# Southeast Texas Urban Integrated Field Laboratory

*Observational Approaches: Building Community Resilience through Rainfall, Water Depth, Water Quality Data Monitoring, and Coastal Marsh Biogeochemical Services*

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## Southeast Texas Flood Coordination Study (Low-Cost Flood Sensors)

### Background

- The Lamar University Center for Resiliency, in partnership with the Southeast Texas Flood Control District and Sabine River Authority, manages an early flood warning system (Southeast Texas Flood Coordination Study, SETx FCS).
- There are 279 flood level sensors spread across 6,000 square miles, operated by Jefferson County DD6, USGS, and the SETxFCD.
  - SETxFCS/DHS monitoring sites: 74 flood monitoring sites
  - Drainage District 6 (DD6) flood monitoring sites: 84 gauges
  - USGS flood monitoring sites: 86 gauges
  - HADS, Sabine/Neches watersheds, and TIDES: 35 gauges

### Flood Sensor Web Dashboard

- Sensor data is stored on a web dashboard that is available to the public (setexasrain.org).
- Each site has stage, precipitation, temperature, pressure readings, and the flood stage thresholds.

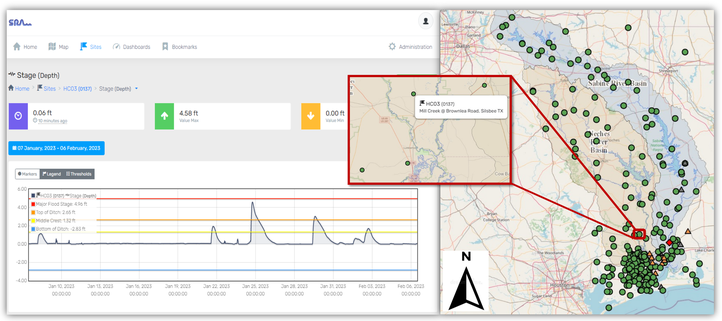

*Fig 1: Flood stage thresholds, a site in Hardin County, Texas (Left). Southeast Texas 279 Flood Monitoring Sites (Right).*

### Data Management

- Cost-effective management is achieved by designating the Center for Resiliency (CfR) at Lamar University as the technical expert and network administrator, utilizing a low-maintenance flood monitoring system with an existing web-based dashboard.
- Public access to flood stage thresholds, sensor data, and historical/real-time data is facilitated through the web platform (Fig 1) operated by the Sabine River Authority (SRA).
- The sensor data is also directly shared with the Texas Department of Transportation (drivetexas.org) and the National Weather Service.


*Fig 2: Sharing map, the main role of SRA web platform.*

### UIFL Sites (New Site Installations)

- Although there are many sensor sites across the region, there is limited coverage in urban areas in Port Arthur, TX, and upstream rural areas in Jasper, Newton, Hardin, and Orange Counties.
- 20 new sites will be strategically deployed over the next 3 years to address low coverage areas. To date, 5/20 sites have been installed.

- Site Location Selection Criteria
  - Local stakeholders (flood plain managers, drainage districts, and emergency managers)
  - Social Vulnerability Index (SVI)
  - Inundation maps
  - Existing sensor placements
  - Critical infrastructure (Fig 3).

The map showing the entire region and then the zoomed-in maps; Jefferson, Hardin, Jasper, Newton, and Orange counties.


*Fig 3: New flood monitoring sites selection in Southeast Texas.*

- Critical areas are demarcated with the circles in Fig 3.
- The ongoing installation spans Newton, Hardin, Jefferson, Jasper, and Orange counties, targeting key water bodies, particularly Neches and Sabine River tributaries, to support flood monitoring in previously underserved areas (Fig 4).

*Fig 4: Flood monitoring sites installation, field surveying and maintenance.*

### Inventory management and Maintenance Route Optimization

- Monitoring and maintaining sensors susceptible to damage is vital for inventory management. An online SQL database allows real-time data storage, data import/export options, and sensor site management (Fig 5).
- Maintenance routes were optimized to minimize travel miles and fuel consumption

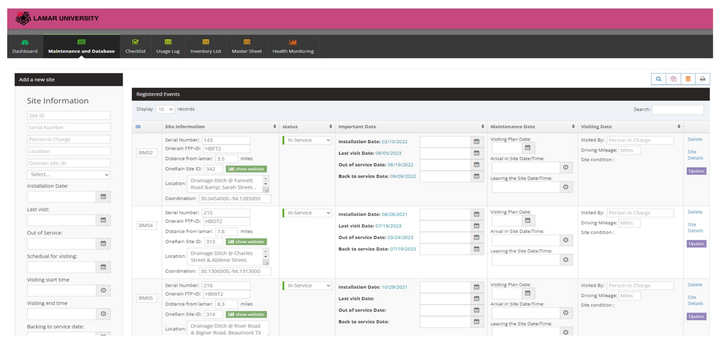


*Fig 5: Inventory management online database.*

## Water Quality Data Monitoring

- As shown in Fig. 1, we have installed the YSI sensor at the Neches Saltwater Barrier since 2021 to record 15-minute interval data of temperature, Specific Conductance (SC), turbidity, TDS, DO, pH, Chlorophyll, fluorescence, BGAPC. The data were preprocessed and merged with USGS gage water depth and flow rate data to investigate the correction among the parameters.

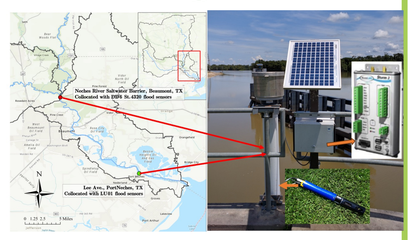


*Fig 1: Sensor locations*

The correlation data analysis showed that extreme floodings flushed nonpoint sources in the watershed sources to cause depressed Dissolved Oxygen (DO) and elevated E. coli. The correlation between E. coli and turbidity determines that turbidity > 45 NTU in the Neches River can serve as a proxy for E. coli to indicate the bacterial outbreak.

The new YSI sensor will be installed downstream, as shown in Fig. 1 in the Port Neches. According to the feature importance and significant negative correlation between DO and temperature, an LSTM model with 2 input features (temperature and DO) was trained by the Pine Island Bayou dataset and used to predict the daily DO of the Saltwater Barrier. The model results demonstrate high agreement with measurements, as shown in Figure 2 and Table 1.

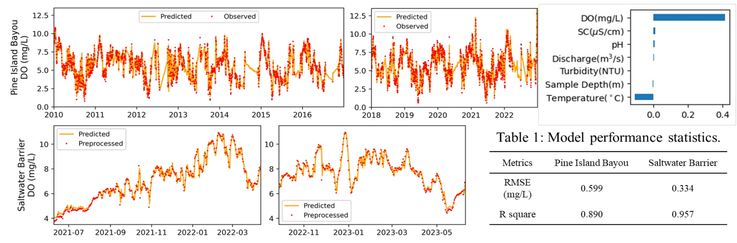


Table 1: Model performance statistics.

| Metrics | Pine Island Bayou | Saltwater Barrier |
|---|---|---|
| RMSE (mg/L) | 0.599 | 0.334 |
| R square | 0.890 | 0.957 |

*Fig 2: Predicted DO generated by LSTM model and feature importance analysis*

## Coastal Marsh Biogeochemical Services


**Background:** Coastal marshes provide valued ecological services including fisheries, recreation, storm protection, and carbon sequestration. SETX marshes have experienced inundation stress and erosion fragmenting land cover to open water. Subsidence and sea level rise are primary drivers. Efforts to restore coastal marsh health involves dredge material placement across the land surface to increase elevations and hydrologic modification to reduce marsh salinity.

**Aim:** The SETX DOE-IFL explores how coastal marsh health state, restoration, and salinity impact carbon biogeochemistry across a landward gradient of decreasing salinity. Estimates of carbon sequestration by vegetation, its sediment storage, and emissions of carbon dioxide and methane, and relevant metadata are being measured. These data will be used in development of regional predictive models of marsh biogeochemistry. Early results (Table 1) demonstrate impacts of elevation on health and salinity on methane inventory and emissions.

*Fig 1: SETX coastal marsh sites, conditions, and $CH_4$ methods.*

*Table 1: Marsh methane inventory, emissions, salinity and elevation*

| Study site | Salinity (ppt) | $CH_4$ inventory ($\mu mol\ m^{-2}$)† | $CH_4$ emission ($mg\ CH_4\text{-}C\ m^{-2}\ d^{-1}$) | Sediment surface MSL elevation (cm) |
|---|---|---|---|---|
| NGOM, Salt Bayou H1 | 18.5 (± 2.9) | 138 (± 76.2) | ND | 42.1 3.0 |
| NGOM, Salt Bayou D1 | 18.2 (± 0.9) | 152 (± 49.3) | 0.14 (± 0.22) | 21.7 6.4 |
| NGOM, Salt Bayou D2* | 8.4 (± 2.3) | 4390 (± 984) | 7.1 (± 1.8) | 11.0 8.1 |
| NGOM, Salt Bayou R1 | 6.8 (± 1.3) | 5340 (± 2600) | 9.0 (± 5.8) | 31.8 4.7 |
| NGOM, Salt Bayou R2* | 20.0 (± 1.0) | 61.8 (± 8.88) | ND | 29.4 4.6 |
| NGOM, Salt Bayou R3* | 11.4 (± 1.7) | 1218.0 (± 38.6) | 3.2 (± 1.7) | 32.9 4.3 |

* = summer sampling only; ND = not detectable

† = Methane inventory was integrated to 25 cm depth.

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