USGS science for a changing world

Texas Water Development Board

TIFF

Texas Integrated Flooding Framework

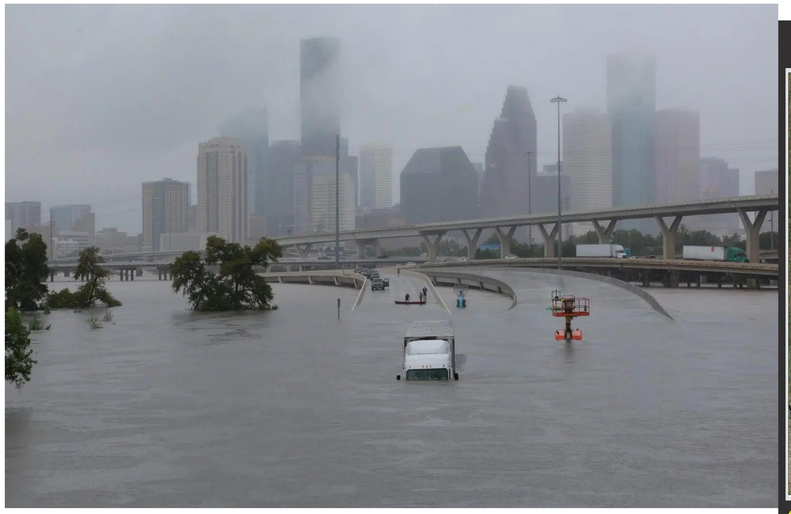
Data collection • Visualization • Modeling • Planning

A collaboration between the Texas Water Development Board, the U.S. Geological Survey, the Army Corps of Engineers, and the Texas General Land Office

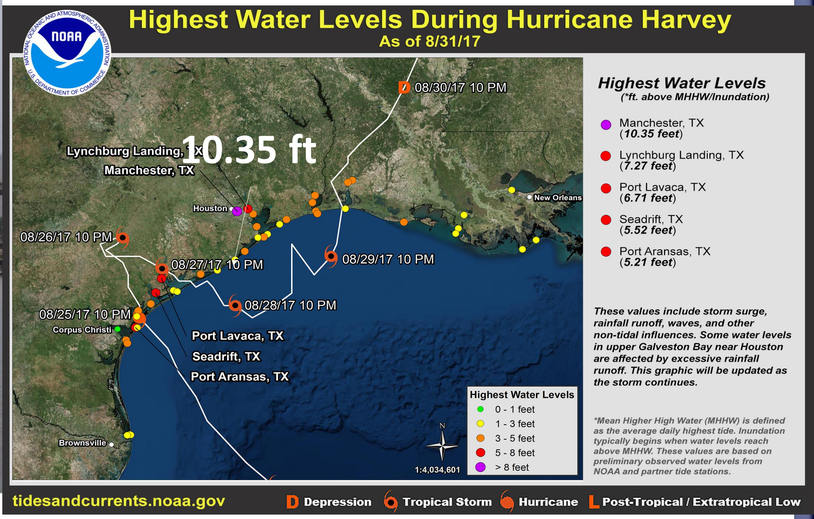
Introduction

- Texas leads the nation in disaster declarations for the recent 2015, 2016, 2018 and 2019 floods
- Texas leads the nation in flood related deaths from 1960-1995 - National Climatic Data Center
- Hurricane Ike (2008) with 17.4 ft. storm surge in Galveston Bay ➔ $36.6 billion in damage
- Hurricane Harvey (2017) with a 7 ft. storm surge in Copano Bay, TX and ~60 inches of rainfall in Nederland, TX ➔ $130 billion

Hurricane Ike storm surge: Sept. 2008 (Photo: NOAA)

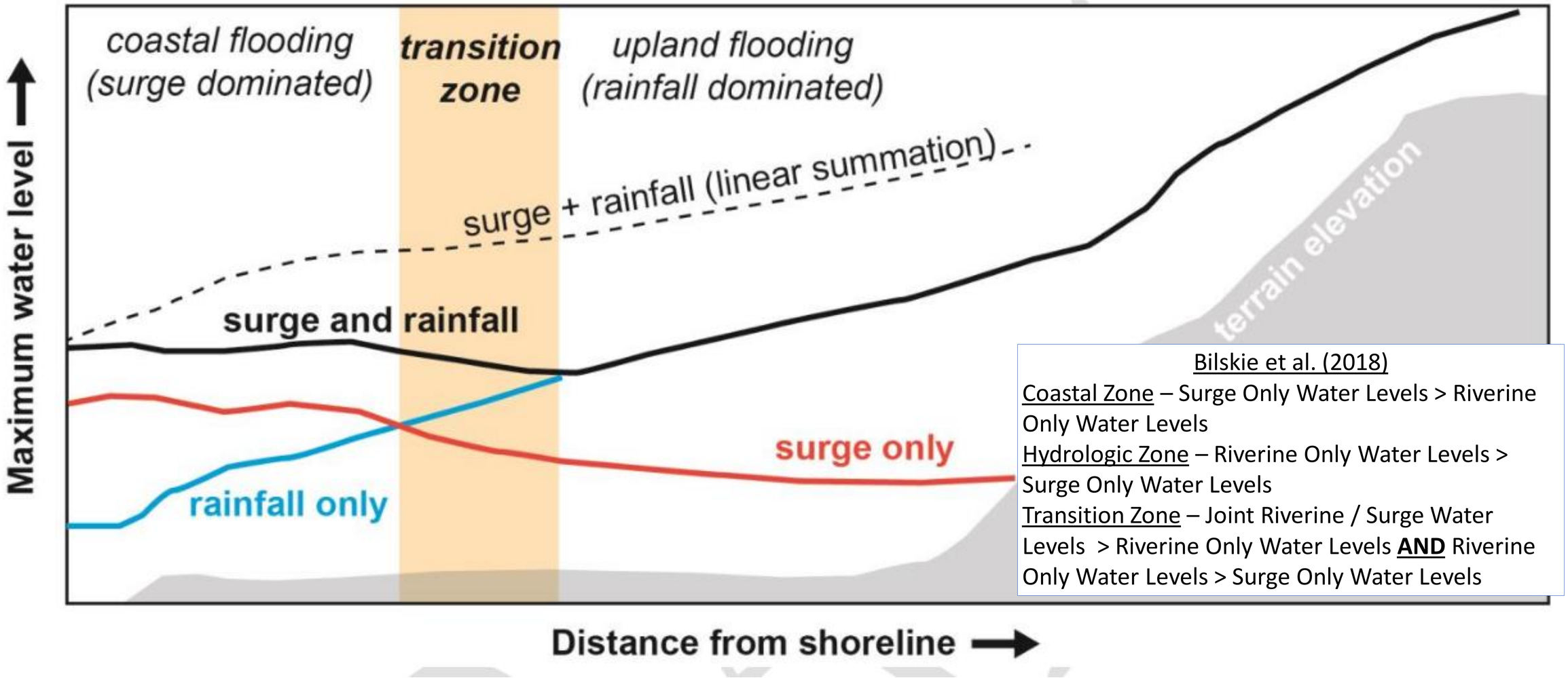


https://qz.com/1068625/hurricane-harvey-a-california-business-is-offering-free-data-recovery-for-wet-and-damaged-phones/



Introduction

Compound Flooding



Bilskie et al. (2018)

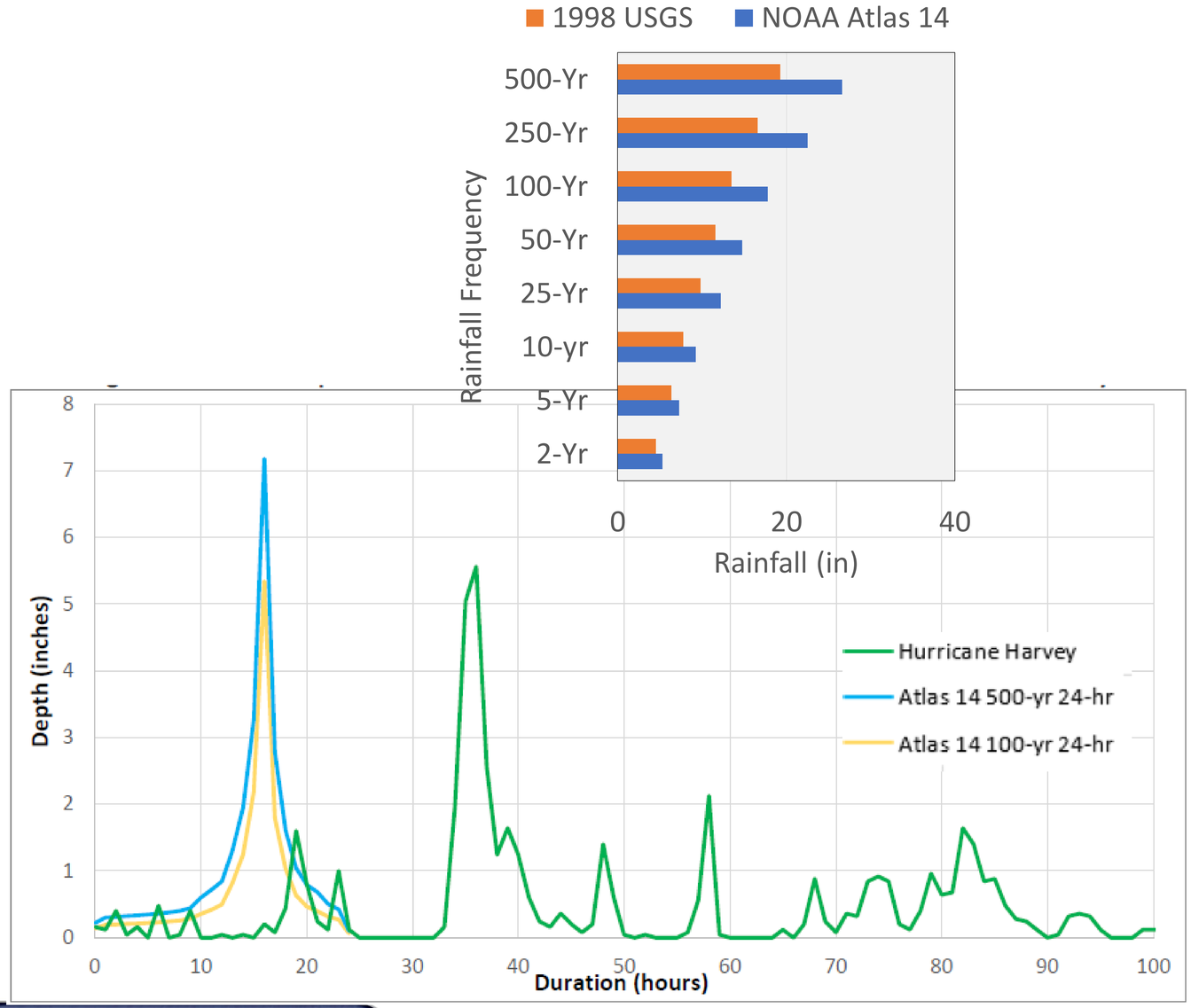
Coastal Zone – Surge Only Water Levels > Riverine Only Water Levels

Hydrologic Zone – Riverine Only Water Levels > Surge Only Water Levels

Transition Zone – Joint Riverine / Surge Water Levels > Riverine Only Water Levels **AND** Riverine Only Water Levels > Surge Only Water Levels

Introduction

Increase Future Flood Risk



Wettest storms in U.S. history

With around 50 inches of total rainfall through Tuesday, Hurricane Harvey is now the rainiest tropical storm in the Lower 48.

Hurricane Harvey (2017)	Texas	~~49.32~~-60.58
Tropical Storm Amelia (1978)	Texas	48
Hurricane Easy (1950)	FL	45.2
Tropical Storm Claudette (1979)	Texas	45
Tropical Storm Allison (2001)	Texas	40.68
Hurricane Georges (1998)		38.46
Hurricane Danny (1997)		36.71
Tropical Storm One (1960)		29.76
Tropical Storm Alberto (1994)		27.85
Hurricane Beulah (1967)	Texas	27.38

Hawaii mountain peaks have reported larger rainfall totals.

Source: National Weather Service

CAPITAL WEATHER GANG

Introduction

Mission:

Texas Integrated Flooding Framework leverages expertise and resources to bring about the best information to enhance coastal flood risk planning and mitigation.

Vision:

Texas Integrated Flooding Framework empowers Texans with reliable information to increase flood resiliency.

Develop guidelines and processes for implementing an integrated framework to model, visualize, and plan coastal floods

Compliment the many ongoing efforts

The future of the science

Basics

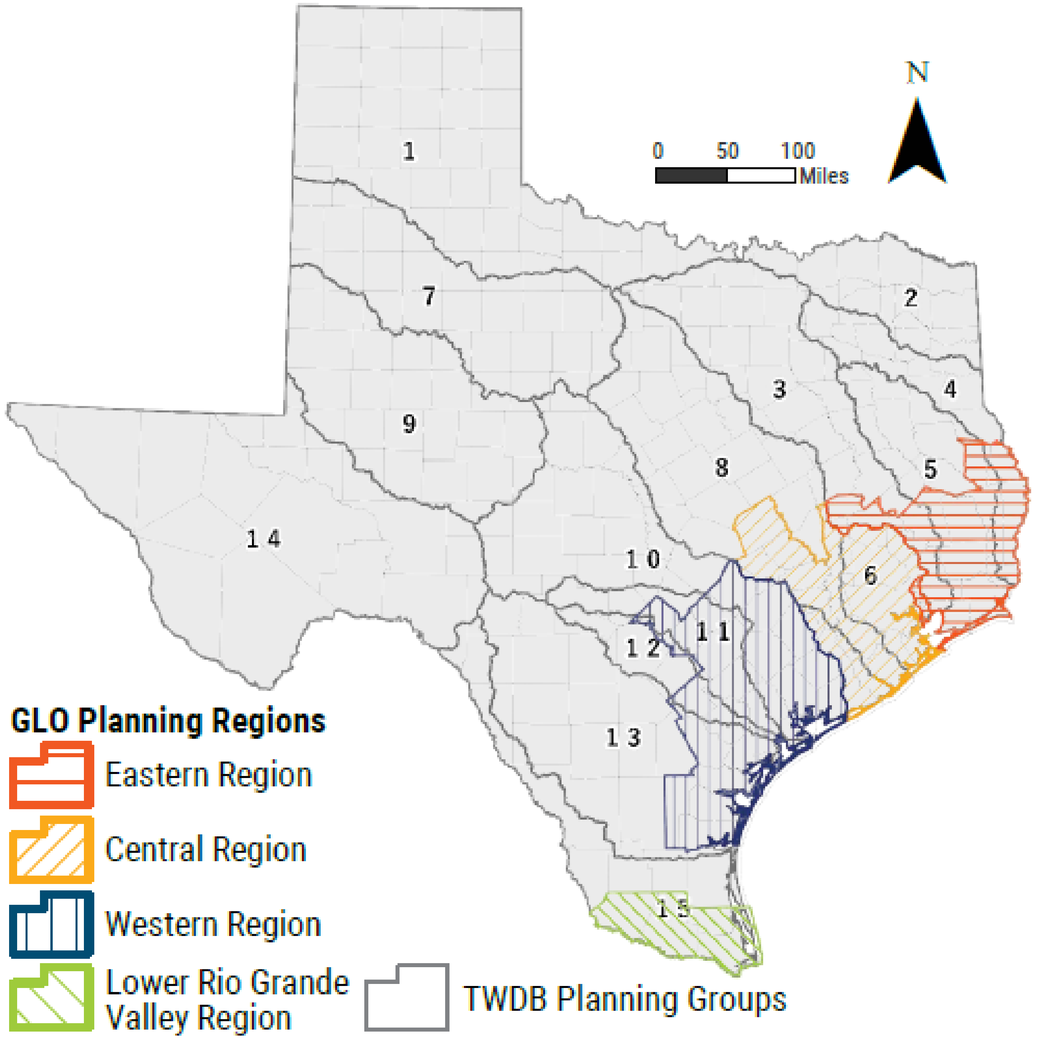
Led by the TWDB, USGS, and USACE

$4M budget over 4 years

Timeframe: November 2020 – December 2024

Four-component study

- Data and Monitoring Gap Analysis
- Data Management and Visualization
- Integrated Flood Modeling Framework
- Planning and Outreach



Each component designed in coordination with *Technical Advisory Teams*

Structure

Steering Committee (SC)

Facilitates access to accurate and reliable compound flood-related information for decision-makers at all levels through a collaborative planning approach and by utilizing quality data, robust models, and sound science.

Facilitation Team

Provide pre- and post-meeting facilitation, support offline collaboration, and stakeholder engagement.

Technical Advisory Teams (TATs)

Groups of technical experts serve as the source of expertise guiding the TIFF project from vision to execution.

Texas Water Development Board

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TIFF Project Manager
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Facilitation Team

Texas Water Development Board

The Meadows Center for Water and the Environment

Texas State University

Carrie Thompson

Director of Operations
(512) 245-4476
carriethompson@txstate.edu

Mission

Inspiring research, innovation, and leadership that ensures clean, abundant water for the environment and all humanity.

Vision

A world where all people understand and embrace the value of water and environmental stewardship.

USGS science for a changing world

Technical Advisory Teams

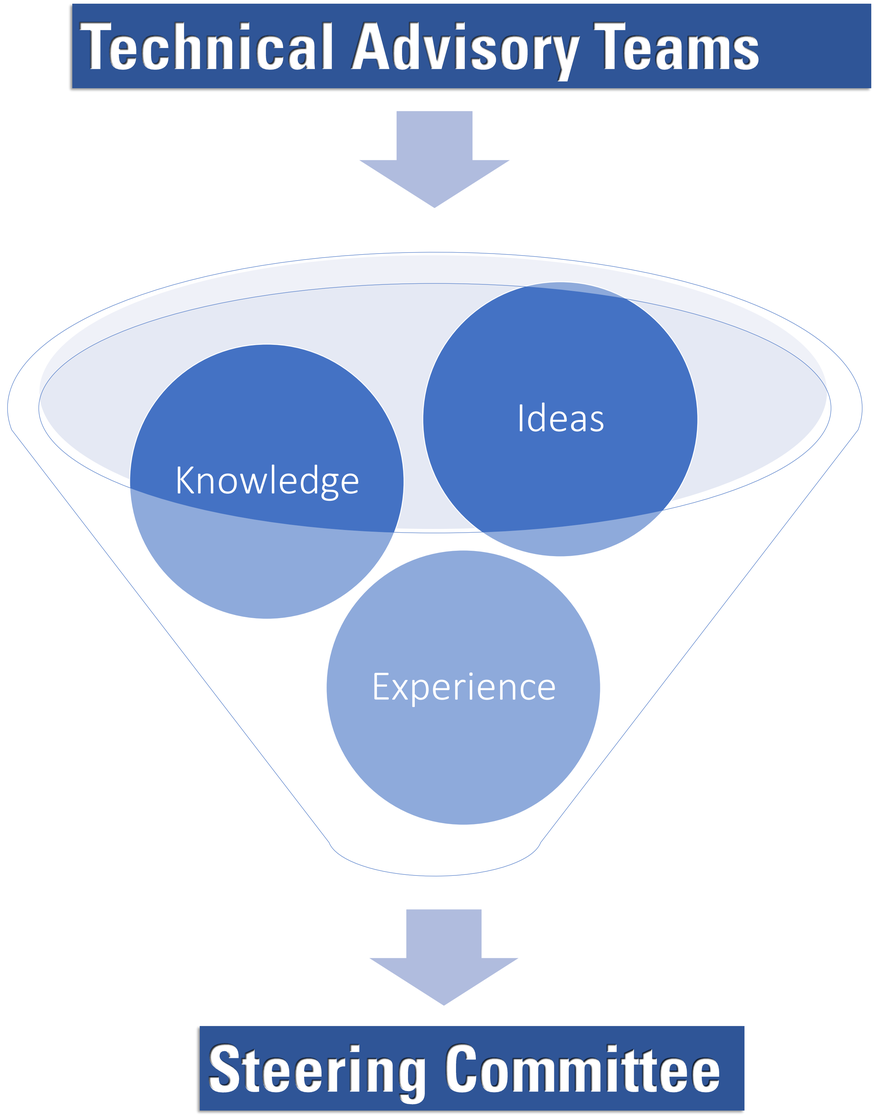
Groups of technical experts

Initially Selected by the Steering Committee

Many Volunteers

About 88 total advisors among the 4 components

Over 50 organizations represented



Technical Advisory Teams

Adaptation International	NOAA/National Ocean Service, Center for Operational Oceanographic Products and Services	Texas Division of Emergency Management	University of Notre Dame
AQUAVEO LLC		Texas Floodplain Management Association	University of Texas - Arlington
Center for Space Research - UT Austin	Princeton University	Texas General Land Office	University of Texas at Austin
Coastal Bend Bays & Estuaries Program	Region 5 Flood Planning Group (Neches River), Lamar University	Texas Natural Resources Information System	University of Texas Rio Grande Valley
Coastal Emergency Risks Assessment - Louisiana State University	Seahorse Coastal Consulting	Texas Spatial Reference Center, TAMU Corpus	US Army Corps of Engineers - Engineer Research and Development Center
DSI LLC	Southwestern Division Office	Texas Water Development Board	
Federal Emergency Management Agency	Texas A&M - Institute for a Disaster Resilient Texas	The University of Iowa	US Army Corps of Engineers - Fort Worth District
Harris Country Flood Control District	Texas A&M AgriLife/Community Health and Resource Management (CHARM)	The University of Texas at Austin	US Army Corps of Engineers – Galveston District
Harte Research Institute	Texas A&M- College Station	The University of Texas Rio Grande Valley	
Institute for a Disaster Resilient Texas, Texas A&M University-Galveston	Texas A&M- Corpus Christi	The Water Institute of the Gulf	US Army Corps of Engineers - Hydrologic Engineering Center
Iowa Flood Center		United States Geological Survey	
January Advisors (data science consultants, part of core TDIS team)	Texas A&M University- Kingsville	United States Naval Academy	US Geological Survey
National Oceanic and Atmospheric Administration	Texas Advanced Computing Center	University of Central Florida	Utah Water Research Laboratory - Utah State University
National Weather Service	Texas Commission on Environmental Quality	University of Georgia	
National Weather Service - West Gulf River Forecast Center	Texas Department of Transportation	University of Houston	Virginia Institute of Marine Science
	Texas Disaster Information System	University of North Carolina at Chapel Hill	Virginia Tech
		University of North Florida	West Consultants

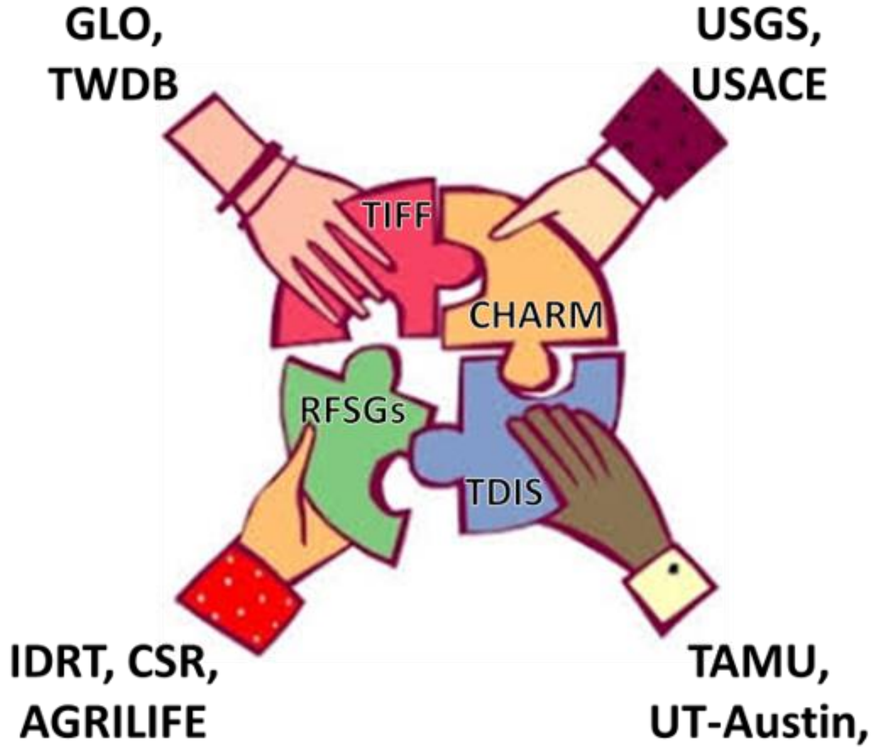
Looking to the Future

Texas Water Development Board

Decrease past **redundancy**

Increase **synergy**

Many federal and state agencies **working together**



USGS science for a changing world

Relationships

First TAT Kickoff Meeting (April 2021)

Regional Flood Planning Groups (RFPGs) or their Coastal Liaisons (September 2021)

TAT component meetings (December 2021)

Texas Disaster Information System (TDIS)

Community Health and Resource Management (CHARM)

TWDB Regional Flood Planning Groups (RFPGs)

GLO Regional Flood Study Groups

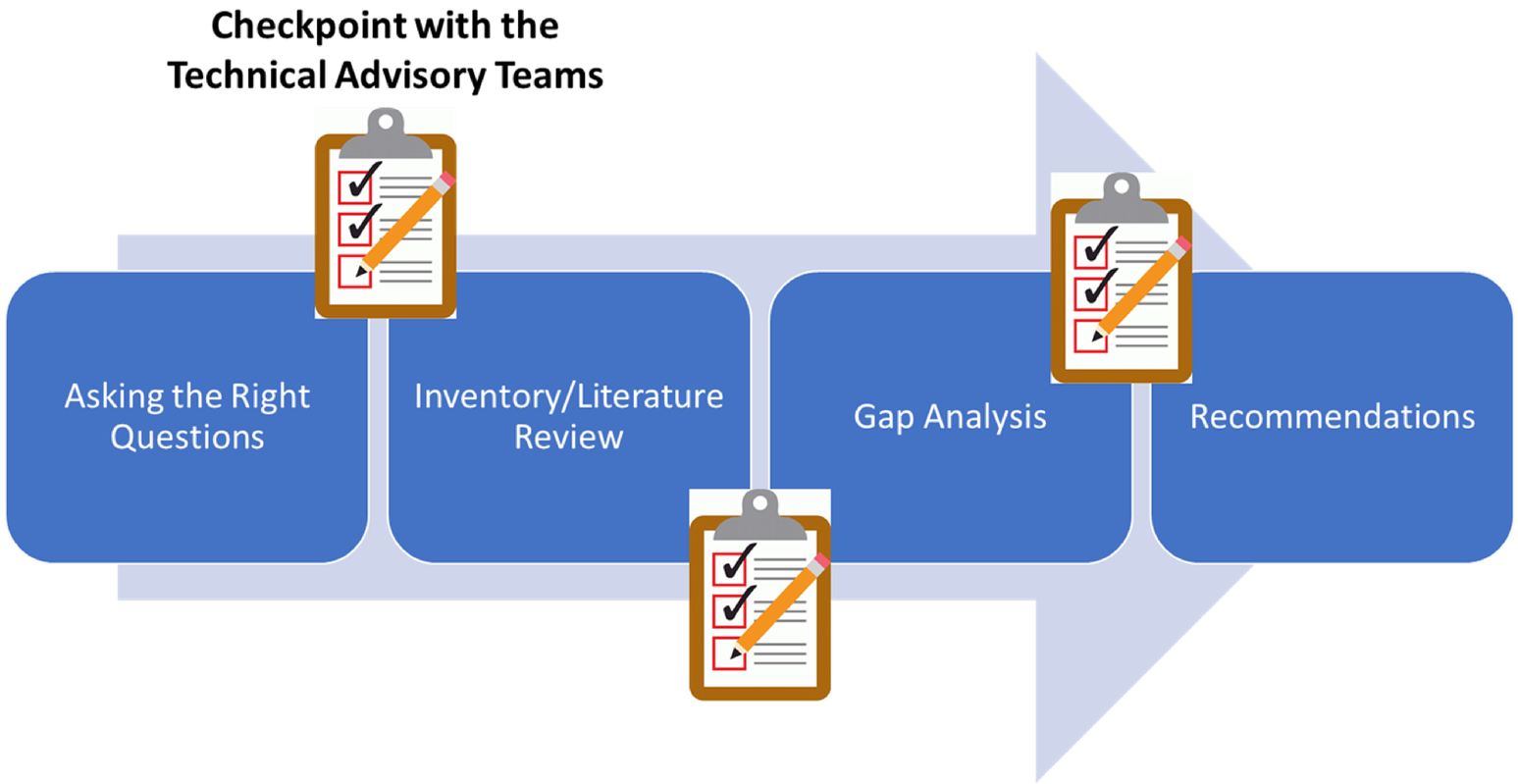
Engineering Firms

TWDB Community Assistance Program

Texas Coastal Master Resiliency Plan

Execution

Pioneering a new collaborative effort to address compound flooding impacts



TIFF by the numbers

TIFF website: https://webapps.usgs.gov/tiff/

88 Technical Advisory Team members confirmed

5 TAT meetings held

TIFF Bathymetry Workshop

Interagency contracts executed

4 deliverables submitted to TGLO

Scope of works for new contracts

The Components

Component 1: **Data and Monitoring Gap Analysis -** Establish a plan for obtaining continuous and up-to-date data critical for compound flood monitoring and modeling across inland, coastal, and ocean systems.

Component 2: **Data Management and Visualization -** Ensure that any coastal flood related data and model outcomes can be properly visualized for both technical and non-technical end-users.

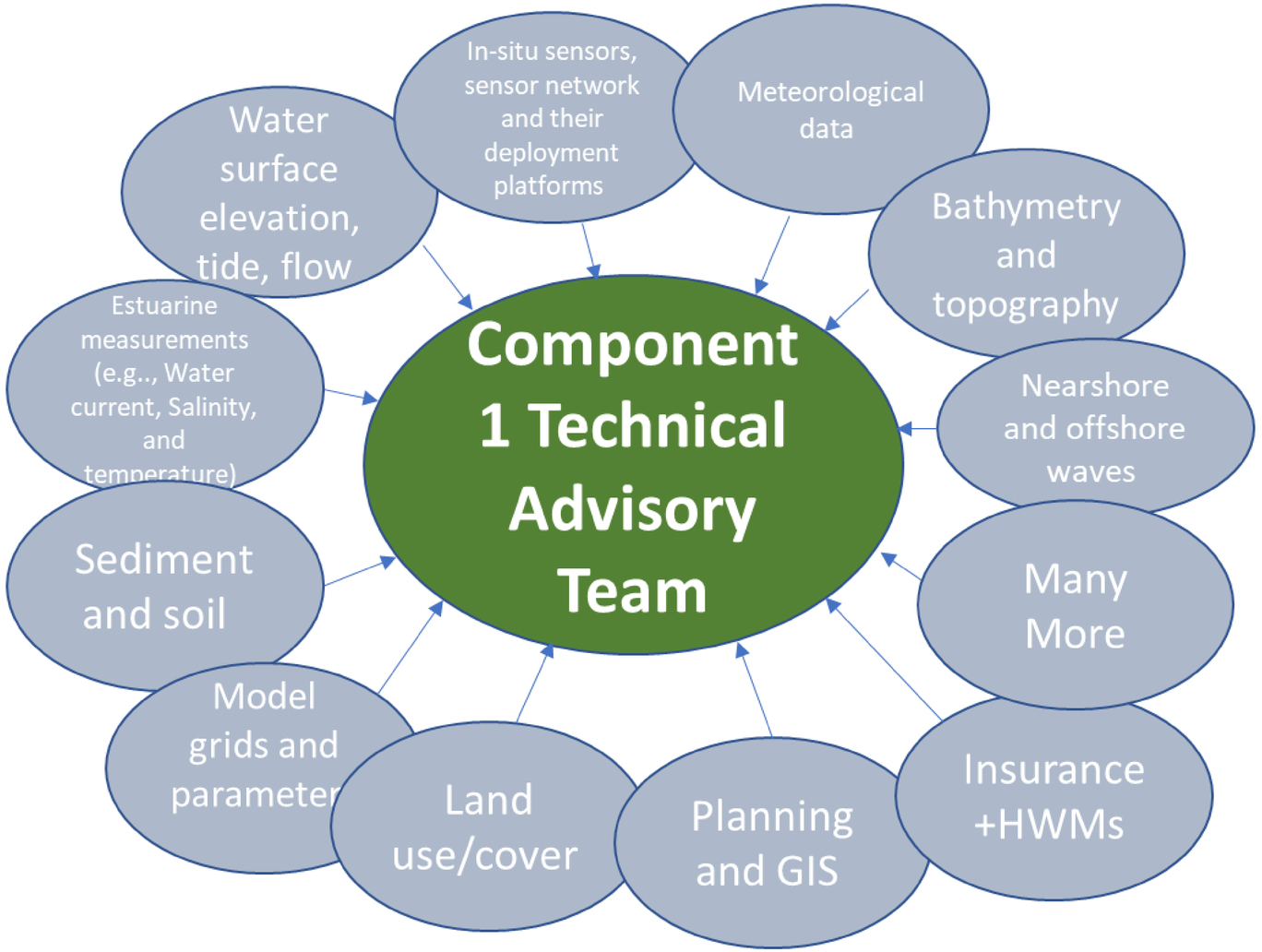
Component 3: **Integrated Flood Modeling Framework -** Develop conceptual model-coupling workflows for assessment of flooding hazard in the Coastal Texas Region

Component 4: **Planning and Outreach -** Ensure flood planning and mitigation needs for various end users are incorporated into the data and modeling frameworks.

Component 1

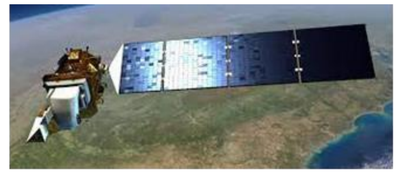
Why is data and monitoring important?

- Model grid and definition
- Model forcing
- Continuous model validation and improvements
- Post-event analysis

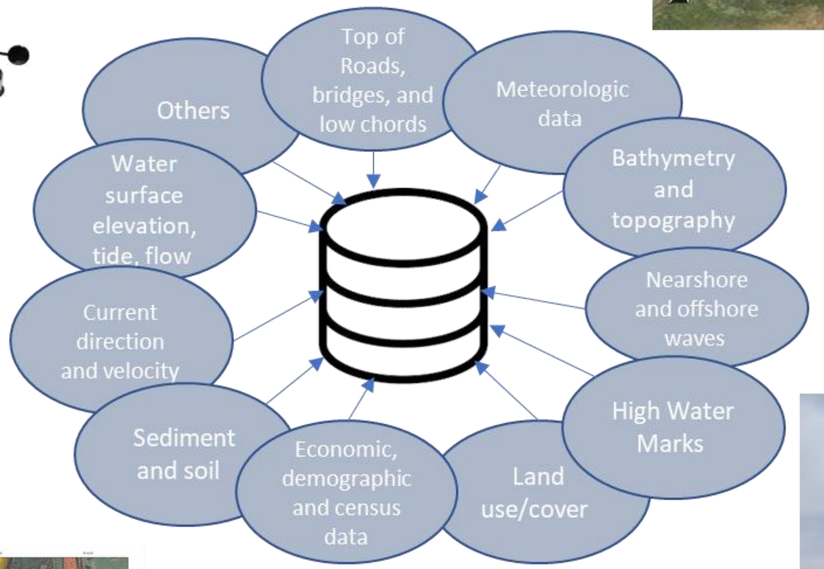


Component 1

Data and Monitoring Gap Analysis — Establish a plan for obtaining continuous and up-to-date data critical for compound flood monitoring and modeling across inland, coastal, and ocean systems.



Inventories created by many partners (TDIS, TWDB Datahub, RFSGs)



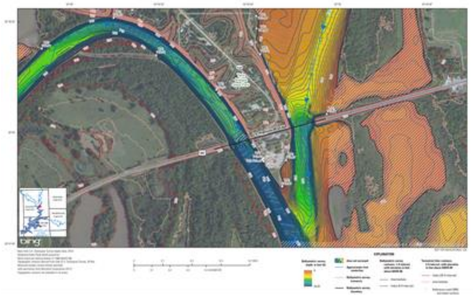
Gap Analysis

Q. What is a gap analysis?

A. Whatever you want it to be.

Use cases

Working components 3 and 4



https://pubs.usgs.gov/sir/2017/5101/sir20175101_ver1.1.pdf

TCOON Sentinel Platform (Galveston, TX)

Component 1

Data Sharing and Archiving

Advise on:

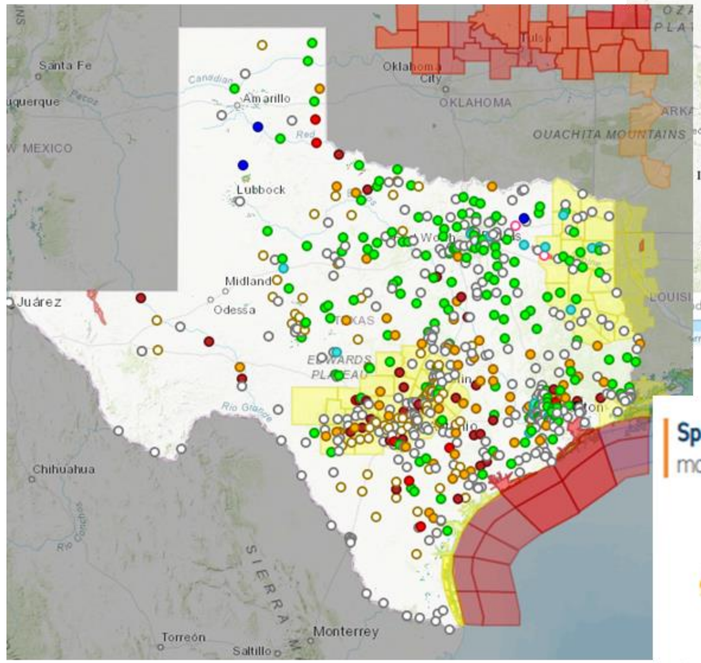
- Data sharing,
- Archiving
- BMPs for QA/QC
- Working closely with component 2

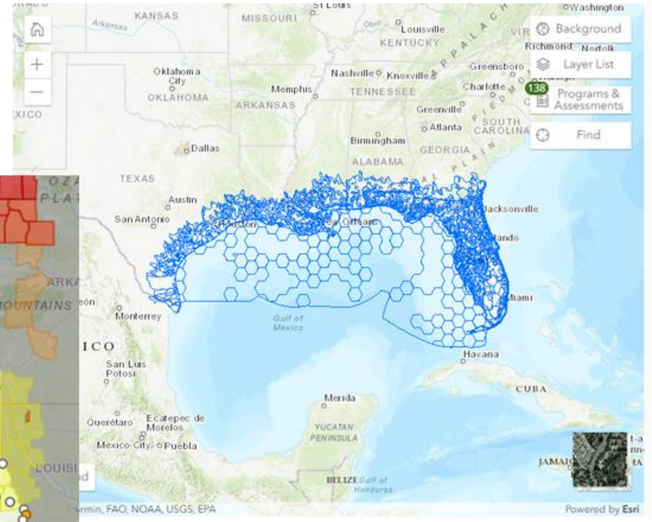
Evaluate new monitoring technologies

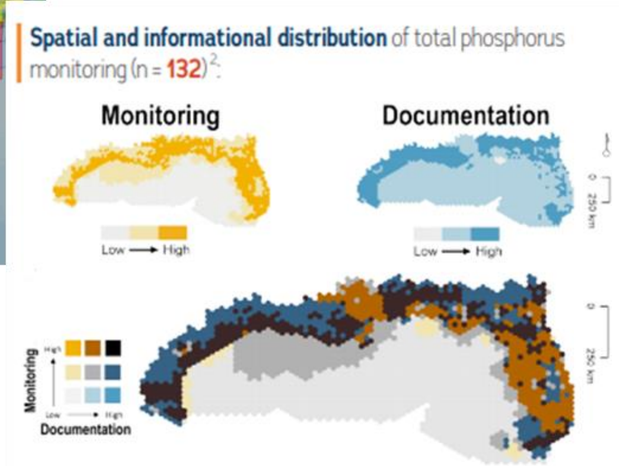
Long and short frequency wave measurements

Rapid deployment storm surge sensors

https://txpub.usgs.gov/txwaterdashboard/



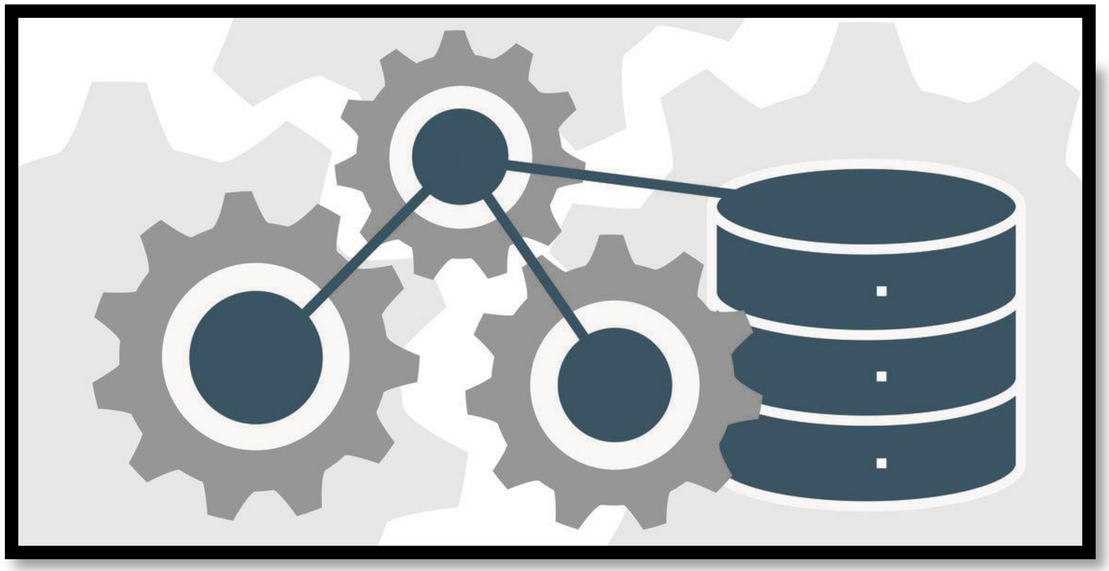




Component 1

Progress

- List of important datasets
- Assisting with data naming & metadata standards
- Bathymetry workshop



Future Plans

- Gap analysis
- Bathymetry recommendation
- Wave data recommendation

Component 2

Data Management and Visualization - Ensure that any coastal flood related data and model outcomes can be properly visualized for both technical and non-technical end-users.

Progress

Dataset naming, taxonomy, and ontology

Summary of existing statewide flood-related studies

Inventory of user interfaces

Future Plans

Human-centric visualization

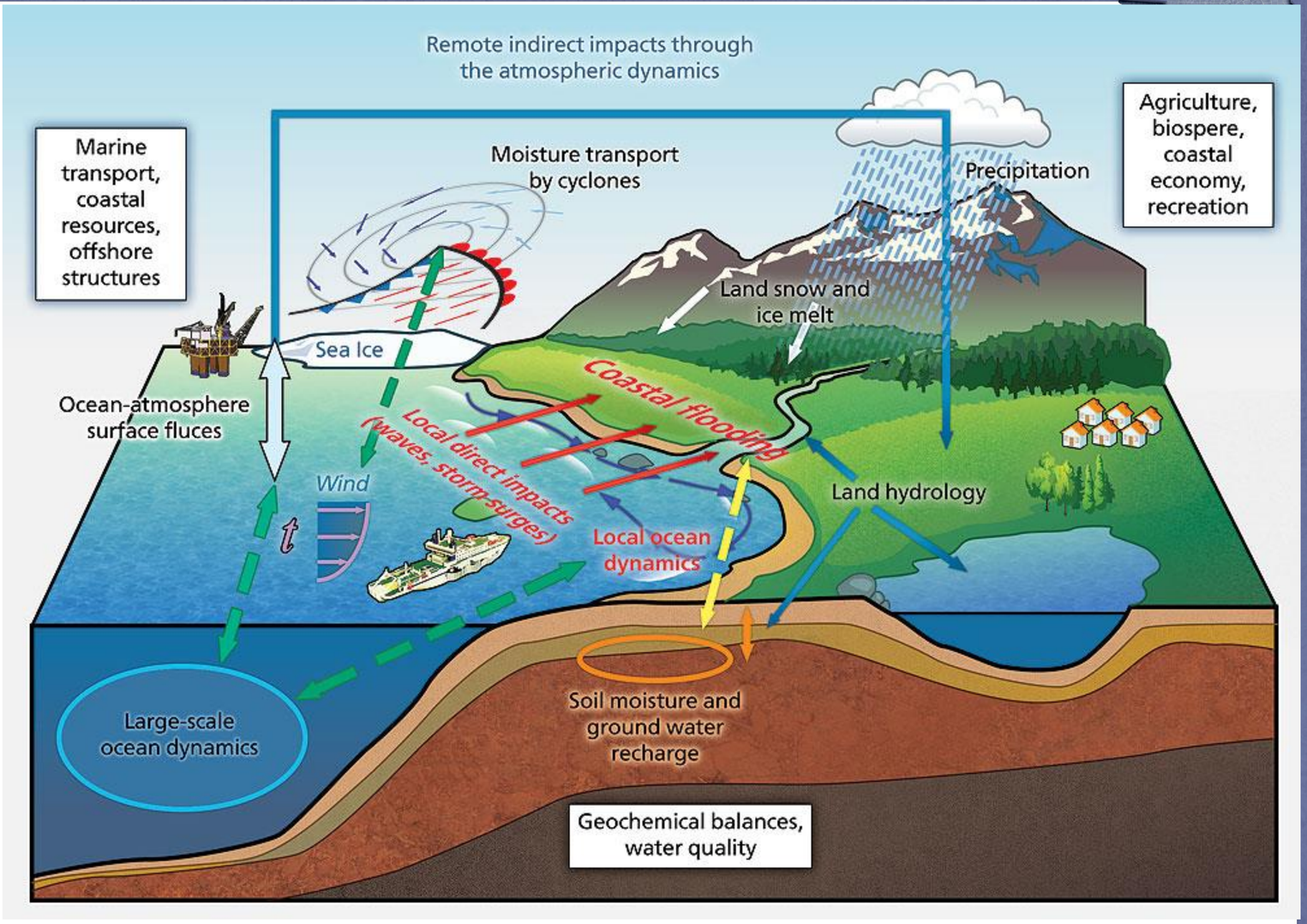
Assist TDIS on developing guidance on

- data management and visualization framework
- computational hardware/software requirements for model data management

Component 3

Objectives

Develop an integrated modeling framework to support inland and coastal flood hazard identification



* Compound flooding depends on dynamic feedbacks between multiple time/length scales and processes

Component 3

Technical Advisory Team

Multi-disciplinary teams

Nationally-recognized experts

Diverse stakeholder representations

*Team Champion: Mohammad "Shahidul" Islam	U.S. Army Corps of Engineers- Galveston District
Andre Vanderwesthuysen	National Oceanic and Atmospheric Administration
Andrew Kennedy	University of Notre Dame
Ben Hodges	University of Texas at Austin
Charles Erickson	US Army Corps of Engineers – Ft. Worth District
Chris Massey	US Army Corps of Engineers -
Clint Dawson	University of Texas at Austin
Derek Giardino	National Weather Service, W Gulf River Forecast Center
Don Resio	University of North Florida
William Asquith	US Geological Survey
Gaurav Savant	US Army Corps of Engineers - Engineer Research and Development Center
Hugh Roberts	The Water Institute of the Gulf
Jim Gibeaut	Harte Research Institute
Joseph Zhang	Virginia Institute of Marine Science
Ken Asch	WOODPLC
Mark Jensen	United States Army Corps of Engineers
Matt Bilskie	University of Georgia
Ning Lin	Princeton University
Norberto Nadal-Caraballo	US Army Corps of Engineers - Engineer Research and Development Center
Patrick Barnard	US Geological Survey
Richard Wade	Texas Natural Resources Information System
Rick Luettich	University of North Carolina at Chapel Hill
Saul Nuccitelli	Texas Water Development Board
Suzanne Pierce	Texas Advanced Computing Center
Thomas Wahl	University of Central Florida
Yu Zhang	University of Texas - Arlington

Component 3

Model Inventory Development

- Develop model metadata template
- Outreach stakeholders (e.g., GLO RFS vendors, TWDB) to gather model metadata
- Compile model metadata and develop a GIS database displaying model coverage
- Co-ordinate with TDIS on the model metadata management

Model Metadata Template

- ✓ Study Title
- ✓ Study Objective
- ✓ Model software name
- ✓ Model software version
- ✓ Model Type
- ✓ Model Dimension
- ✓ Model Coverage
- ✓ Model Calibration event/time period
- ✓ Model Validation event/time period
- ✓ Model Update History
- ✓ Model Developer POC
- ✓ Additional Comments

Component 3

Flood Hazard Assessment Model Literature Review

Meteorologic
Hydrologic
Hydraulic
Estuarine Hydrodynamic
Wave
Large Scale Surge Model

What key processes and parameters need to be characterized for each modeling efforts?

What are the existing methods or parametrization techniques available to characterize those processes?

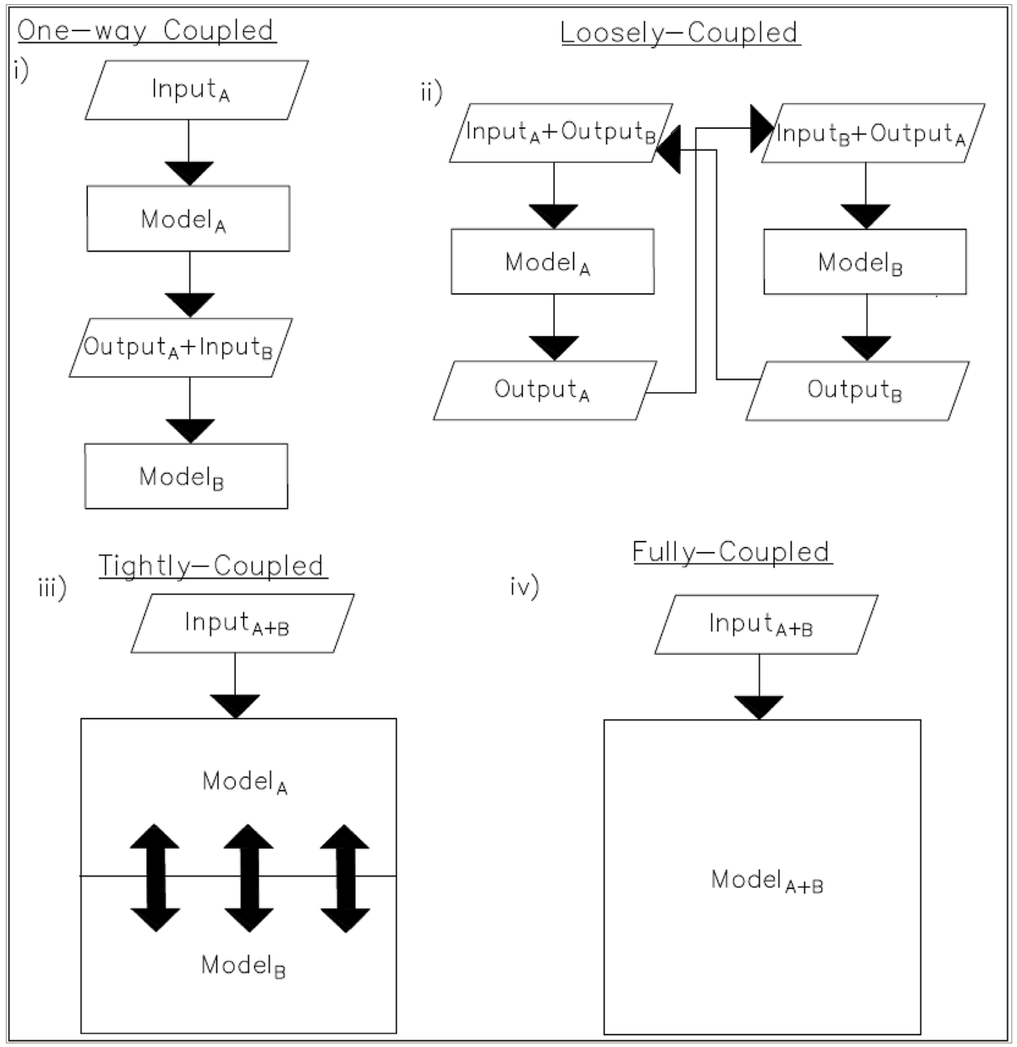
What are the state-of-the-art models available for modeling those processes?

SWOT Analysis-What are the advantage and limitations of each model for characterizing flooding hazards in the Texas costal region?

Component 3

CONCEPTUAL MODEL-COUPLING WORKFLOWS DEVELOPMENT

- Component-based modeling framework
  - NEMS/NUOPC/ESMF
  - CSDMS
  - OMS
  - OpenMI
- Monolithic modeling framework

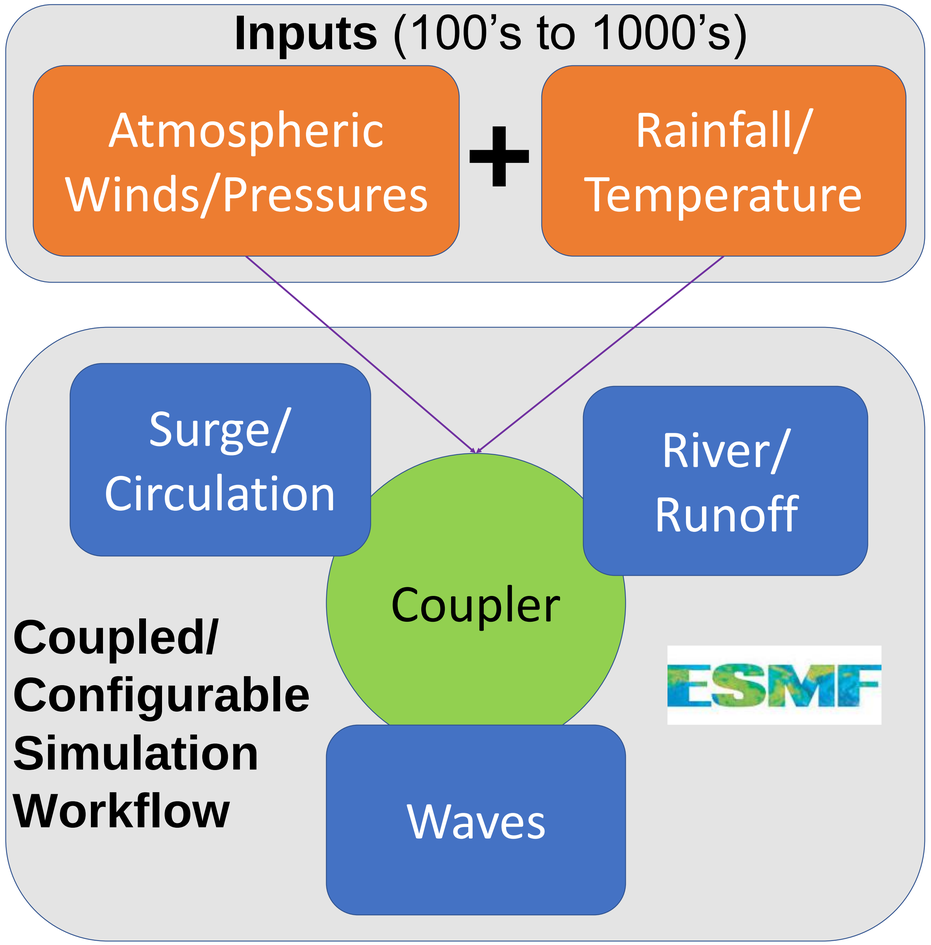


Santiago-Collazo et al. (2019): A Comprehensive Review of Compound Inundation Models in Low-Gradient Coastal Watersheds

Component 3

CONCEPTUAL MODEL-COUPLING WORKFLOWS DEVELOPMENT

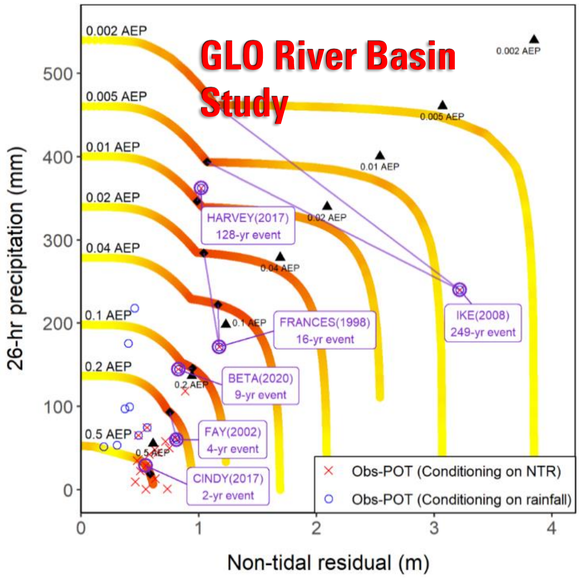
- ❑ The model coupling workflows must:
  - be highly **computationally efficient**
  - require **no manual** user **manipulation**
  - **robust** and **extensible**
  - allow individual **process models** to be **exchanged (plug-n-play)**
  - **portable** to many computational **systems**
- ❑ Develop scenarios and an evaluation matrix
  - Hindcasts/Forecasts scenarios
  - Real-time Forecasts scenarios
  - Evaluation Matrix development

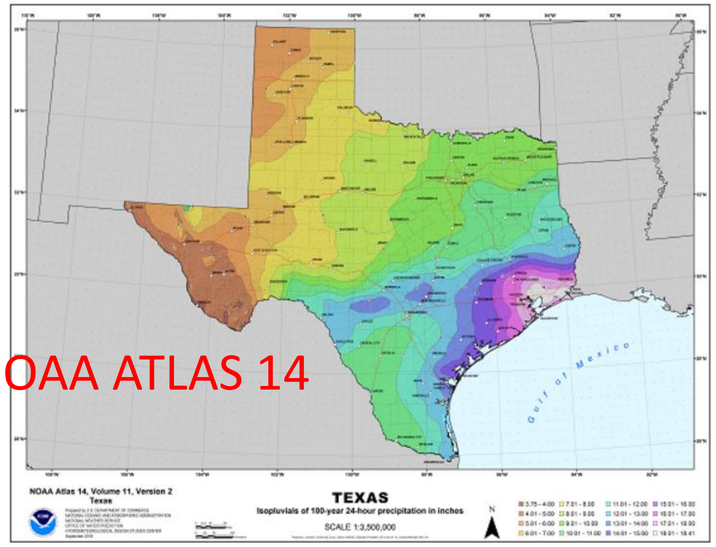


Component 3

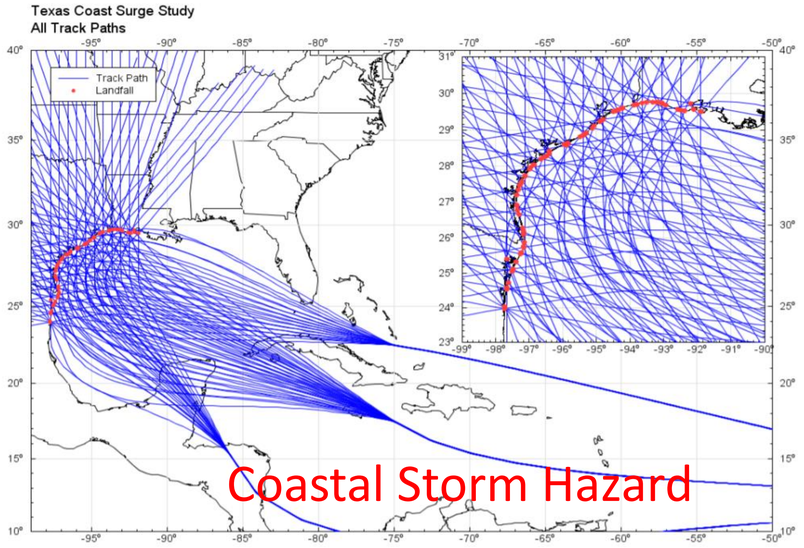
PROBABILISTIC FLOOD HAZARD ESTIMATION

- Perform literature review to identify the best suitable flood hazard estimation methods for the Coastal Texas Region
  - Independent Flood Driver
  - Conditional Flood driver
  - joint flood drivers





NOAA ATLAS 14



Coastal Storm Hazard

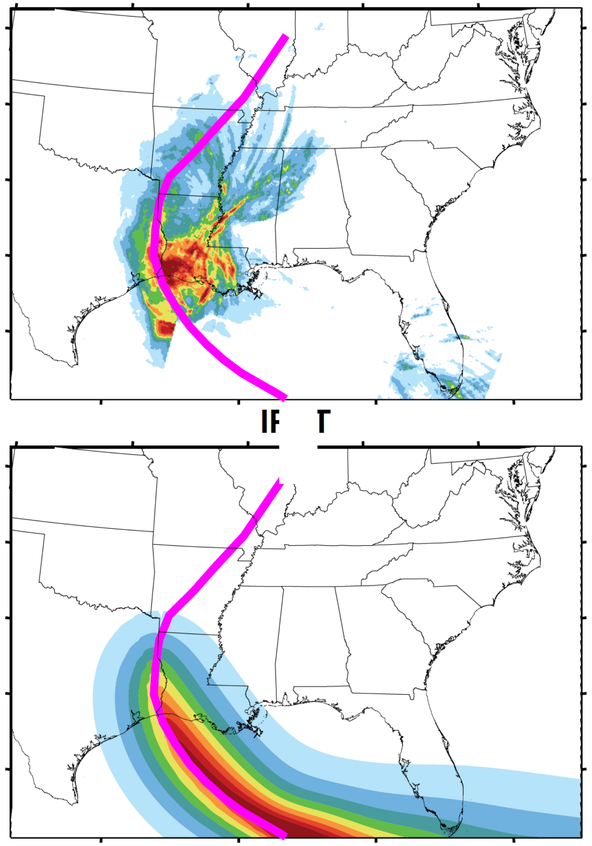
Received: 22 February 2021 | Revised: 24 June 2021 | Accepted: 3 August 2021
DOI: 10.1002/joc.7335

RESEARCH ARTICLE

International Journal of Climatology | RMetS

Probabilistic rainfall generator for tropical cyclones affecting Louisiana

Gabriele Villarini[1] | Wei Zhang[1,2] | Paul Miller[3] | David R. Johnson[4] | Lauren E. Grimley[5,6] | Hugh J. Roberts[5]



Component 4

Planning and Outreach - Ensure flood planning and mitigation needs for various end users are incorporated into the data and modeling frameworks.

Progress

- Inventory of planning tools
- Multiple outreach efforts and collaborations
- Outreach plan

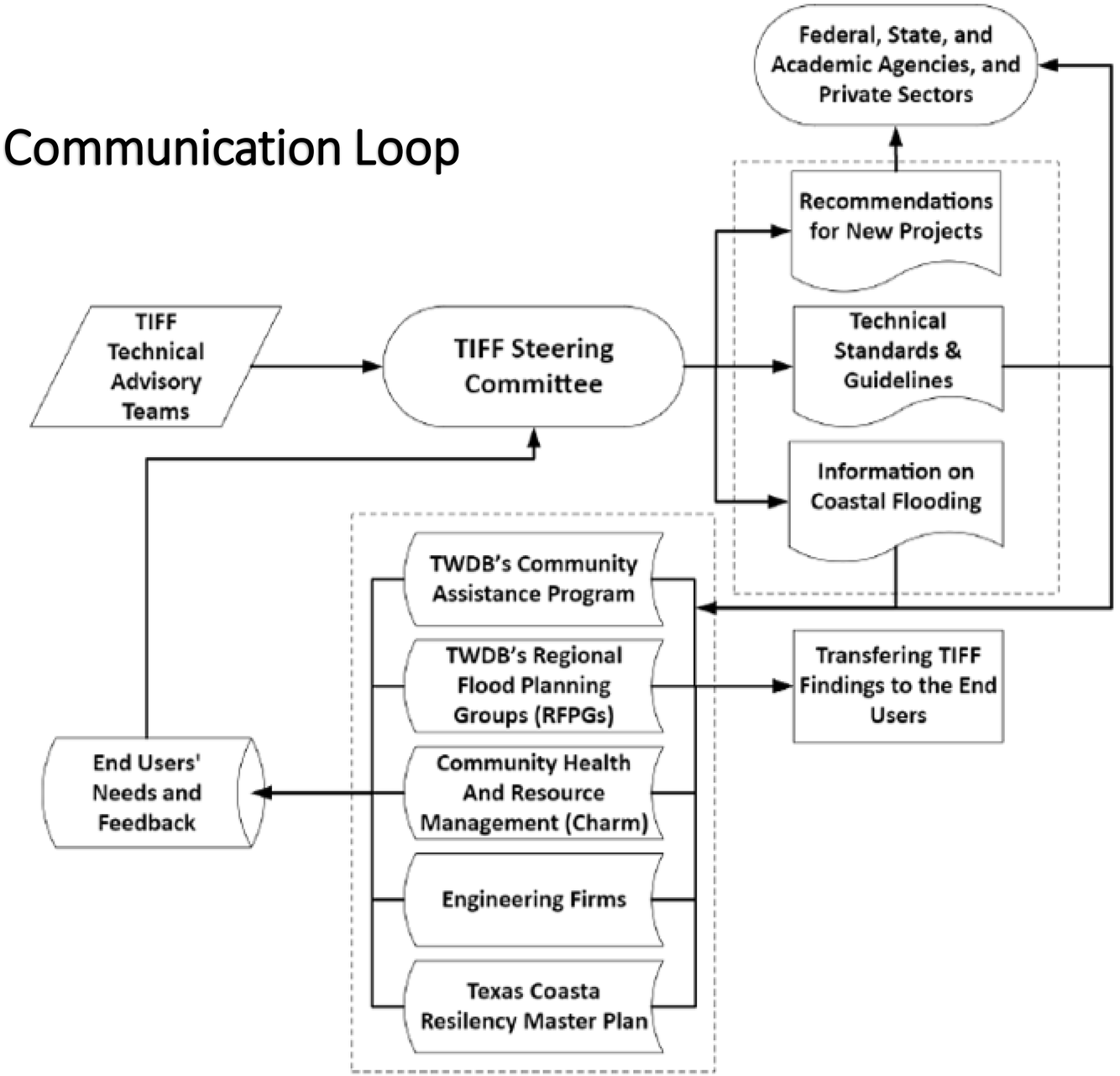
Future Plans

- Flood communication and awareness research
- Customizable campaign toolkit

FIGURE 1 – FLOOD PLANNING REGIONS

Component 4

TIFF Communication Loop



Summary

The Texas Integrated Flooding Framework

is

A set of recommendations, guidelines, and frameworks to improve the modeling, data collection, data management, visualization, planning, and outreach efforts in the future.

In the case where information, products, or models to best meet identified needs do not yet exist, TIFF will recommend their creation or development.

As TIFF continues to evolve to meet the future resiliency needs of Texans, the TIFF Steering Committee will continue to look for opportunities to fill gaps in flood science by recommending advanced work for the future.

is not

TIFF is not an effort to produce individual products (i.e., models or datasets).

TIFF will not change the scope of work of any current project funded by the TWDB, GLO, or others.

Discussion