Spatial and Temporal Variation in Nitrate Contamination as a Function of Well Depth in the Seymour Aquifer

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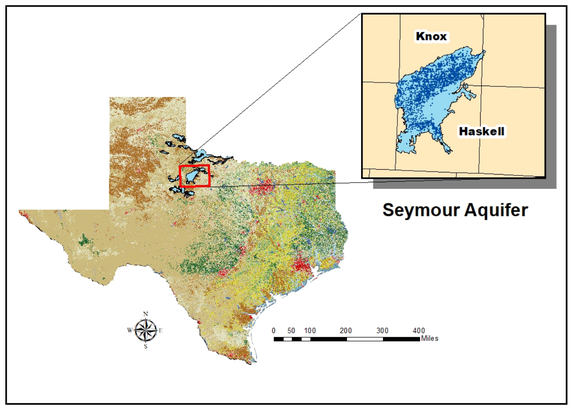
Introduction

- 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 (*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.
- 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)

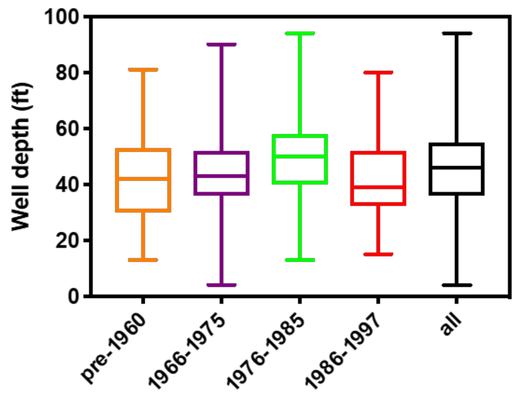
Study Area



- My research combined statistical and geospatial analysis with specific objectives:
  1) Viewing nitrate contamination as a function of well depth
     - Groundwater quality data from the Texas Water Development Board was used in conjunction with geospatial analysis to identify the correlation of NO3-N with well depth
     - Empirical Bayesian kriging (EBK) analysis was used to interpolate well depth and log[NO_3-N] across the study area pre-1960 (pre-heavy fertilizer use) and thereafter.
     - Based off of previous studies, it was expected that shallower wells would have higher NO3-N concentrations

  2) Determining the temporal change in NO3-N concentrations over a distribution of well depth
     - After determining that aquifer wells had a Gaussian (normal) distribution, depths were partitioned into four percentiles
     - The log(NO3-N) was taken in order to distribute the data normally, and an EBK was performed

Research Approach (Continued)



- Figure on left: Well data had a Gaussian distribution throughout all decades
- Coordinates of wells containing no depth data and/or no NO_3-N data were excluded from this study
- Depth over all wells sampled meeting the criteria above were broken into quartiles (the 25th, 50th, 75th, and 100th percentile)

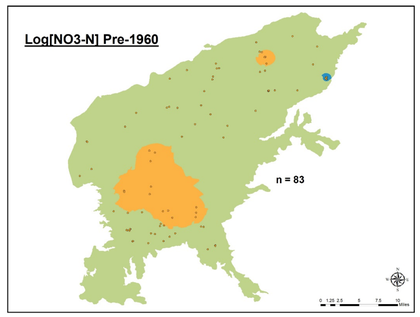
Conclusions and Further Research

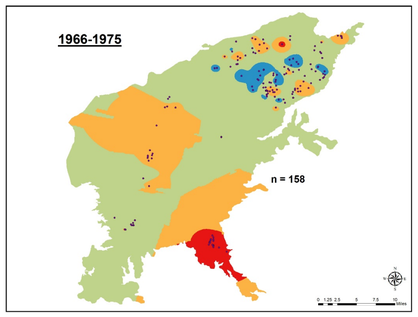
- Log[NO_3-N] concentrations are significantly higher in shallower wells
- Over time, median concentrations of log[NO_3-N] are increasing in deeper wells, and two probable scenarios exist:
  1) NO_3-N is leaching downwards into deeper wells over time
  2) Excessive pumping has begun to force NO_3-N contamination into deeper wells
- Further research will include:
  - Consideration of land cover development over time
  - Conducting well sampling transects longitudinally across the middle of the aquifer as well as taking samples from NO_3-N "hot spots" to provide a better view of present aquifer contamination in relation to concentration and depth
  - Conducing a detailed isotopic analysis to differentiate between origins of NO_3-N as soil N and sewage N

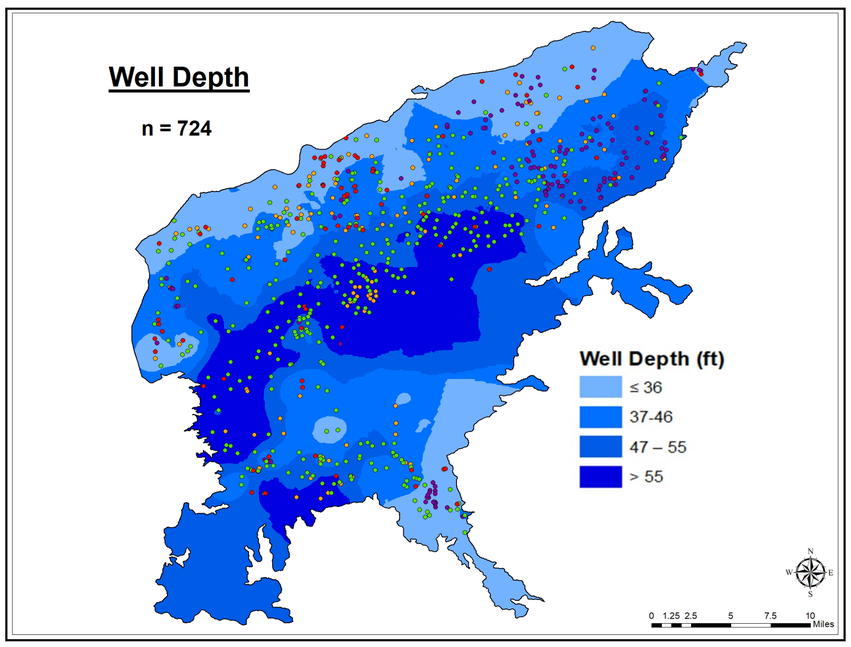
References and Acknowledgements

"Groundwater Database (GWDB) Reports." *Groundwater Data | Texas Water Development Board*, Texas Water Development Board, www.twdb.texas.gov/groundwater/data/gwdbrpt.asp.
"Texas Natural Resources Information System." *TNRIS - Texas Natural Resources Information System*, tnris.org/.

Research Findings

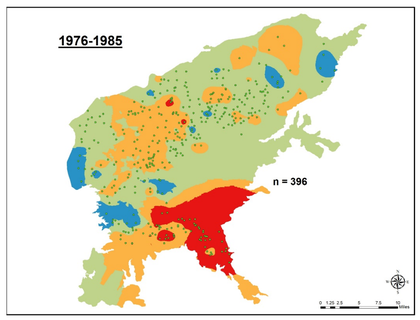


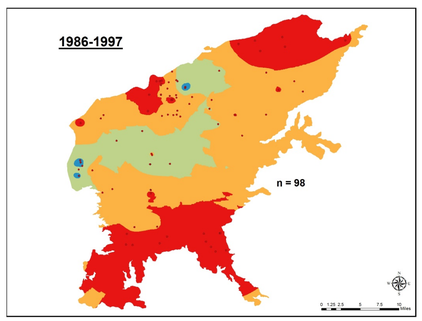




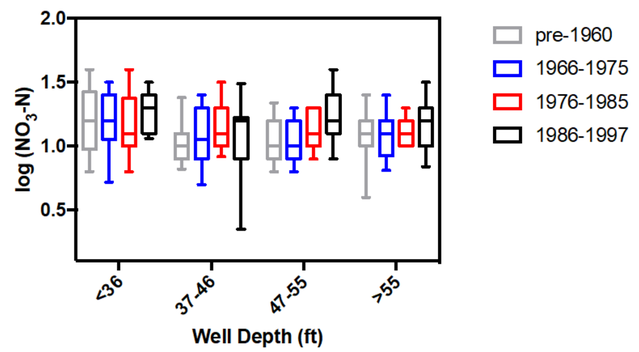
Log[NO_3-N] Evolution

- Wells dug with shallower depths along the outer portions of the aquifer have higher log[NO3-N] concentrations than the central portion of the aquifer throughout all decades





Temporal Variation



- The median concentrations of log(NO3-N) have increased in deeper wells over time, with a tremendous increase occurring from 1986-1997 in wells between 47-55 ft, and greater than 55 ft deep.
- Key for log[NO_3-N] represents a log normal distribution broken into quartiles

Nitrate Log[NO_3-N]

- ≤ 1
- 1.01 – 1.12
- 1.121 – 1.28
- > 1.28

Well Decade

- Pre-1960
- 1966-1975
- 1976-1985
- 1986-1997