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ASSESSMENT OF NITRATE AND PFAS CONTAMINATION OF PRIVATE WELLS IN SOUTH CENTRAL KANSAS

Introduction

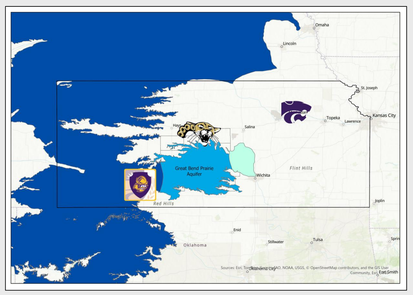
- Private wells are the water source for roughly 40 million Americans and between 151,000 and 177,000 Kansans.
- Unlike public water systems, private well water quality is not regulated by any federal or state laws.
- Private well water quality data is not widely available and most well owners do not regularly have their water tested.

Nitrate contamination
- The US EPA maximum contaminant level (MCL) for nitrate in public water supplies is 10 mg/L as N.
- Drinking water with concentrations above the MCL can cause methemoglobinemia (i.e., blue baby syndrome) in infants
- Drinking water with elevated nitrate also increases risks of multiple cancers, thyroid disease, and neural tube defects.
- Nitrate accumulation in aquatic habitats can also damage ecosystems by causing algal blooms and dead zones.

PFAS contamination
- PFAS is also associated with adverse impacts to human health and ecosystems.
- Thousands of PFAS compounds exist. The US EPA has set MCLs for some (HFPO-DA, PFHxS, and PFNA 10 ng/L; PFOA and PFOS 4 ng/L).
- Health impacts linked to PFAS exposure include decreased fertility and increased blood pressure in pregnant women, developmental delays in children, increased risks of some cancers, reduced ability of the immune system to fight infections, hormonal impacts, and increased cholesterol and risk of obesity.

Methodology

- Students from Kansas State University and Barton and Dodge City community colleges have collected samples each year since 2020.
- We sample from outside spigots to collect untreated water.
- Samples are analyzed for a variety of inorganic ions, dissolved organic carbon, water stable isotopes, PFAS, and more.



Study Area: Great Bend Prairie Aquifer in south-central Kansas

Nitrate

- Out of the 218 Great Bend Prairie Aquifer wells sampled across ten counties, 46.8% had nitrate content above the EPA standard (10 mg/L) (Fig. 1, 2).

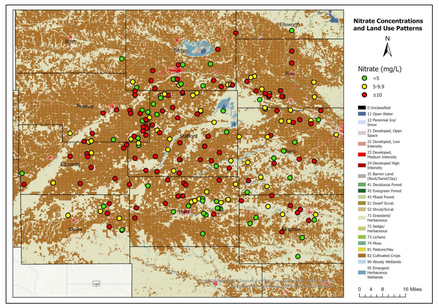


Figure 1: Nitrate distribution and land use patterns in the Great Bend Prairie Aquifer region.

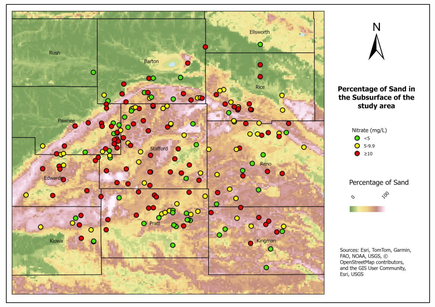
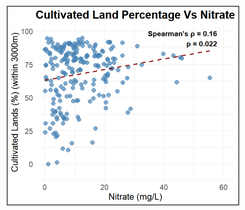
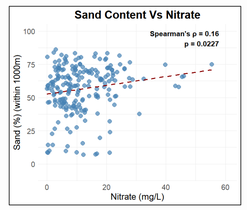


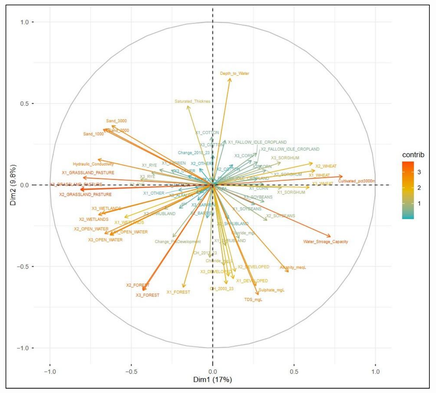
Figure 2: Nitrate Distribution and soil sand content (30-60 cm depth) in the Great Bend Prairie Aquifer region.

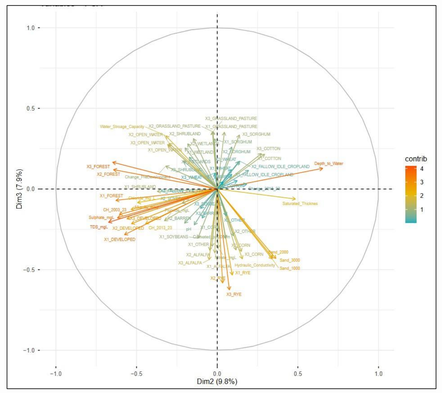
- Agricultural practices combined with sandy soils and subsurface sediment are the driving forces behind nitrate contamination. Other controls include O2(aq) concentrations and potentially recharge timing.



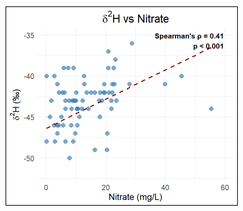


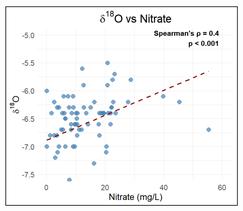
- Areas with cultivations such as corn, wheat, alfalfa, and rye show a positive correlation compared to areas with less fertilizer application, such as forests, wetlands, grasslands, pastures, and developed areas.





- Positive correlations of nitrate concentration with water stable isotope ratios suggest that recharge during growing season/warmer periods has higher nitrate content.





PFAS (Per- and polyfluoroalkyl substances)

- We found concerning levels of PFOS(16.7%; ≥ EPA, 0.004 µg/L), PFOA(5.5%; EPA, 0.004 µg/L), and PFOSA(46.3%; ≥ Wisconsin DHS, 0.004 µg/L) in analyzed samples.
- Potential sources include biosolids in farmlands, septic drainage, solid waste facilities, closed city dumps, leaking underground storage tanks, Kansas Department of Health & Environment (KDHE) identified contaminant sites, or KDHE "regulated/contaminated" interests.

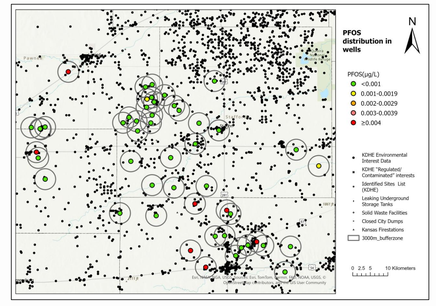


Figure 5: PFOS distribution in the study area

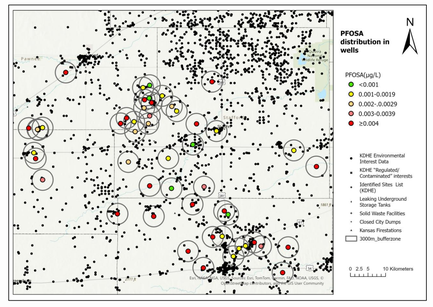
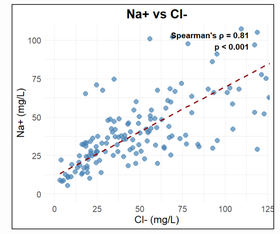


Figure 6: PFOSA distribution in the study area

Natural saline water contamination

- Among other analytes, sodium (Na+) and chloride (Cl-) show a strong linear correlation in response to mixing between deep salty water and fresh water in the aquifer



Conclusions

- Nitrate contamination is widespread in the study area.
- PFAS contamination also appears to be present, though additional testing is needed to evaluate its distribution.
- The sandy soil and subsurface sediment in the study area makes the aquifer vulnerable to contamination from human activities.
- Our research underscores the need for improved nutrient management and private well testing in the study area.

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