Assessing the Relationship between Changes in Corn and Soybean Density and Nitrogen in Nearby Streams within the Watersheds of the Midwestern United States

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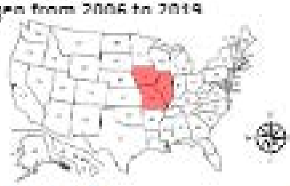
INTRODUCTION

- Corn and soybeans dominate the Midwestern United States agriculture.
  - Makes up 25.6 million hectares, or 74% of all cropland (Russell et al., 2009).
- Recent population and consumption increases have led to an agricultural boom in the Mississippi River Watershed.
- From 2000 to 2019, world corn production increased from 600 million to 1.2 billion tons (FAO.org, 2021).
- Nitrogen-based fertilizer is commonly used to aid crop growth, especially in corn.
- Excess nitrogen in streamflow causes eutrophication; this is unhealthy for ecosystem and human health (Shayo and Limbu, 2018).
- **This study aims to examine the relationship between the change in corn and soybean production and change in total nitrogen from 2006 to 2019.**

Figure 1: Study location: Illinois, Missouri, and Iowa are highlighted in red on the USA map.



METHODS

- Total nitrogen (mg/L) data from 2006 and 2019 collected from National Water Quality Monitoring Council.
- 5 available study points were selected along the Mississippi River.
- HUC-8 watershed data was retrieved from USGS
- Watersheds were imported into USDA National Agricultural Statistics Service's "CropScape" portal.
- Crop density (corn and soybean) within selected watersheds from 2006 and 2019 were downloaded from CropScape.
- Percent change was calculated for nitrogen, cornfields, and soybean from 2006 to 2019.
- All data was imported into ArcMap 10.7.
  - Layers were cleaned to display only corn and soybean crop density.
  - Subtracted 2006 crop data from 2019.
- Standard correlation test was run between percent change in nitrogen, cornfields and soybean fields.

Figure 2: Increase in corn and soybean acreage from 2006 to 2019 in selected watershed boundaries. All values from 2006 were subtracted from 2019 to display the (positive) difference over time.

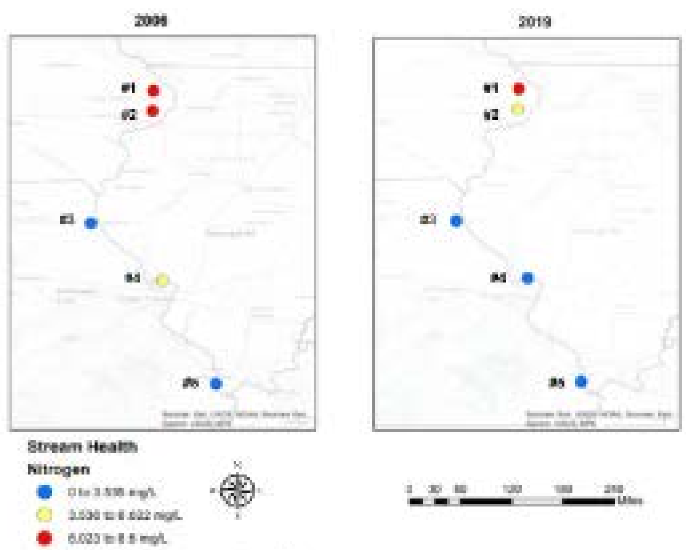


Figure 3: Nitrogen content (mg/L) in study points in 2006 and 2019.

RESULTS

- Four out of five study locations had a positive percent increase in cornfields (Figure 2, Table 1).
- Three out of five had a positive percent increase in soybean fields from 2006 to 2019 (Figure 2, Table 1).
- Overall negative trend in nitrogen concentrations (Figure 3).
- Correlation tests between corn and soybean field percent change and nitrogen percent change were not significant (P= 0.4 and 0.6 respectively).

Table 1: Percent change from 2006 to 2019 in Nitrogen, Corn, and Soy for each location.

Site Number	Corn % Change	Soy % Change	Nitrogen % Change
1	38.7	-15.8	5.5
2	10.6	-8.8	-28.0
3	18.6	19.4	-27.8
4	-5.9	18.3	-12.5
5	10.7	28.7	-14.1

DISCUSSION

- Although there was no significant correlation, this could be due to change in factors like nitrogen application rates or precipitation (Kalkoff et al., 2016).
- These variables typically are correlated; however, decrease in precipitation may prevent nitrogen from leaching into nearby waters (Kalkhoff et al., 2016; Shayo and Limbu, 2018). Additionally, recent legislation may have prevented excess nitrogen application rates, thus causing a negative trend over time (Donner, 2003; Russell et al., 2009).
- Limited resources only allowed for analysis on nitrogen within 5 study points. Future research including more study points and variables may show which underlying factor lead to the increase in nitrogen over time.

ACKNOWLEDGMENTS

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SOURCES

Donner, S. (2003). The impact of cropland cover on river nutrient levels in the Mississippi River Basin. Global Ecology and Biogeography, 12: 341-355. Kalkhoff, S. J., Hubbard, L. E., Tomer, M. D., & James, D. E. (2016). Effect of variable annual precipitation and nutrient input on nitrogen and phosphorus transport from two Midwestern agricultural watersheds. Science of the Total Environment, 559, 53-62.

Russell Ann E., Cambardella Cynthia A., Laird David A., Jaynes Dan B., & Meek David W. (2009). Nitrogen Fertilizer Effects on Soil Carbon Balances in Midwestern U.S. Agricultural Systems. Ecological Applications, 19(5), 1102-1113.

Shayo, S., & Limbu, S. M. (2018). Nutrient release from sediments and biological nitrogen fixation: advancing our understanding of eutrophication sources in Lake Victoria, Tanzania. Lakes and Reservoirs, 23(4), 312-323.