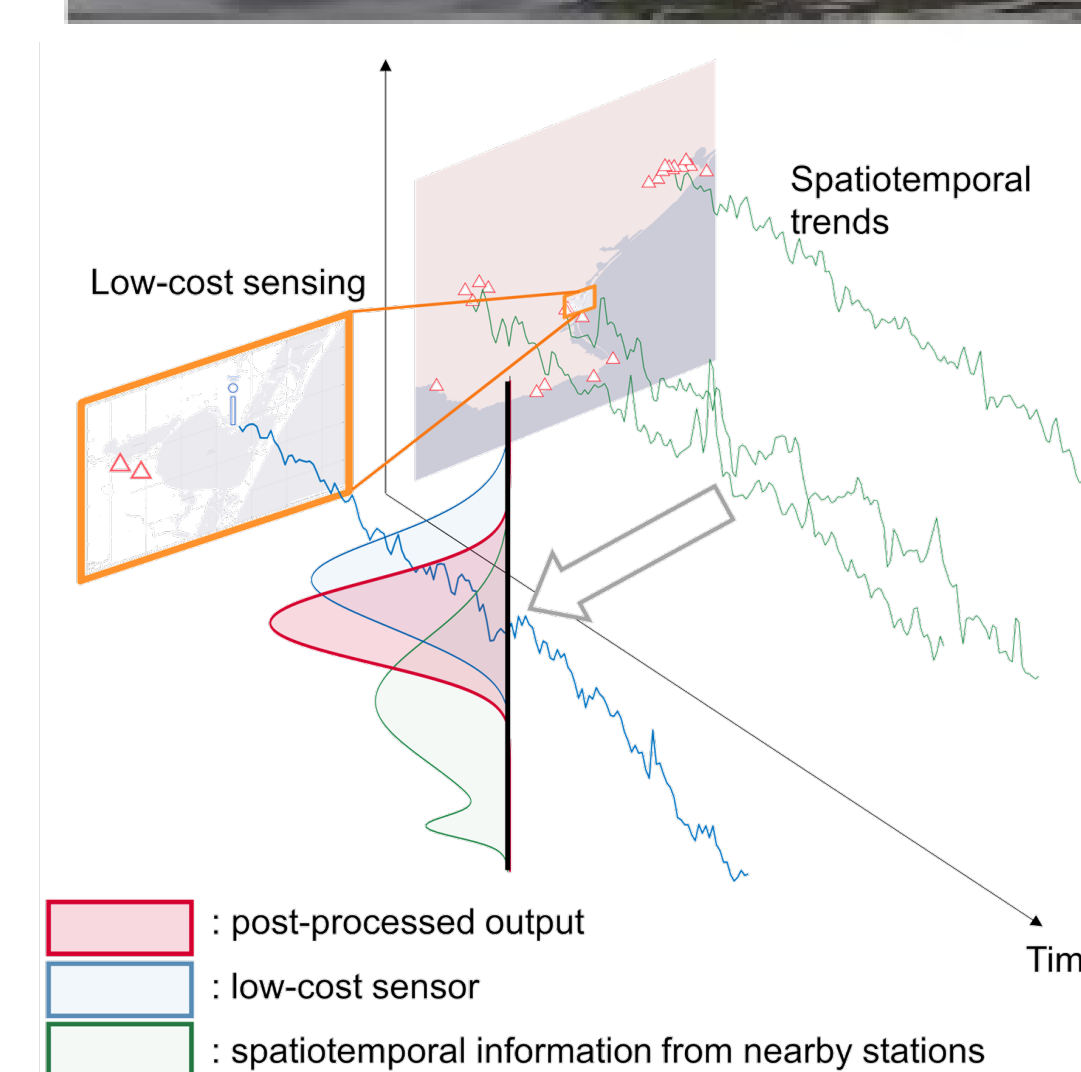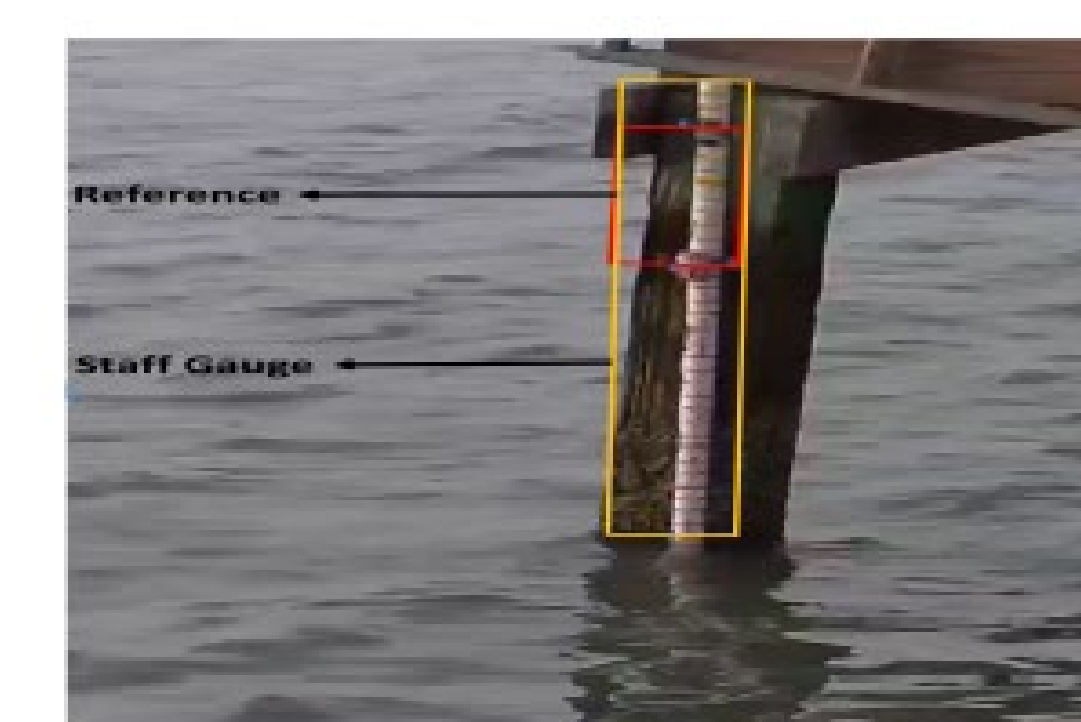
Intellectual Merit

Social science contributions:

- Analyzing how regional network structures develop in response to environmental threats.
- Assessing the role of diverse organizations in promoting regional adaptive capacity.

Technical contributions:

- Demonstrating the value of integrating wireless sensor networks with conventional measurement approaches to monitor local-level environmental conditions.
- Developing multimodal data fusion, learning, and prediction approaches to draw new insights into the drivers and impacts of environmental change.

Sociotechnical contributions:

- Examining how environmental monitoring data can be integrated into regional policymaking structures to support environmental stewardship, equitable risk reduction, and economic growth.

Broader Impacts

- Strengthening multidisciplinary, cross-sector partnerships to advance the use of data in policymaking efforts.
- Enhancing understanding of environmental conditions among the Coastal Bend population by developing and evaluating multiple data visualization and communication approaches that target a range of audiences.
- Engaging underrepresented groups and frontline communities in workshops, usability tests, and sensor monitoring and maintenance activities to enhance public engagement with science and technology.

Future Goals

- Conduct semi-structured interviews with key stakeholders to understand the role that different organizations play in the regional network.
- Validate multimodal data analysis frameworks to demonstrate the added diversity and insights gained through integration of low-cost sensors.
- Organize and host the Smart Coast Symposium.
- Engage undergraduate researchers through an REU supplement.