Introduction

- Nitrate nitrogen (NO$_3$-N) contamination of groundwater in the Seymour Aquifer has been documented since pre-1960.
- Concentrations as high as 35 mg/L NO$_3$-N have been reported.
- While most water from the Seymour Aquifer is used for agricultural irrigation, a portion is still used for domestic drinking water.
- The specific source of NO$_3$-N contamination is still debated.

Research Approach

- Three possible sources of NO$_3$-N contamination were considered in this study:
  - geology of the aquifer (natural salt accumulation from water confined in patches of Quaternary-age alluvium)
  - contribution of nitrate from sewage and agricultural fertilizers (cotton, wheat, peanuts)
  - historical land use change of the area above the aquifer (leguminous nitrogen-fixing mesquite cleared in the 1930’s for agriculture)

My research combined chemical and geospatial analysis with specific objectives:

1) Assessing the evolution of groundwater in the Seymour Aquifer since pre-1960 and after the middle 20th century.

- Groundwater quality data from the Texas Water Development Board was used in conjunction with geospatial and chemical analysis to identify changes in the groundwater quality over time.
- Empirical Bayesian kriging (EBK) analysis was used to interpolate chloride (Cl) and NO$_3$-N across the study area pre-1960 (pre-heavy fertilizer use) and thereafter.

2) Determining the most likely source(s) of NO$_3$-N in sampled wells.

- 14 groundwater samples were collected in Spring 2017 (3/18/17) and Fall 2017 (9/14/17) from selected domestic and irrigation wells.
- δ$_{15}$N and δ$_{18}$O stable isotopic signatures of the samples were evaluated as a means of isolating NO$_3$-N source as fertilizer/rain, soil or septic/manure in origin.

Methodology

- My research combined chemical and geospatial analysis with specific objectives:
  - Assesing the evolution of groundwater in the Seymour Aquifer since pre-1960 and after the middle 20th century.
  - 14 groundwater samples were collected in Spring 2017 (3/18/17) and Fall 2017 (9/14/17) from selected domestic and irrigation wells.
  - δ$_{15}$N and δ$_{18}$O stable isotopic signatures of the samples were evaluated as a means of isolating NO$_3$-N source as fertilizer/rain, soil or septic/manure in origin.

Research Findings

Cl and NO$_3$-N Evolution

- Stiff diagrams represent average groundwater composition across the aquifer.
- Averaged groundwater composition was graphed over the past six decades to determine which component (if any) drove overall chemical change.
- From stiff diagrams, chloride was the main component driving overall changes in groundwater.

Cl and NO$_3$-N Evolution

- Groundwater Cl- and NO$_3$-N changed more in the northern and southern portions of the aquifer.
- Widespread NO$_3$-N contamination pre-1960 to 1997 with trends suggesting co-variation in Cl and NO$_3$-N.

Isotopic Analysis of Sampled Wells

- Based on isotopic signatures, two possible scenarios exists for NO$_3$-N contamination in sampled wells:
  - NO$_3$-N existed as soil N and then transformed via partial denitrification into septic nitrogen.
  - Nitrogen in groundwater may have resulted from the 1972 Clean Water Act.
  - Nitrogen in groundwater may have resulted from the 1972 Clean Water Act.
  - Fertilizer use didn’t drop while NO$_3$-N did in decades post-1975—possibly due to better agricultural management.

Conclusions and Further Research

- Cl and NO$_3$-N behavior is concomitant and changes are likely being driven by the same phenomenon.
- NO$_3$-N is potentially coming from soil-N with partial denitrification and or a septic/manure source.
- Further research will include increasing sample size (from n=14 to n = 30) to provide a better view of present aquifer contamination and conducting more detailed isotopic analysis methods to differentiate between origins of NO$_3$-N as soil N and sewage N.

References and Acknowledgements


Acknowledgments: Dave Carrol and well owners, UC Davis Stable Isotope Facility, Stephen F. Austin Soil, Plant, and Water Analysis Lab.