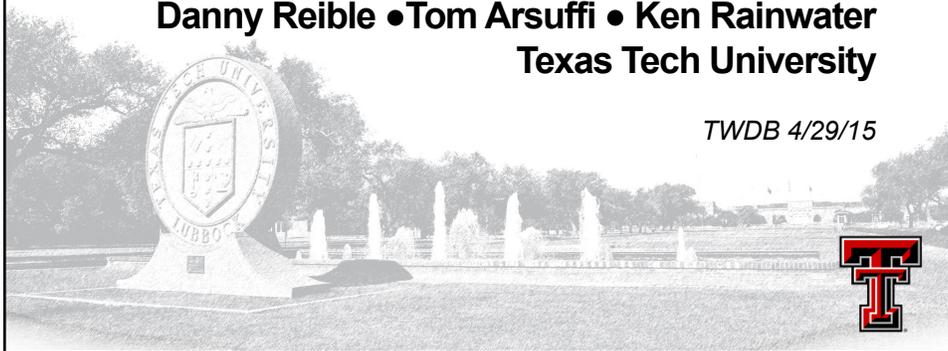


*Water Research and Expertise
Texas Tech University
Ready to Serve Texas' Water Challenges*

**Danny Reible • Tom Arsuffi • Ken Rainwater
Texas Tech University**

TWDB 4/29/15



Water Focused Research Activities



More than 100 faculty

- **College of Agriculture Science and Natural Resources Water Center** investigates water management and policies regarding agricultural and urban landscape water use
- **Department of Environmental Toxicology's Institute of Environmental and Human Health** examines the environmental impacts of toxic chemicals and human health consequences
- **Water Resources Center** encourages, conducts, and coordinates water resources and environmental engineering research
- **Llano River Field Station** develops water and watershed related research, education, and engagement efforts in the Texas Hill Country
- **Climate Science Center** serves as the regional hub for climate change, providing expertise on linking regional climate projections to agricultural production, ecosystem services, water policy and planning, and sustainability of natural and agro-ecosystems
- **Center for Geospatial Technology** applies geographic information systems to map and analyze the distribution and depletion of groundwater in the Ogallala Aquifer in and beyond Texas, as well as related demographic impacts
- **School of Law's Center for Water Law and Policy** assesses legal, regulatory, institutional, and policy aspects of water use, allocation, regulation, and conservation
- **International Center for Arid and Semiarid Land Studies** promotes and facilitates multidisciplinary initiatives in research, education, and regional development programs

Supporting Activities



Examples

- National Academy of Sciences evaluation of Edwards Aquifer Authority Habitat Conservation Plan 2013-2017 (D. Reible, Chair)
- Science Committee, Edwards Aquifer Authority (T. Arsuffi)
- SB3 Nueces River – Basin and Bay Expert Science Team (T. Arsuffi)
- Llano River Watershed Protection Plan (T. Arsuffi, K. Rainwater)
- Water Supply Enhancement Program, TSSWCB (K. Rainwater)
- Regional Water Planning Committee (K. Rainwater, Region O)
- Integrated wind-water desalination demonstration (K. Rainwater)
- The Academy of Medicine Engineering and Science of Texas Water Summits in 2012, 2014 (D. Reible, Chair)
- National Science Foundation, Food, Energy, Water Workshop initiative for Southern High Plains (D.Reible)

Agenda



Selected campus activities

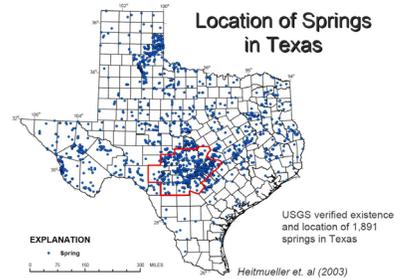
- Tom Arsuffi
 - ✓ Llano River Field Station
 - ✓ Invasive species
 - ✓ Land stewardship
 - ✓ Protecting healthy watersheds
- Ken Rainwater
 - ✓ Texas Alliance for Water Conservation and CASNR
 - ✓ Recent TWDB Research Projects by Water Resources Center
 - ✓ Regional drinking water concerns
 - ✓ Support for regional water management districts
- Danny Reible
 - ✓ Food Energy Water (FEWs) Initiative
 - ✓ Water management for oil and gas activity
 - ✓ Water for future population and economic growth

Llano River Field Station

Connections Upstream and Downstream



- **Unique Location**
 - ✓ **Springs, headwaters of five river systems**
- **Land Stewardship**
 - ✓ **Brush control**
 - ✓ **Drought planning and response**
- **Aquatic Invasive Species**
- **Stream Ecosystem Health**
- **Unique Partnerships**
- **Engagement, Outreach, and Natural Resource Literacy**



Increasing Water Supplies



- **Non-traditional Strategies**
 - ✓ **Conjunctive use of groundwater and surface water**
 - ✓ **Brush control**
 - ✓ **Interbasin transfer**
 - ✓ **Desalination**
 - ✓ **Weather modification**
 - ✓ **Rainwater catchment and graywater systems**
 - ✓ ***Invasive species mitigation***
 - **Need synthetic analysis of ecology and impacts on ecosystem goods and services**
 - **Several countries consider invasive species control and management a water conservation strategy**
 - **\$120 billion per year in environmental and public health damages in the USA (Pimentel et al. 2007)**

Example Invasive Species

Eichhornia crassipes




Arundo donax along the Rio Grande





Elephant Ear
17500 acre-ft/yr ET
over 10 river miles



Protecting Healthy Watersheds – Benefits

- **Decreases**
 - ✓ Flood risk
 - ✓ Regulatory compliance costs
 - ✓ Drinking water treatments cost
 - ✓ Health care cost
 - ✓ Stormwater infrastructure cost
- **Increases**
 - ✓ Property values
 - ✓ Tourism and recreation spending
 - Guadalupe bass – \$143 M/yr angler spending, 776 jobs
 - ✓ Timber and farm production
 - ✓ Nutrient cycling, carbon storage
 - ✓ Biodiversity, wildlife movement corridors
 - ✓ Water storage
 - ✓ Micro-climate regulation



Current Market System



How we value ecosystem services

- Healthy watersheds provide ecosystem services at little to no cost
- Systems are under-valued, their roles misunderstood
- Services provided by intact watersheds are costly to replicate (if possible)
- Conservation of healthy watersheds is a wise investment, and also provides a variety of monetary and non-monetary benefits

Development of Upper Llano River Watershed Protection Plan



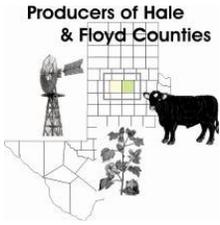
- Empowering local stakeholders
- Characterizing current water quantity and quality conditions
- Analyzing watershed data using eco-hydrologic models
- Increasing education among the targeted audience
- Funded by Environmental Protection Agency and Texas State Soil and Water Conservation Board
 - ✓ Healthy Watersheds Initiative
- Collaboration with Texas Water Resources Institute



Texas Alliance for Water Conservation

College of Agricultural Science and Natural Resources

- **Leaders:** Chuck West, Others in CASNR
- **Funded by the Texas Water Development Board**
 - ✓ Phase 1 – 2005-2013
 - ✓ **Phase 2 – 2014-2020**



Producers of Hale & Floyd Counties



FARM Assistance
Planning Solutions



TEXAS A&M
AGRILIFE
EXTENSION



Texas Water
Development Board



USDA
NRCS & ARS



TEXAS A&M
AGRILIFE
RESEARCH



HPWD
High Plains
Underground Water
Conservation District



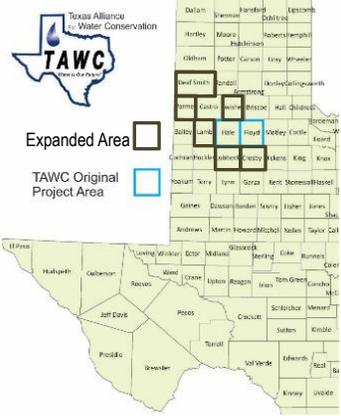
TEXAS TECH UNIVERSITY
College of Agricultural Sciences
& Natural Resources

Objectives of TAWC

- **Identify and communicate technologies**
- **Provide planning aids**
- **Sustain agriculture in the South Plains of the Ogallala Aquifer region**



OGALLALA AQUIFER



Expanded Area

TAWC Original Project Area

Phase 1 Accomplishments



- Demonstrated how to increase water use efficiency with decision aids
- Compared profitability of crop and irrigation options
 - ✓ Enterprise budgets
 - ✓ Field testing of technology
- Got out the message with meetings and electronic media
- Wide recognition for educational efforts



Phase 2 Emphasis



- Expanded counties
- Reduce irrigation to 75% of potential ET
 - ✓ Monitoring soil water content
 - ✓ New precise irrigation techniques
- Water College, training crop consultants
- Advanced online tools
 - ✓ <http://tawc.us>



Technology Comparison and Demonstration



Spray



PMDI

LEPA

Comparisons of different water application configurations

Variable Rate Technology



Delivers right amount of water where needed

Control individual nozzles and speed of pivot



CASNR Departments



Emphases on Water Expertise

- **Plant & Soil Science**
 - ✓ Drought-tolerant crops, water-use efficiency, irrigation and grazing management
- **Natural Resource Management**
 - ✓ Watershed management for water yield and grazing, wetland and stream conservation
- **Agricultural and Applied Economics**
 - ✓ Economic consequences of farm/ranch policies and practices
- **Animal and Food Sciences**
 - ✓ Low-water cattle grazing and feeding
- **Landscape Architecture**
 - ✓ Xeric landscape designs, erosion control

Recent TWDB Research Projects



Water Resources Center

- **Demonstration a High Recovery and Energy Efficient RO System for Small-Scale Brackish Water Desalination**
 - ✓ L. Song, B. Schuetze, K. Rainwater (2012)
 - ✓ Novel flow circulation system
- **Assessment of General Circulation Models for Water-Resources Planning Applications**
 - ✓ S. Tummuri, D. Thompson, K. Rainwater (2013)
 - ✓ Identify GCMs for downscaling for Texas regional water planning
- **An Integrated Wind-Water Desalination Demonstration Plant for an Inland Municipality**
 - ✓ K. Rainwater, L. Song, T. Lehman, and J. Schroeder (2015 pending)
 - ✓ Deployed at Seminole, Gaines County, Texas

Drinking Water Quality Issues



Preliminary work underway with TCEQ

- Many non-compliant groundwater-dependent systems
 - ✓ Arsenic, fluoride, radionuclides, TDS, other solutes
 - ✓ Previously only disinfection, now advanced treatment
 - ✓ Engineering feasibility and pilot studies currently required (typical cost \$100,000 to \$300,000)
 - TCEQ, TWDB, and others cooperated to allow permits for reverse osmosis for TDS only based on vendor modeling
 - Dozens of small cities and community water systems now need updates for compliance
- Possible solution – group non-compliant systems based on capacity and target contaminants
 - ✓ Share feasibility study costs and vendor information
 - ✓ Perform fewer pilot studies at central location with different source waters
 - ✓ Potential for third-party service providers

Regional Water Management



Opportunities

- Drought-inspired public awareness of conservation
- Recognition of shared surface water and groundwater supplies
- Economies of scale can affect cost of water/volume
- Public or private sources of capital
- Spread capital and O&M costs over larger populations
- Provide highly skilled treatment system operators
- Interdisciplinary cooperation to integrate consideration of energy for water treatment and transmission
 - ✓ Energy and water equipment vendors may not see synergy
 - ✓ Researchers can work with consultants to conceive and analyze alternatives



Food Energy Water Nexus

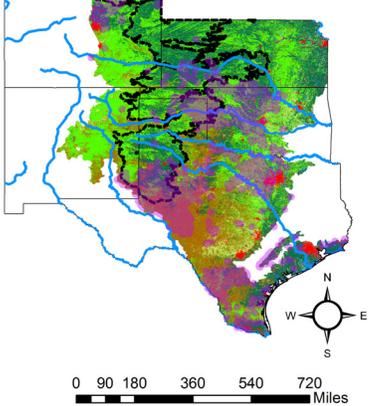
Southern Great Plains



- **Agriculture**
 - ✓ 80% of consumptive water use in US
 - ✓ Historical community economic foundation
- **Growing pressure from population and high value economy (i.e. energy economy)**
- **NSF proposal building on "Big 12" water summit**

Legend

- Oil and Gas
- Major Rivers
- Ogallala Aquifer
- Barren Land
- Cultivated
- Developed
- Forest Land
- Grassland
- Rangeland
- Water
- Wetlands

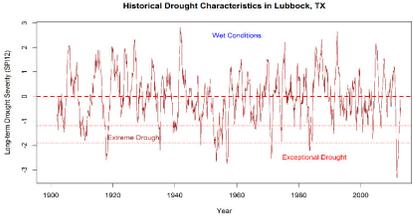


Water Resources Center

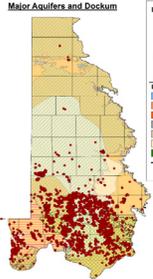
Director, Venki Uddameri



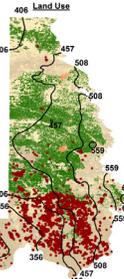
- **Assessment of Brackish Water Resources in West Texas**
 - Understand geochemical evolution
 - Ways to reduce freshwater footprint in Ogallala
 - Current efforts focused on Dockum group of sediments
- **Reuse of Produced Water from Oil and Gas Operations**
 - Chemical characteristics of produced water
 - Thermodynamic modeling of brine chemistry
 - Technologies for cost-effective treatment for reuse in hydraulic fracturing
- **Drought Atlas for the Ogallala Aquifer**
 - Understand historical drought severity and duration characteristics in West Texas
 - How does Ogallala Aquifer respond to droughts?
 - Climate change and future drought stresses in the region
- **Securing Water for Economic Future of Texas**
 - Feasibility evaluation of very-large scale seawater desalination for creating a 20% water surplus in the State by 2060

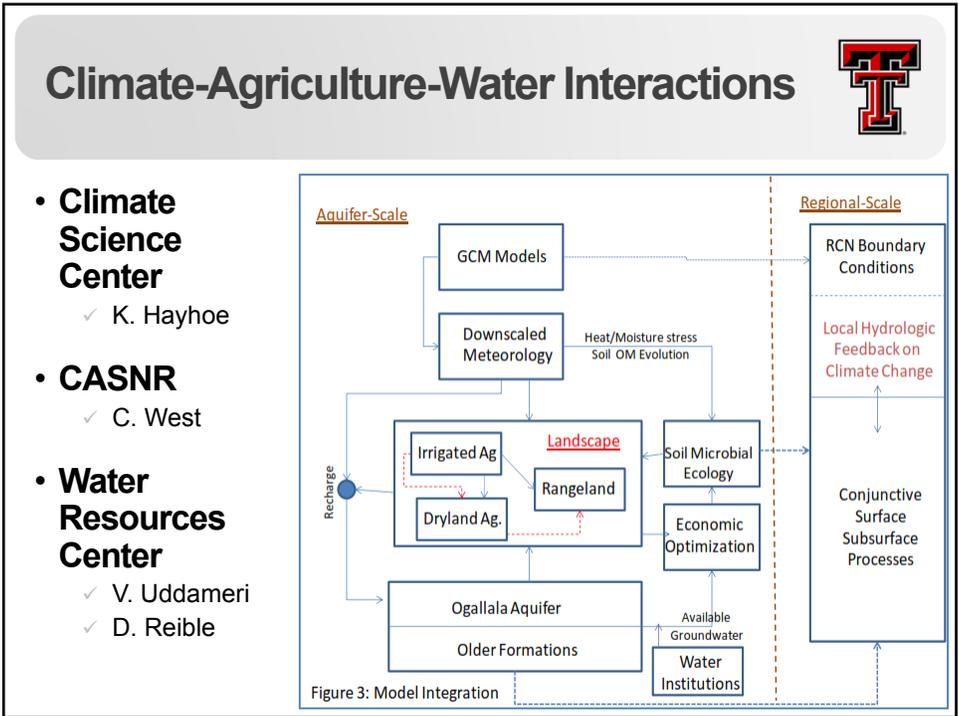
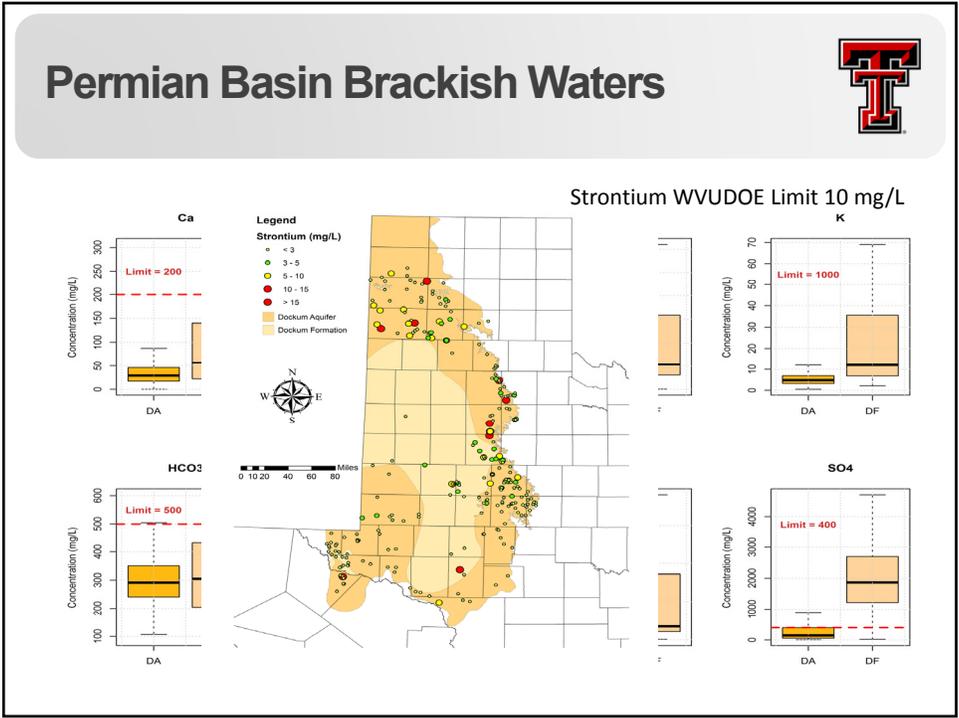


Major Aquifers and Dockum



406 Land Use

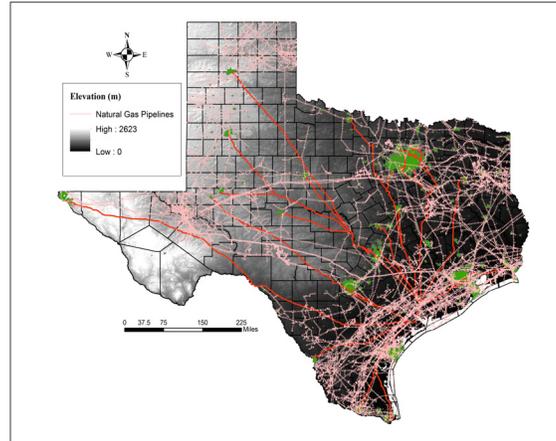




Future State Water Needs



- **Project of 500 MGD (560,000 acre-ft/yr) supply 20% of future needs in central, east TX**
- **Coastal desalination of that magnitude feasible?**
 - ✓ Likely for population centers, energy use, manufacturing
 - ✓ Would reduce pressure on agriculture and ecological needs in period of drought
- **Conducting preliminary feasibility assessment**



Pipeline easements for transport?

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