Salinity in the Northern Segment of the Brazos River Alluvium Aquifer: A Hydro-Forensic Approach

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Introduction

• Growth along I-35 corridor has strained regions water resources

• Brazos River Alluvium aquifer (BRAA) is an underutilized minor aquifer

• Salinity varies throughout BRAA

• Effective aquifer management requires a better understanding of salinity sources and variability
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Objective

• Characterize the variability of salinity in the northern segment of the BRAA and evaluate potential sources of salinity
**Hypotheses**

1. Groundwater – surface water interactions between aquifer and Brazos River
2. Irrigation and evapotranspiration
3. Brine contamination from historic oil and gas fields
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Hydrogeologic Setting

- Primarily used for irrigation
- Heterogeneous but typically exhibits fining upward sequence
- Recharged by precipitation and discharges at Brazos River
- Elevated salinity levels documented as early as 1967 by Cronin and Wilson
Methods

1. Analysis of historical BRAA and Brazos River chemistry data
2. BRAA and Brazos River water sampling: Specific conductance, temperature, major cations and anions, and ratios of hydrogen and oxygen isotopes
3. Coring and in-situ water sampling at three sites
4. Installation of data loggers to monitor changes in water level over time
TDS of the Brazos River Alluvium Aquifer

- 32 total samples
- High degree of variability in salinity
- TDS can double over the course of a few hundred yards
- Brine contamination from oil fields not likely cause of high TDS in Falls County
Land Cover

- 2011 USGS land cover map
- Falls County has a significantly higher proportion of land used for cultivated crops than McLennan County
- McLennan County has a much higher population than Falls County
- Cultivated crops can be either irrigated or non-irrigated
- Historically, Falls County has significantly more irrigation than McLennan County
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Piper Diagram

- Brazos River: Sodium chloride type water
- BRAA McLennan County: Calcium bicarbonate type water
- BRAA Falls County: Mixed bicarbonate to mixed cation and anion type water
- Aquifer and river tend to have distinct chemistries
Coring and In-situ Water Sampling

- Three sites: Non-irrigated pasture, irrigated orchard, and irrigated row-crop farm
- Core and in-situ water samples collected next to 3-4 wells at each site
- In-situ water samples collected using 1.5-foot screened interval
- Composite well sample also collected
Coring and In-situ Water Sampling

- In-situ water sampling showed some stratification present in aquifer.
- However, specific conductance was found to both increase and decrease with depth, and in some cases was constant depending on the location.
Groundwater / Surface Water Interactions between BRAA and Brazos River
• To create 10.78 foot rise in water level (assuming a porosity of 25%) would need 32.34 inches of recharge

• Area only received 15.24 inches of precipitation

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Discussion and Conclusions

• Aquifer shows significant variability in salinity
• Aquifer specific conductance in Falls County is almost double that of McLennnan County
• Little change in aquifer specific conductance due to seasonality or since 1960’s
• In-situ sampling showed some salinity stratification, but stratification is not consistent
• River is not likely source of aquifer salinity
  • Aquifer and river tend to have different ionic chemistries
  • Aquifer and river are isotopically distinct
  • During 37-day gradient reversal, river water only traveled ~88 feet into aquifer
• Historic oil and gas fields do not appear to be salinity source
• In-situ sampling showed that irrigation could potentially impact aquifer salinity
Acknowledgements

• Wayne Hamilton, Jacob Jarvis, Wynne Casteel, William Brewer, and Stephanie Wong

• Scooter Radcliffe at the Southern Trinity Groundwater Conservation District

• The Brazos River Authority, Texas Water Resource Institute, and the Southern Trinity Groundwater Conservation District

• All land owners who participated in this study
References

- Baker, R.C., Hughes, L.S., and Yost, I.D., 1964, Natural Sources of Salinity in the Brazos River, Texas: With Particular Reference to the Croton and Salt Croton Creek Basins, United States Geological Survey Water-Supply Paper 1669-CC.


