WATER MODELING FOR COASTAL FLOOD PLANNING

SOUTHEAST TEXAS
URBAN INTEGRATED FIELD LAB

Modeling the effects of planned infrastructure and flood mitigation

WHY NOW?

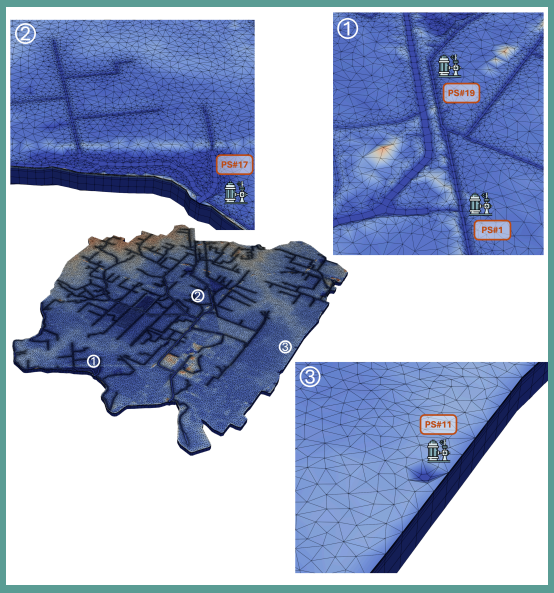
Coastal communities are facing intense storms and continued growth. To manage flooding, low-lying regions rely on pumps, gates, canals, and detention basins. These systems strongly influence how floods rise and recede, yet they are often missing from watershed-scale models used for planning. Modeling the effects of planned infrastructure and flood mitigation investments is necessary to compare options and ensure sufficient investments are made.

WHAT WE DID

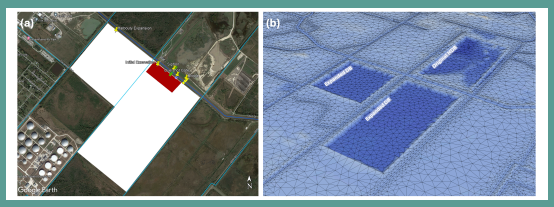
The SETx-UIFL research team built a detailed computer model of the Alligator Bayou watershed that includes the full drainage system -canals, pump stations, gates, detention basins, and directly connected impervious areas. The model simulates how rainfall moves across the land, through canals, and into pumps in real time. This allows infrastructure operations and watershed flooding to influence each other, just as they do in the field. This model was used to evaluate current system performance during major storms and to test scenarios such as the proposed expansion of the Halbouty Detention Basin and changes in pump performance under high water conditions.

WHO WAS INVOLVED?

Drainage District 7 (DD7) staff provided canal maps, pump station capacities, operating practices, engineering plans, and hosted site visits to key pump and gate facilities. Their insights into day-to-day operational constraints and system bottlenecks directly informed how infrastructure was represented in the model. This close collaboration ensured that simulated scenarios reflected real-world conditions and management practices, which strengthened the model's relevance for planning, design decisions, and future flood response strategies.



Computational mesh for the Alligator Bayou Watershed. Drainage canals are resolved with channel-aligned quadrilateral elements. Callouts highlight three representative pump-station configurations



Halbouty Detention Basin (HDB) expansion scenario. (a) Engineering plan for the proposed excavation, image courtesy of Drainage District 7. (b) Baseline and expanded HDB geometries embedded in the computational mesh, connected to the Main "C" canal via a gate.

FINDINGS

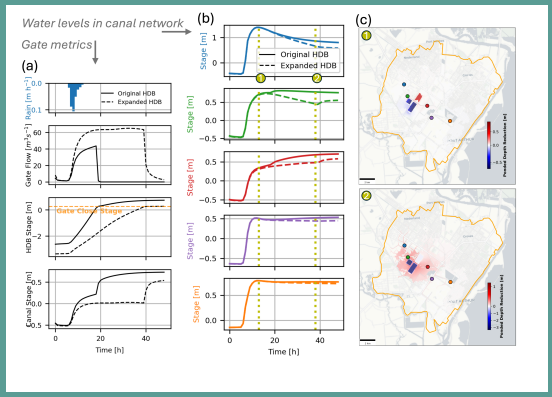
This work brings basin-scale hydrology and localized infrastructure operations into one actionable modeling tool. In Alligator Bayou, we found:

- Explicitly representing pumps, gates, and canals improves model realism and usefulness for operations and capital planning.

- Expanding the Halbouty Detention Basin (~5,000 acre-feet) lowers canal stages both upstream and downstream. The largest benefit is faster post-storm drawdown and reduced ponding in low-lying areas; peak flood levels decrease modestly.

- Pump stations can approach or reach capacity during major storms, increasing flood duration in certain areas.

The infrastructure tools developed in this project are available in open-source platforms (ATS v1.6; Watershed Workflow 1.6) and can support future "what-if" analyses for design and planning decisions.



Effects of HDB expansion during a 100-year storm. Time series diversion to HDB, basin level, and canal stage for baseline vs. expanded cases; canal stages are shown at five network locations. Maps illustrate how ponded depth changes at two times (13h and 32h): red indicates less ponding, blue indicates more.

MORE ABOUT SETX-UIFL

The Southeast Texas Urban Integrated Field Lab (SETx-UIFL) is one of four projects funded in 2022 by the U.S. Department of Energy to study how climate, environment, and urban changes affect cities. A team of over 80 researchers from UT, Lamar University, Texas A&M, Prairie View A&M, Oak Ridge National Lab, and Los Alamos National Lab has collected data and conducted modeling across hazards including flooding, hurricanes, heat stress, and air quality. Our Why: Southeast Texas faces numerous hazards, yet smaller communities like this one have often felt forgotten compared to larger cities. The SETx-UIFL was designed to explore the complex dynamics of disaster vulnerability for this economically and culturally vibrant region. We believe Southeast Texas is a bellwether for the entire Gulf Coast, and an exemplar for strategies that protect people and places. We hope this effort supports your path toward lasting resilience.

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