

# Making Energy Development Safer in the Gulf

Ramanan Krishnamoorti  
Director, Subsea Systems Institute  
Professor, University of Houston



[www.subseasystems.institute](http://www.subseasystems.institute)



## COLLABORATORS AND PARTNERS

University of Houston  
Johnson Space Center (NASA)  
Rice University  
Houston Community College  
Lone Star College  
Texas Southern University  
Academic and Research Institutions  
along the Gulf Coast



# Subsea Systems Institute (SSI)

A Texas Center of Excellence (RESTORE Act)

## Overview:

A collaboration between the University of Houston, Rice University and NASA-JSC, SSI pursues applied science and engineering technology development for offshore energy development, including improving sustainable/safe development, with a focus on the Gulf of Mexico.

## Mission:

To positively impact safety and efficiency of offshore energy development by 1) facilitating engineering, science and policy research and through third party unbiased validation of technology and practices and 2) increasing skill sets across the workforce aligned with the development and deployment of new technologies



**Ramanan Krishnamoorti**  
Chief Energy Officer, UH  
Director, Subsea Systems Institute  
[ramanan@uh.edu](mailto:ramanan@uh.edu)  
713-743-4307



**John Allen**  
Industry Liaison  
Allen Energy Consultants, LLC  
[john.o.allen1@comcast.net](mailto:john.o.allen1@comcast.net)  
713-894-1102



**Andy Chang**  
Program Director  
[kachang3@uh.edu](mailto:kachang3@uh.edu)  
713-743-5331



**Marie Contou-Carrere**  
Research Advisor for Industry  
Partners  
  
Interim Executive Director,  
Carbon Hub Management Team



**Kamlesh Lulla**  
Director, University Collaboration  
and Partnership, NASA-JSC



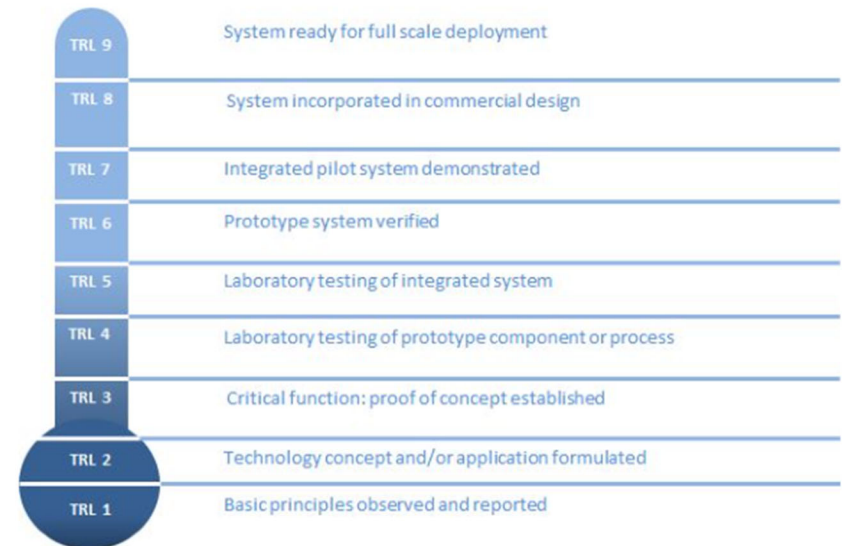
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# Scope of SSI Activities

SSI Research Grants are designed to develop innovative research that can positively impact safe and reliable exploration and energy production from the Gulf of Mexico.

Successful applications lead to technology advancement consistent with the mission objectives of the SSI.

1. Automation & Robotics
2. Asset – Integrity Monitoring
3. Power – Management
4. Energy Transition in the GoM



**\$28**  
**MM**

in Research Funds  
Received

**50**

Faculty Members  
in SSI

**20**

Companies  
Participate



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# SSI - Advisory Board Members



Tom Feutrill



Anish Simon



Nikunj Patel



Chuck Reynolds



Dave Burns



Pat Toomey



Sudhir Pai



Brian Skeels



Diana Grauer



Jared Ciferno



Cheng Tai



Paul Hughes



Holger Stibbe



Aaron Culver



Francesco Tripodi



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# Current Research Projects (2022 - 2024)

1. Offshore Robotics and Automation for Safer Offshore Energy Systems
  - A. *Robotic Fish Enabled Sensing and Inspection*
  - B. *Autonomous underwater vehicle navigation through steel scaffolding*
  - C. *Monitoring subsea connections using percussion and machine learning*
2. Offshore Asset Integrity Monitoring: Environmental Monitoring
  - A. *Development of self-powered distributed sensors/reporters for integrated offshore asset and local environment monitoring*
  - B. *Practical implementation of organic electrochemical transistors (OECTs) for subsea detection*
3. Design and Development of Offshore Power Systems
  - A. *Multi-port Energy Router using Intelligent Transformers (MERIT): Energy Management and Supervisory Control*
  - B. *Optimal Sizing of Onsite Generation Resources for Self-Sustainable Offshore Loads*



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# Newly Funded Projects (2022 - 2024) Part 2

## Research Activities Just Commenced (Continued):

4. Offshore Energy Transition: Repurposing Gulf of Mexico Assets
  - A. *Characterization of deep-water GoM salt domes and proximal sediments for storage of hydrogen and sequestration of CO<sub>2</sub>*
  - B. *Developing methods of producing and processing marine algae to biocrude*
  - C. *Extending the life of offshore oil and gas infrastructure in the Gulf of Mexico for profitable new uses in power and hydrogen generation in preparation for the energy transition.*



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# Developing Bio-inspired Buoyancy Control for Subsea Service AUVs

## Project Focus:

Developing service robotics for subsea system maintenance.

## Need/Significance:

Replacing parts and tools using subsea service robot plays an important role in extending the life time of multi million dollar subsea assets. During the operation, picking up and dropping a tool causes dramatic buoyancy change in service robot, which calls for an efficient and automatic buoyancy control.

## Relevance to SSI Mission:

Replacing tools using subsea service robot will extend the life time of subsea infrastructures, which is relevant to SSI mission.

### Zheng Chen

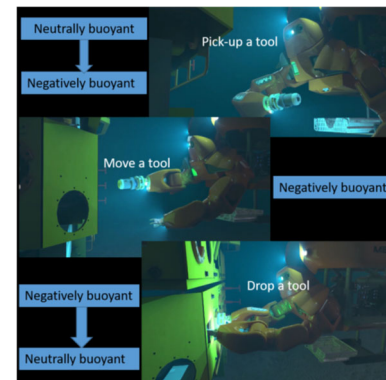
Assistant Professor  
Mechanical Engineering Dept.  
University of Houston

### Fathi Ghorbel

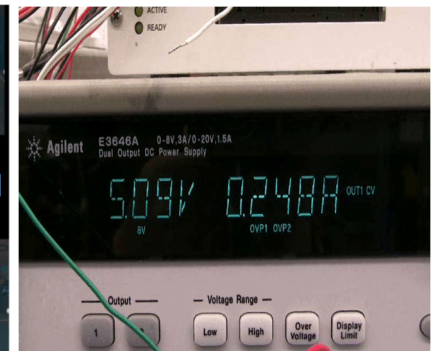
Professor  
Mechanical Engineering Dept.  
Rice University



Motivation: Service robot delivering tools to a subsea infrastructure (animation from Houston Mechatronics)



Challenges in buoyancy control in tool delivery



Efficient buoyancy control using ionic polymer metal composite enabled water electrolysis

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SYSTEMS INSTITUTE



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# Developing Bio-inspired Buoyancy Control for Subsea Service AUVs

## Project Goals:

Develop an efficient buoyancy control for subsea service robots to achieve neutral buoyancy state when delivering tools.

## Approach:

- Using IPMC water electrolyzer and fuel cell to transform water to gas (reversibly) thus changing the buoyancy of the AUVs.
- Developing a nonlinear control of simultaneous hard and soft actuation to achieve fine buoyancy and depth control.

## Anticipated Impact:

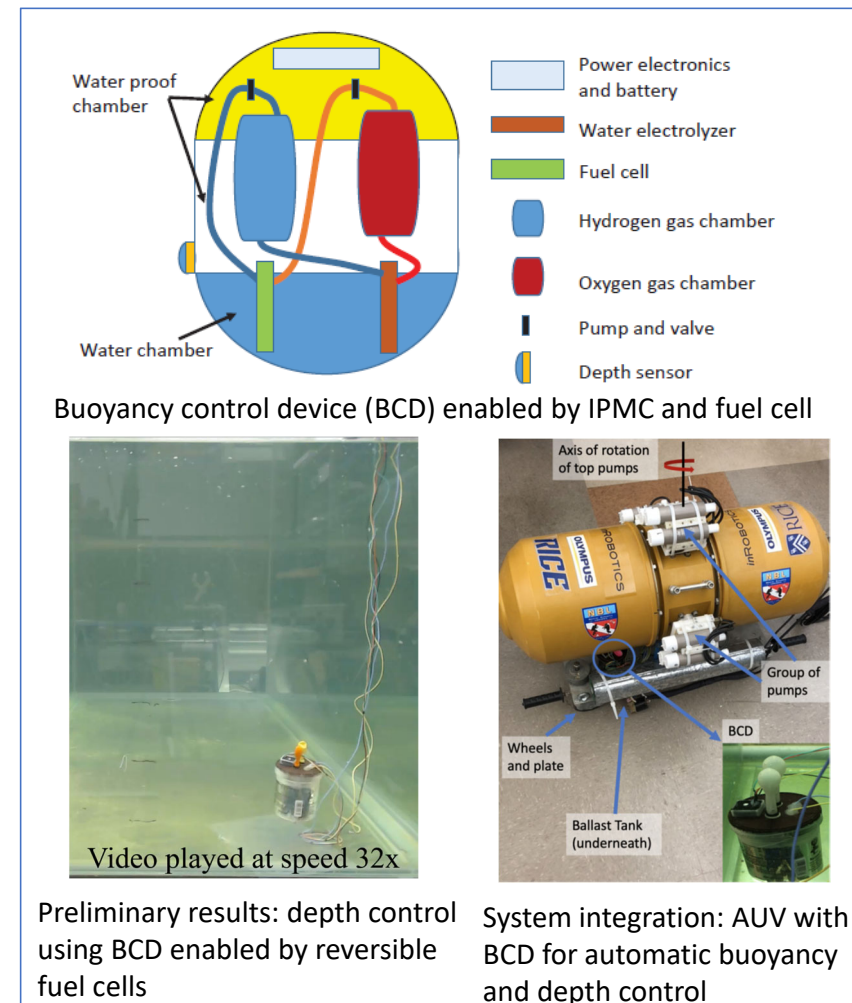
Service robot with efficient buoyancy control will save energy for AUVs to deliver tools to subsea infrastructures.

### Zheng Chen

Assistant Professor  
Mechanical Engineering Dept.  
University of Houston

### Fathi Ghorbel

Professor  
Mechanical Engineering Dept.  
Rice University



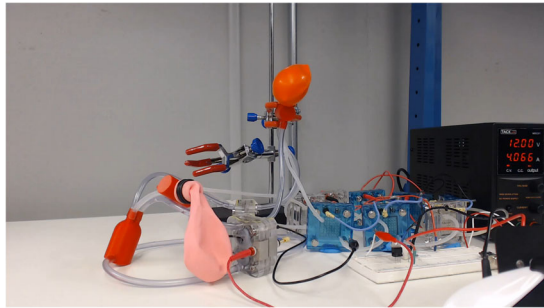
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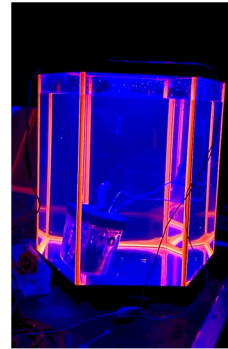
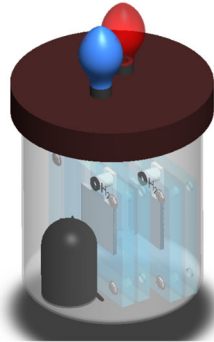
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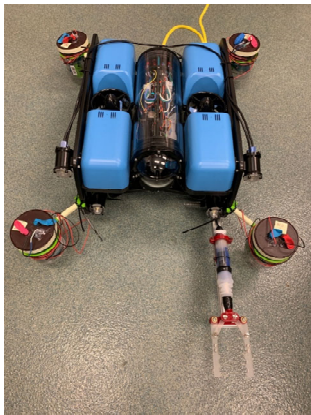
# Experimental and Simulation Results



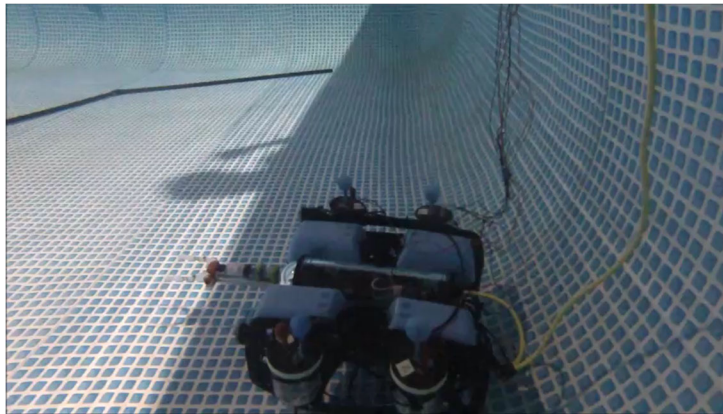
Reversible Fuel Cell Enabled Volume-to-Electricity Engine



Buoyancy Control Device Design and Open-loop Test



Integration with Blue ROV



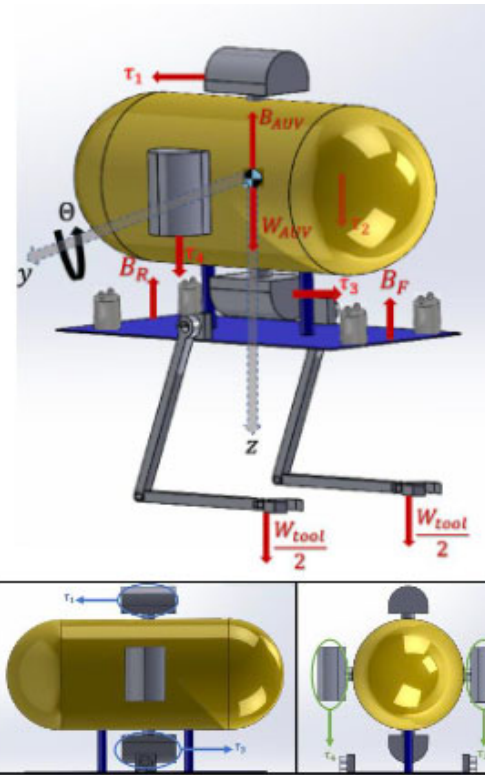
Open-loop Swimming Pool Test

**Zheng Chen**

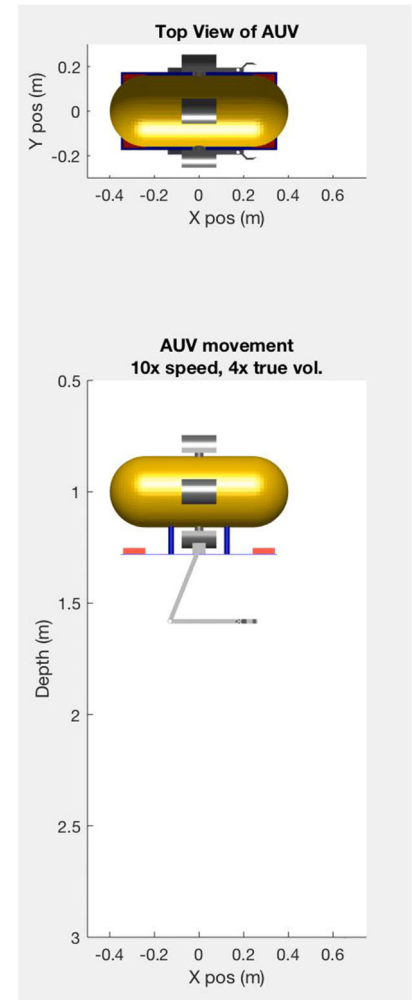
Mechanical Engineering Dept.  
University of Houston

**Fathi Ghorbel**

Mechanical Engineering Dept.  
Rice University



6-DOF Dynamic Model and Control of Service Robot with Simulation Results



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# Robotic Fish Enabled Pipeline Inspection

## Project Focus:

- Developing bio-inspired robots for pipeline inspection.

## Need/Significance:

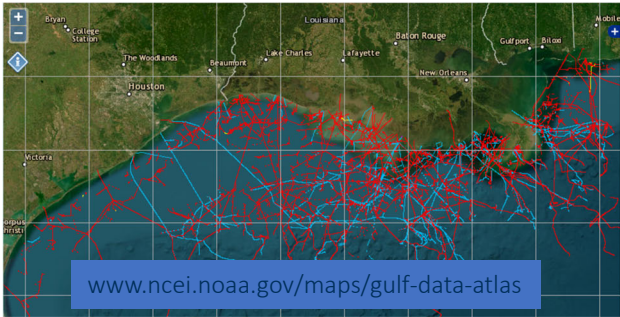
- Pipelines need timely and cost-effective inspections.
- UAVs autonomously detect the ruptures of pipeline, interpret results through unsupervised ML and edge computing, and communicate with a nearby station through underwater communication;
- Pipeline anomalies due to seismic activity, offshore drilling, turbulence, and ship anchoring may be detected at early stages allowing operators to make informed decisions on maintenance and repairs of the pipeline.

## Relevance to SSI Mission:


- Pipeline anomalies will protect our environment from oil spillage, which is relevant to SSI mission.

**Zheng Chen**  
Assistant Professor  
Mechanical Engineering Dept.  
University of Houston

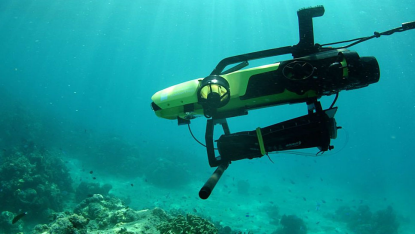
**Xuqing Wu/Jiefu Chen**  
Associate Professor  
Technology /Electrical&Comp Dep.  
University of Houston




Motivation: Low cost and time efficient pipeline inspection




Pipeline damage caused 25,000 gallons oil spill in O.C. in 2021.



Convention ROV/AUV approach



Bio-inspired Robot





# Robotic Fish Enabled Pipeline Inspection

## Project Goals:

Develop low cost, noiseless, and energy-efficient UAVs for offshore infrastructure monitoring and inspection.

## Approach:

- Bio-inspired robotic fish for pipeline inspection;
- Pipeline tracking control for the robotic fish;
- ML for pipeline detection;
- Develop edge computing for limited bandwidth transmission.

## Anticipated Impact:

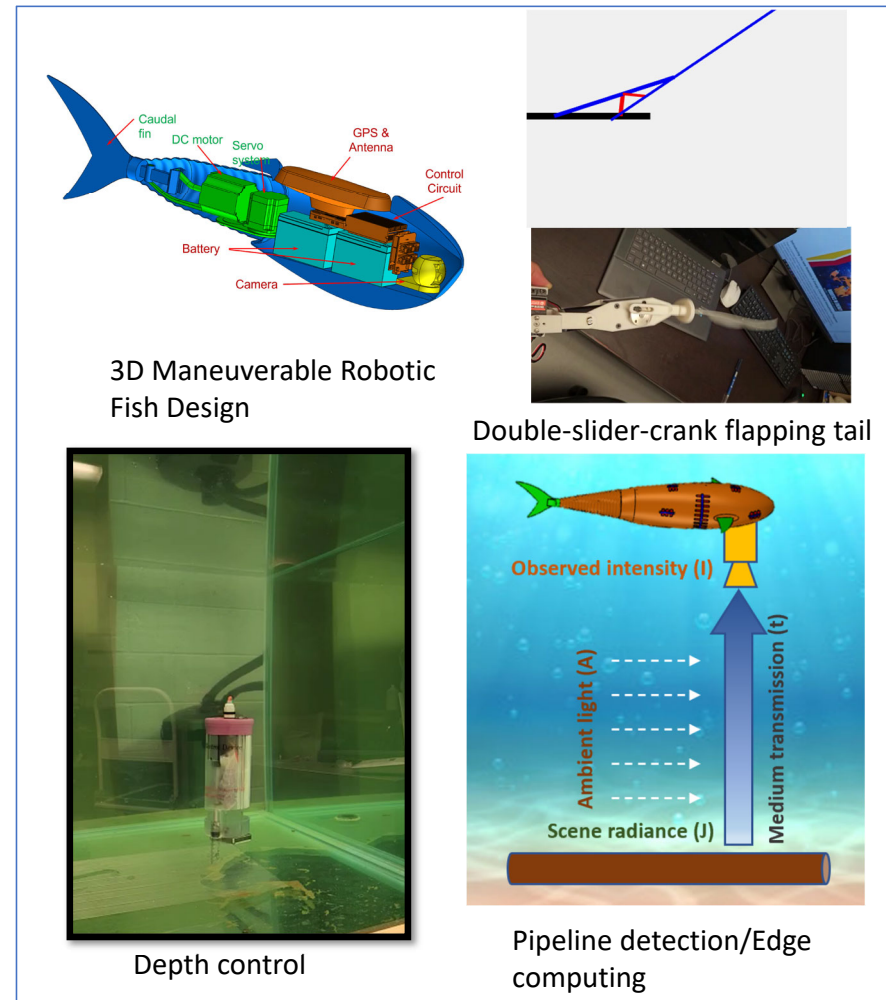
- Reduce the cost and time for underwater pipeline inspection;
- Enable robots to enter combined space.

### Zheng Chen

Assistant Professor  
Mechanical Engineering Dept.  
University of Houston

### Xuqing Wu/Jiefu Chen

Associate Professor  
Technology /Electrical&Comp Dep.  
University of Houston



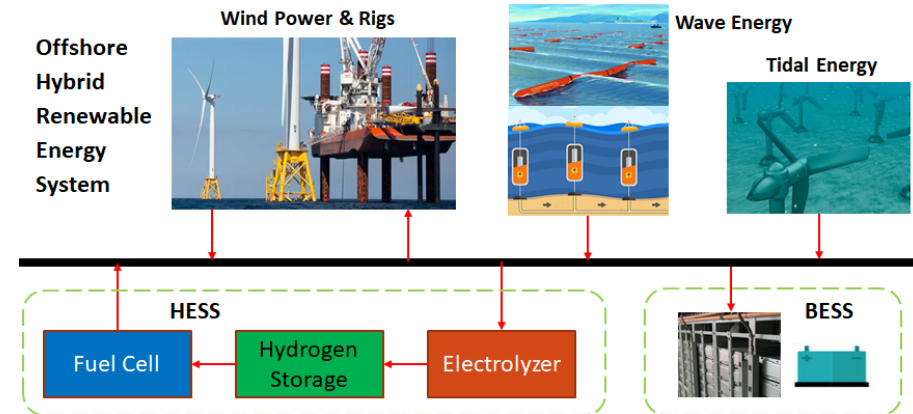
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# Optimal Sizing of On-site Generation Resources for Self-Sustainable Offshore Loads

- Most existing power systems for offshore rig platforms rely on diesel and gas generators
  - Offshore rigs consume ~16 TWh energy a year to power their operations
  - Substantial GHG emissions
- Create a hybrid power energy system, using
  - Renewables: offshore wind power, tidal power and wave power
  - Energy Storage: battery and hydrogen storage
- Goal: Design a local sustainable power system to ensure continuous power supply to offshore loads in an economic and reliable manner



- Modeling and parametrization of offshore renewable resources.
- Modeling and parametrization of energy storage resources.
- Battery (Li-ion) degradation modeling.
- Long-term planning for OHRES (investment decision-making step)
  - Formulate it as an optimization model.
  - Develop advanced algorithms to solve this planning problem.
  - Obtain the optimal size of each candidate energy resource.
- Evaluation and Validation
  - Power flow and stability analysis of the designed system.

# Storing Hydrogen from Offshore Wind Power for Load-balancing and Carbon Elimination

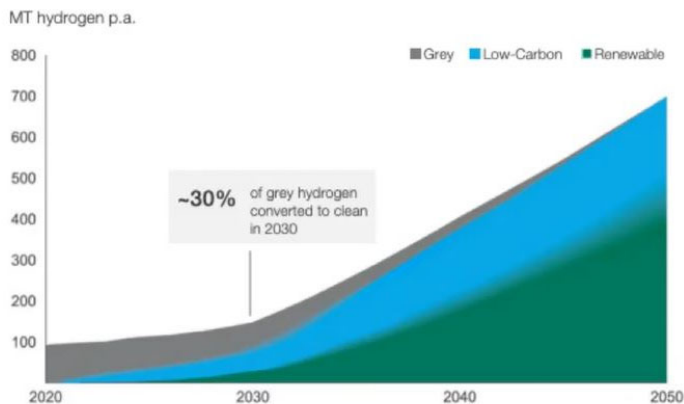
*Multiple studies predicting key role for hydrogen in low-CI energy mix – 6 to 8 x increase in demand by 2050*

*Demand drivers: process industry fuel switching, power gen, long haul mobility*

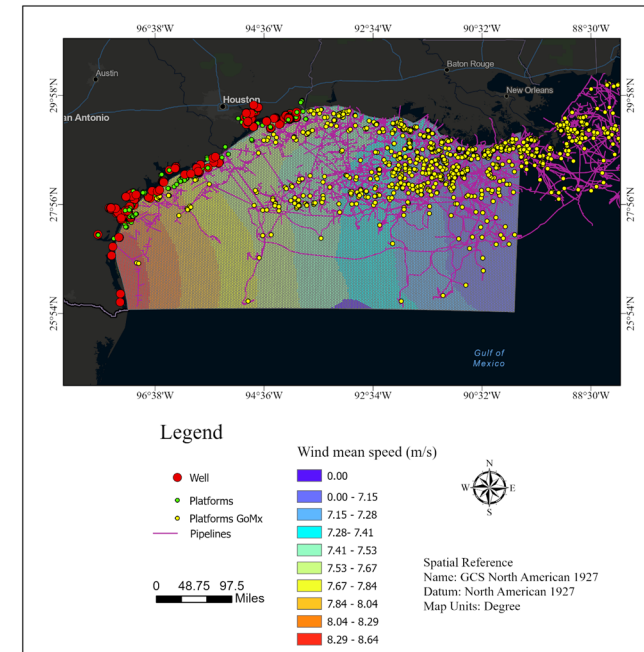
*~2000 platforms and >10,000 miles of pipelines potentially available for repurposing when they reach the end of their oil & gas life*

*Wind speeds in the GOM, sufficient to anchor wind energy projects*

*Many challenges: structural integrity, remaining life, regulatory requirements, cost of repurposing, low wind speeds in the GOM etc.*



Source: Hydrogen Council 2021



Mean Wind Speed (m/s)



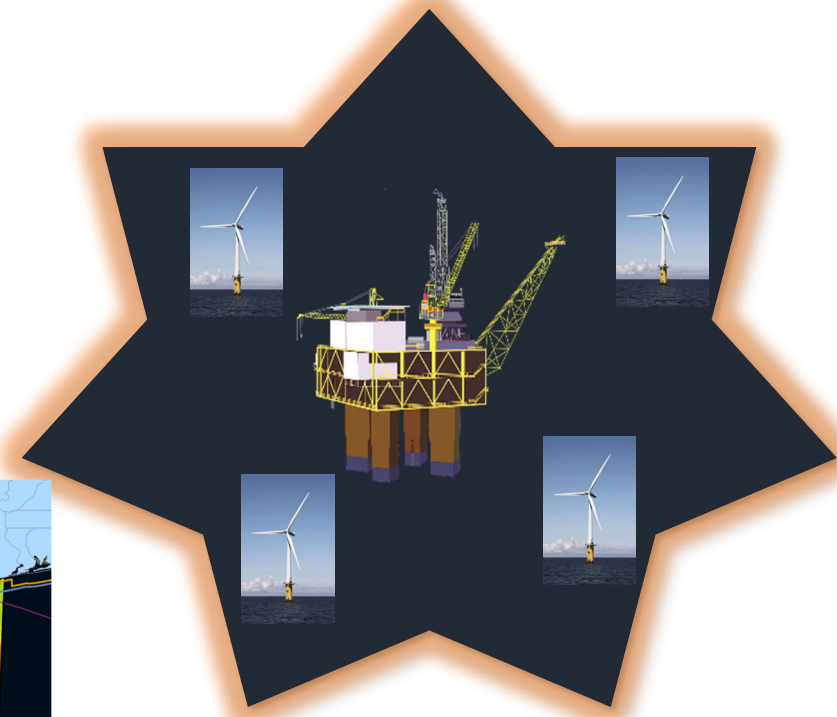
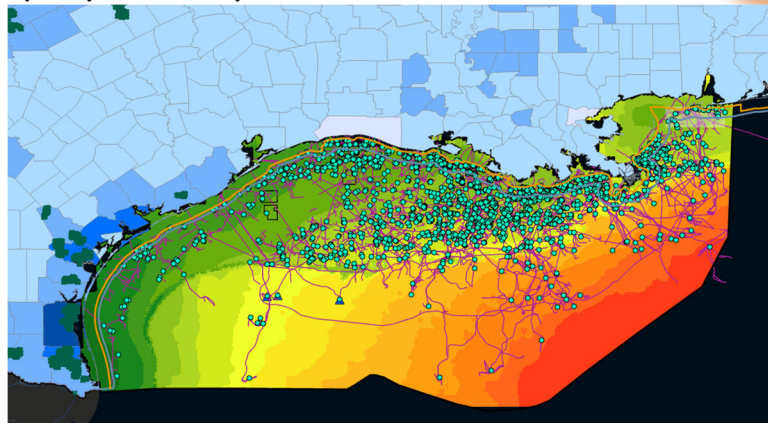
Division of Energy and Innovation  
UNIVERSITY OF HOUSTON

# SHOWPLACE: Techno-Economic Feasibility Studies

SHOWPLACE will develop the engineering and economic models to evaluate the potential for Repurposing Offshore Infrastructure for Clean Energy (ROICE) projects in the Gulf of Mexico

- ❑ Multiple clean energy projects and use cases to be evaluated, such as
- ❑ Power Project Case:
  - ❑ Install floating wind turbines with existing platforms as hub
  - ❑ Transport power to onshore electric grid
- ❑ Hydrogen Project Case:
  - ❑ Utilize wind power to generate freshwater via desalination
  - ❑ Generate hydrogen from freshwater via electrolysis
  - ❑ Transport hydrogen to shore using existing pipelines
- ❑ In consultation with 30-company Advisory Board

Results: “Heat Map”  
of Levelized Cost for  
a Hydrogen Project



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# ROICE: Regulatory and Financial Framework



**ROICE will develop the implementation framework for clean energy repurposing projects**

## **Kickoff Workshop Successful**

- Attended by key stakeholders: Regulatory bodies, Investors, Operators, Researchers, Engineering Companies
- Held Three deep dive sessions: Regulatory, Financial, Technology
- Developed list of key issues to be worked to support clean energy repurposing projects
- Workgroups defined and initial members list developed

**Next steps: Workgroups to begin working through issues in detail and develop roadmaps**

# Questions?

**Ramanan Krishnamoorti**

VP Energy & Innovation, University of Houston  
Director, Subsea Systems Institute  
[ramanan@uh.edu](mailto:ramanan@uh.edu)  
713-743-4307

**Andy Chang**

Program Manager  
Subsea Systems Institute  
[kachang3@uh.edu](mailto:kachang3@uh.edu)  
713-743-5331

**John Allen**

Industry Liaison  
Allen Energy Consultants, LLC  
[john.o.allen1@comcast.net](mailto:john.o.allen1@comcast.net)  
713-894-1102

This project was paid for [in part] with federal funding from the Department of the Treasury through the State of Texas under the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012 (RESTORE Act). The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the State of Texas or the Department of the Treasury.

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# TEXAS ONEGULF: PARTNERING IN TOOL DEVELOPMENT FOR LOCAL HAZARDS RESILIENCE PLANNING

**Harte Research Institute for Gulf of Mexico Studies**  
**Texas A&M University Corpus Christi**

Dr. Katya Wowk  
Director of Texas OneGulf Center of Excellence  
Chair for Community Resilience

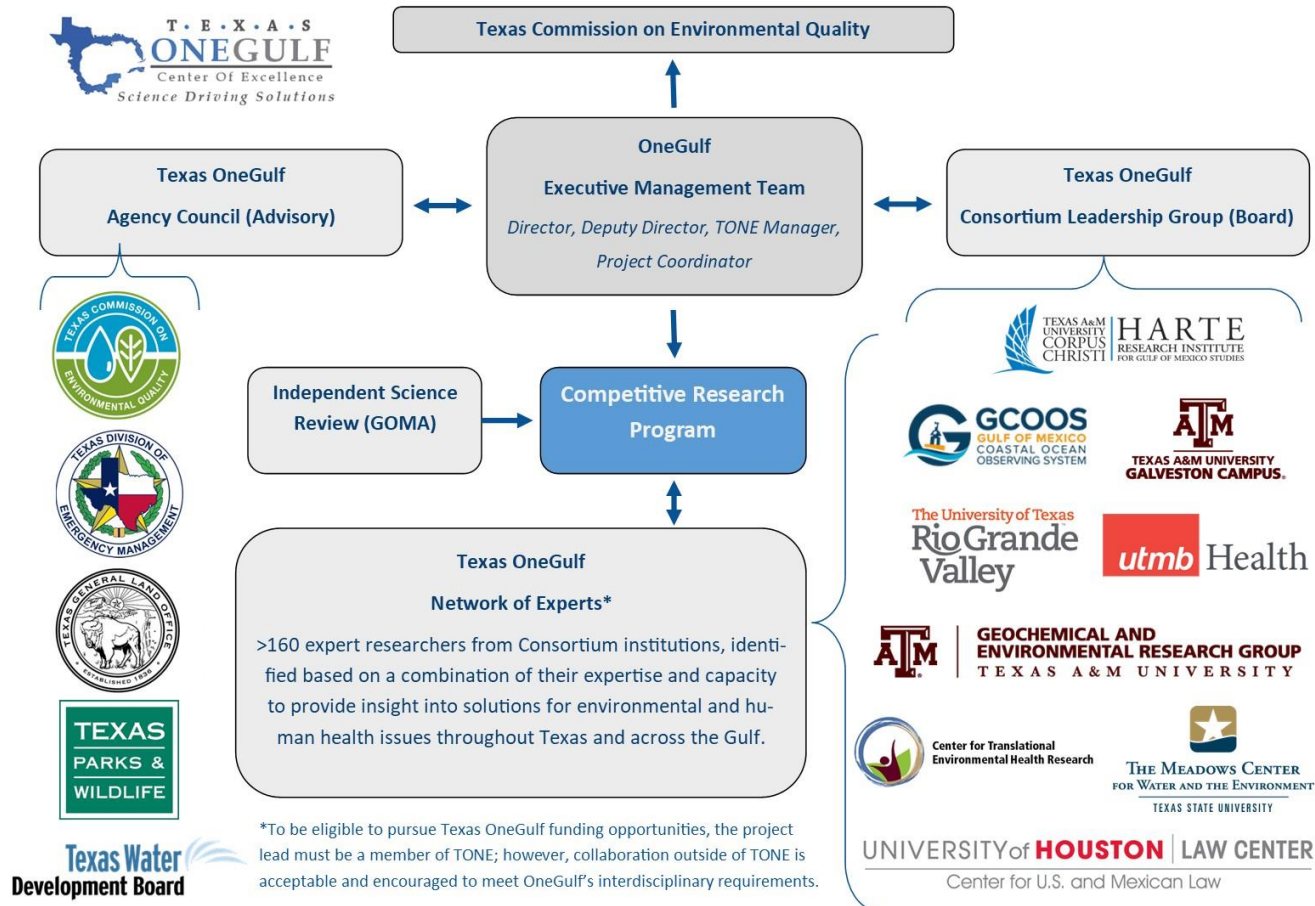
Dr. James Gibeaut  
Endowed Chair for Coastal and Marine Geospatial Sciences

**Coastal Bend Council of Governments**  
Emily Martinez  
Director of Regional Economic Development



T . E . X . A . S  
**ONEGULF**  
Center Of Excellence





# Texas OneGulf Organization Chart

- Coastal and deltaic sustainability, restoration and protection, including solutions and technology that allow citizens to live in a safe and sustainable manner in a coastal delta in the Gulf Coast Region
- Sustainable and resilient growth, economic and commercial development in the Gulf Coast Region

## Executive Management Team



Dr. Katya Wowk,  
Director

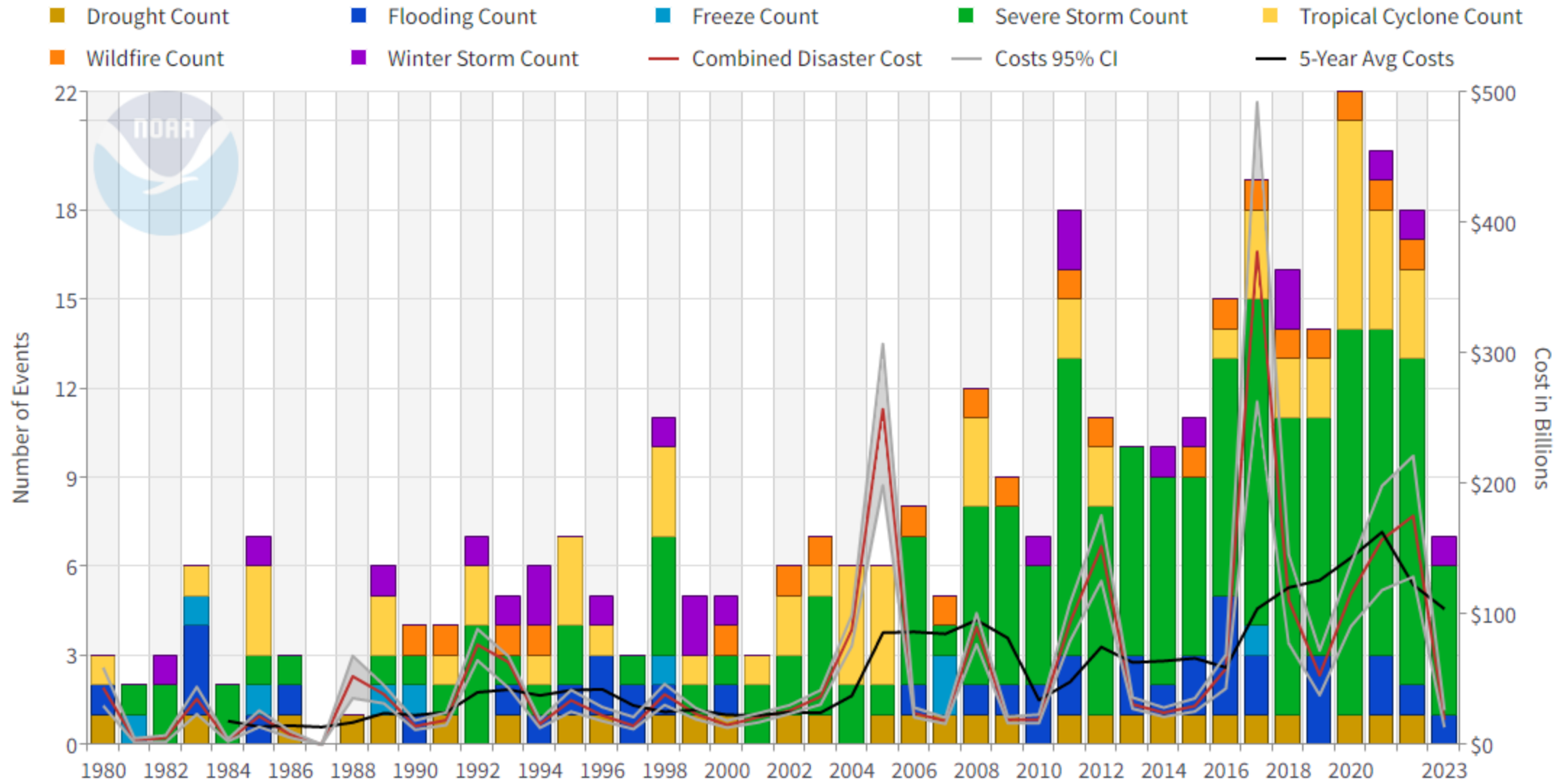
Christine Hale,  
Deputy & TONE  
Manager

Kara Coffey,  
Project  
Coordinator

Dr. Diana Del  
Angel, Research  
Specialist

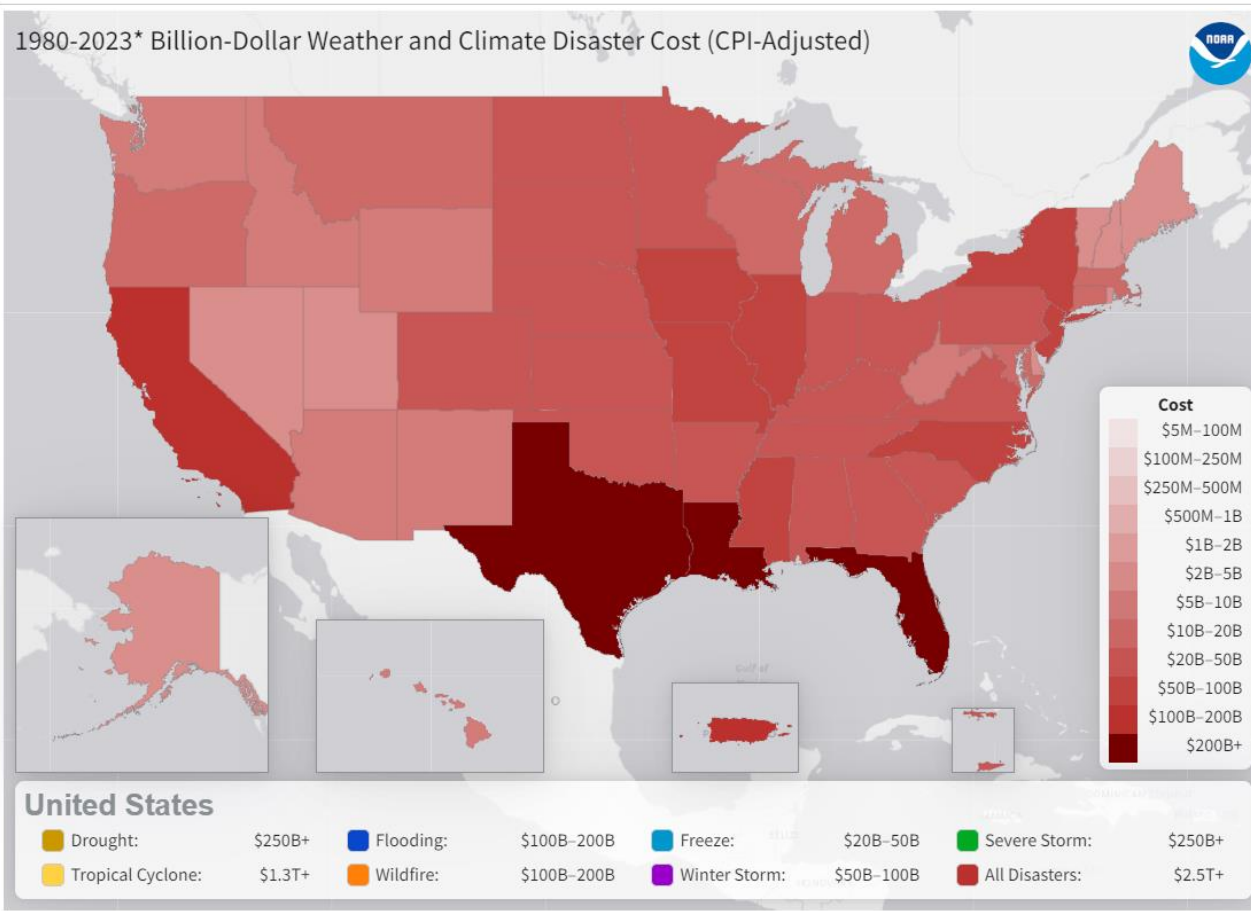


## United States Billion-Dollar Disaster Events 1980-2023 (CPI-Adjusted)



Updated: May 8, 2023

Powered by ZingChart





*Following Harvey, Texas OneGulf worked to identify linkages between human, socioeconomic and environmental impacts to develop decision support data while accelerating disaster recovery*



Texas OneGulf RESTORE Center of Excellence:  
Hurricane Harvey Decision-Support -  
Resilient Environments and Communities

GAD No. 8-582-19-91613  
Final Project Report  
May 30, 2020



[www.harterresearch.org/texasonegulf](http://www.harterresearch.org/texasonegulf)



TEXAS A&M UNIVERSITY  
Institute for Sustainable  
Communities



TEXAS A&M UNIVERSITY  
Texas Target  
Communities



Center for U.S. and Mexican Law  
University of Houston  
Law Center





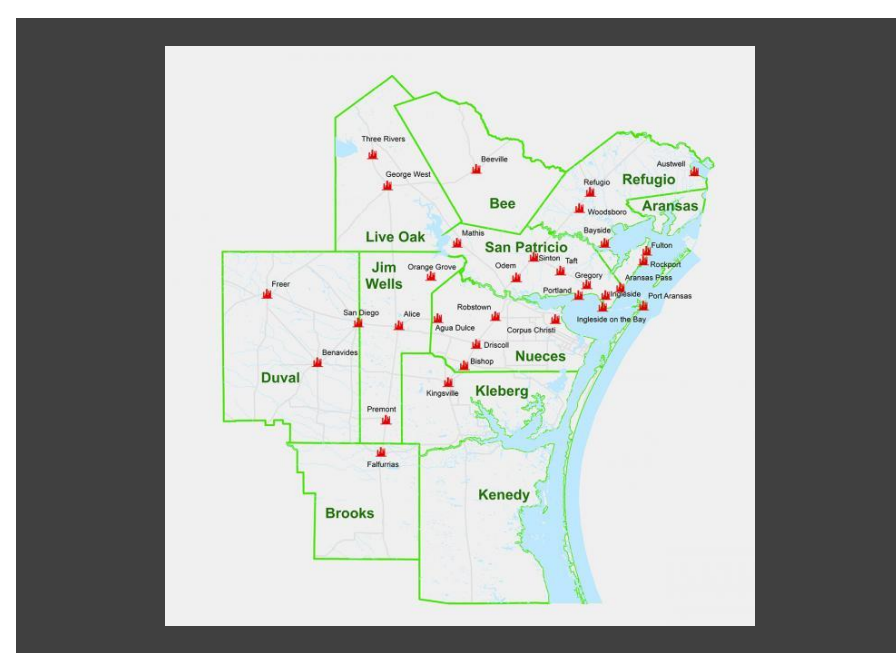


KEY LESSON: COMMUNITY RESILIENCE IS *LOCAL*  
*STRENGTHENED CAPACITY IS NEEDED FROM THE  
LOCAL TO REGIONAL LEVEL!*



# REGIONAL RESILIENCE PARTNERSHIP INITIATED

## 2019 COASTAL BEND HURRICANE CONFERENCE



# REGIONAL RESILIENCE PARTNERSHIP *TEXAS COASTAL BEND*

MEMORANDUM OF UNDERSTANDING  
ESTABLISHING A JOINT PROJECT BETWEEN  
TEXAS A&M UNIVERSITY-CORPUS CHRISTI  
AND  
COASTAL BEND COUNCIL OF GOVERNMENTS  
Agreement No. 1

## I. PARTIES

This Memorandum of Understanding ("Agreement") is entered into by Texas A&M University-Corpus Christi ("TAMUCC"), represented herein by Dr. Kelly Quintanilla in her capacity of President, and the Coastal Bend Council of Governments (CBCOG), represented herein by Mr. John Buckner, in his capacity of Executive Director, with the purpose of setting forth the general framework for specific projects in the future in matters related with: Disaster Resilience and Mitigation of the Texas Coastal Bend and Investigation and the Disclosure thereof, subject to the following considerations, recitals and clauses:

## RECITALS

### II. TAMUCC HEREBY DECLARES THROUGH ITS AGENT:

- (1) That it is a university managed by a Board of Regents of The Texas A&M University System (the "A&M System"), and that it has legal capacity to engage in, and be engaged under the terms of the policies of the A&M System and the laws of the State of Texas.
- (2) That its purpose is supporting investigation and education activities as well as the disclosure thereof, which includes long term development in the sustainable use and preservation of the Gulf of Mexico and resilience building of Gulf coastal communities, specifically through the Harte Research Institute for Gulf of Mexico Studies.
- (3) That the TAMUCC President has the legal capacity to execute this Agreement and additional agreements with other institutions according to the laws of the State of Texas and the policies of the A&M System.
- (4) That its legal domicile is located at Texas A&M University Corpus Christi, 6300 Ocean Drive, Corpus Christi, Texas 78412, United States of America, telephone +1(361) 825-2000.



## MOU finalized December 2019 to build community capacity to mitigate disaster risk

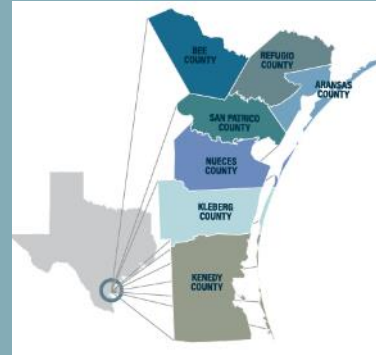
- RRP Listserv for training and funding announcements
- Develop funding strategies, assist with grants applications and administration
- Co-develop feedback to state/federal surveys
- Training sessions (local officials, small business, NGOs, students)
- Direct technical support on building and implementing recovery, resilience and risk mitigation plans
  - Technical assistance in data and GIS

**Partners:** RRP primarily engages communities in the Texas Coastal Bend region. Examples include:

- Local government
- Chambers of Commerce
- Economic Development Corporations
- Workforce
- Independent School Districts
- Non-profit organizations
- Churches
- Public health entities
- Industry partners
- Higher Education
- State agencies and federal partners



# GEOSPATIAL RESILIENT ECONOMIC DEVELOPMENT TOOL (GEORED)



~\$1.4M project to build the Texas Coastal Bend Platform for Resilient Economic Development in seven Counties to:

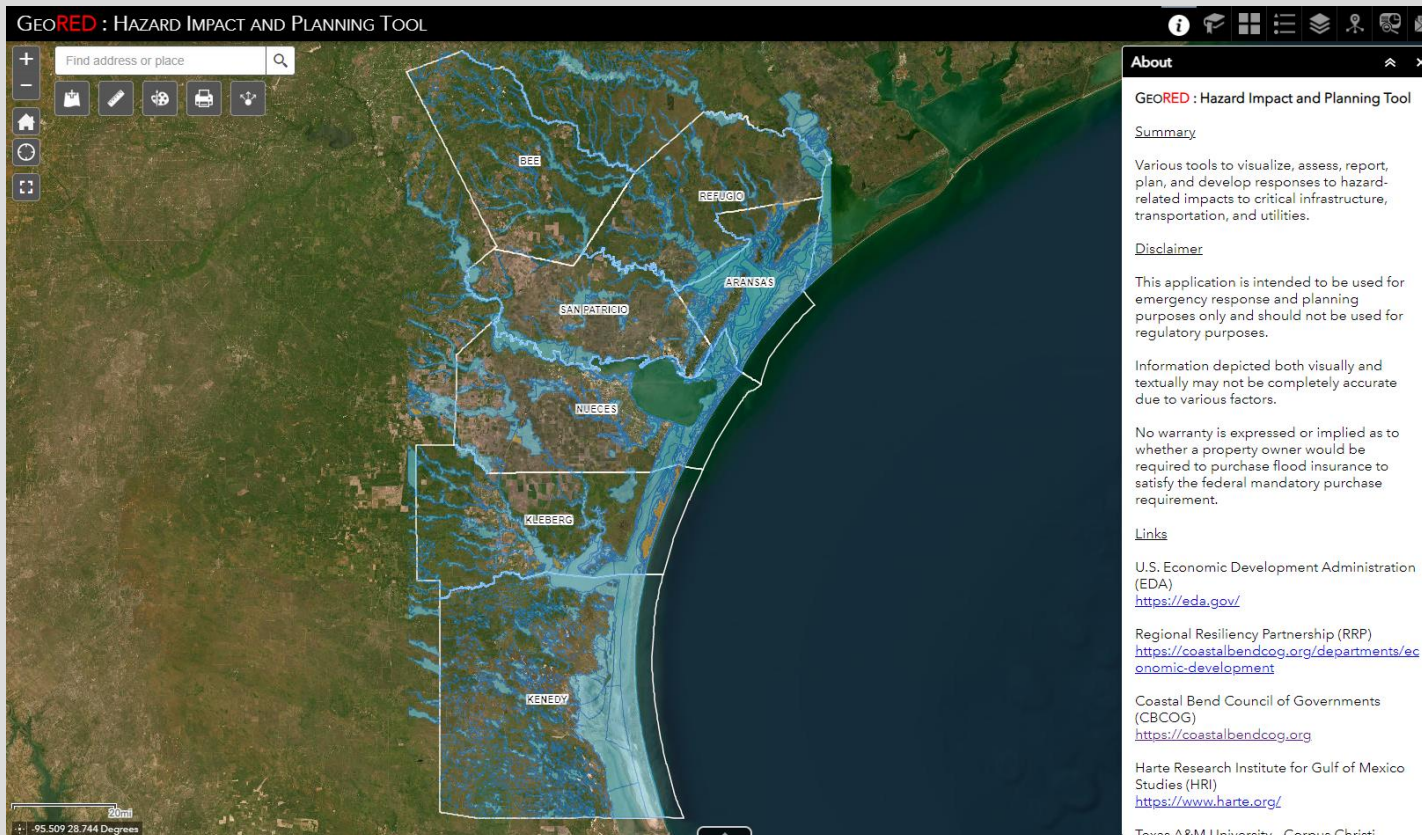
- Provide a common online platform to assess environmental and economic risk in a geospatial framework
- Offer a platform to capture and analyze contextualized local data
- Work with local experts to understand local needs



2020 Economic Development Administration funded the initial phase with focus on: Aransas, Bee, Refugio, San Patricio (\$1M)

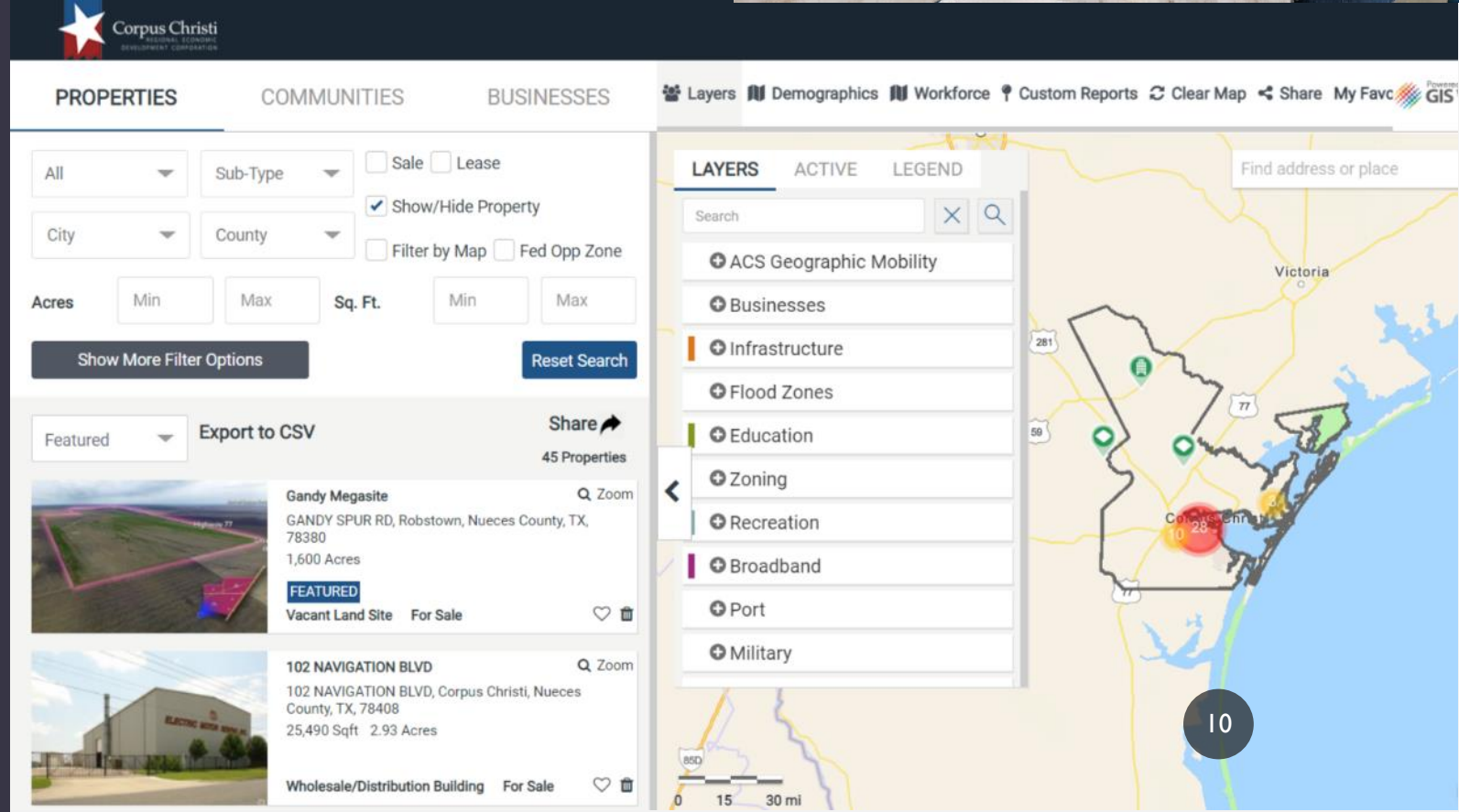


2020 Texas OneGulf provided additional support for Nueces, Kleberg and Kenedy Counties (~\$430K)



# GEORED: CO-PRODUCING THE TOOL


- Worked with local officials to integrate, digitize and QA/QC local physical data, e.g., parcel level data, critical infrastructure, road data, etc.
- Worked with ECDs and Chambers to identify and display economic data layers, e.g., supply chains, labor market analytics, opportunity zones, infrastructure etc.
- Overlaid environmental and hazard information to enhance understanding of risk and opportunity






GEORED

[HTTPS://GEORED.ORG/](https://geored.org/)



PRESENTED BY



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# GeoRED - Geospatial Resilient Economic Development

Welcome to GeoRED, a geospatial data portal designed to assist the communities of the Coastal Bend, Texas in practicing smart growth practices by providing regional hazard, modeling, and economic development data. Begin by exploring data layers available in each category below or by using the interactive map tool.

[Learn More](#)

### Hazard Impacts

GeoRED can be used by decision-makers and the public to build resilience to weather events, flooding and other disruptions.

[→](#)

### Social Vulnerability

Community resilience and social vulnerability are intensely local. GeoRED builds specialized local data into resilience assessments.

[→](#)

### Economic Development

Coastal Bend partners depend on a strong economy – learn how GeoRED can help strengthen economic resilience.


[→](#)

### Environmental Resilience


GeoRED can be used to identify areas of priority concern to build environmental resilience, such as those listed in the Texas Coastal Resiliency Master Plan

[→](#)

||



# Story Maps

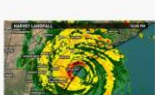


October 12 2022

## Economic Development

Coastal Bend partners depend on a strong economy – learn how GeoEITD can help strengthen economic resilience.

[Read Story →](#)




October 12 2022

## Hazards Impacts and Planning

GeoEITD can be used to build resilience to weather events, flooding and other disruptions.

[Read Story →](#)




October 12 2022

## Social Vulnerability

Resilience and social vulnerability are intimately tied. GeoEITD builds specialized local data into resilience assessments.

[Read Story →](#)



May 09 2023

## Environmental Resilience

A healthy environment is key to societal well-being. GeoEITD provides the tools needed to understand these links.

[Read Story →](#)

[HTTPS://GEORED.ORG/](https://geored.org/)



# HAZARD IMPACT AND PLANNING TOOL

- Report/extract features tool: user can place a point or draw a polygon on the map and a buffer radius of, e.g., 1 mile to see the results within those bounds
- Data layers are all downloadable and shareable without account restrictions and free of charge.
- Users can also add their own data layers and create maps to be downloaded, shared, or even used in grant applications.



# ENVIRONMENTAL PLANNING

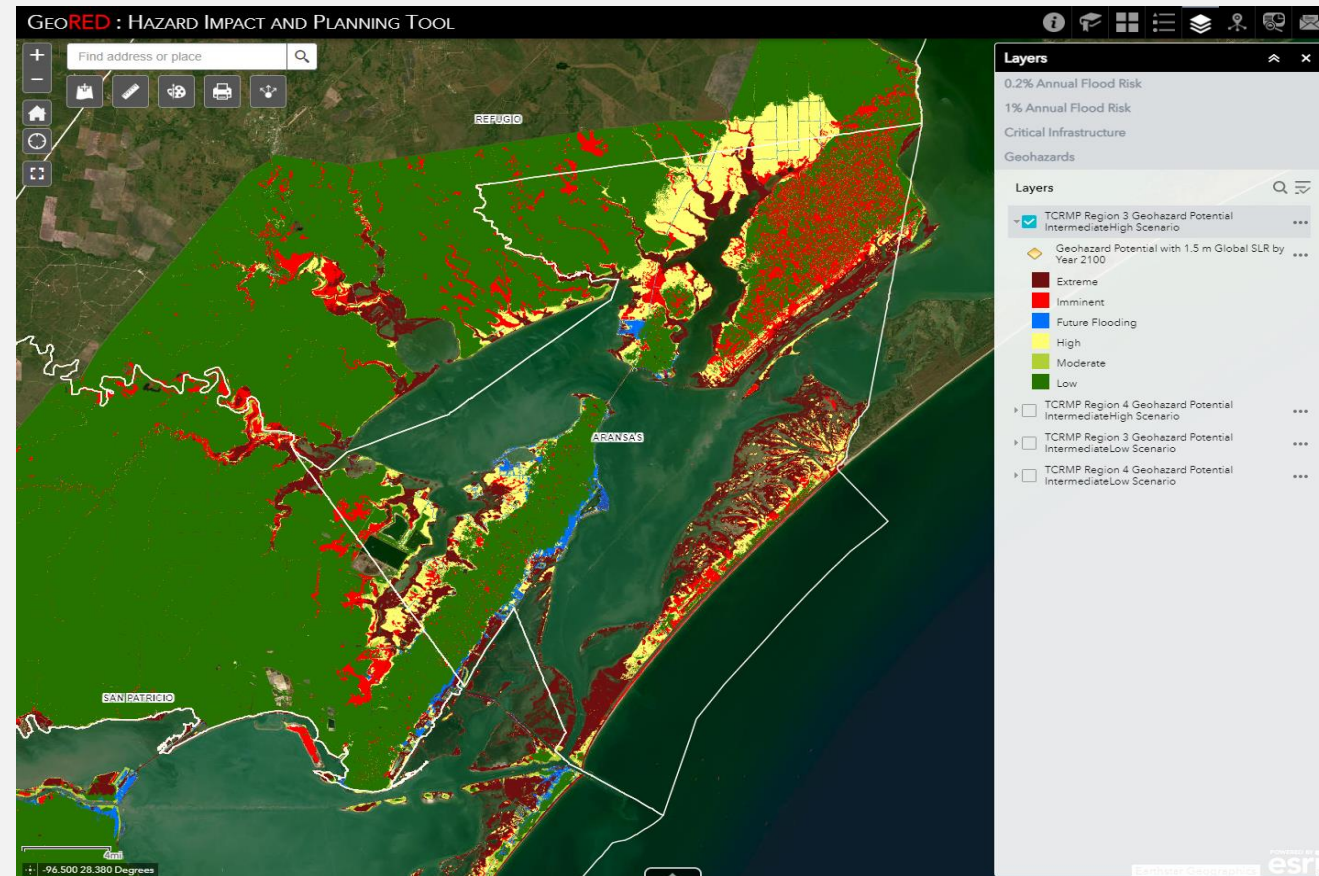
## Examples

### *Restoration of Texas Natural Resources*

- GeoRED can be used to plan for restoration of oyster reefs, wetlands, mangroves, water quality, and other natural assets critical to a functioning economy and to resilience as a whole
- Currently planning to use GeoRED to design a Nature Based Solution/green infrastructure project in partnership with Refugio County

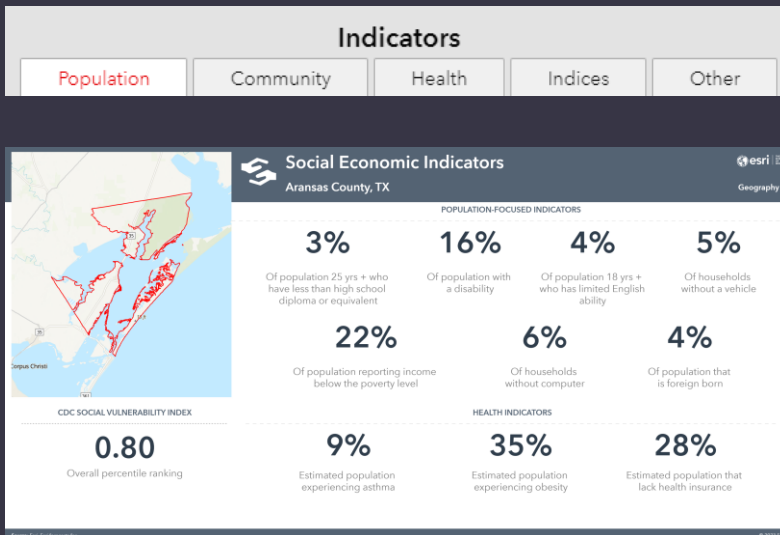
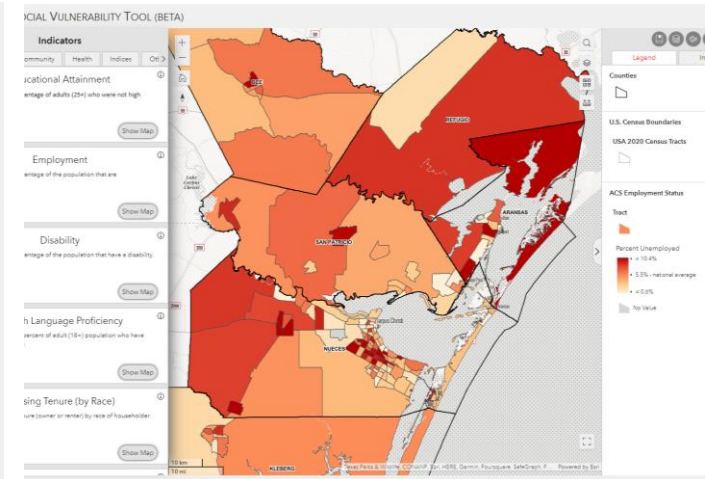
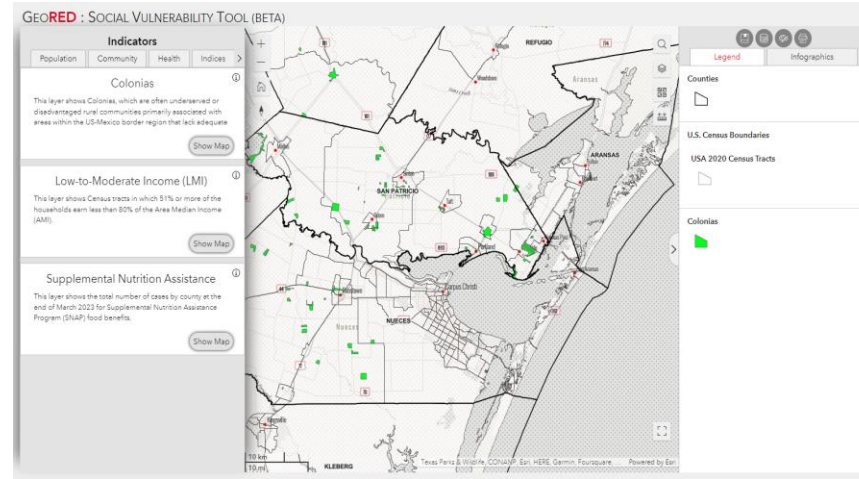
### *Texas Oyster Commercial Mariculture Planning*

- Permitting is now under way via Texas Parks and Wildlife- Coastal Fisheries
- While TPWD does provide the public a web-based map that shows where pending and currently permitted sites are located, GeoRED can be used to help new oyster farmers explore and identify ideal locations

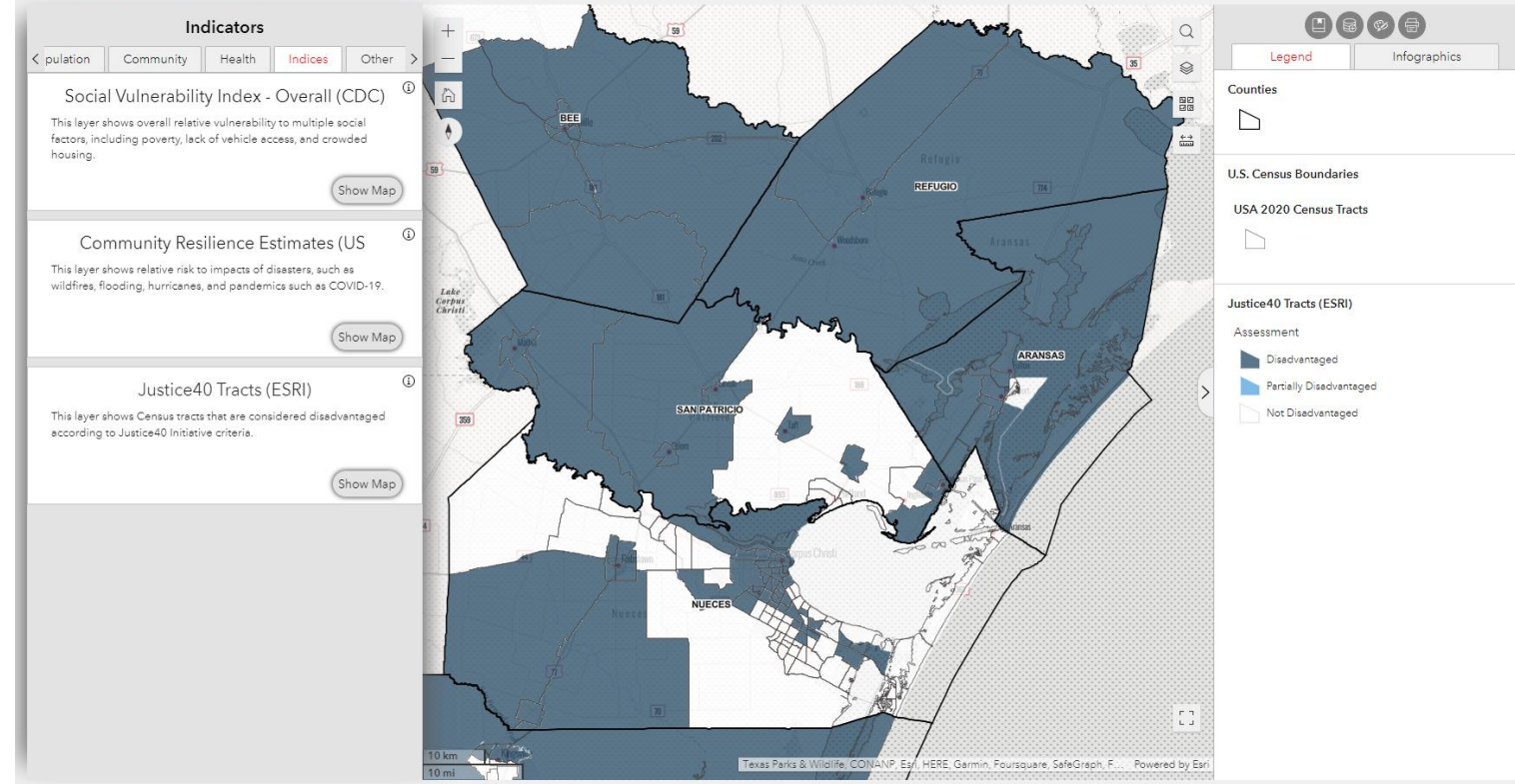




# SOCIAL VULNERABILITY TOOL



## GEORED : SOCIAL VULNERABILITY TOOL (BETA)



## UPCOMING TOOLS: *DRAFT DATA* LAYERS

### Environmental Resilience

Historical landmarks

Public boat ramps

Parks and protected lands

Bike routes

Museums

Trails and walking paths

Protected habitats (wetlands, oysters, rookeries, etc.)

Public beaches

Airports

Hotels

Restaurants

Wetlands and waterways

TCRMP Tier I sites

EJ Screen info -pollution

GLO Beachwatch data

TCEQ monitoring data

### Economic Development

Population

Elevation

Proximity to utilities and transportation

Railways

Pipelines

Broadband

Building and parcel footprints

Zoning (commercial v. residential)

City owned properties

Land use/landcover

Future land use

Sewer service areas

Schools

Critical facilities

Major industrial facilities

Wind turbines and solar

Housing availability

Geology/soil type

Flood layers

Minority owned businesses

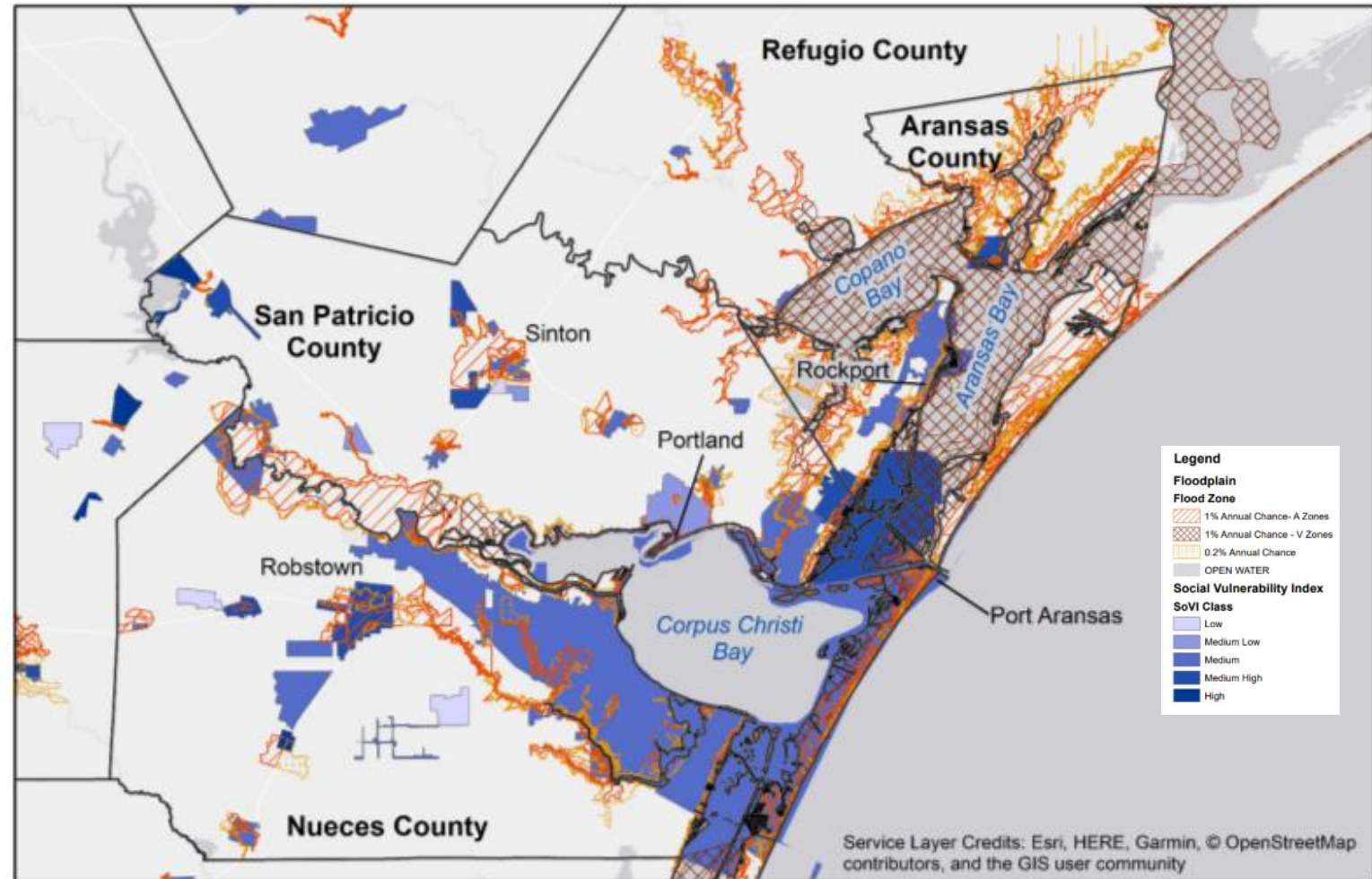
Main event locations (conventions, etc)



GEORED DATA IRL:  
COMMUNITY DEVELOPMENT  
BLOCK GRANT – MITIGATION  
(CDBG-MIT) FUNDING

- Applied data in allocating **\$179,547,000** in CDBG-MIT funds
- Used data to map: Flood Zones; Population; Low-to-Moderate Income; Social Vulnerability; FEMA Individual Assistance Applications; Critical Infrastructure; Land Use/ Landcover
- Received waiver from GLO to use TWDB Texas Floodplain Quilt data in the Coastal Bend MOD – the only COG to do so
- Funding being used by local jurisdictions to develop strategic, high-impact activities to mitigate disaster risks

## Social Vulnerability Index and FEMA Flood Zones Regionwide



Maps available at:

<https://coastalbendcog.org/regional-resilience-partnership>

# RRP COMMUNICATIONS



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Read the Latest RRP Listserv News here!  
Thanks to many for sharing the information below :)

## ----- Important Information & Updates! -----

[Webinar] Financial Assistance Workshop Webinar – April 27, 10:00a-12:30p:  
The Texas Water Development Board is inviting you to join a financial assistance workshop webinar with valuable information and updates. This webinar will provide an overview of some funding programs. Please register for this webinar in advance. There will be time for questions during and after the presentation. [Register](#)

[Webinar] Affordable Housing Financing Resources from HUD – April 12, 1-2:30p:  
This session of the Federal Financing Webinar Series will highlight the resources available at the U.S. Department of Housing and Urban Development to support projects in affordable housing and disaster relief on both the state and local levels. Learning about these programs can help with projects in your community. A registration fee of \$55 is required for non-members of the CDFA. [Register](#)

[Webinar] TWDB Board Meeting – April 11, 9:30a-12:00p:  
The Texas Water Development Board (TWDB) will hold a board meeting to consider approving financial assistance for water, wastewater, and flood projects. The board will also consider adopting rules for the Economically Distressed Areas Program (EDAP) and the State Water Implementation Fund for Texas (SWIFT) program. [Register](#)

## ----- Resilience Webinars, Information, and Funding! -----

### WEBINARS:

Addressing the Silent Epidemic of Pedestrian Deaths – April 12, 12:00-1:00p

The number of pedestrian deaths has been rising in recent years. What can communities do to turn this around? Join the Smart Growth Network as author and speaker Angie Schmitt explains why many pedestrian deaths are avoidable and what communities can do to reframe the problem, make improvements, and help to save lives. [Register](#)

Meet the Grantmakers Webinar – April 13, 10-



### INFORMATION:

CDFA Announces Infrastructure Finance Learning Series, In Partnership with EY  
The CDFA Infrastructure Finance Learning Series, created in partnership with Ernst & Young Global Limited (EY), is designed to help communities develop a comprehensive

### FUNDING:

Energy Transitions in Underserved Communities – April 28

The EPA, as part of its Science to Achieve Results (STAR) program, is seeking applications proposing community-engaged research that will address the drivers and environmental impacts of energy transitions in underserved communities. [Information](#)

Rural Health & Safety Education Competitive Grants Program (RHSE) – April 29  
This program supports

SIGN UP: [RRP@TAMUCC.EDU](mailto:RRP@TAMUCC.EDU)

Project Title	Lead Institution/PI	Start Date
Evaluating the Fiscal and Social Implications of Property Buyouts in Flood-prone Communities	TAMUG / Davlasheridze	1/25/23
An Observational Study of Ship Channel and Shallow Bay Interactions and their Influence on Sediment Transport, Mixing, and Water Quality in Corpus Christi Bay	UTRGV / Brier	1/25/23

# OneGulf: New Projects

*Science Driving Solutions to Gulf Problems*  
[katya.wowk@tamucc.edu](mailto:katya.wowk@tamucc.edu)



This project was paid for in part with federal funding from the Department of the Treasury through the State of Texas under the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012 (RESTORE Act). The content, statements, findings, opinions, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the State of Texas or the Treasury.