Evolution of Groundwater Quality and Source Tracking of Nitrate Contamination in the Seymour Aquifer of Texas

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Introduction
- Nitrate nitrogen (NO₃-N) contamination of groundwater in the Seymour Aquifer has been documented since 1960.
- Concentrations as high as 35 mg/L NO₃-N have been reported (3.5 times the EPA allowable standard for drinking water).
- While most water from the Seymour Aquifer is used for agricultural irrigation, a portion is still used for domestic purposes and poses potential risk to human health.

Research Approach
- Three possible sources of NO₃-N contamination were considered in this study:
  - 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)

Study Area
- 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
  2) 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.
  3) Empirical Bayesian kriging (EBK) analysis was used to interpolate chloride (Cl⁻) and NO₃-N across the study area pre-1960 (pre-heavy fertilizer use) and thereafter.

Research Findings
- Chloride pre-1960
- Nitrate pre-1960
- Chloride pre-1986
- Nitrate pre-1986
- Chloride post-1986
- Nitrate post-1986

Research Findings (continued)
- Map on left shows the locations for the 14 wells sampled in 2017 overlaid onto 1986-1997 groundwater composition map.
- The graph on the right shows extrapolated averaged Cl⁻ and NO₃-N at sampled locations
- Confirms covariation between Cl⁻ and NO₃-N in the aquifer.

Isotopic Analysis of Sampled Wells
- Based on isotopic signatures, two possible scenarios exists for NO₃-N in sampled wells:
  - NO₃-N existed as soil N and then transformed via partial denitrification into septic nitrogen or
  - There are two separate sources, septic and Soil N
- Widespread NO₃-N contamination pre-1960 to 1997 with trends suggesting co-variation in Cl⁻ and NO₃-N

Conclusions and Further Research
- Cl⁻ and NO₃-N behavior is concomitant and changes are likely being driven by the same phenomenon.
- NO₃-N is potentially coming from soil-N with partial denitrification 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 NO₃-N as soil N and sewage N

References and Acknowledgements