Digging Deeper: Land-use Effects on Soil-water Nutrients in the Kansas Prairie Precipitation Gradient

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OBJECTIVES

AIM 1: Determine soil-water nutrient concentrations important for vegetation productivity and soil formation including dissolved organic carbon, nitrate, phosphate, ammonium, potassium, calcium, sulfur, and magnesium for native, restored, and agriculture land-use plots

AIM 2: Model current and future projections of vertical soil-water nutrient concentration profiles using a variety of interdependent factors to examine land-use effects and biogeochemical inputs (e.g. evapotranspiration, temperature, soil pore geometry, microbial activity, and groundwater flow)

INTRODUCTION

According to the U.S. Global Change Research Program, land-use can be defined as anthropogenic modification to the natural system's surface (e.g., cropland, grazing pasture, and urbanization). Approximately half of the habitable land in the world is used for agriculture purposes (See Figure 1) . The effects of agriculture often depleting soil nutrients are well known. However, the effects of agriculture on the larger biogeochemical cycles and the resiliency of restored ecosystems are scarce and the studies that have been done are typically limited to ~30cm or less.

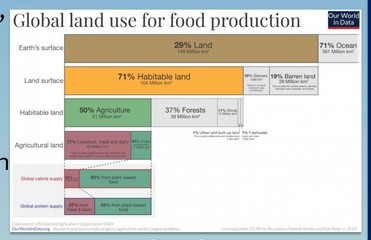


Figure 1 Global land use percentages

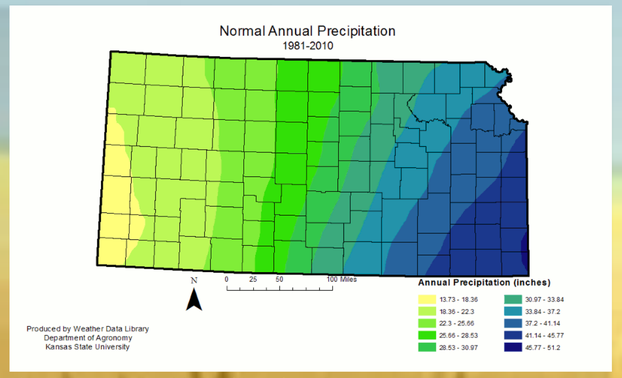
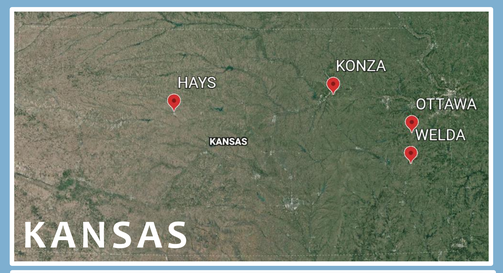


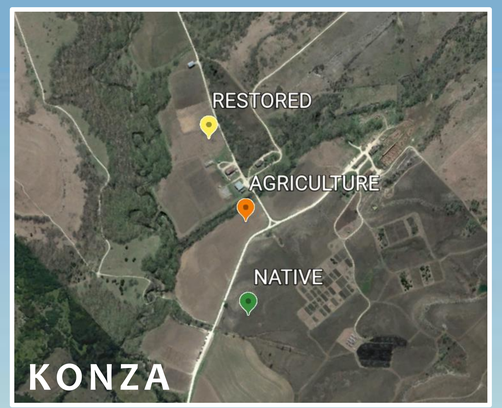
Figure 2 Normal annual precipitation of Kansas from 1981-2010

Kansas is an ideal setting to investigate how nutrients in soil- water change with agricultural land-use as there is a distinct precipitation gradient (See Figure 2) ranging from 400mm/yr in the west to 1000mm/yr in the east. Study sites within Kansas can be categorized into agricultural, restored grasslands (from agriculture), and native grasslands. Agriculture is defined as sites present with crops, restored grasslands are sites have been actively or passively replenished with native (or non-native) vegetation after a period of agriculture use, and native grasslands are sites without any historical agriculture practices. Kansas allows us to investigate land-use and climate dynamics as driving forces for variations in soil-water nutrient concentrations. The quantification and correlation of soil conditions and climate/land-use interactions is valuable to better understand the complex mechanisms which drive resilient soils.

STUDY AREA



Three locations in Kansas are being investigated: Hays, KS (low precipitation), Konza Prairie in Manhattan, KS (medium precipitation), and Welda, KS/Ottawa,KS (high precipitation). At each location site three different land-use types are studied: native, restored, and agriculture. At each of the land-use sub sites, lysimeters (See Figure 4) are installed at depths of 10cm, 40cm, and 120cm or until the point of depth refusal. A total of 27 lysimeters, 9 at each study area, have been installed and will remain in place for long-term monitoring of soil-water nutrients and are sampled on a bi-weekly basis.



METHODS

This study utilizes suction lysimeters to collect soil-water from different depths. Soil-water will be collected bi-weekly or after an extreme precipitation event has occurred. Samples will be analyzed for dissolved organic carbon, nitrate, phosphate, ammonium, potassium, calcium, sulfur, and magnesium, using analysis of variance (ANOVA) to determine statistically significant differences in study area factors such as precipitation, land-use, and depth. Post-hoc and multivariate statistical tests will be used to pinpoint the degree of forcing between land-use, precipitation, and depth variables.

What is a lysimeter?

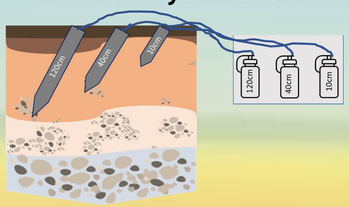


Figure 3 Schematic of lysimeter installation at sites

- **A lysimeter is a probe buried in the ground and collects water found in soil pores**
- **The lysimeter is buried underneath the soil at a 45-degree angle with tubing connected to collection jars**
- **Collection jars are housed in a separate box and negative pressure is applied to pull water up through the tubing**
- **Using lysimeters as a collection method allows for undisturbed soil to be analyzed**

FUTURE DIRECTIONS

Results from this study will reveal deep soil responses from which we can make assumptions about soil's resiliency to anthropogenic disturbances. Comparing the restored plots to native and agricultural plots will allow us to determine the degree to which soil-water nutrients are changing. Framing results in a way that can improve adaptation or mitigation strategies around anthropogenic disturbances is a priority for disseminating this research. Additionally, the linking of anthropogenic disturbances, precipitation, and deeper soil profile relationships is very timely and compelling to understanding rapid global ecosystem changes that are still to be realized in the Anthropocene.

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