Integrating the Vadose Zone into Nitrate Contamination of Groundwater in Nebraska

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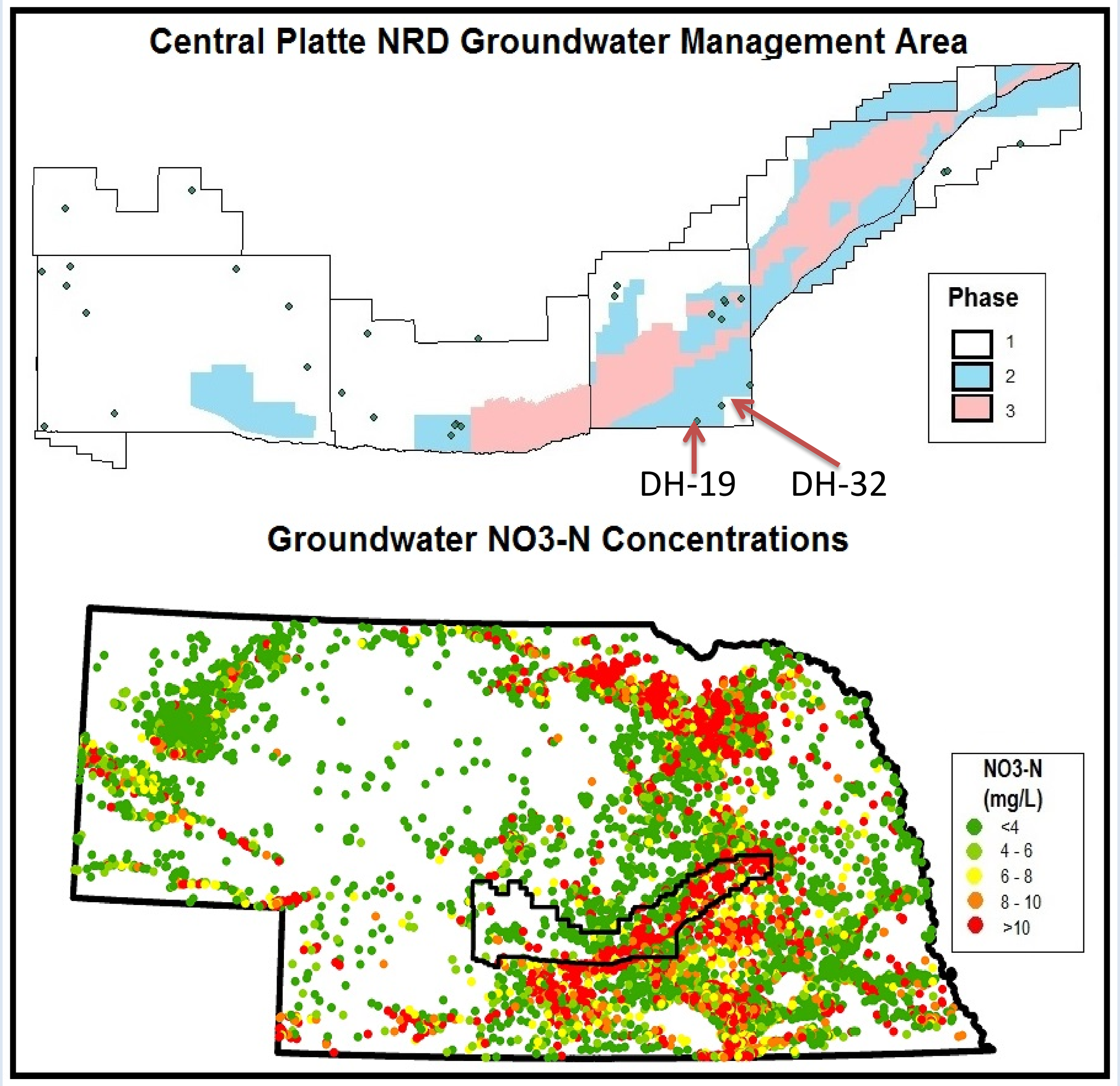
Introduction:

- Nitrate-nitrogen (N) is the most common drinking water contaminant throughout the worlds aquifers[3]
- Nebraska (NE) has one of the largest agricultural economies in the US and relies heavily on sustained irrigation and fertilizer application to maintain yields[2]
- Annual application of N has led to accumulation of nitrate-N in soils and sediments of the vadose zone throughout the state[1]
- Due to the persistence and mobility of nitrate, many water supplies in NE are dealing with nitrate contamination of drinking water
- In NE, Natural Resource Districts (NRDs) are responsible for groundwater quality and quantity, soil conservation, and pollution control within their boundaries
- NRDs are uncertain of the effectiveness that current management practices have on the resulting groundwater N
- NO_3-N concentrations higher than 2mg/L generally reflect excess input[3]
- Safe Drinking Water Act 1974 set maximum contaminant level (MCL) for nitrate-N in drinking water at 10 mg/L[1,3]
- As NO_3-N levels exceed the MCL, municipalities face increasing costs with treating their impacted water supply, finding alternate supplies, and preventing further contamination[1]

Objectives

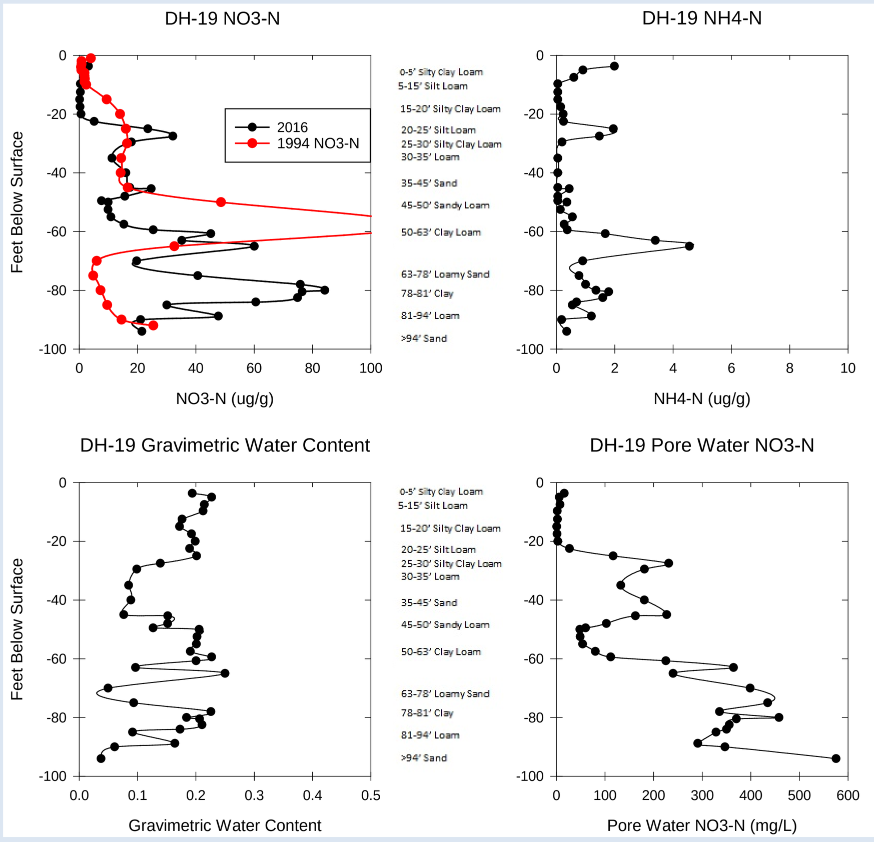
- Quantify the total mass of nitrate-N stored in the vadose zone at selected sites
- Graph results to help estimate transport rates through the profile
- Compare historical and current data to compile into a single database

Area of Study:

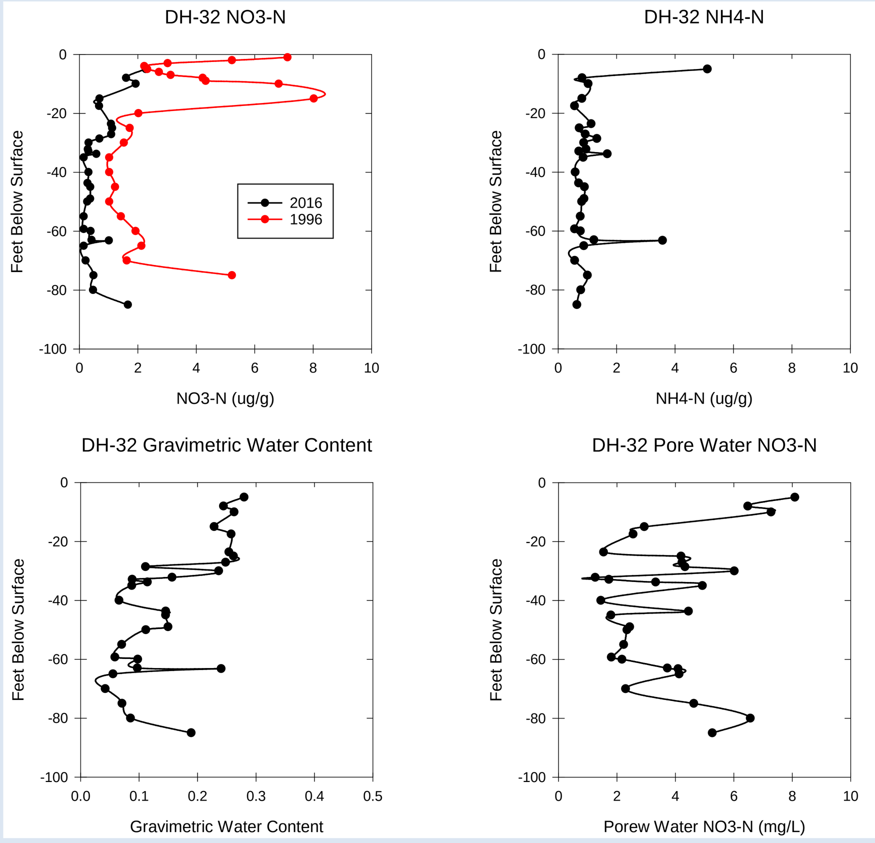


- In the current study, all sampling sites are located in agricultural fields.
- 14 sites have been cored to the water table, with depths ranging from 60-140 feet
- Topsoil consists of different variations of silt loam.
- High sand content with clay lenses throughout vadose zone results suggest potential for rapid movement through sand and accumulation above clay layers

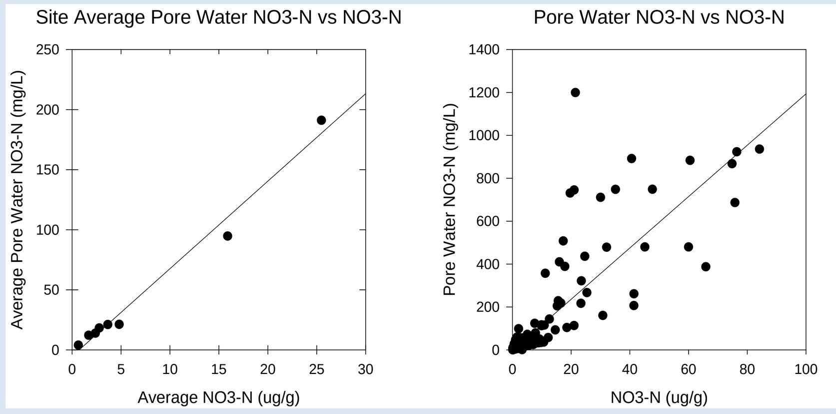
Results:



Depth to water: 93.4 feet

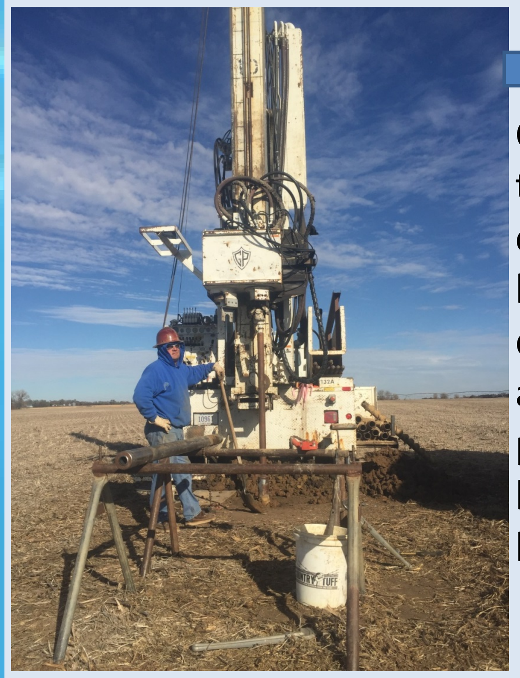


Depth to water: 83.0 feet



- Site DH-19 historically has had elevated vadose nitrate-N and has receive regular application of manure for fertilizer for the past 8 years. Nitrate-N levels near the surface have declined in comparison to the historical profile from the mid-1990's. A peak of stored NO_3-N at 60 feet in 1994 may correlate to a deeper concentration peak at 80 feet below the surface today suggesting a transport rate of about 1 foot/year
- High sand content at DH-32 may correlate to more rapid movement of water and NO_3-N and disappearance of a peak of NO_3-N at 19 feet indicated at 1996. Rapid transport may be due to a high infiltration rate and low the pore water NO_3-N at this site
- Data collected during this project suggests there is a positive correlation between sediment NO_3-N and pore water NO_3-N and this correlation may help demonstrate subsequent impacts to groundwater from vadose zone nitrate-N

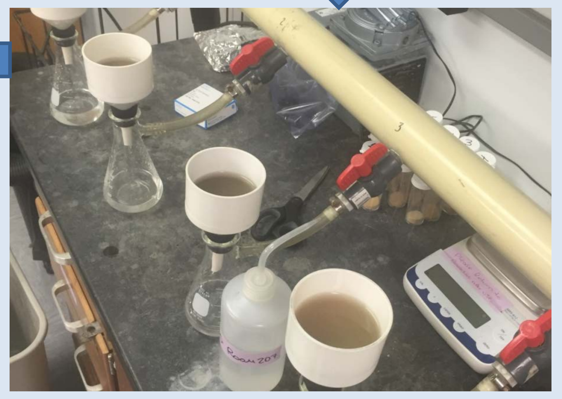
Methods:



Continuous cores of the vadose zone are collected using a hollow stem auger drill rig. Samples are collected before planting and after harvest from farm land.

Cores are stored in a freezer to maintain moisture and NO3-N content.

Sub-samples are analyzed for moisture content, hydraulic conductivity, and bulk density. Sediment composites are dried, ground, and homogenized for chemical extraction and particle–size analysis.



Nitrate and ammonium is extracted from samples using 1M KCl and then run on a Lachat Quikchem 8500 flow injection analyzer.

Recently, a hydraulic profiling tool (HPT) system was purchased for use with the school's Geoprobe. The HPT measures water injection pressure with depth and helps determine formation permeability. It can also measure saturated hydraulic conductivity below the water table.

Future Directions:

- **Investigate:**
  - **The effect of changing land use, irrigation and nitrogen application methods on nitrate movement**
  - **The influence that changes in better management practices have on N loading**
  - **The links between nitrate and the presence of other agrichemicals**

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