Nutrient export to groundwater across a land use and historical climate gradient

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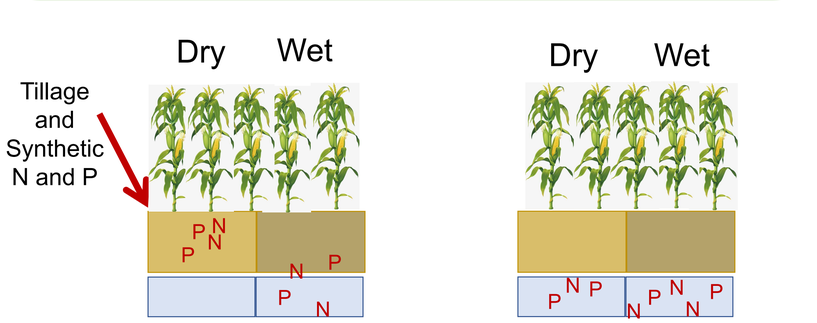
Background

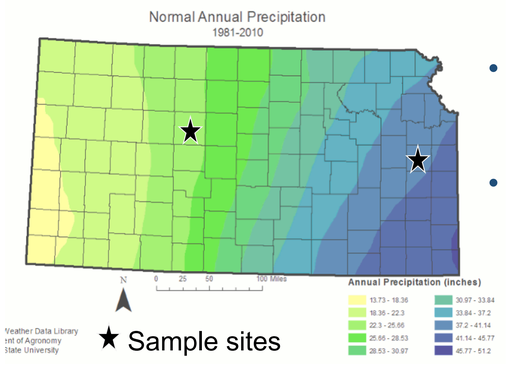
Groundwater inputs to streams are important sources of nutrients, especially in intermittent streams. Agricultural N and P can stay in the soil long after fertilizer is applied, and nutrients exported to groundwater ultimately affect downstream chemistry, including harmful algal blooms. It is important to understand how this influences nutrient export to groundwater, especially under changing precipitation patterns.

Questions:

1. **How is terrestrial-aquatic nutrient transport affected by land use and historical climate?**
   (a) What is the legacy of land use in nutrient export?
   (b) Does historical climate influence nutrient export?

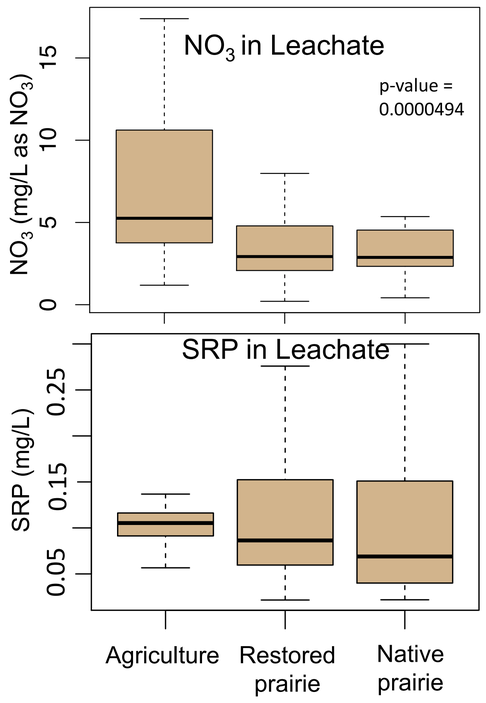


Experimental Design



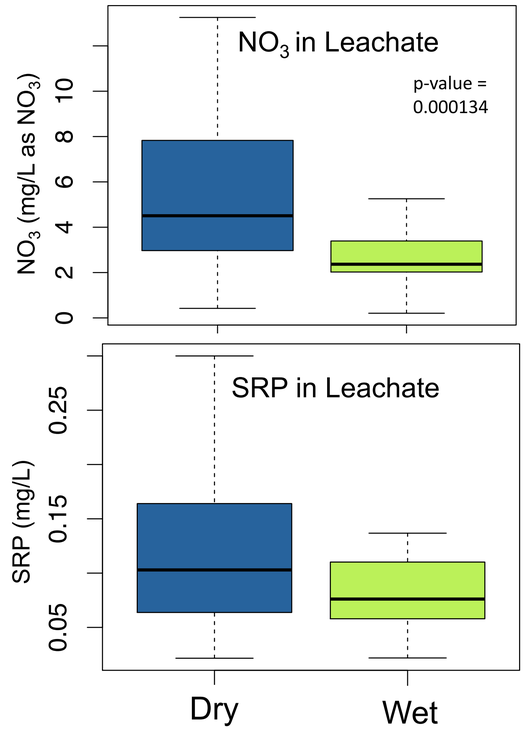
- 135 mesocosms of soil (75 cm long and 30 wide)
- Mesocosms taken from 2 sites (across precipitation gradient) with 3 land uses at each site

What is the legacy of land use in nutrient export?



Restored and native grassland have similar nutrient export, whereas ag lands generate more nutrients. **N export in restored land is comparable to native prairie while P is more persistent.**

Does historical climate affect nutrient export?



The drier site exports greater nutrients than the wetter site in a controlled environment. Under changing precipitation regimes, **dry regions may export greater nutrients than wet climates.**

TAKE HOME MESSAGE:

Row crop agriculture and climate are major controllers of terrestrial nutrient export to aquatic ecosystems.

Conclusions

(a) Restored prairie can attain comparable nutrient exports to native prairie, especially in N export. N legacy is short, while P is more persistent.
(b) Dry climates export greater nutrients than wet climates after similar precipitation events.

Field and Lab Methods

- Use hydraulic press to collect soil in PVC pipe
- Leach mesocosms with "rain event" = at least 3 cm of water
- Leachate analyzed for NO3, NH4, SRP, Cl, SO4 with ion chromatography and colorimetry methods

Future Directions

Future work will apply differential rain treatment to mesocosms to disentangle the effects of daily precipitation and land use on microbial activity and water quality. This study is part of a larger project to understand Microbiomes of Aquatic, Plant, and Soils across Kansas (MAPS).

Acknowledgements

Funding sources: NSF Kansas EPSCoR #OIA-1656006, Zadigan Scholarship, SFS Undergraduate Travel Fund. Many thanks to field assistance and data analysis from members of the Burgin-Loecke lab.

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Title: Nutrient export patterns to groundwater across land use and precipitation gradients

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Abstract:

Groundwater inputs to streams are important to intermittent stream function and can be a source of nutrients such as nitrogen and phosphorus. The amount of nutrients within groundwater are an important factor for downstream processes, including eutrophication far from the groundwater source. We asked whether land use and precipitation affect nutrient export patterns to groundwater. Soil samples were taken from sites across a variable precipitation gradient in Kansas with three land uses: agriculture, native prairie, and restored prairie. By analyzing the relative concentrations of nitrogen and phosphorus in the water after leaching the soil samples in mesocosms, we can tell how water quality is affected by land use and precipitation patterns, especially in intermittent streams.

Keywords:

Nitrate leaching; nutrient retention; land use