

EVALUATION OF NUMERIC AND INTEGRATED MODELS: APPLICATIONS IN TEXAS

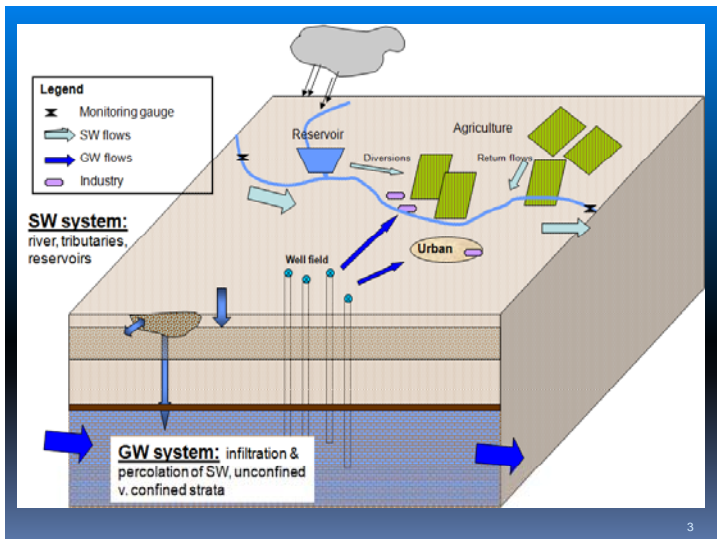
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Conjunctive Use Overview

- Multiple water sources
- Characterization
- Optimization

Conjunctive use - a strategic approach to optimal management and beneficial uses of more than one source of water.



Analysis of Models

Criteria

- Model must allow evaluation of water resources or water supply
- Explicit recognition of conjunctive goals

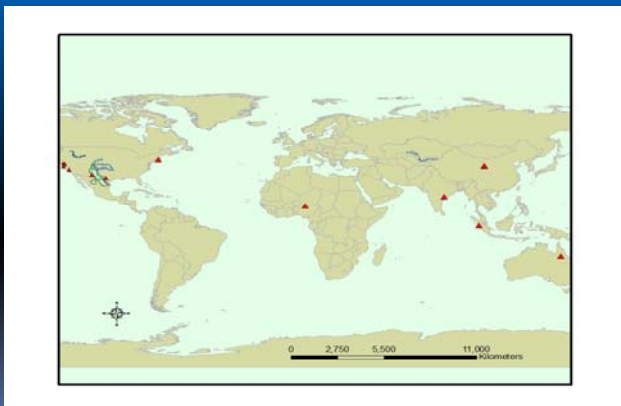
Target

- Determine commonalities, differences, data ranges between models

Model Types

- ❖ Surface water-focused
- ❖ Groundwater-focused
- ❖ Economics & water resources
- ❖ Integrated

Model Study Areas



Map by K. Tower, River Systems Institute

Water Balance Models

Varied approaches to modeling

- Software or developed model code
- Primary model focus (SW or GW)
- Integrate other factors

Differing goals

- Optimizing water supplies
- Basin-wide water resources evaluation
- Specific research targets

General Systems & Data

Data Set	Low Range	High Range	Unit
Flow records	6	> 100	years
Area of study	49	8,784	km ²
Area of basin	up to 30,000		km ²
Regional precipitation	10 - 25	120 - 290	cm / yr
Stream-aquifer connectivity	Reported in 12 of 15 models		

Water uses in modeled system:

- Predominant** - Agriculture, municipal/urban, flood control
- Other** - Environmental, fish hatcheries, hydropower, domestic, livestock, coal washing, thermal power, forestry

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Groundwater Systems

Data Set	Low Value	High Value	Unit
Number of GW basins	1	>28	
Recharge	0.03	250,000	m ³ /s
Saturated thickness	0	200	m
Hydraulic conductivity	61	243	m/d
Specific yield	0.1	0.3	[dimensionless]
Pumping yields	0.006	10.2	m ³ /s
Total average pumping rate per number of wells	22 - 80 Mm ³ / yr	89 - 160 wells	Well Types
			3 public supply; irrigation
	1.92 Mm ³ / yr	18 wells	14 public supply 1 industry 3 fish hatchery
	703 Mm ³ / yr	33 wells	Irrigation & public supply
	937 Mm ³ / yr	> 10,700 wells	Irrigation

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Selected Model Results

Optimization

- Increase pumping by 18% and decrease stream depletion by 15% (Barlow et al. 2003)

Integrated Model

- increased probability of major drought cost when inflows are 50-75% of historic averages (Booker et al. 2005)

Habitat Requirements

- Model demonstrated flow requirement (200-300 Mm³/yr) and long-term aquifer restoration could be met through conjunctive management (Fleckenstein et al. 2004)

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Selected Economic Model Results

GW valuation - buffer to stochastic SW supplies

(Tsur & Graham-Tomasi 1991; Knapp & Olson 1995)

GW levels as valuation of social welfare

(Acharya & Barbier 2000)

Well capacity as estimate of risk aversion

(Bredehoeft & Young 1988)

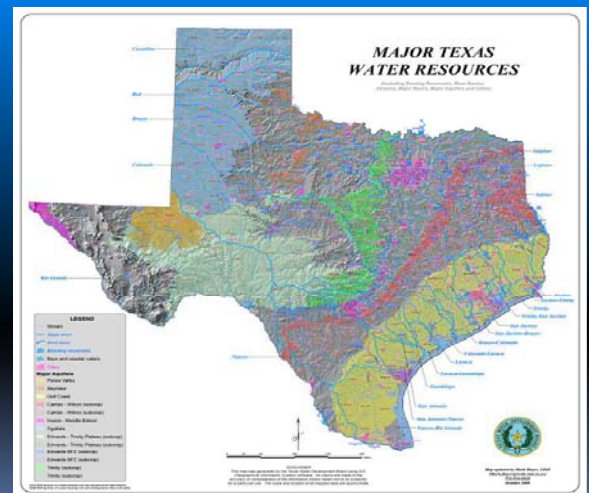


Texas & Water Challenges



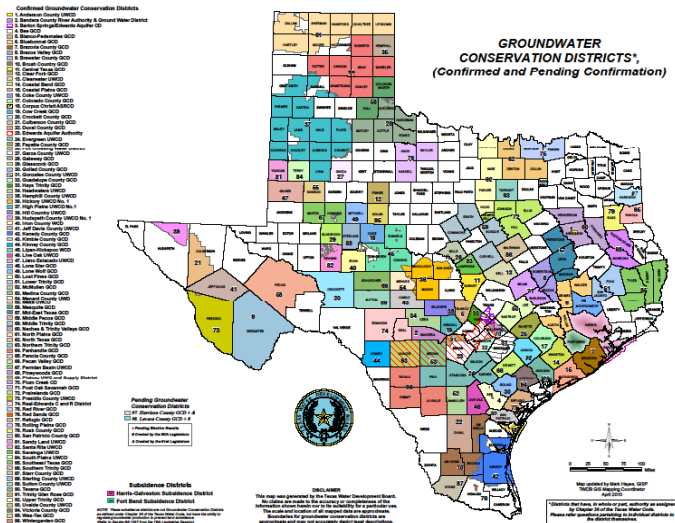
Photo courtesy of River Systems

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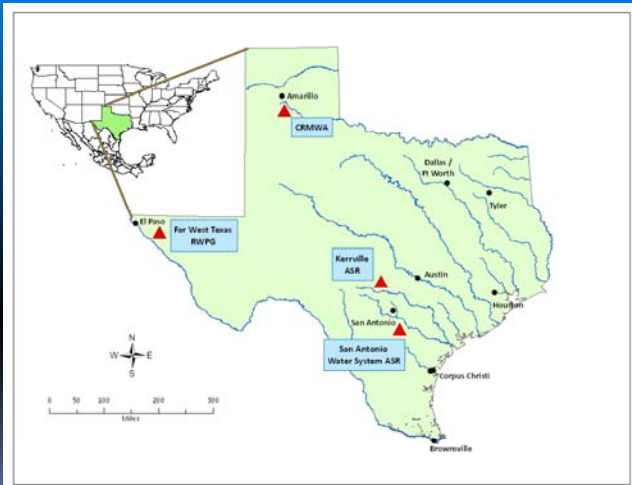
Texas Water Development Board, 2010

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Institutional Approaches to Conjunctive Management

- 16 Regional Water Planning Groups
 - Required to consider **conjunctive use** as water management alternative
- GCDs
- Groundwater Management Areas
 - Current modeling efforts to determine available water to meet Desired Future Conditions



Map by S. Bray, River Systems Institute, 2010

Conjunctive Use & Models: Strengths, Limits

- ❖ Wide variety of approaches, goals, and physical conditions
- ❖ Proven economic efficiencies
- ❖ Models - key to achieving project targets
- ❖ Know the project assumptions!
- ❖ Determine timeline & costs

Cost Comparison of Water Strategies

(from LAEDC, 2008)

Strategy	Potential Water Volume Realized (1000-acre foot)	30-Year Treated Costs (\$ per acre-foot)
Urban water conservation	1,110 +	\$ 210
Groundwater storage	1,500 +	\$ 580
Water transfers (agriculture -> urban)	200 +	\$ 700
New surface water storage	Case-by-case basis	\$ 760 - \$1,400

Policy Recommendations for Texas

- ❖ Recognize conjunctive use - comprehensive, efficient, varied management strategies
- ❖ Support supplemental approach to existing water supply programs
- ❖ Reduce model & project design, OM costs through local/regional approach
- ❖ Adapt existing models as appropriate

Acknowledgements

Conjunctive use models
and research studies

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