Impacts of Climate Change on Soils

How does vegetation influence the amount of CO_2 in soil?

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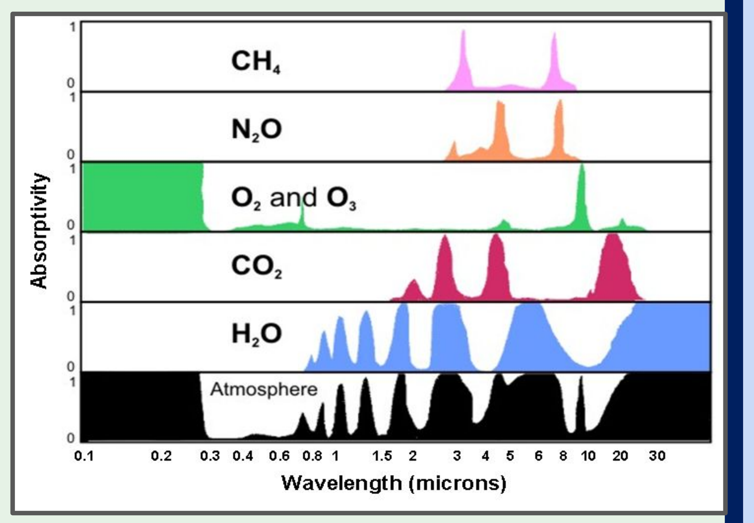
Oak Ridge National Laboratory

Introduction

Global impacts of climate change - Rising CO_2 levels and the addition of other greenhouse gases cause infrared wavelengths of light to become trapped in the atmosphere, leading to a generally warmer global climate.

1. Record wildfires (e.g. Australia)
2. Record heat waves (e.g. AZ)
3. Extreme droughts (e.g. CA)
4. Extreme rainfall (e.g. MD)
5. Intensified hurricanes (e.g. FL)

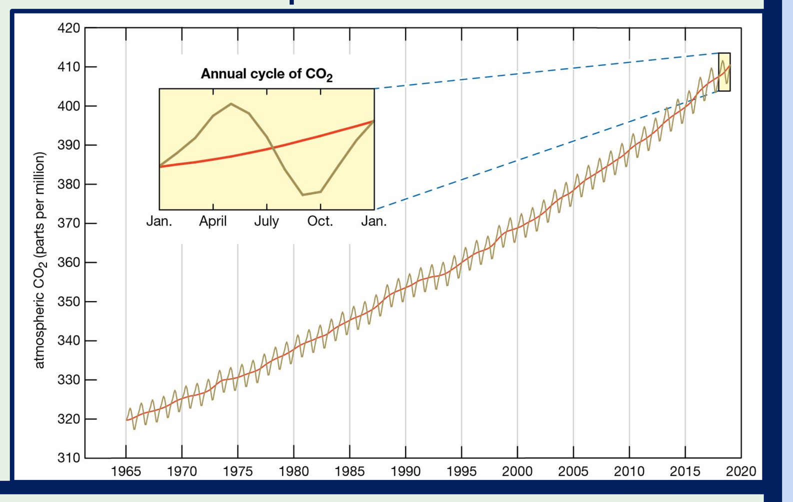


Time Scales - Climate normals are usually gathered over a 30-year period, meaning the time scales are very long. Weather timescales are shorter and very chaotic

Background

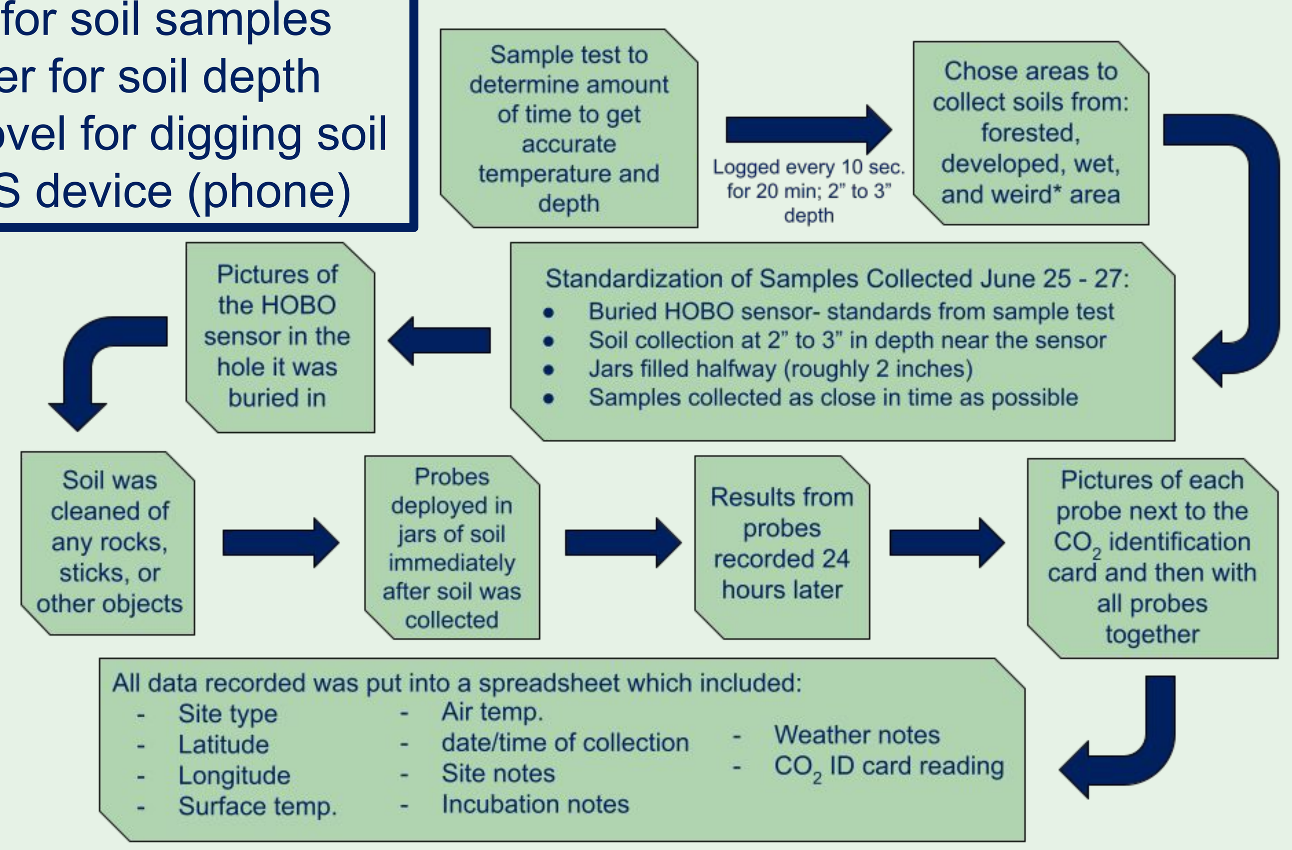
Vegetation and soils store around 50% of the CO_2 being produced by humans. Plants use photosynthesis to absorb CO_2 from the atmosphere. Organic matter is created from leaves and plant mortality. The dead organic matter creates food for microbes in the soil, which create CO_2 that goes back to the atmosphere.

-Keeling Curve shows annual cycle;
-Growth mid-year decreases CO_2
-Winter months release CO_2
-Overall upward trend:
-Starting at CO_2 320 PPM ~1965
-Ending at CO_2 410 PPM ~2020



Materials and Methods

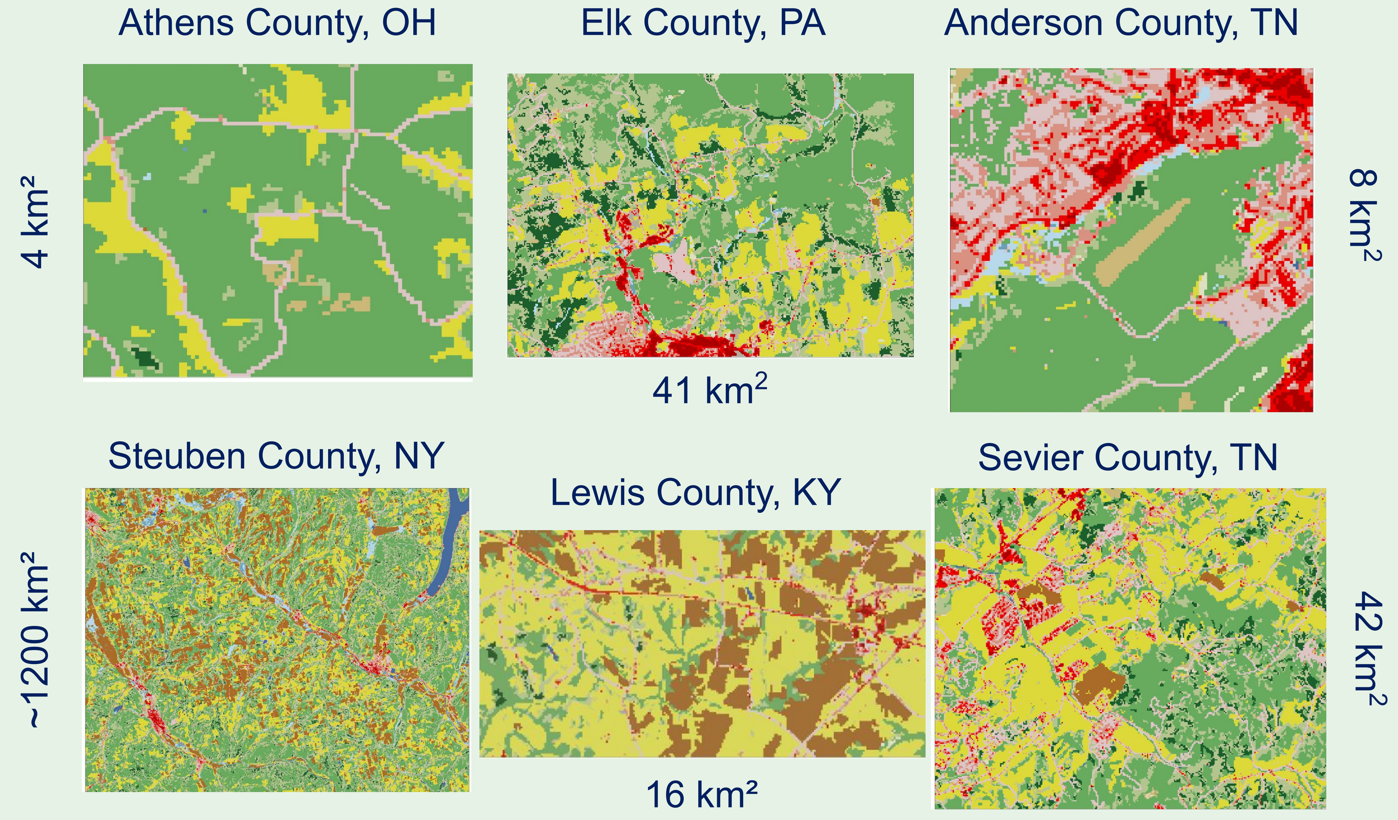
-HOBO temperature sensor
-Solvita CO_2 probes
-Jar for soil samples
-Ruler for soil depth
-Shovel for digging soil
-GPS device (phone)



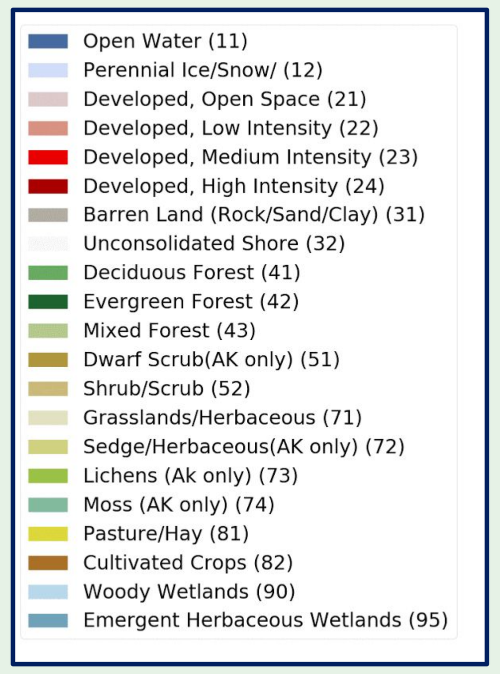
*A "weird" location was anything deemed interesting to test such as a farm field or the soil near decomposing material.

Results

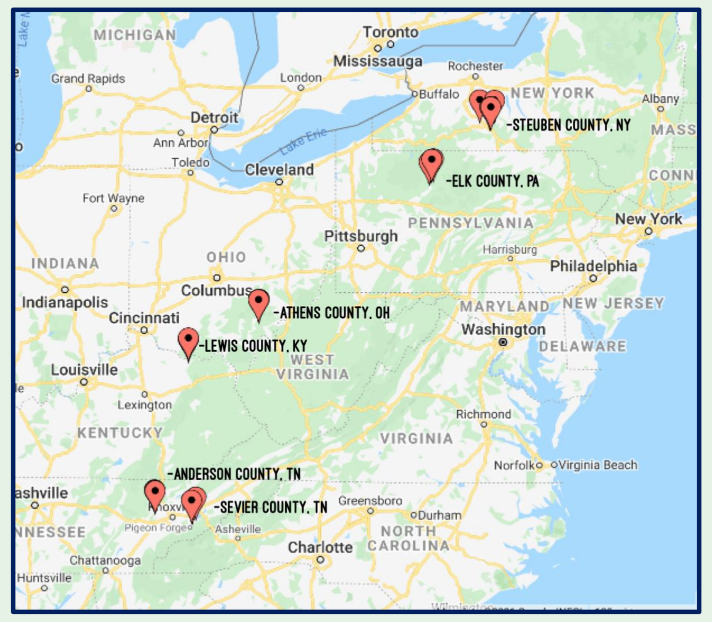
Our results showed that larger amounts of vegetation led to a greater CO_2 content within the soil. Below is the vegetation of our land areas based on the Multi-Resolution Land Characteristics (MRLC) 2019 data:



Legend



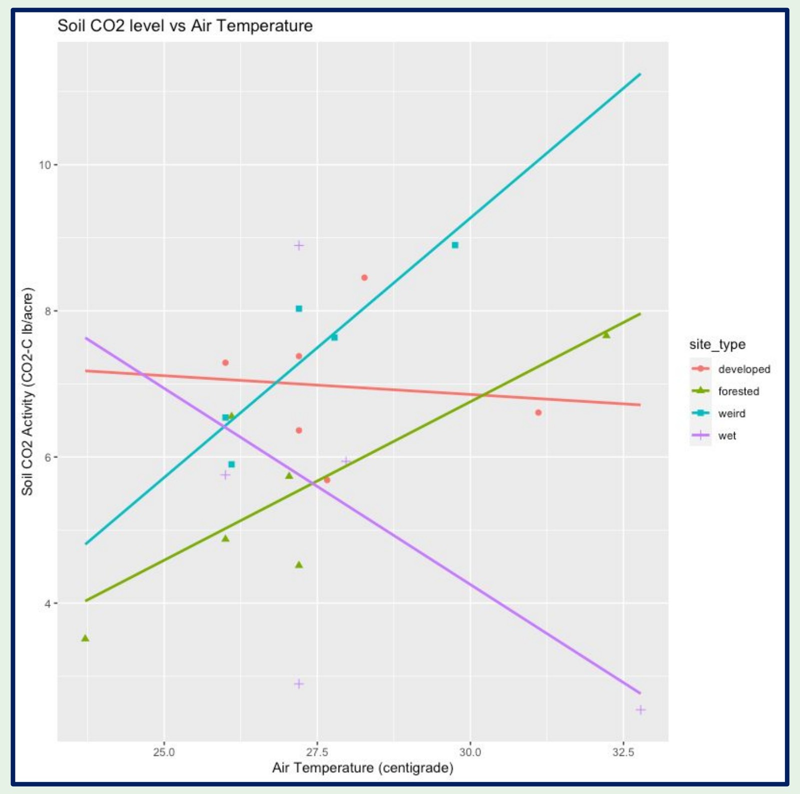
Different Points Where Soil was Collected



Map made in batchgeo.com

CO_2 vs Temp from collection sites:

- Developed regions; CO_2 content was high and had little temperature correlation
- Weird and forested; higher CO_2 levels than developed areas and a positive correlation
- The wet sites had the least amount of CO_2, with a strong negative correlation



Graph data made in RStudio

Conclusions

Based off of the results, we found:

- Forested and weird areas held the most carbon in their soil, especially at higher temperatures
  - i. Forested areas due to the vast amounts of plants that absorb CO_2 in their vital processes (respiration and photosynthesis)
  - ii. Weird areas due to various possible reasons
    - Some were farmland, whether that be for crops or animals, that produced carbon from animal waste and fertilizers
    - Others had decomposing plant matter on or near it causing carbon to be generated

The data collected shows **a positive relationship between the amount of vegetation in an area and the amount of carbon recorded.**

- This is reflected in the land usage maps from MRLC
- Areas that recorded high amounts of carbon were either mostly deciduous forests or pastures/hay.

The forest soils having larger amounts of CO_2 could be in part due to the time of year when data was gathered (summer months)

Why this is important:

- Improving carbon through soil use and land management can help to mitigate climate change, combat degrading soils, and address food security.
- Deforestation, wildfires, and other forms of ecosystem disturbances are causing the Earth to lose some of its best forms of CO_2 mitigation.

Acknowledgments

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