Urban Soil Characteristics and Their Effects on Greenhouse Gas Emissions

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INTRODUCTION

- Agricultural practices and urban land uses may contribute significantly to greenhouse gas (GHG) emissions.
- CAP LTER studies have quantified GHG emissions from some terrestrial environments and denitrification rates (resulting in N₂O and N₂) from episodically flooded areas.
- Few studies have investigated the soil characteristics in a broad range of urban patch types.

METHODS

- Examined 10 different urban patch types (three replicate sites per patch type; n=30) representing different land uses (see Fig. 1). Three locations within each site were sampled.
- Year-long study capturing cool and warm-season soil characteristics (Jun and Nov 2013).
- Collected air samples from three gas chambers placed on the soil surface at each patch replicate; samples were analyzed for N₂O and CO₂ using a gas chromatograph (GC).
- Collected two soil cores and measured soil and air temperature for each gas chamber.
- Measured soil moisture, percent organic matter, and extractable inorganic nitrogen in soil cores.

QUESTIONS

Q1: What are the different soil characteristics for each patch type in the urban Phoenix area?
Q2: What quantity of GHG emissions is predicted from different patch types in the urban Phoenix area?

Figure 1. SOIL CHARACTERISTICS

- Figure 1 boxplots A, B, C, and D show soil characteristics measured from 10 different patch types (n=30) across the urban Phoenix area. Dot = outliers, asterisks = far outliers.
- Similar trends for soil moisture and organic matter, high nitrate values for sites with low soil moisture and organic matter.

GHG EMISSIONS: PREDICTIONS

N₂O and CO₂ were measured using a gas chromatograph with a dysfunctional detector. CO₂ will be re-measured at all sites using an infrared gas analyzer (IRGA).

1. Air Temperature:
   Temperatures stimulate microbial processes, increasing GHG emissions. Very high heat will stress or kill microbes and decrease emissions slightly.

2. Soil Moisture:
   GHG production will be low when soil moisture is low. If soil moisture is high enough to create anoxic conditions, then GHG emissions will decline.
   - 2A: CO₂ emissions will decline sharply at high soil moisture.
   - 2B: N₂O emissions will decline more slowly at high soil moistures, with N₂O production resulting predominantly from denitrification vs. nitrification.

3. Organic Matter:
   GHG production will be higher in soils with higher organic matter content, but will not increase above a particular soil organic matter content.

4. Inorganic Nitrogen:
   Production of N₂O will be higher in soils with higher total available inorganic nitrogen concentrations, but will not increase above a particular inorganic nitrogen content.

CONCLUSIONS and FUTURE DIRECTIONS

- This study provides a thorough look at soil characteristics in many different patch types across the urban Phoenix area.
- Areas with turf grass (irrigated lawn, mesic basins and washes) and wetland had the highest soil moisture and organic matter, potentially indicating high potential for GHG emissions.
- Inorganic N is clustered around low %water, potentially from decreased microbial activity related with low %water. This could indicate a decrease in GHG emissions at sites with low soil moisture.
- Large seasonal differences in metrics related to GHG emissions may indicate seasonal shifts in total emissions and GHG hot spot locations.
- Gas sample analysis will allow us to use soil variables to estimate the emissions from different land use types.

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