Texas Water Needs A Brain

Presentation By:

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Rice University

And

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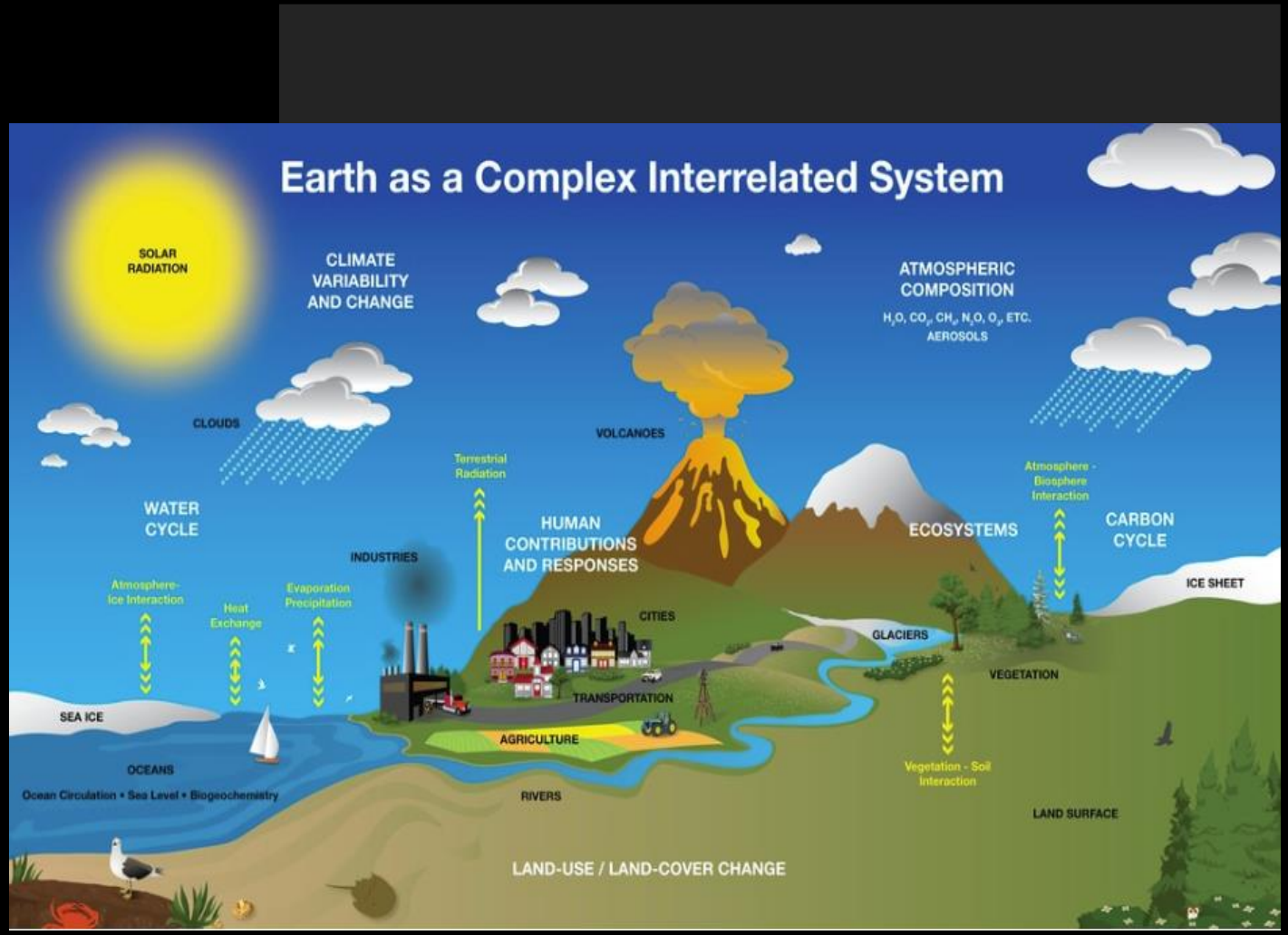
CEO EnviroAI

April 7, 2026

Earth Rules

- Physical processes that shape a livable world
- Circular nature of natural processes
- Gives rise to the circular economy of the future
- Includes the carbon cycle and hydrologic cycle

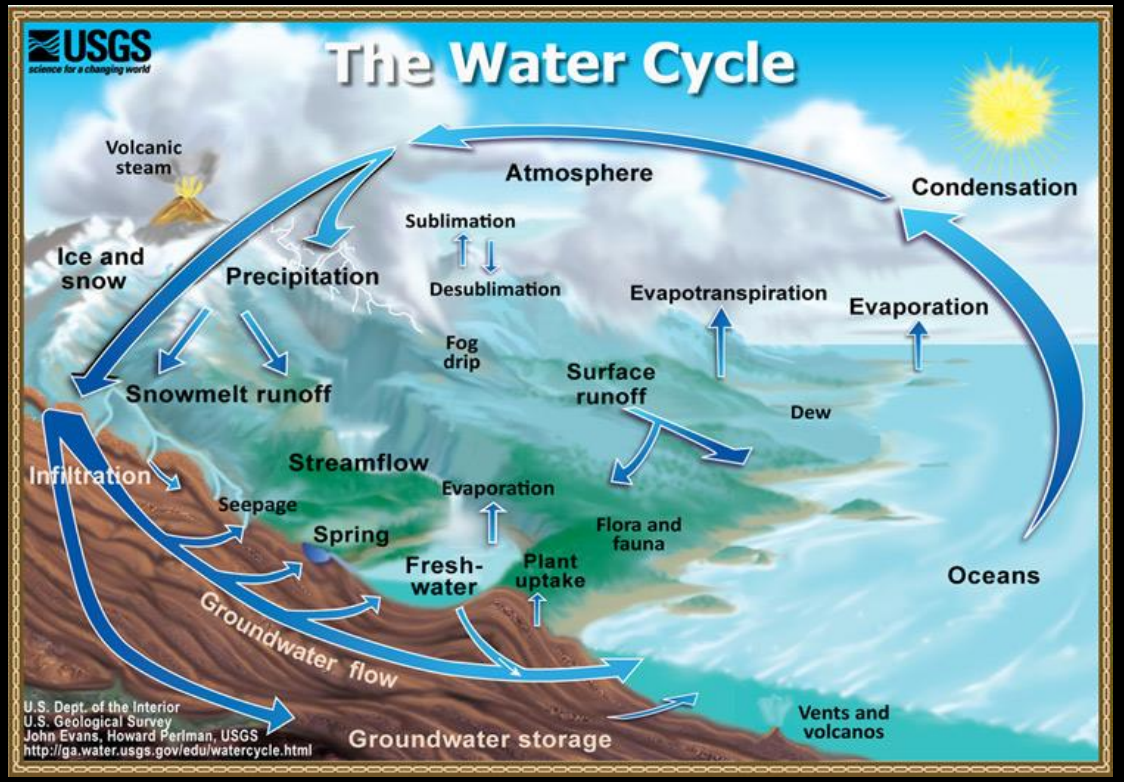


https://mynasadata.larc.nasa.gov/basic-page/energy-and-matter-cycles

Earth Rule –
The Earth Has Evolved Around the Hydrologic Cycle

Goal –

safely deliver water supply while maintaining the integrity of the hydrologic cycle

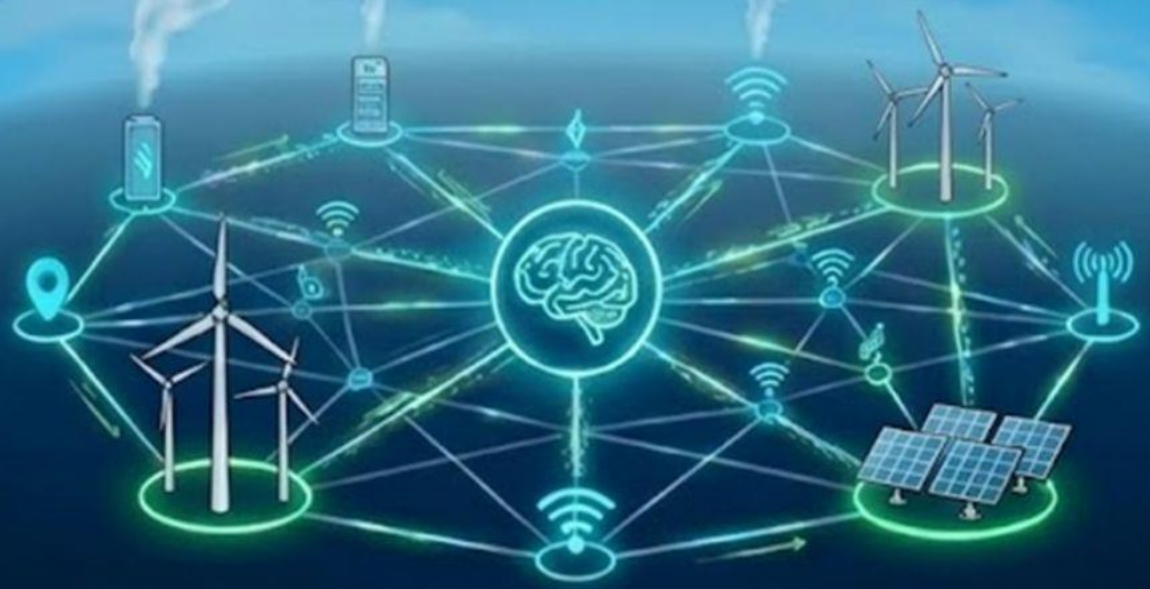


The Issues

- Texas water management system is archaic and has significantly modified the hydrologic cycle
- Our legal concepts are far behind the emerging problems
- Texas will fail to deliver water consistently in a climate-changed world and will alter the water systems from headwater to baywater
- Our management system is static based on assumptions and past conditions
- Could and should be dynamic based on real time conditions and future projections

SMART GRID FOR ELECTRICITY

AI-OPTIMIZED, DYNAMIC, EFFICIENT



OPTIMIZED POWER FLOW

EMISSIONS LOAD-BALANCING

DUMB GRID FOR WATER

STATIC, ONE-TIME ONLY

DRY SPRING

LOW RESERVOIR

TCEQ / STATE

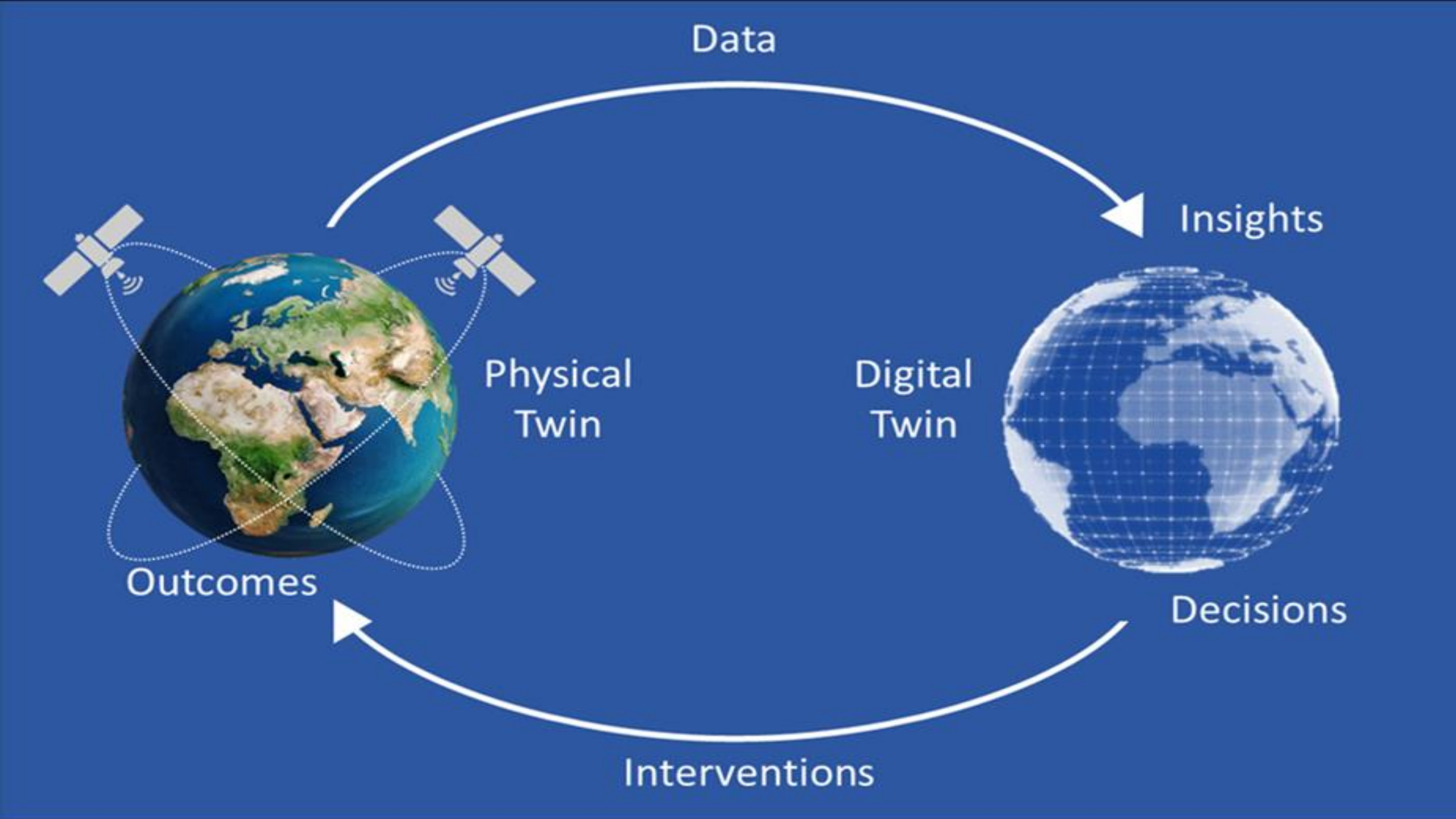
CITY TOWER

GROUNDWATER WELL

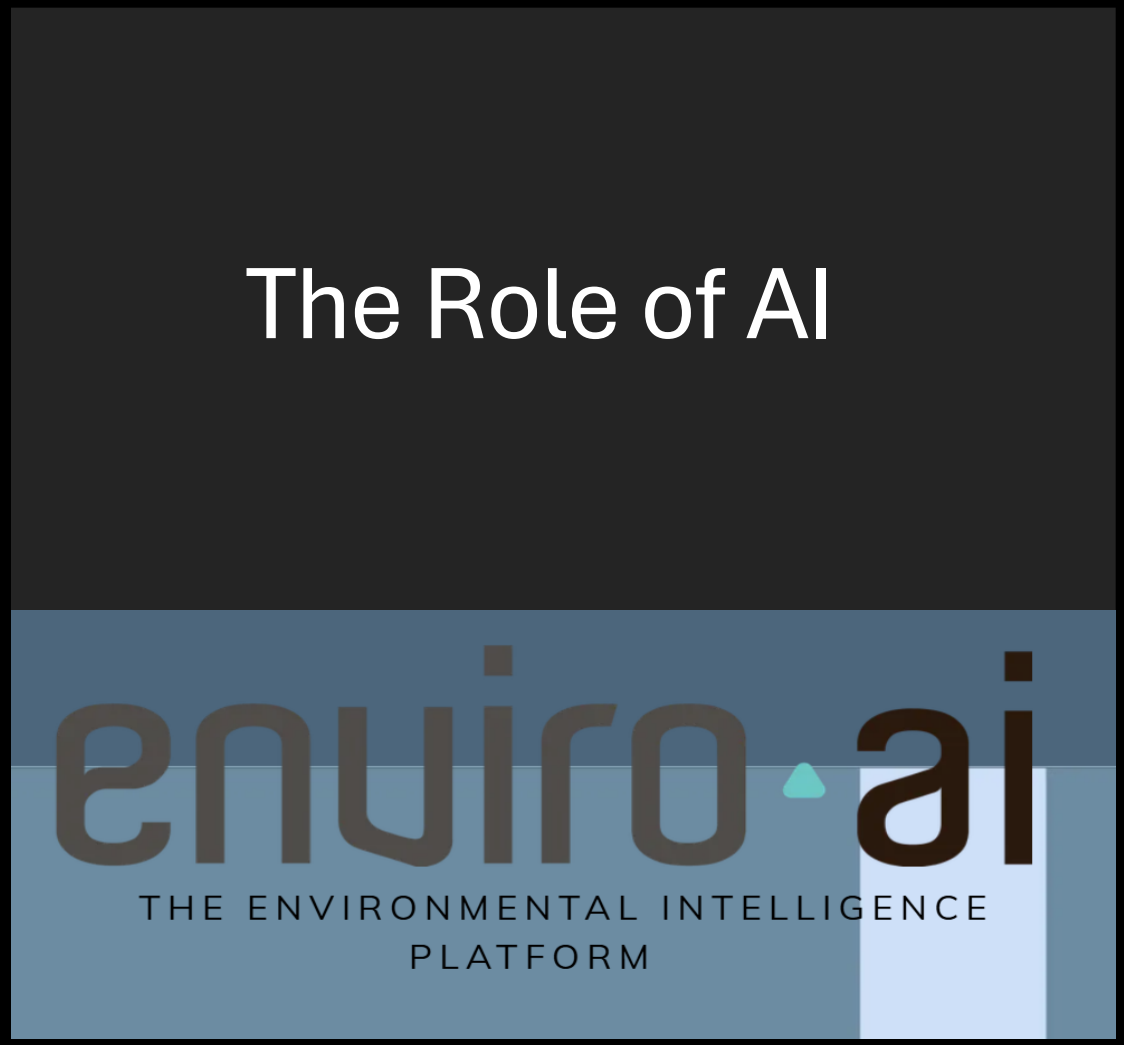
DRY ESTUARY

CONSTANT ASSUMPTIONS

NO ADJUSTMENTS


Data
Insights
Physical
Twin
Digital
Twin
Outcomes
Decisions
Interventions

- Goal – to create a dynamic interactive system of the hydrologic cycle for every river system in Texas
- Developing concepts in association with EnviroAI
- Cautionary Approach
  - Great concern about AI from many perspectives
  - Errors can be made and must be detected and subroutines vetted
  - Stepwise process – first one watershed – then others
- Reasonable Expectations and Freedom to Fail
  - No promises
  - No guarantees at this point in time
  - This is at the early stages of development – may or may not work



How To Use AI for Water Intelligence

- It is a tool – not a solution
- Must be verified and validated
- Rapid fast failure – create it, run it, check results and do it again
- Incredibly fast in computations – in development - but must not overpromise

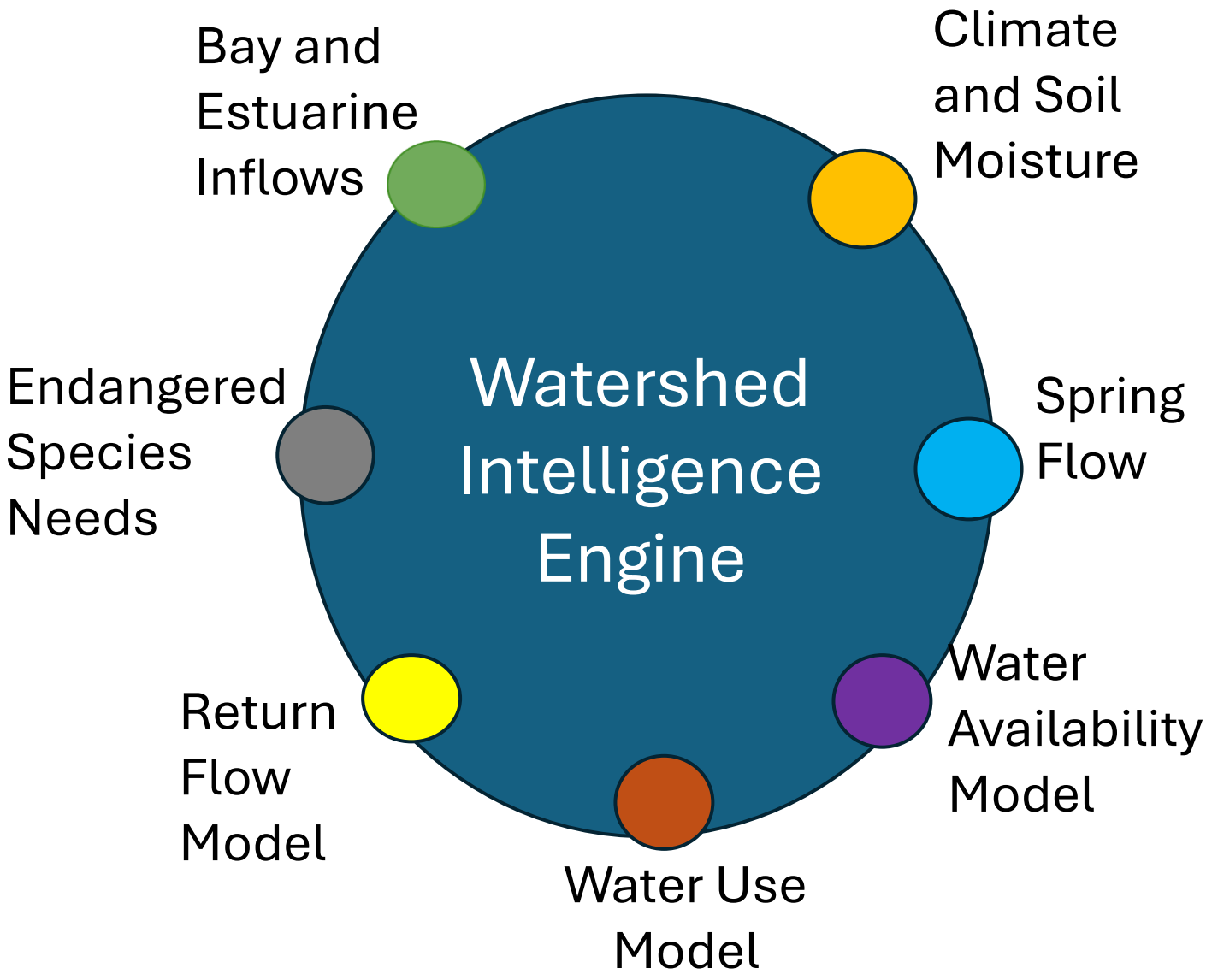
Remember

The Water In Texas Rivers Is Owned By The State of Texas

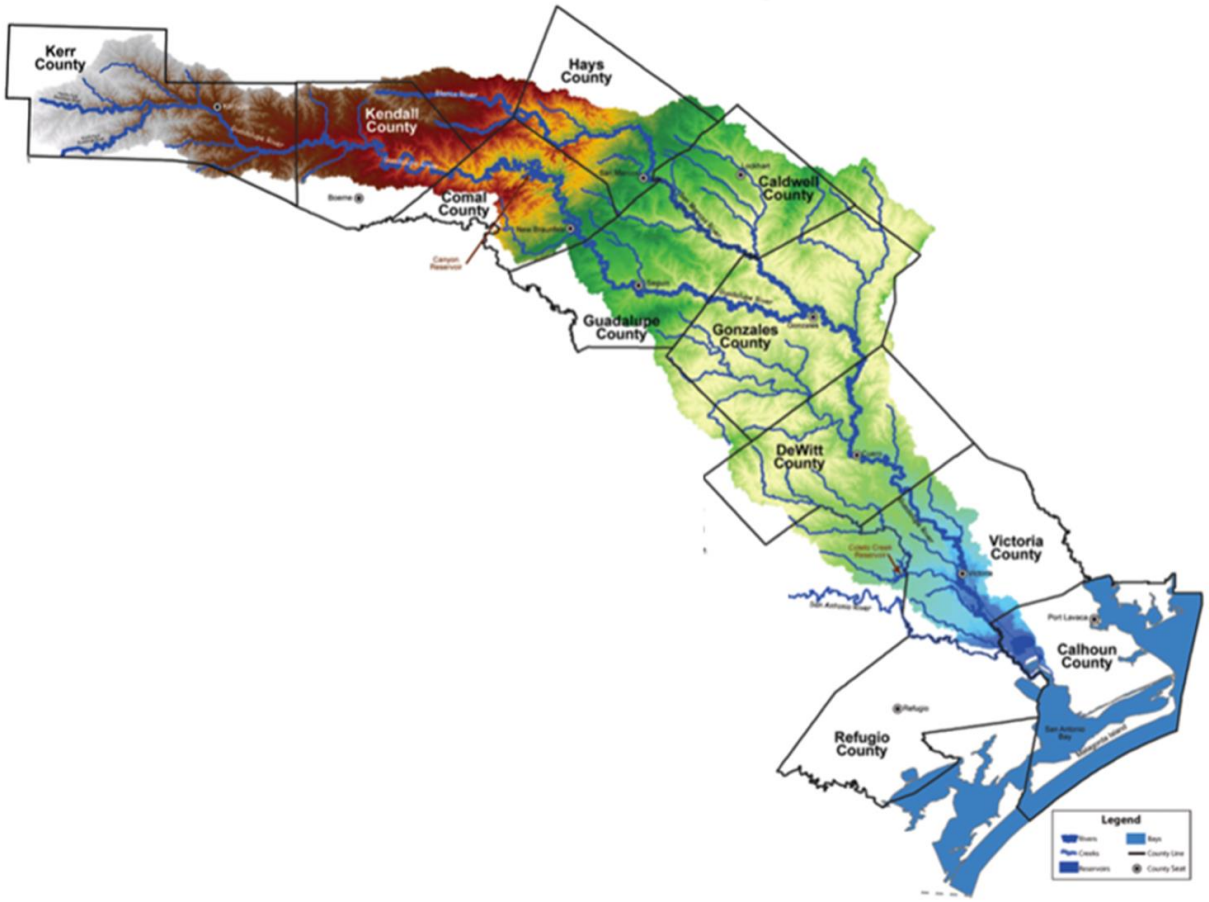
Intelligent Watershed

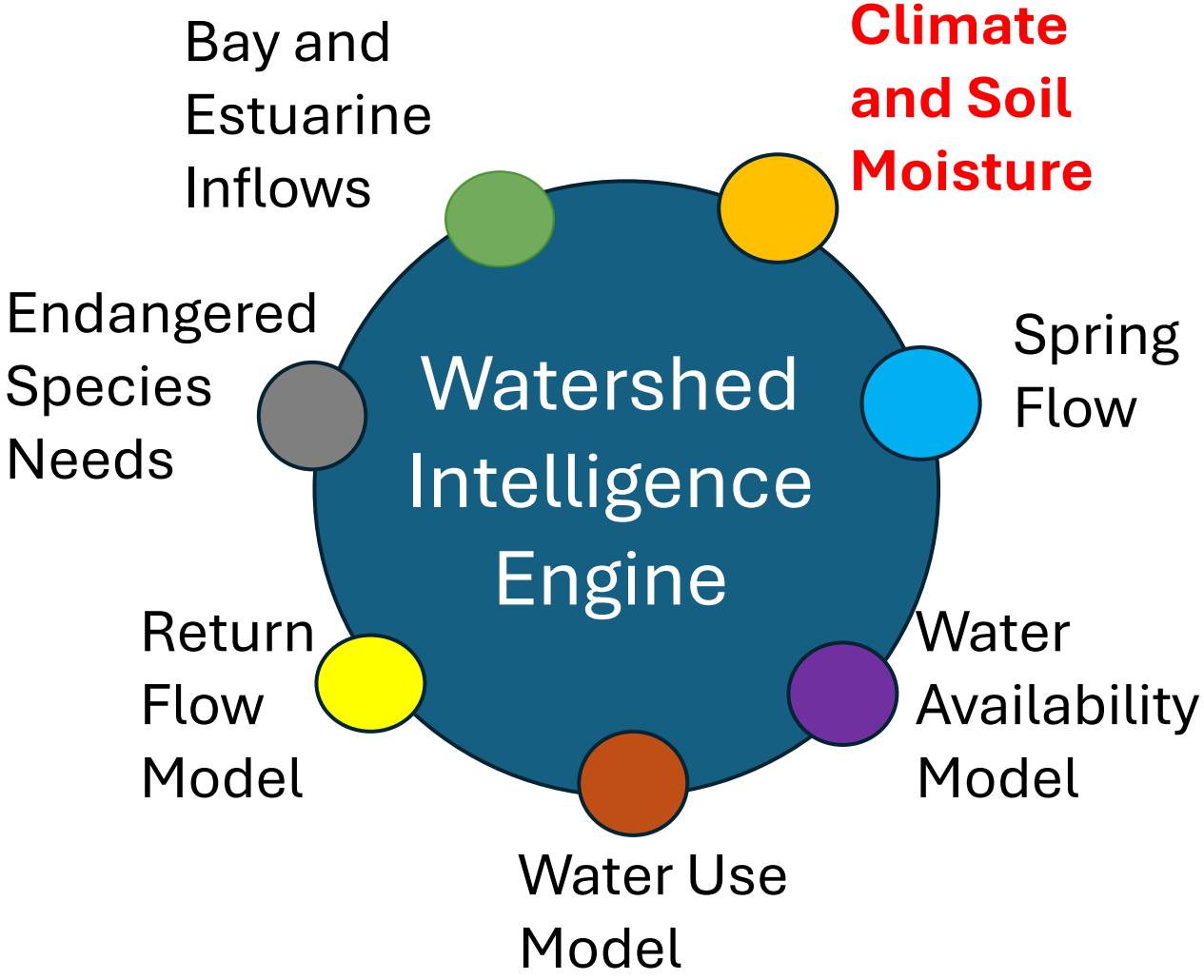
- a modern, technology-driven approach to water management that integrates data, modeling, and artificial intelligence to connect raw data to actionable decisions across a watershed.

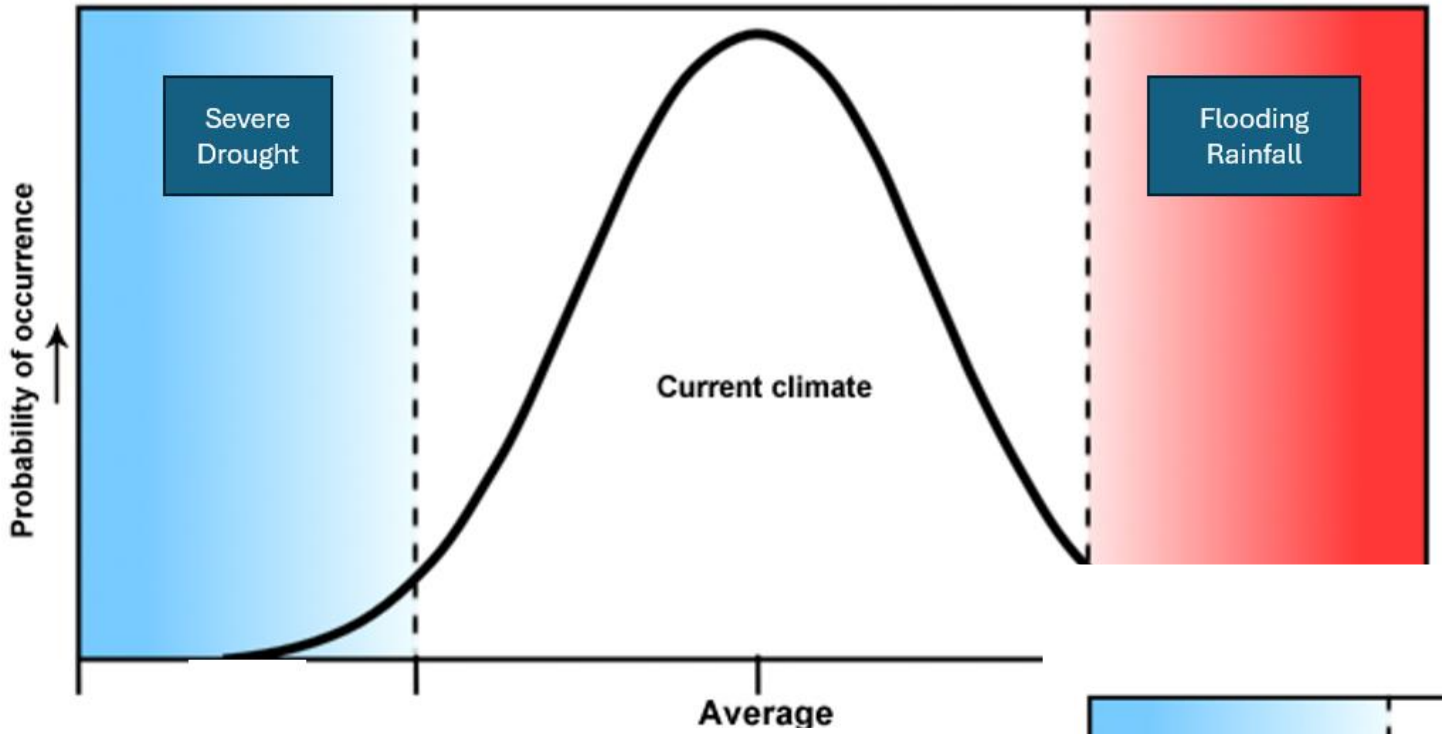
Source. Oak Ridge National Lab



Application to the Guadalupe River System

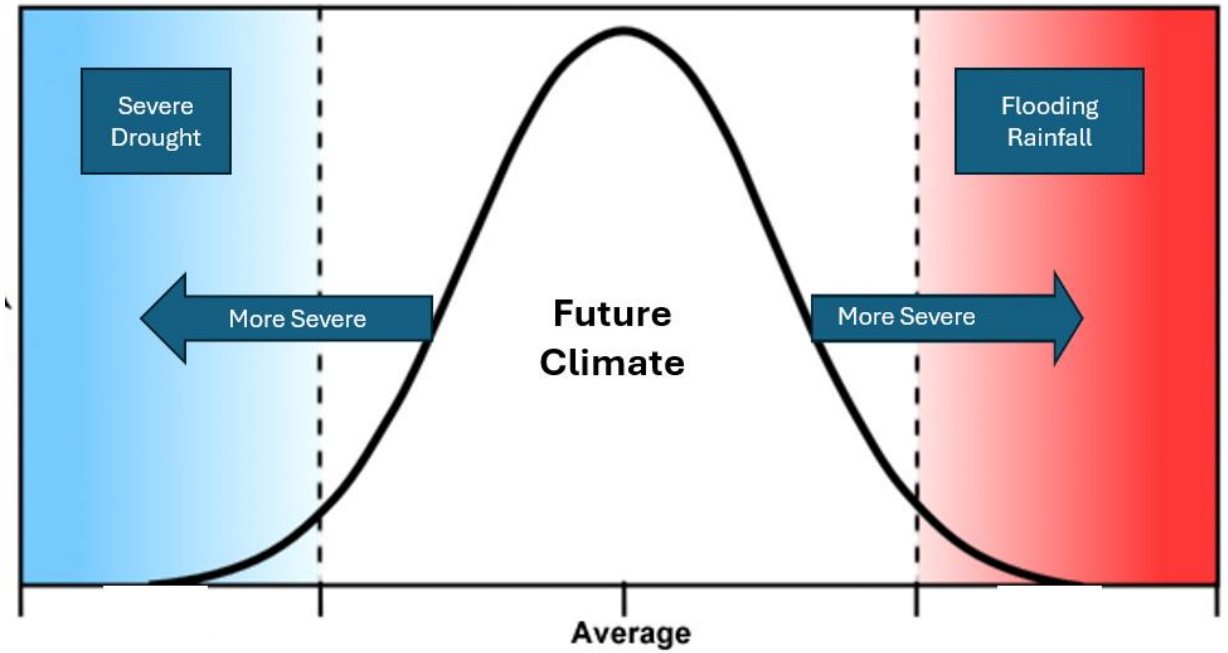


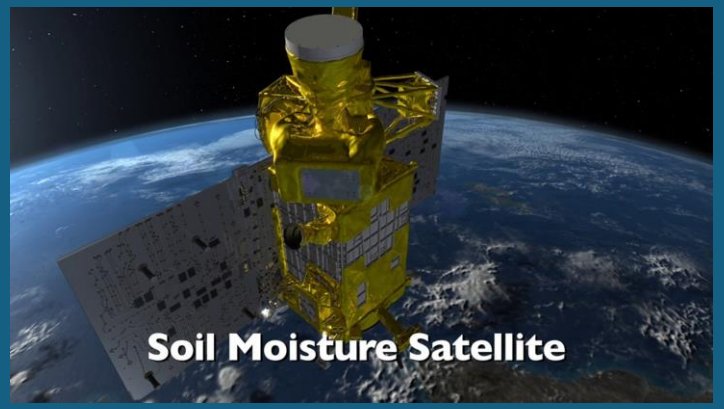




Our Climate Is Changing and We Need To Keep Up

Real-Time Gaged Rainfall Updates





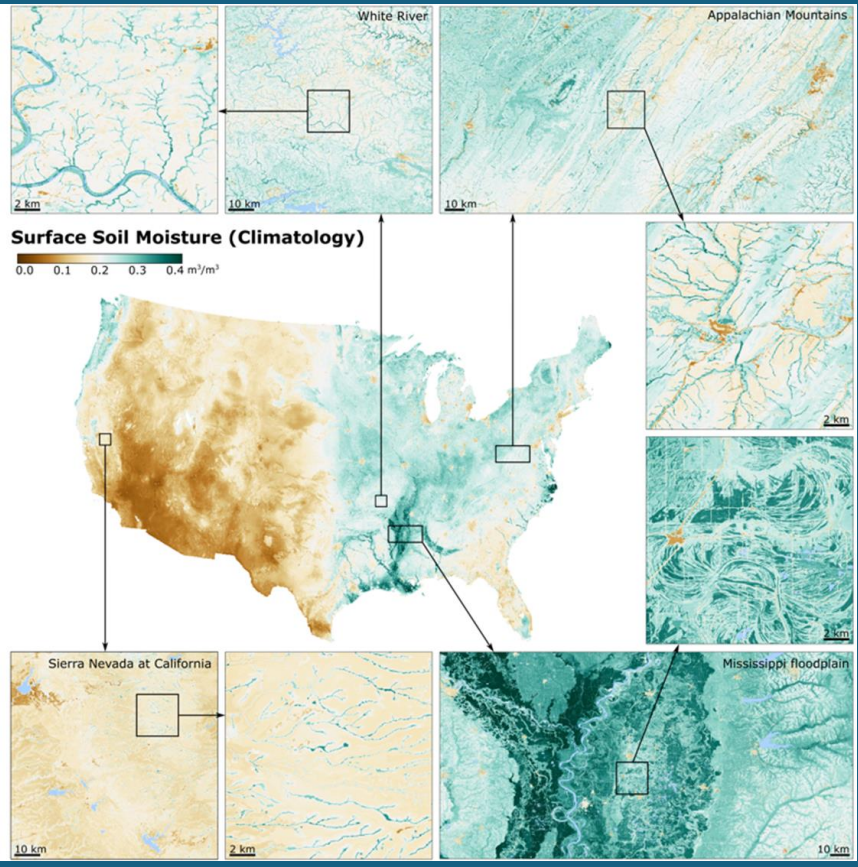
SMAP-HydroBlocks

The first 30-m resolution satellite-based soil moisture dataset for the US

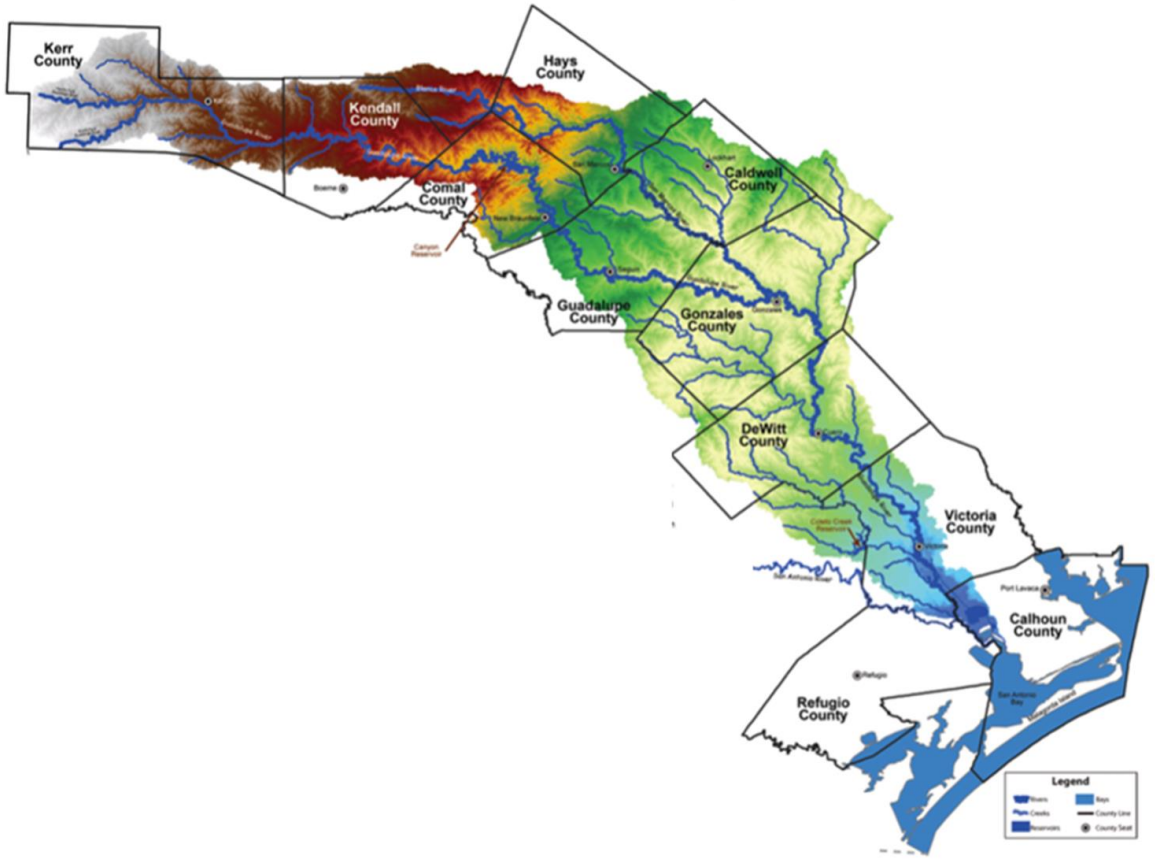
Data characteristics:

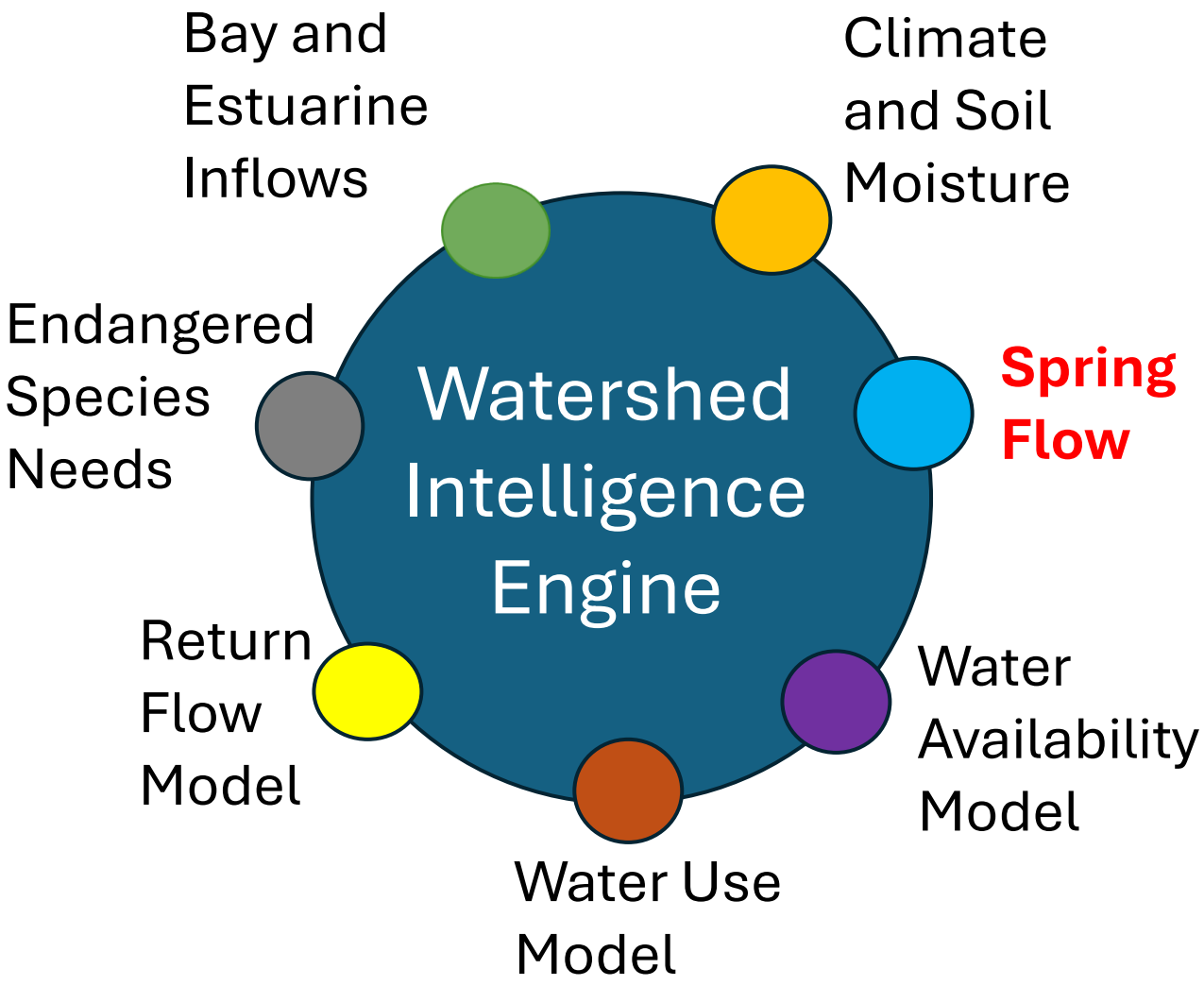
- Open Access
- 30m resolution, 2-3 days revisit time
- 2015-2019 (62 TB)

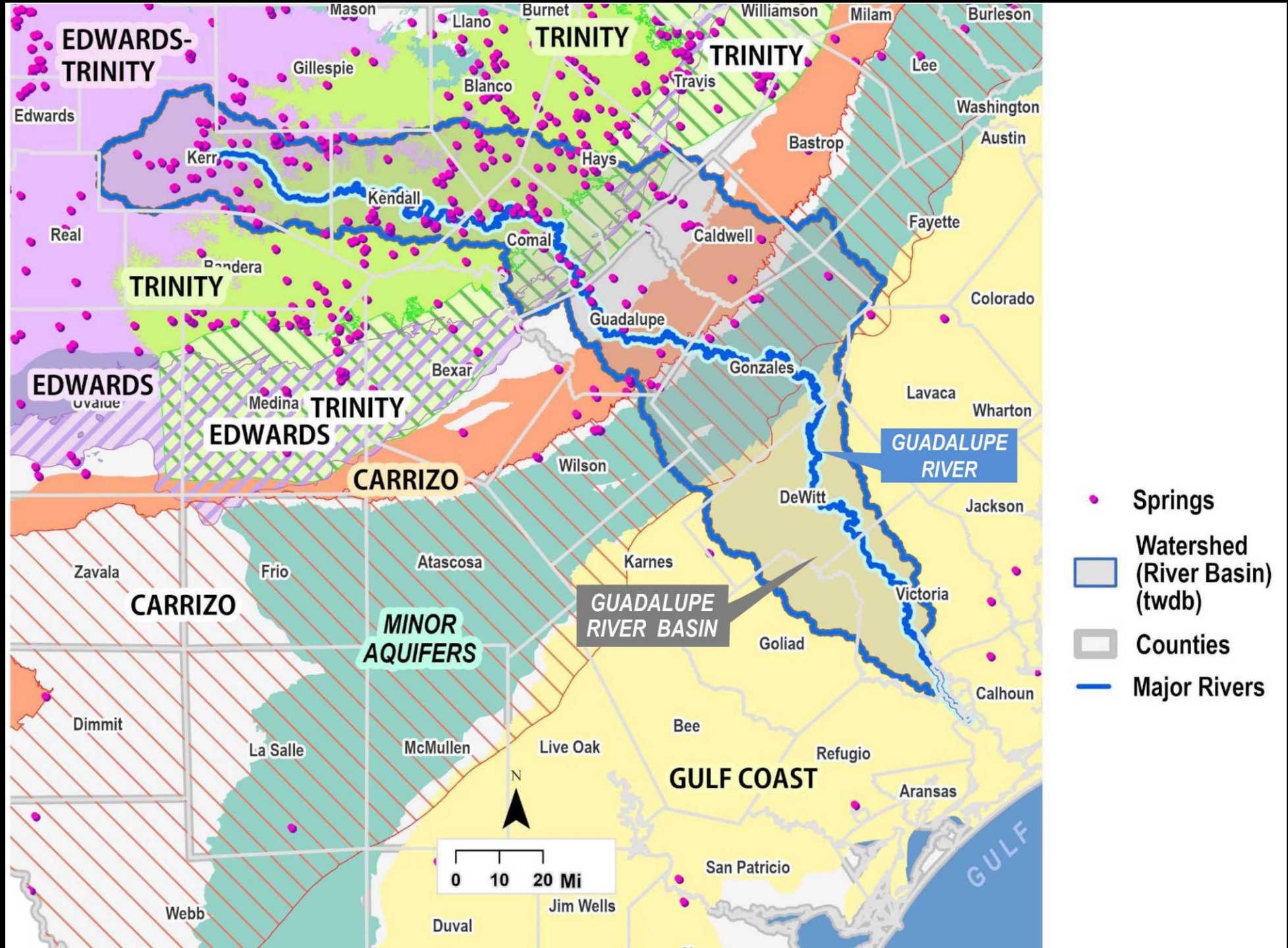
Vergopolan et al. (2021). SMAP-HydroBlocks, a 30-m satellite-based soil moisture dataset for the conterminous US. Nature Scientific Data.



Application to the Guadalupe River System






EDWARDS-
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EDWARDS
CARRIZO
CARRIZO
MINOR
AQUIFERS
GULF COAST
GUADALUPE
RIVER
GUADALUPE
RIVER BASIN
Mason
Llano
Burnet
Williamson
Milam
Burleson
Gillespie
Blanco
Travis
Lee
Washington
Edwards
Kerr
Hays
Bastrop
Austin
Kendall
Real
Comal
Caldwell
Fayette
Bandera
Guadalupe
Colorado
Bexar
Gonzales
Medina
Lavaca
Wharton
Uvalde
Wilson
DeWitt
Jackson
Karnes
Zavala
Frio
Atascosa
Victoria
Goliad
Calhoun
Dimmit
Bee
La Salle
McMullen
Live Oak
Refugio
Aransas
N
0 10 20 Mi
San Patricio
Webb
Jim Wells
Duval
GULF
Springs
Watershed
(River Basin)
(twdb)
Counties
Major Rivers

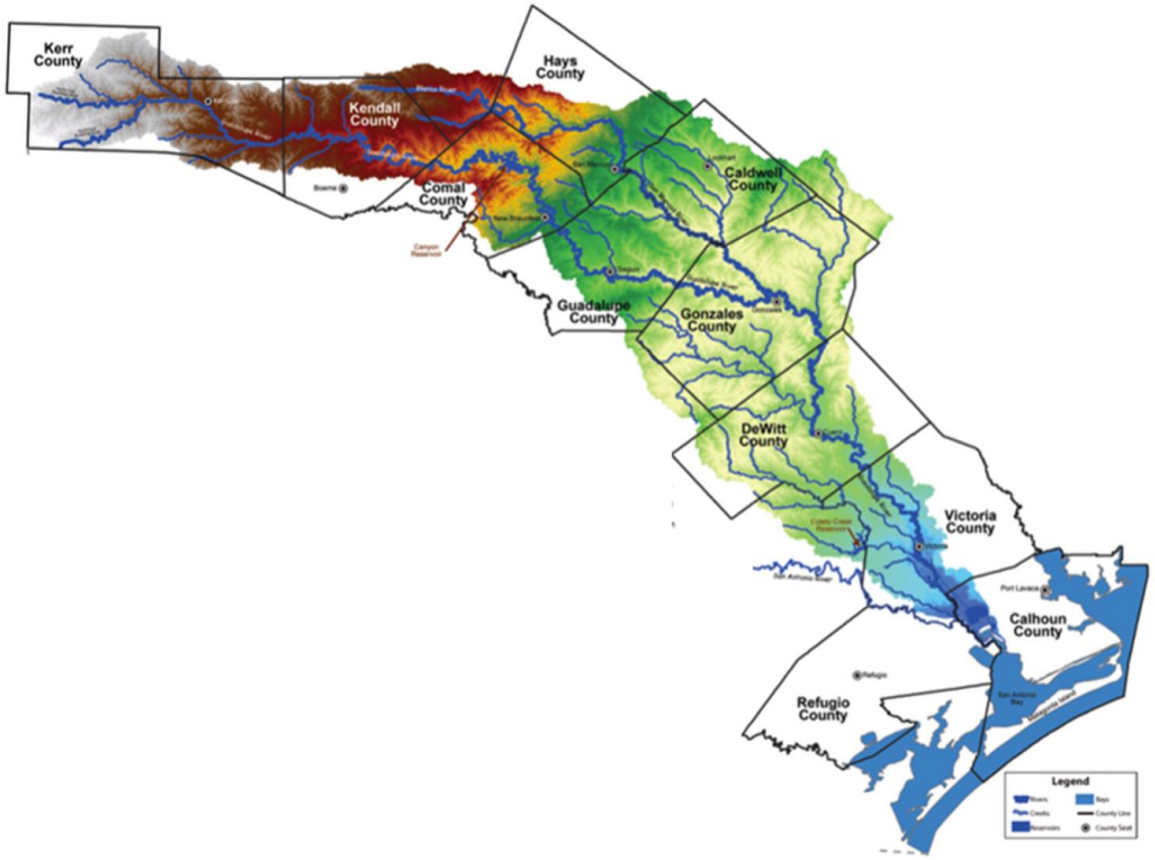
Comal Springs
Primary Spring
New Braunfels

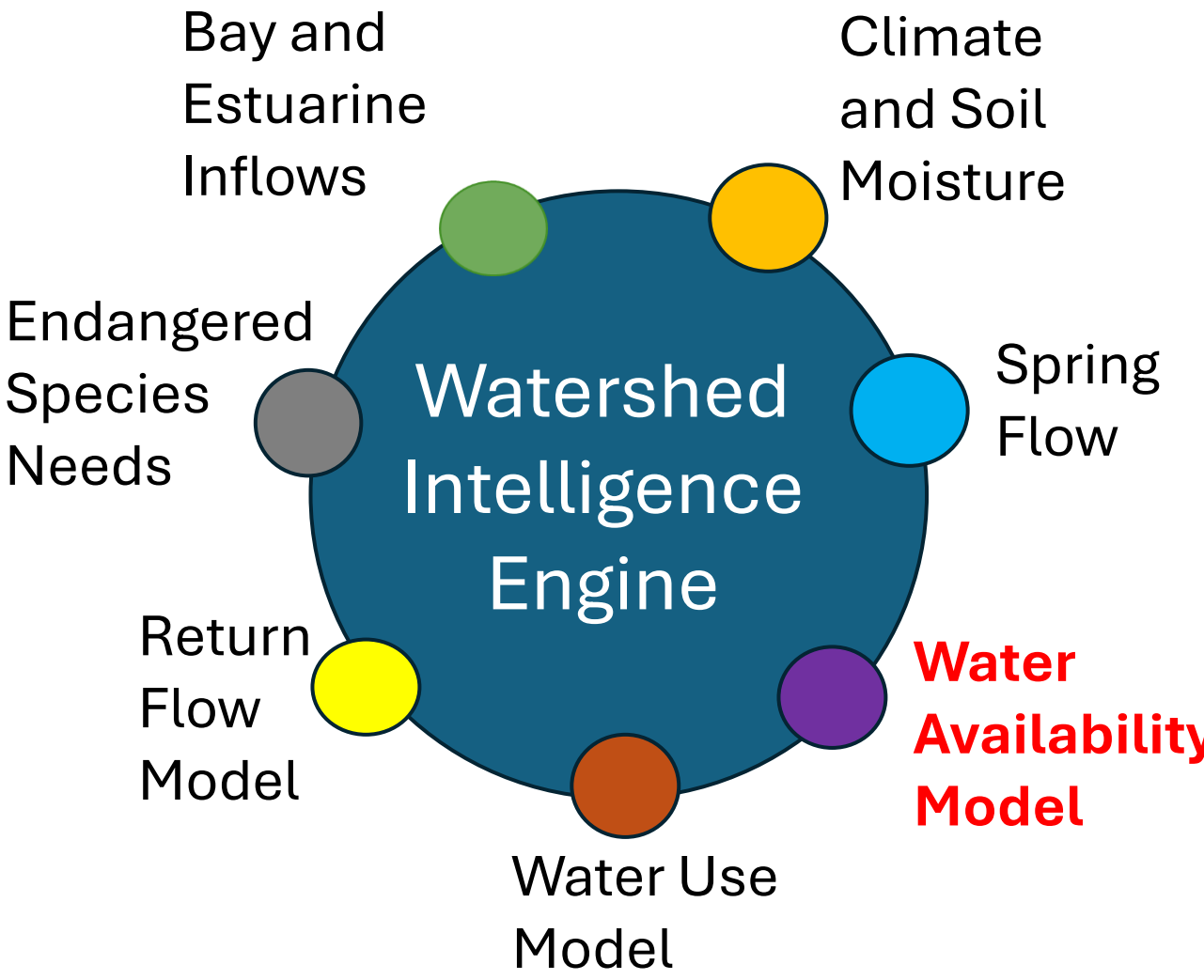
Jacobs Well Wimberley


Texas Water
Development Board

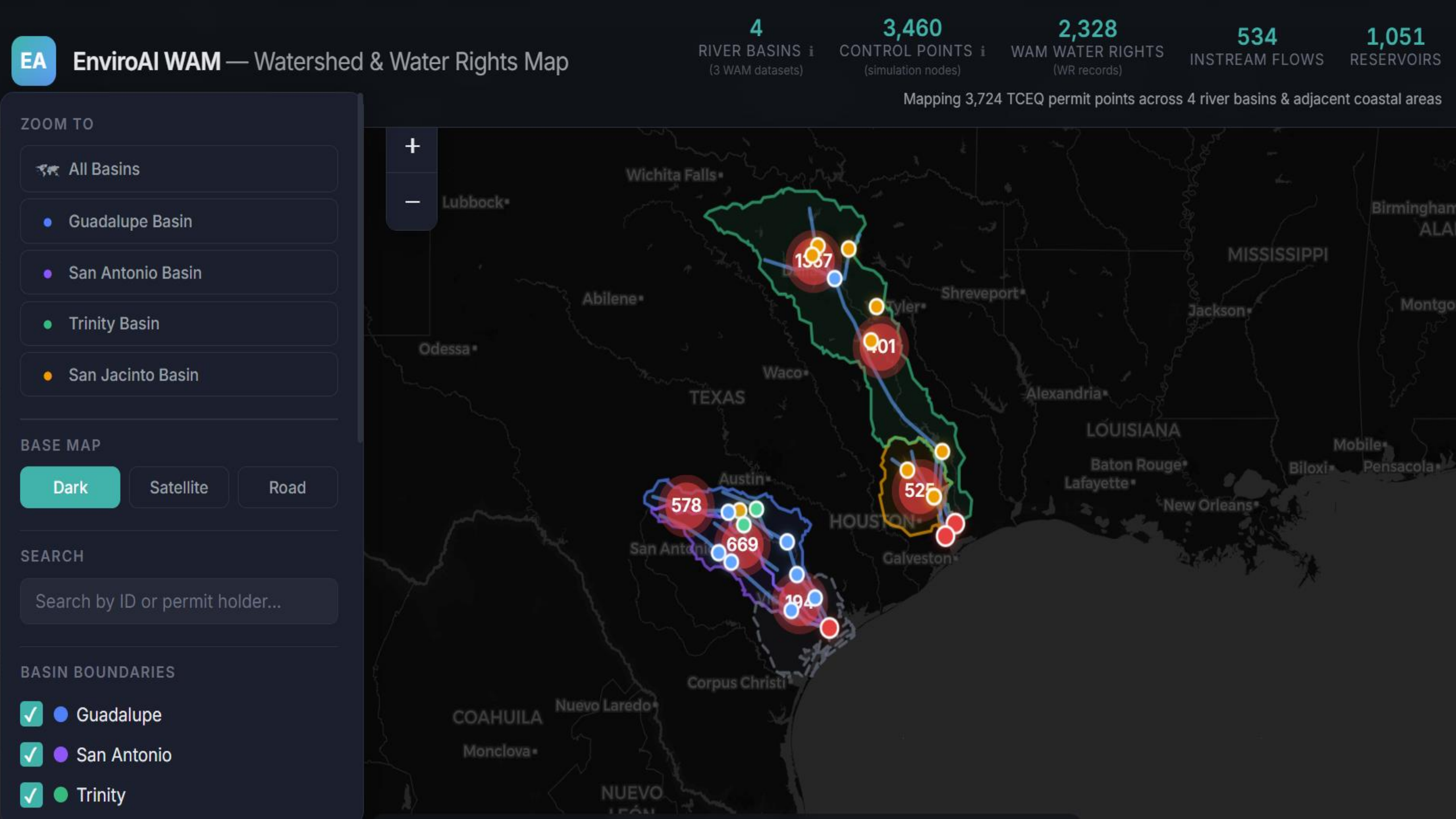
Real-Time Monitoring Spring Flow?

Application to the Guadalupe River System





USGS River Flow Gages


EA
EnviroAI WAM — Watershed & Water Rights Map
4
RIVER BASINS
(3 WAM datasets)
3,460
CONTROL POINTS
(simulation nodes)
2,328
WAM WATER RIGHTS
(WR records)
534
INSTREAM FLOWS
1,051
RESERVOIRS
Mapping 3,724 TCEQ permit points across 4 river basins & adjacent coastal areas
ZOOM TO
All Basins
Guadalupe Basin
San Antonio Basin
Trinity Basin
San Jacinto Basin
BASE MAP
Dark
Satellite
Road
SEARCH
Search by ID or permit holder...
BASIN BOUNDARIES
Guadalupe
San Antonio
Trinity
Wichita Falls
Lubbock
Abilene
Odessa
Waco
TEXAS
Austin
San Antonio
HOUSTON
Galveston
Corpus Christi
Nuevo Laredo
COAHUILA
Monclova
NUEVO
Shreveport
Jackson
MISSISSIPPI
Alexandria
LOUISIANA
Baton Rouge
Lafayette
New Orleans
Mobile
Biloxi
Pensacola
Birmingham
ALA
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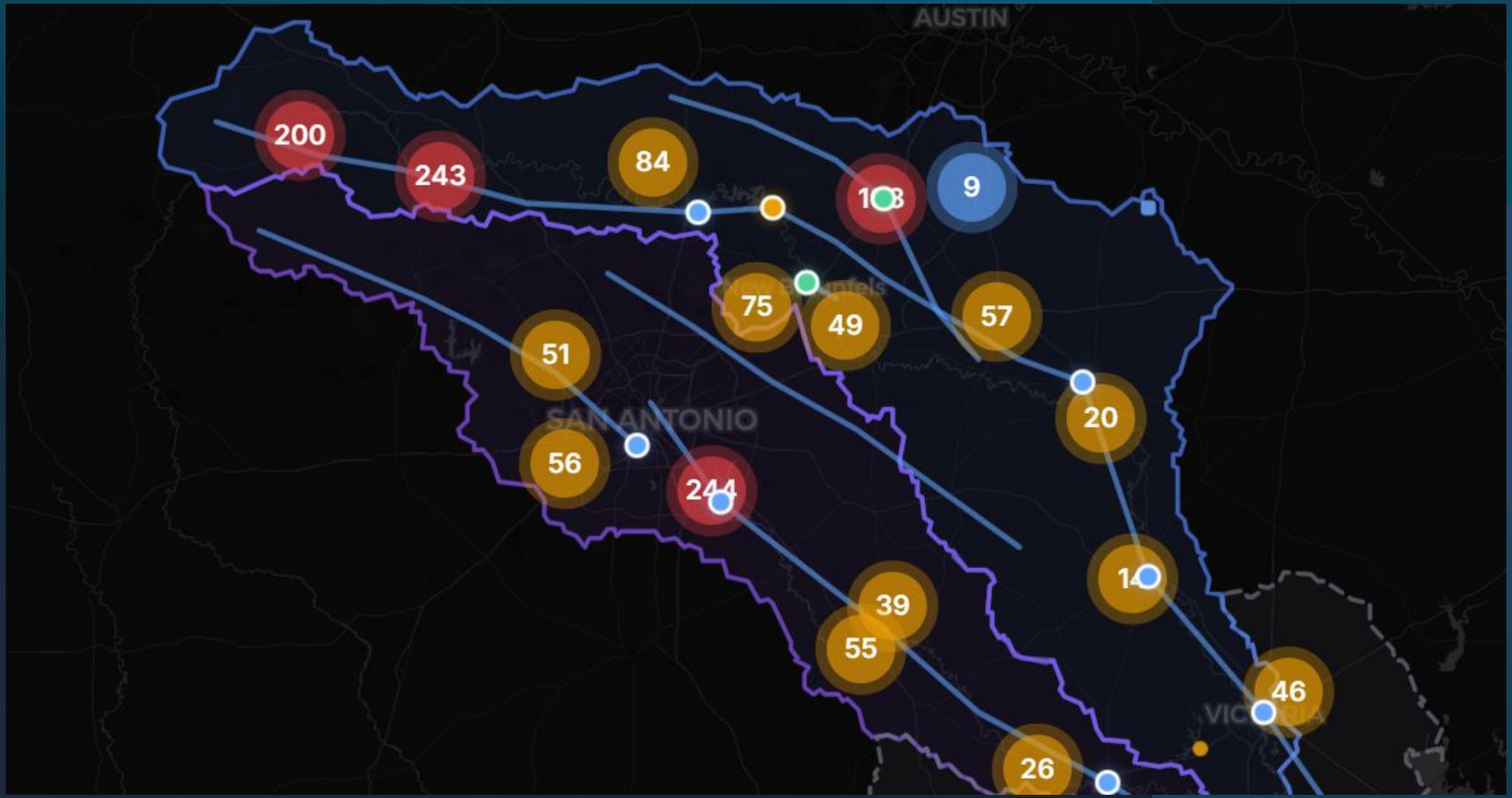
AUSTIN
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SAN ANTONIO
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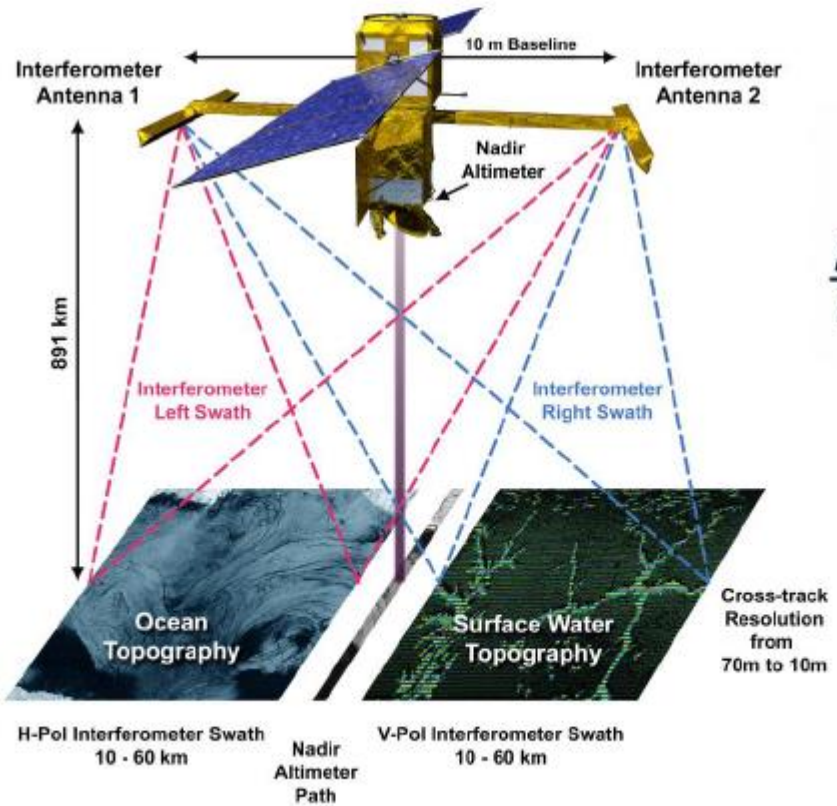
Integrating satellite observations and AI to model river discharge and floods

SWOT Altimeter
Water Level & Extent

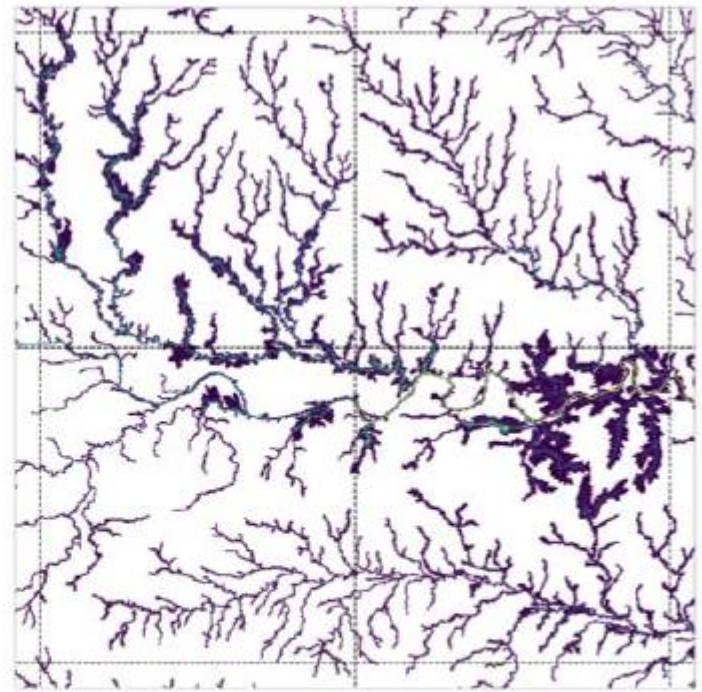


$$\frac{h}{h}\frac{\nu u}{\partial x}$$

PINNs
PHYSICS-INFORMED NEURAL NETWORKS

+

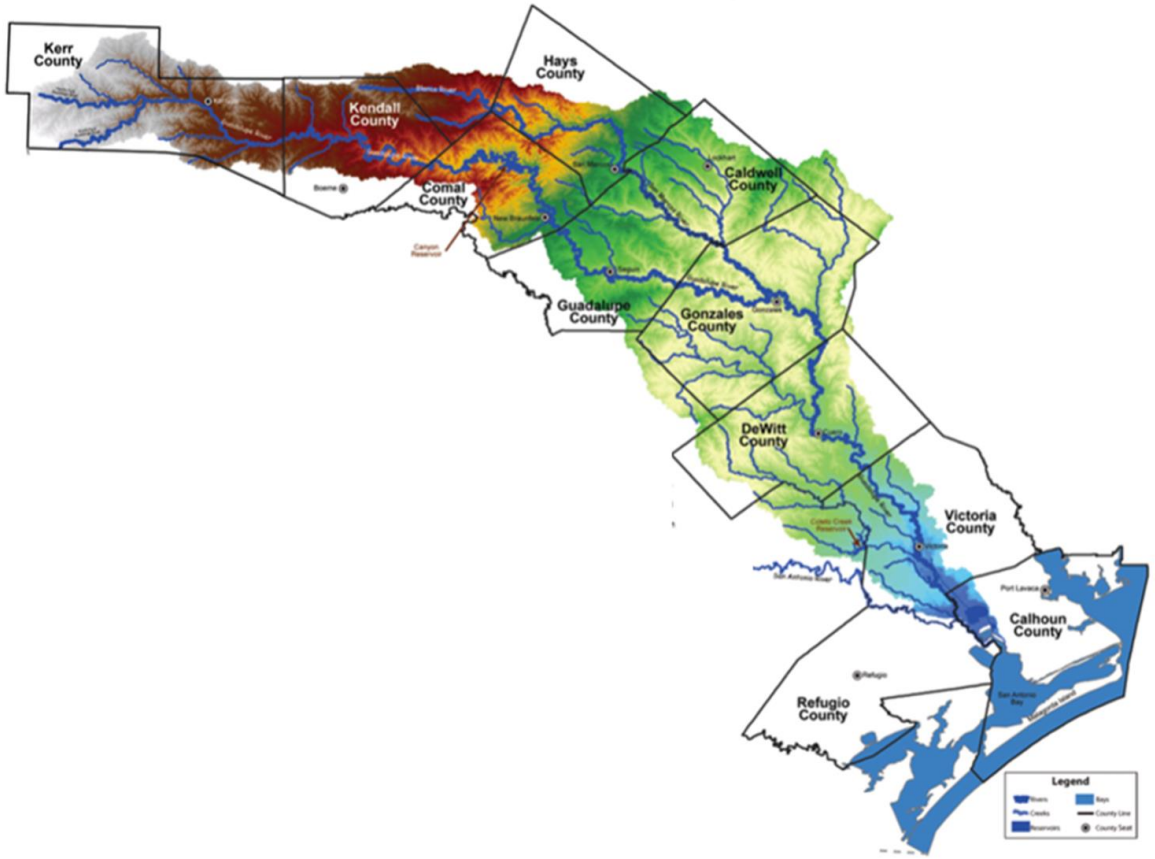
Modeling
Water level & flood extent

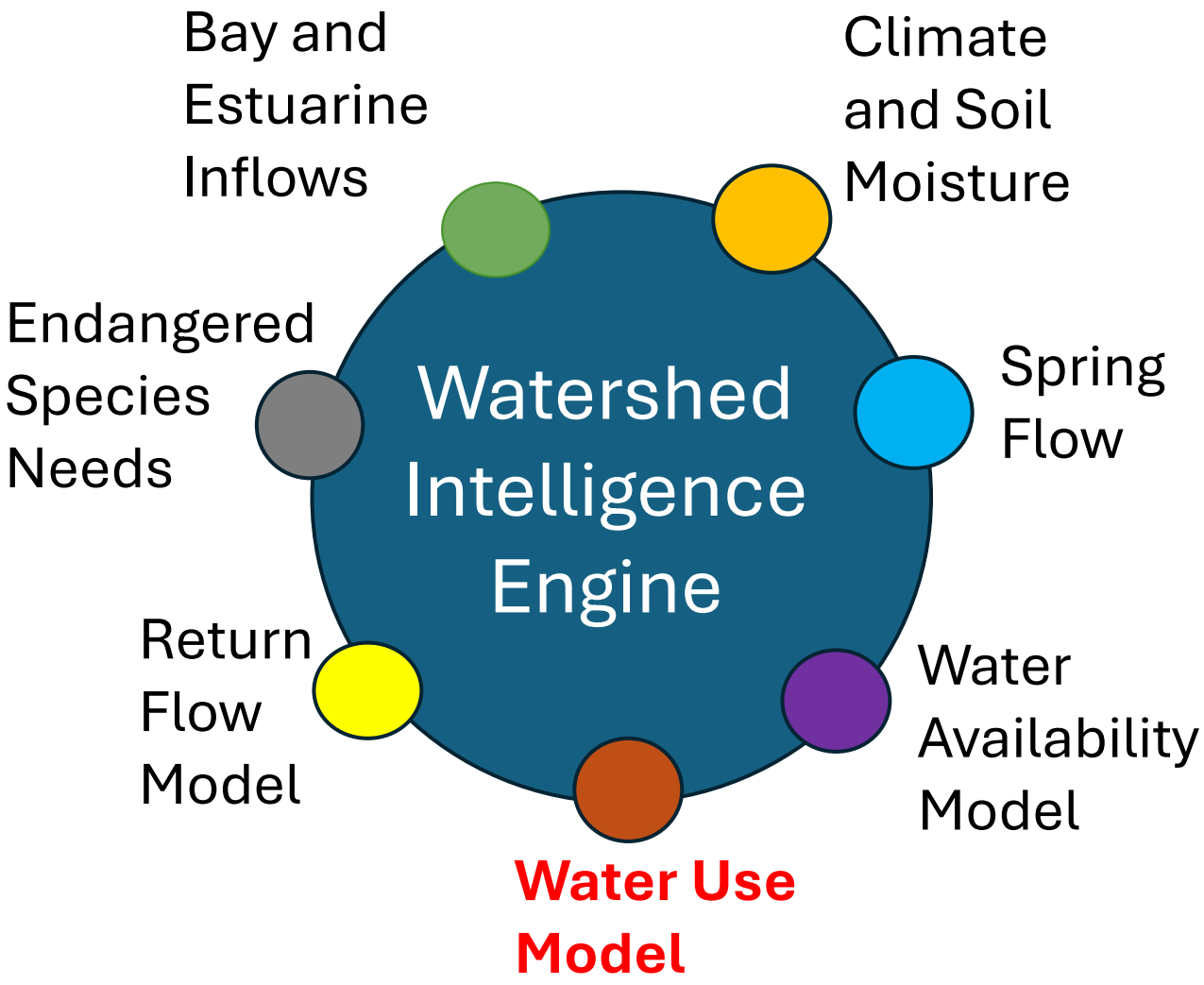


Identification of Unused Water Rights

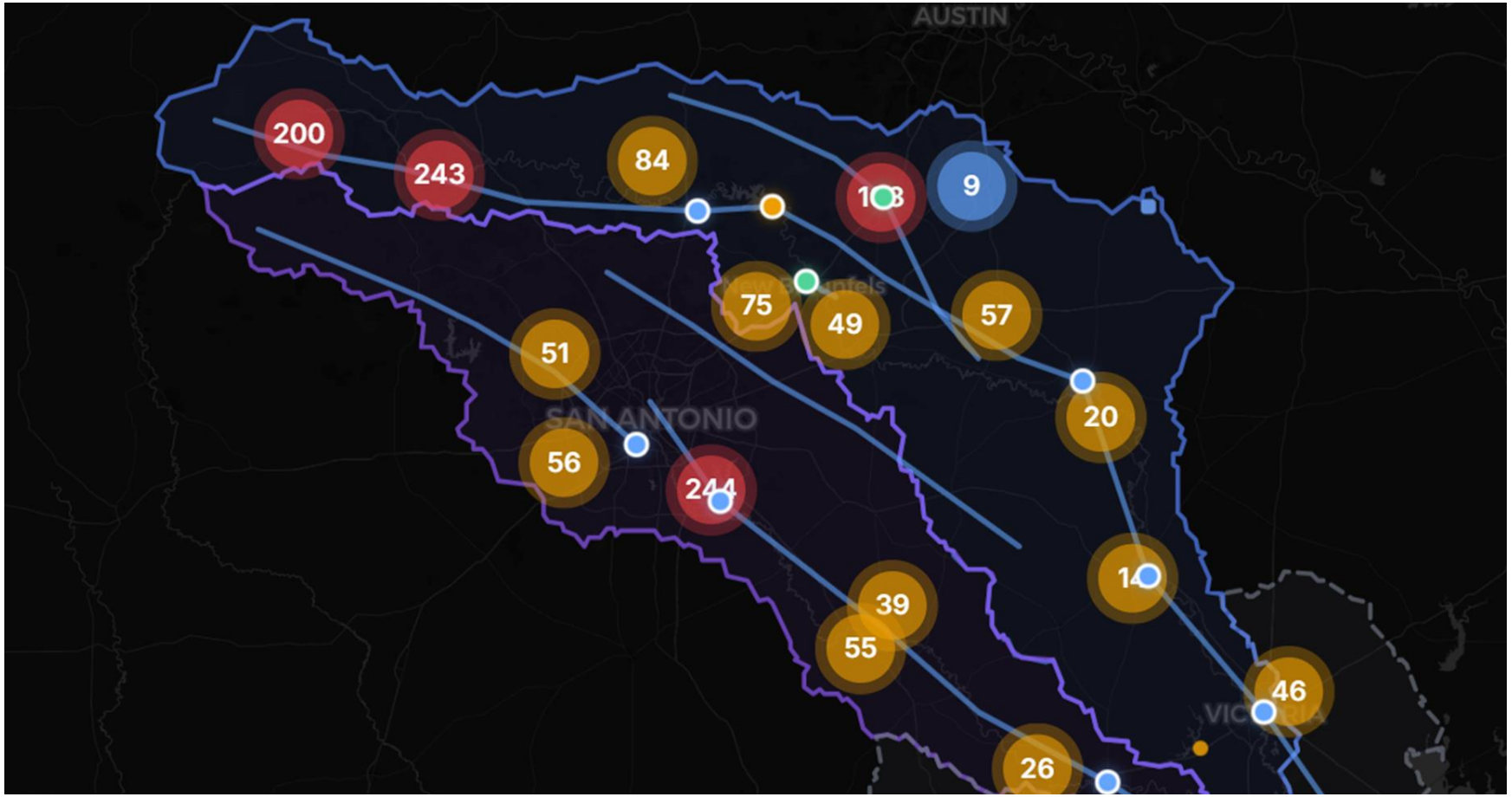
- Unused water rights are subject to cancellation
- Last major cancellation 2001-2002 on the Rio Grande
- WIE can identify unused water rights based on reported usage
- Watermaster or others can lead cancellation process
- Can we dedicate cancelled water rights to the bays?

Application to the Guadalupe River System





Monitoring Water Use Withdrawals



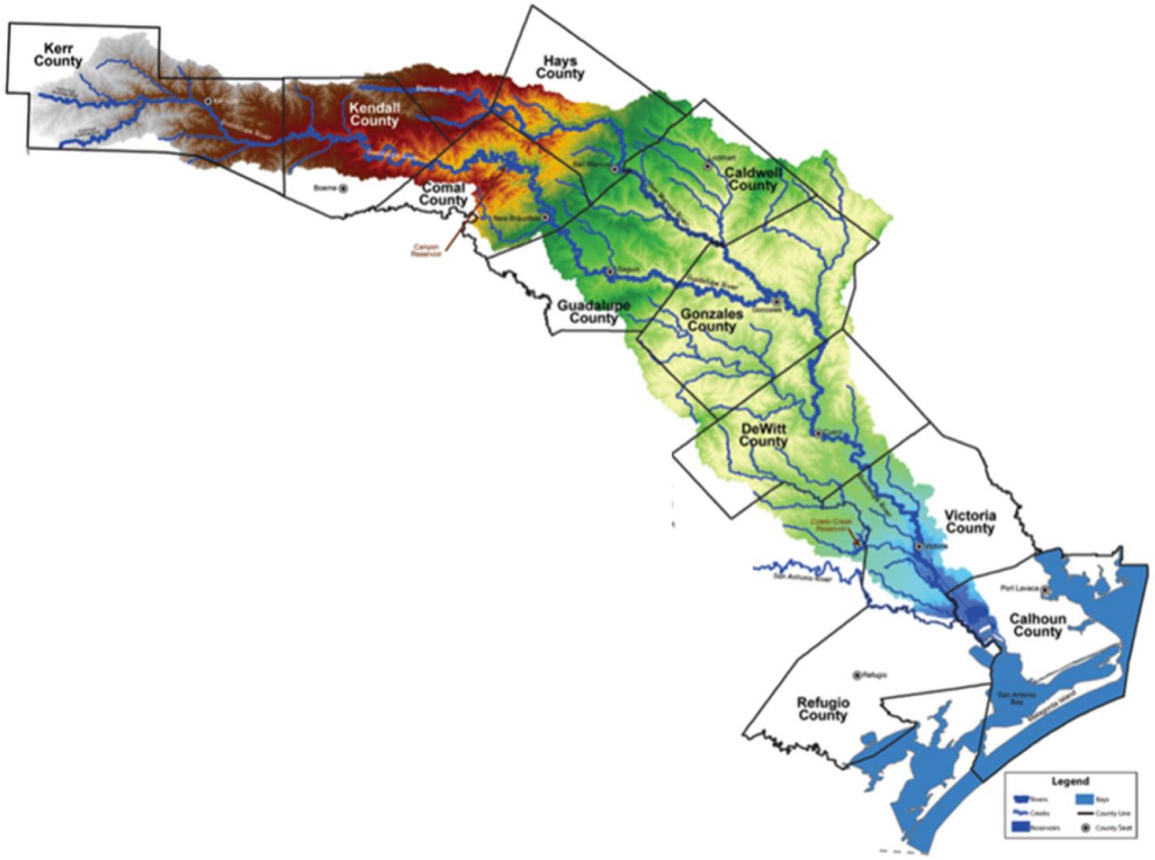
Water Uses of Concern

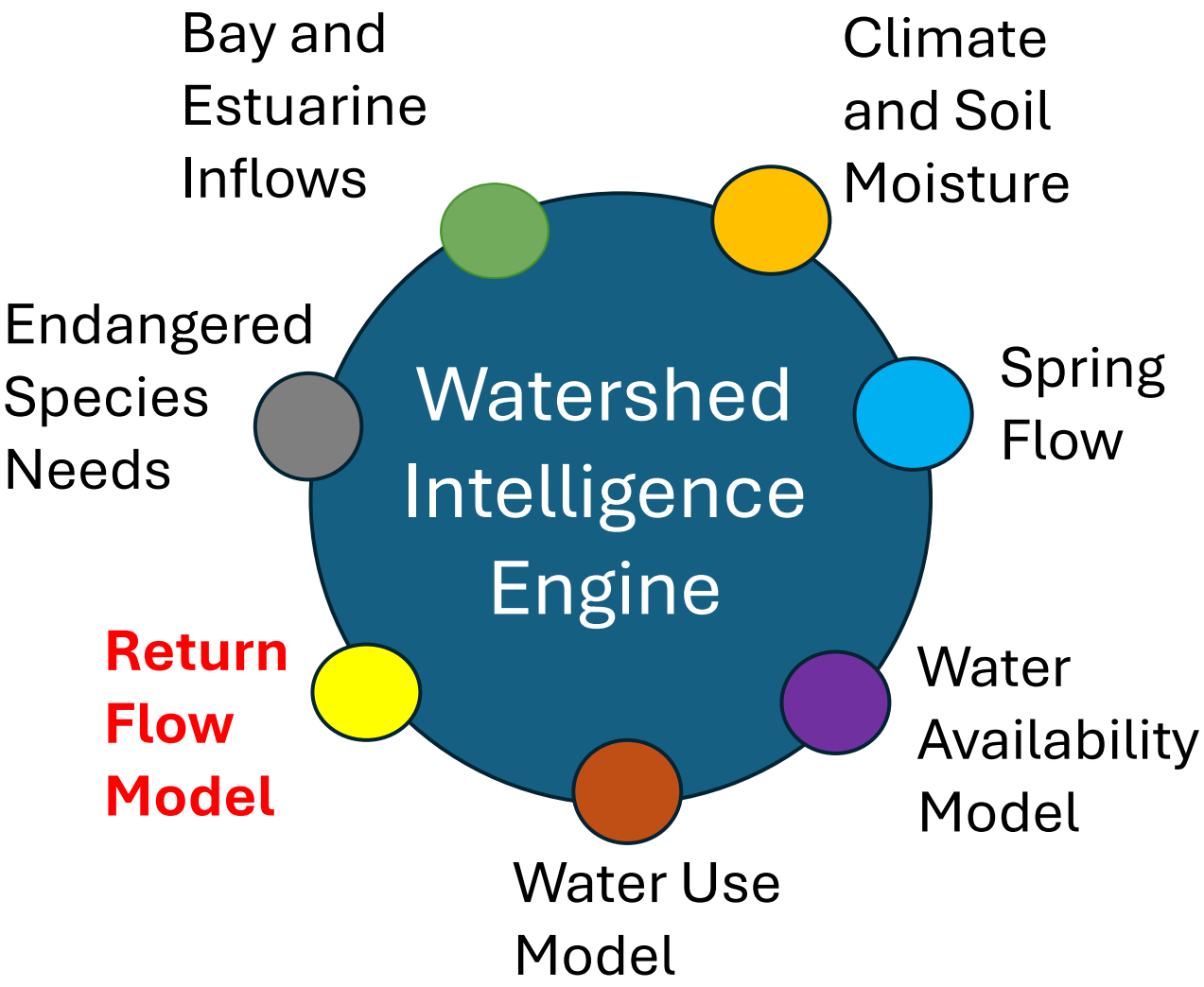
Net Positive Water Pledges

C40 Water Safe Cities

- Buenos Aires, Argentina
- Copenhagen, Denmark
- Freetown, Sierra Leone
- Lisbon, Portugal
- Los Angeles, USA
- Milan, Italy
- New Orleans, USA
- New York City, USA
- Oslo, Norway
- Phoenix, USA
- Quezon City, Philippines
- Quito, Ecuador
- Rio de Janeiro, Brazil
- Rotterdam, Netherlands
- Tokyo, Japan
- Tshwane, South Africa

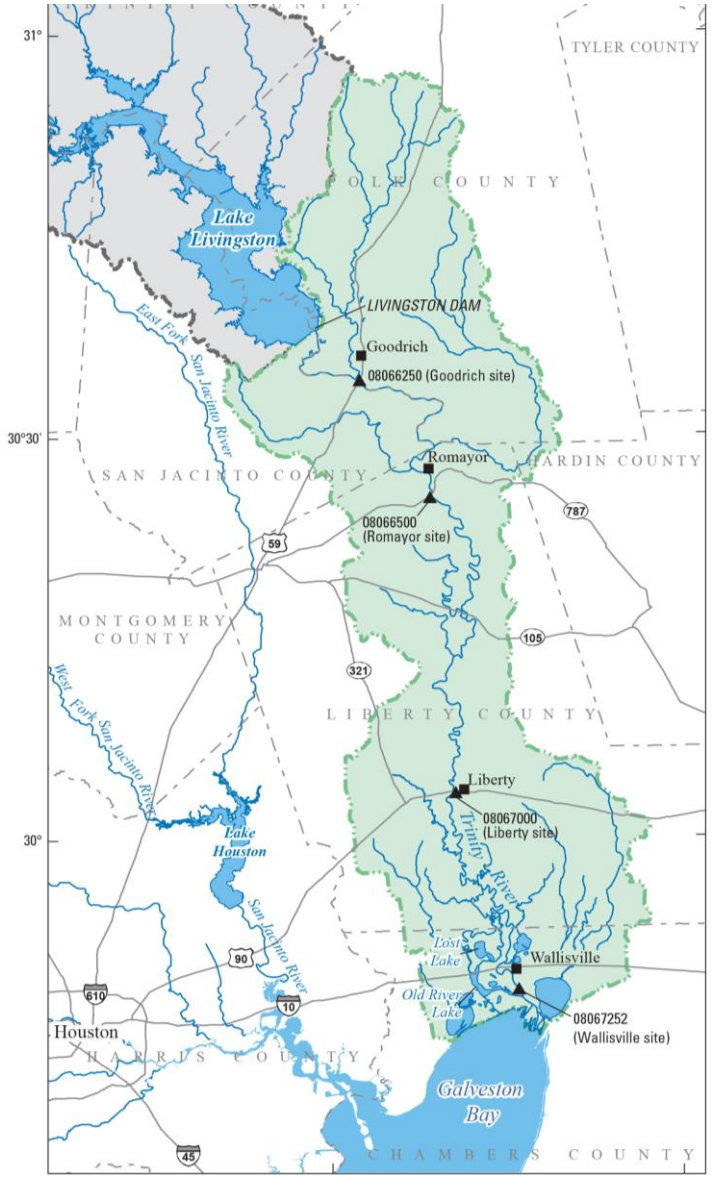
Application to the Guadalupe River System





Wastewater Discharge Flow Monitoring

Consider the Trinity River



Dedicating Return Flows to the Bay

Gregg Eckhardt
Senior Analyst, Production and Treatment Operations

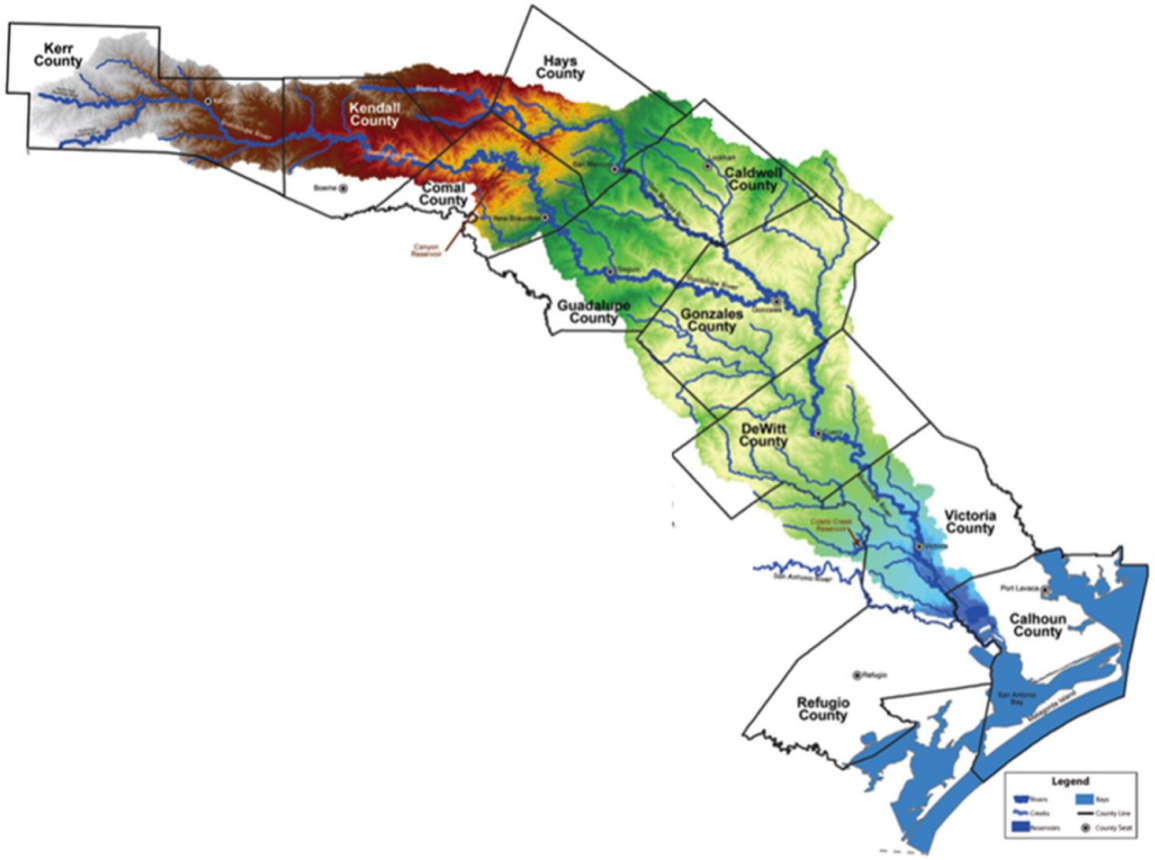
San Antonio Bay Partnership

San Antonio Water System

10th Anniversary Conference

January 23, 2020

Application to the Guadalupe River System



Bay and Estuarine Inflows

Climate and Soil Moisture

Endangered Species Needs

Watershed Intelligence Engine

Spring Flow

Return Flow Model

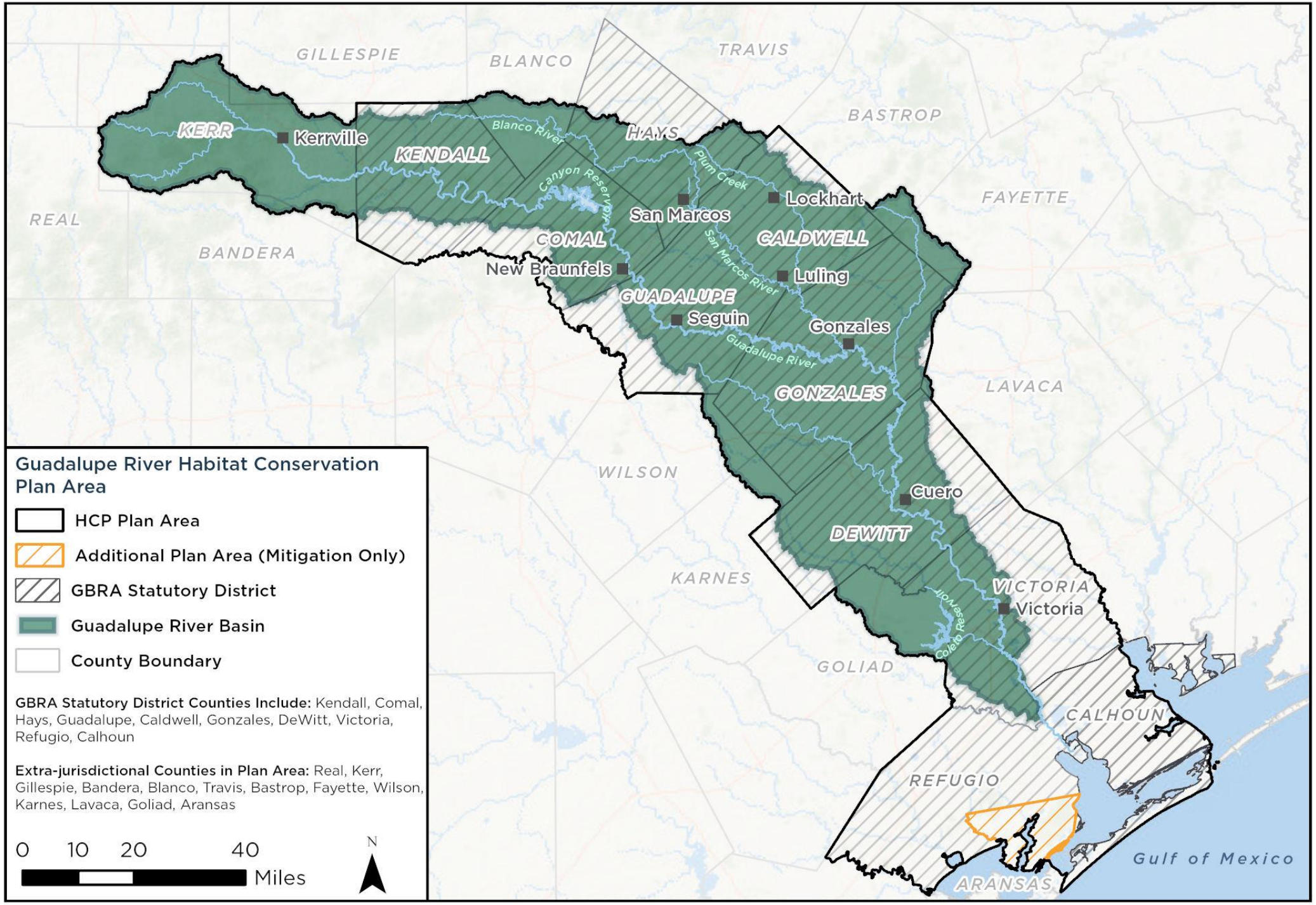
Water Availability Model

Water Use Model

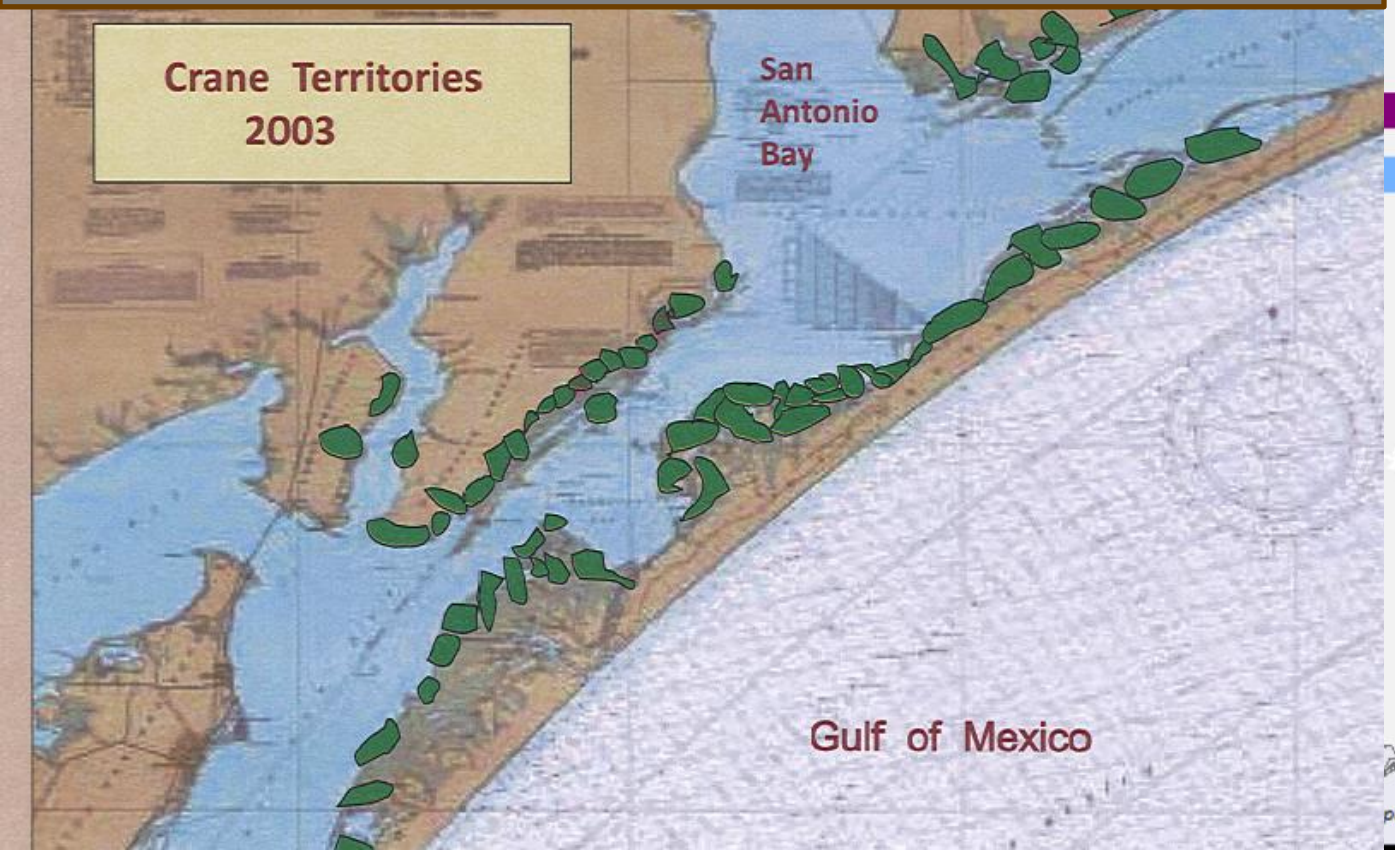
Endangered Guadalupe River Species:
False Spike,Guadalupe Fatmucket, and Guadalupe Orb

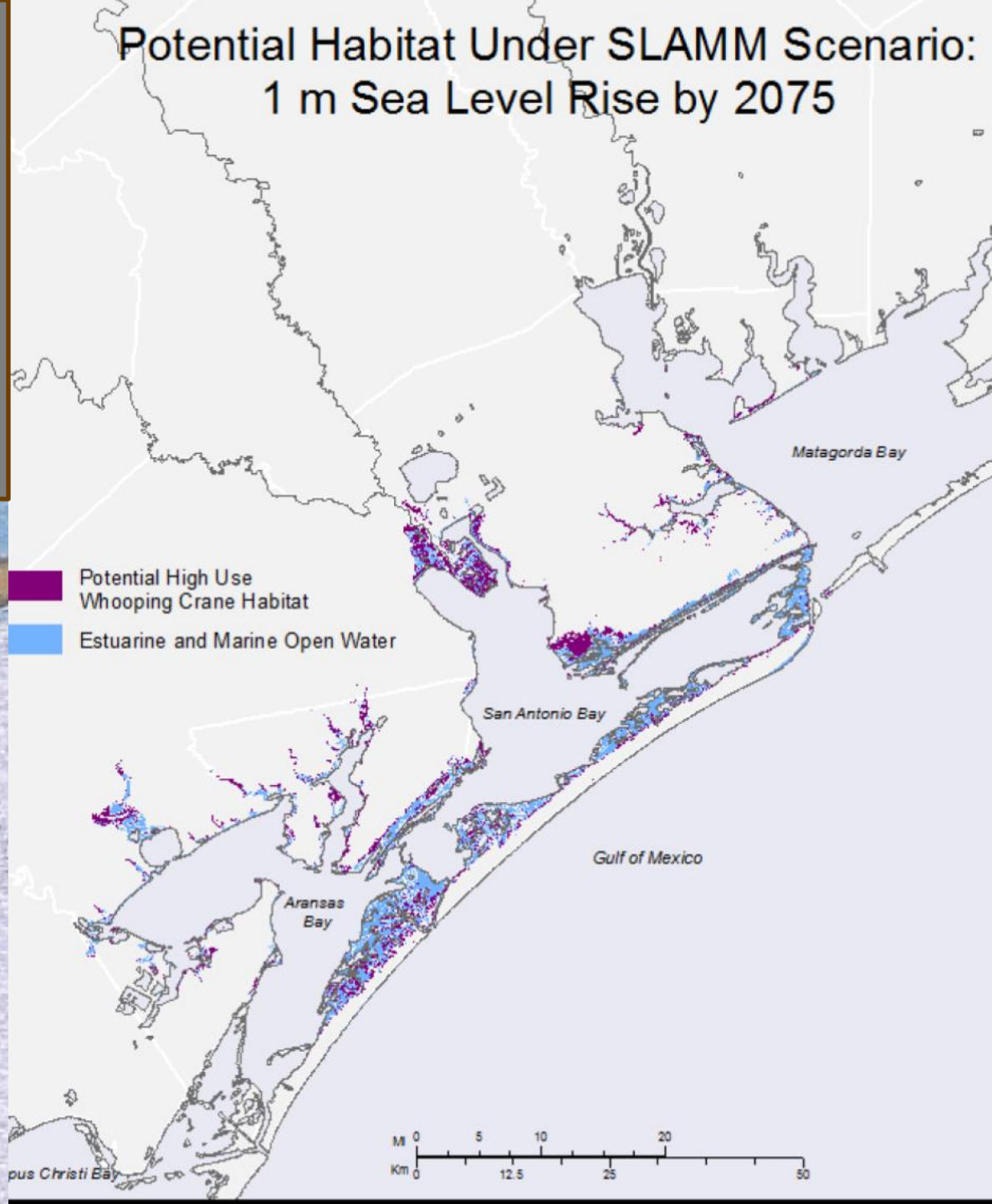
https://www.fws.gov/media/guadalupe-river-basin-mussels-false-spike-guadalupe-fatmucket-and-guadalupe-orb

Photo by Larry Ditto

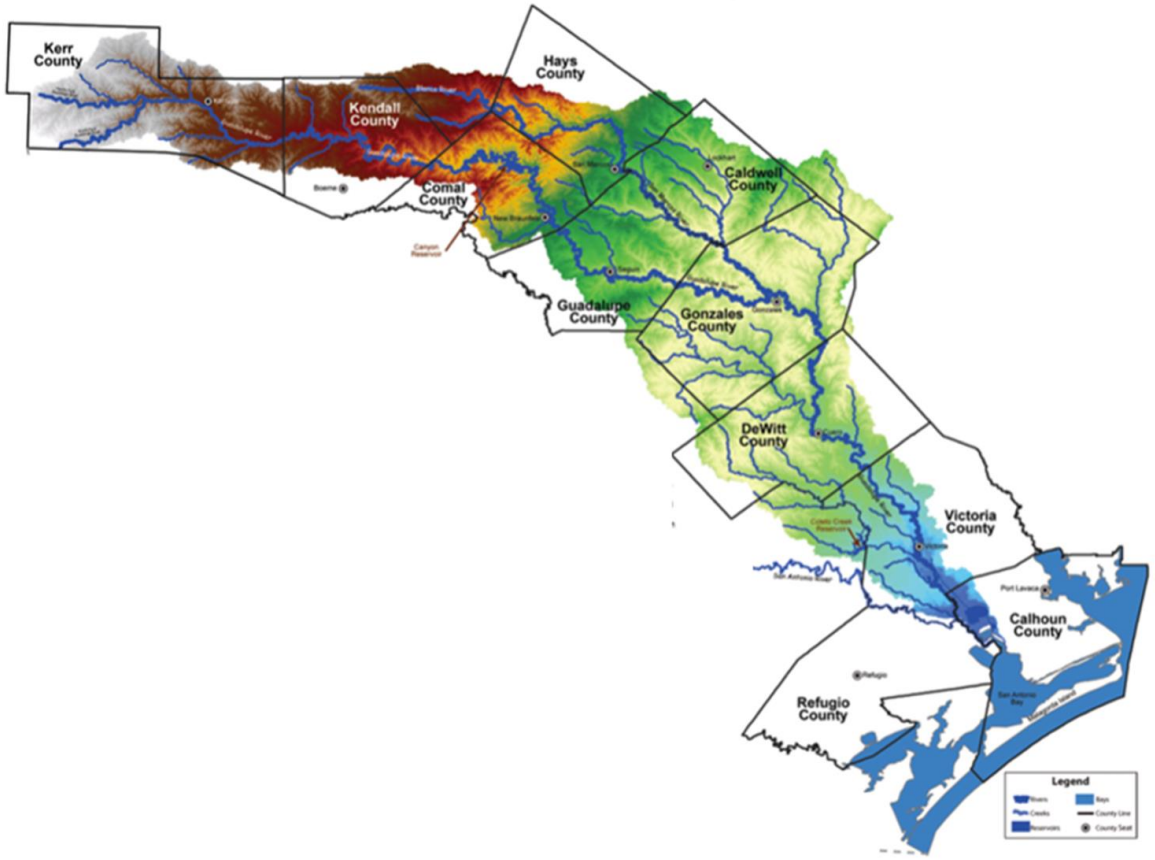

GILLESPIE
BLANCO
TRAVIS
BASTROP
KERR
Kerrville
KENDALL
Blanco River
HAYS
Plum Creek
Canyon Reservoir
Lockhart
San Marcos
FAYETTE
REAL
COMAL
CALDWELL
BANDERA
New Braunfels
San Marcos River
Luling
GUADALUPE
Seguin
Gonzales
Guadalupe River
LAVACA
GONZALES
WILSON
Cuero
DEWITT
KARNES
VICTORIA
Victoria
Coleto Reservoir
GOLIAD
CALHOUN
REFUGIO
Gulf of Mexico
ARANSAS
Guadalupe River Habitat Conservation Plan Area
HCP Plan Area
Additional Plan Area (Mitigation Only)
GBRA Statutory District
Guadalupe River Basin
County Boundary
GBRA Statutory District Counties Include: Kendall, Comal, Hays, Guadalupe, Caldwell, Gonzales, DeWitt, Victoria, Refugio, Calhoun
Extra-jurisdictional Counties in Plan Area: Real, Kerr, Gillespie, Bandera, Blanco, Travis, Bastrop, Fayette, Wilson, Karnes, Lavaca, Goliad, Aransas
0 10 20 40
Miles
N

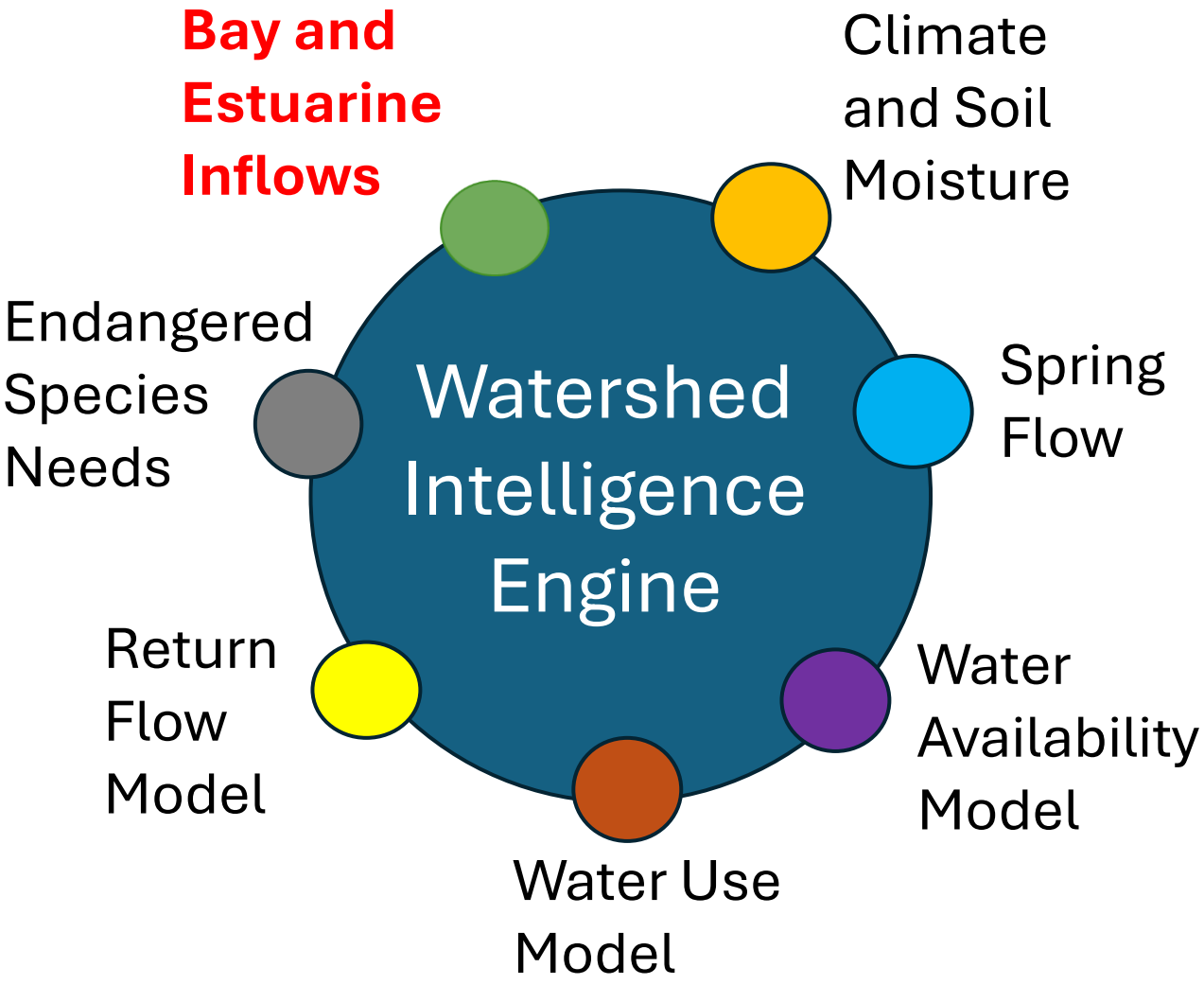
Crane Territories and Sea Level Rise



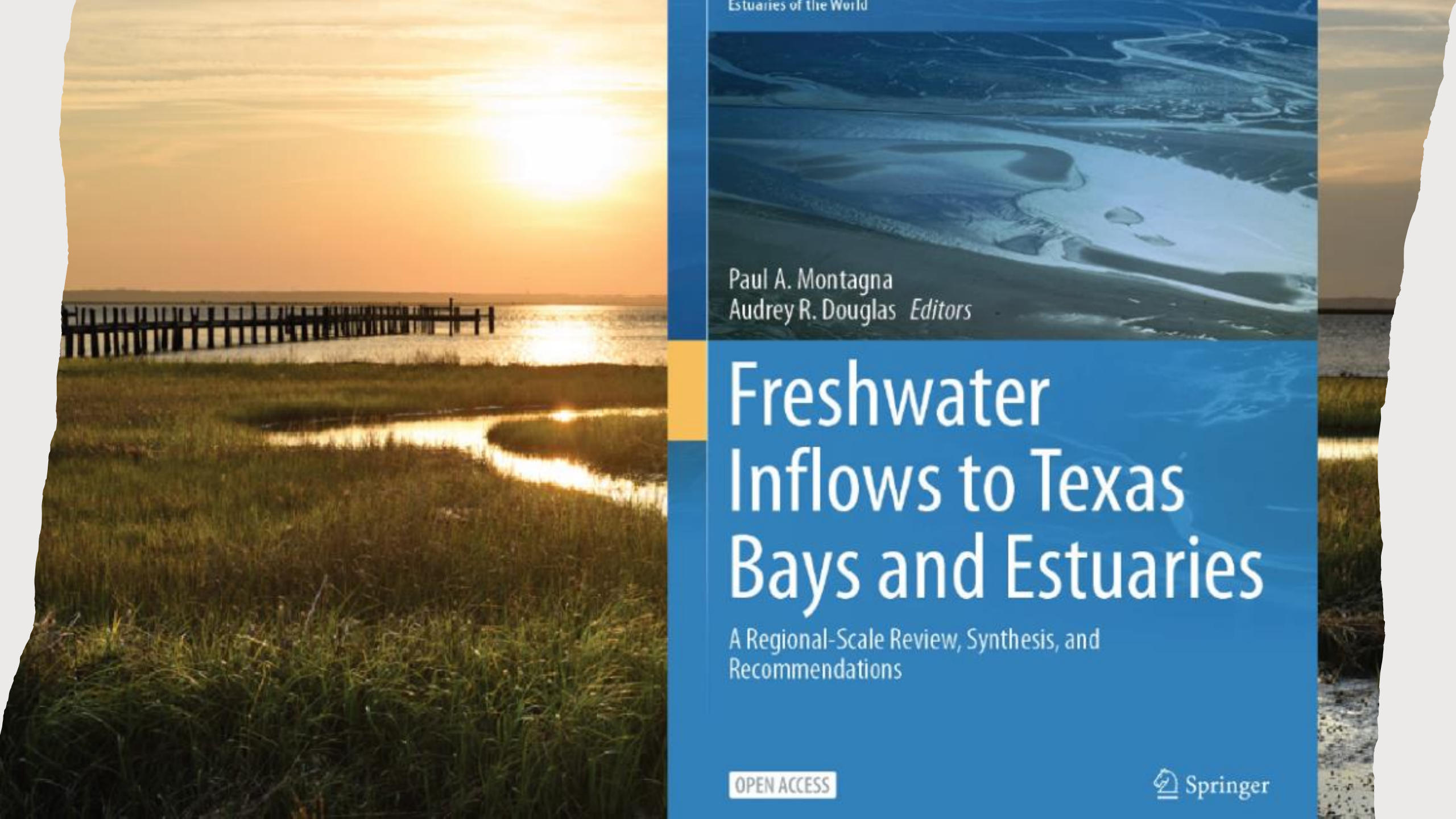


Application to the Guadalupe River System





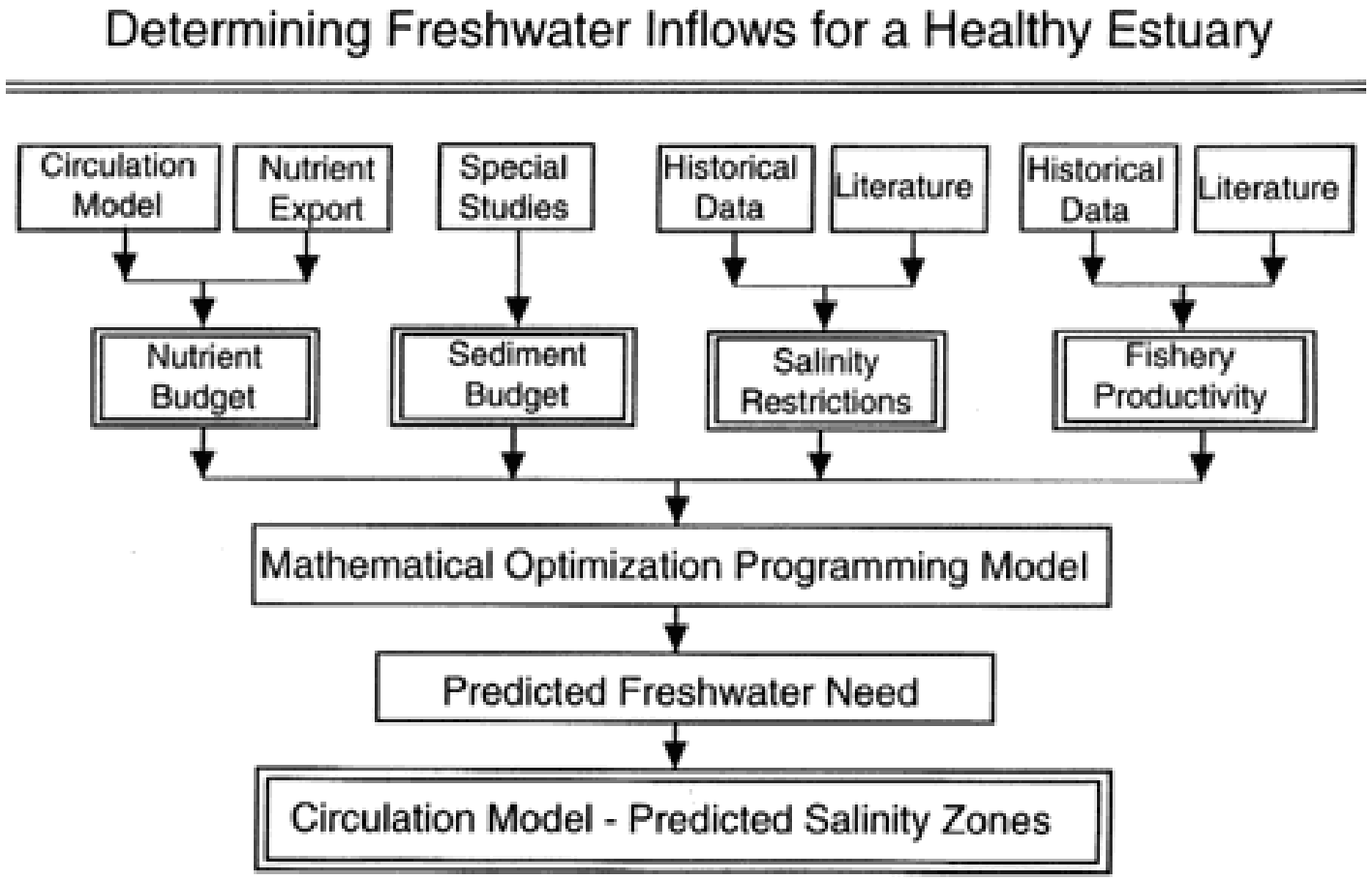
Estuarine Species Needing Freshwater Inflow

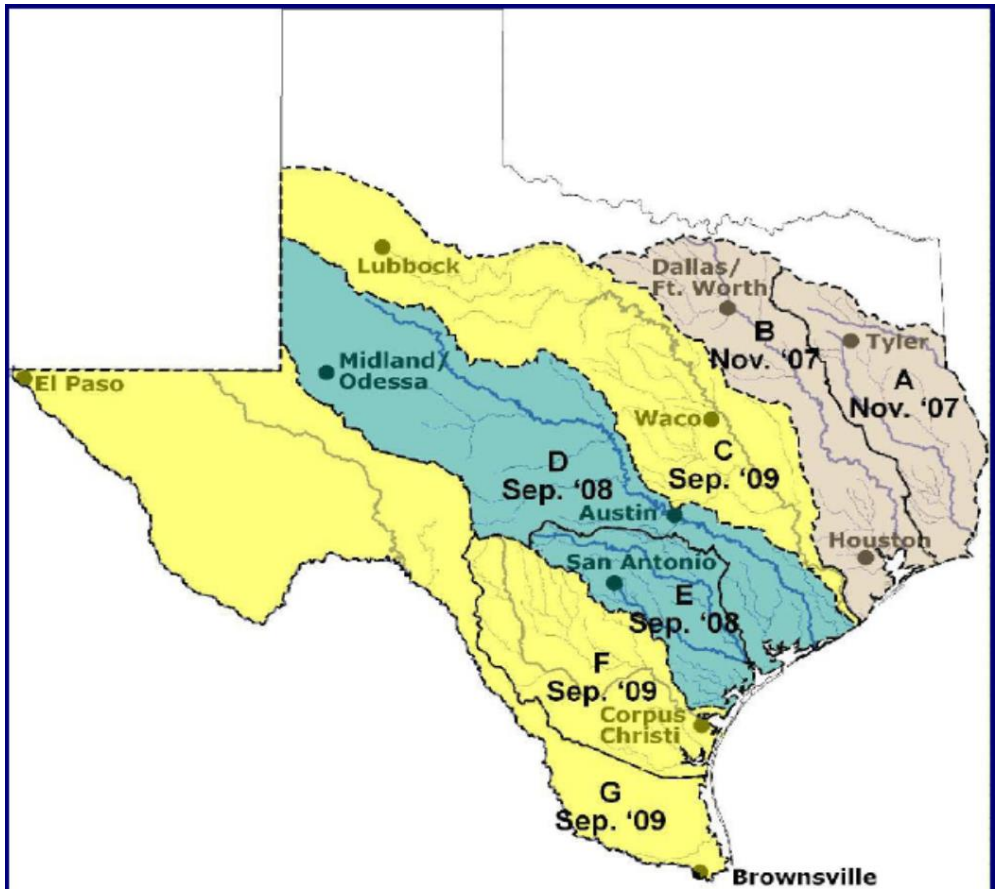

Estuaries of the World
Paul A. Montagna
Audrey R. Douglas Editors
Freshwater Inflows to Texas Bays and Estuaries
A Regional-Scale Review, Synthesis, and Recommendations
OPEN ACCESS
Springer

Nueces Bay Determined To Be Ecologically Dead by SB3 Study

https://www.youtube.com/watch?v=Fz1bcpe1ea4

SB 3 Modeling Completed But Not Being Used Effectively





The Watershed Intelligence Engine

INPUTS: Five Boundary Data Streams

1. Atmosphere
Precipitation, ET, soil moisture

2. Stream Flow
Surface water at pour points, USGS gauges

3. Groundwater
Aquifer levels, recharge, EAA index wells

4. Return Flows
Permitted treated water, TPDES permits

5. Satellite
Regional storage, vegetation stress, bay conditions

Input (15-min)

ENGINE: Three Layers *(Not one model)*

Layer 3: Data Fusion
Ingests 5 data streams, checks quality (15-min))

Layer 2: Physics
Reconstructs 4D hydrologic state.
Models: SWAT, MODFLOW, HEC-RAS, PINN surrogates

Layer 1: Regulatory Intelligence
Maps state to water rights, SB3, permits, endangered species rules

Continuous Learning Loop

Output

OUTPUTS: Three Intelligence Products

1. Current State
Real-time, every-node water budget dashboard (Inflows, Storage, Withdrawals)

- Real Time River Flow
- Spring Flow
- Return Flow
- Estuarine Inflow

2. Dynamic Withdrawal Envelope
Max allowable withdrawal to keep springs flowing and estuaries alive

3. Forecast & Alert
30-day & 90-day aquifer and flow projections. Alerts before crisis

Engineered to deliver decisions, not just measurements. System improves daily.

Watershed Intelligence Engine v1.7

Guadalupe-San Antonio Basin | EnviroAI

SA Pool: Stage 4 (35%) | Uvalde Pool: Stage 3 (35%) | J-17: 0.6 ft above Stage 5

● LIVE 10 gauges via new API @ 7:28:55 AM

↻ Refresh

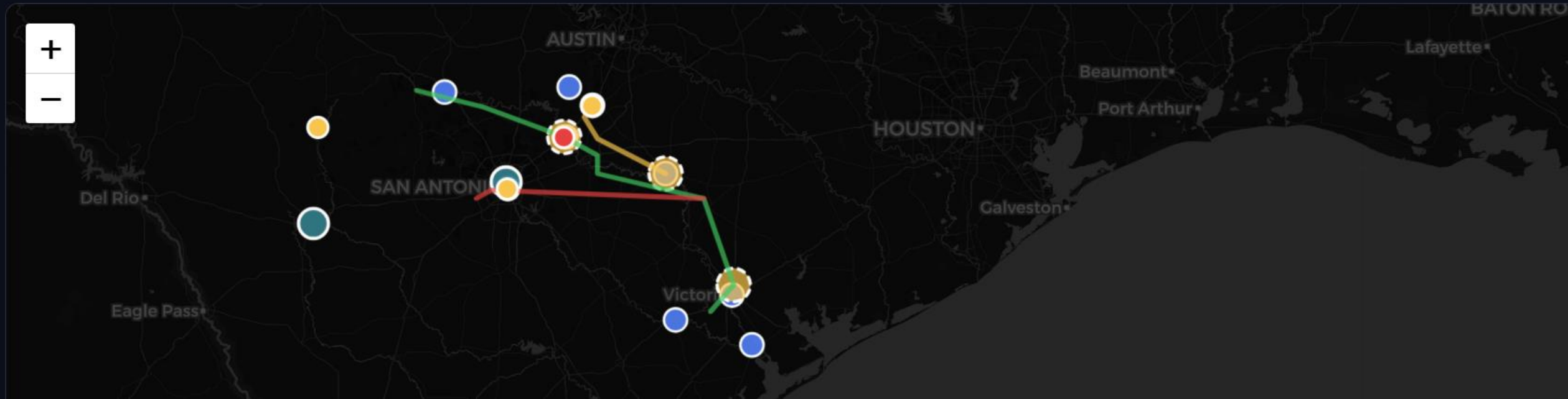
WIE v1.7 — Phase 1 Live Monitoring | AI-Powered Assistant (Perplexity Sonar Pro) | Dual USGS API | Surrogate models for aquifer prediction

Last refresh: Mar 29, 2026

Watershed Map — Guadalupe-San Antonio Basin

Leafle

USGS Gauges (10) | Springs (4) | WAM Control Points (3) | EAA Wells (2) | River Path



Watershed Intelligence Engine v1.7

Guadalupe-San Antonio Basin | EnviroAI

SA Pool: Stage 4 (35%) | Uvalde Pool: Stage 3 (35%) | J-17: 0.6 ft above Stage 5

• LIVE 10 gauges via new API @ 7:34:51 AM

↻ Refresh

Summary

Cranes themselves are thriving numerically, but the freshwater inflow system sustaining their food web is critically undersized for their growing population and current drought stress.

Powered by Perplexity Sonar Pro • Grounded in live USGS data (live) • 7:35:57 AM

Ask about water levels, drought forecasts, species risk, withdrawal envelopes...

QUICK SCENARIOS

Current System Status | Days to Cessation | 1956 Drought Replay | Withdrawal Envelope Now | Bay Salinity Check | Species at Risk

Paper Water Analysis | What if J-17 hits 620?

Upload Data File

CSV, TXT, JSON, PDF accepted

SMART GRID FOR ELECTRICITY

AI-OPTIMIZED, DYNAMIC, EFFICIENT

SMART GRID FOR WATER

AI-OPTIMIZED, DYNAMIC, ALIVE

What Is Done With the Output?
The Power of Information

- Constant understanding of drought conditions and soil moisture content watershed-wide
- Greater focus on springflow and its loss – legal connection?
- Cancellation of unused permits
- Increase focus on return flows – legal connection?
- Shifting of water use by withdrawers – legal connection?
- Increasing water efficiency – net zero water
- Provision of inflow for endangered species and the estuary – legal connection?

Paper Under Preparation
(Not Written by AI)

The Watershed Intelligence Engine

By Jim Blackburn, Jed Anderson and Chris Ordoñez

Texas has a water problem. It has been present for a long time, and it has been addressed with patches and omissions rather than a comprehensive plan. That situation must and will change as is discussed throughout this paper.

Earth Rules Beyond the Law

- Physical processes affected by but beyond the legal system
- Natural Law
- Billions of dollars being spent on carbon dioxide-related aspects without any U.S. federal legal requirements
- Goal is to restore the carbon cycle and halt the increase in CO2 in the atmosphere if not return it to pre-industrial levels
- The same will be true of water


https://mises.org/mises-daily/introduction-natural-law

If we can envision it,
we can build it
(within reason)

Thank you

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