An Investigation of the Long Term Effects of Urbanization on Soil Properties in Fort Worth, TX

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Introduction

- Tarrant County is undergoing unprecedented growth, especially urban areas of Fort Worth, TX.
- Rapid urbanization, or suburbanization, can often lead to unintended disturbances in eco-regions causing localized environmental degradation, specifically soil health.
- Because of this trend, we wanted to observe the trends that occur after suburban areas are developed.
- In order to determine whether the condition of a soil varies based on suburban development, soil samples were collected from three temporally different rural areas in an urban area, shown in **Figure 1**.
- Our hypothesis is that the shorter the time since a house has been built (i.e. most recently disturbed), the greater the difference between our control area: a nearby open plot of land termed "park". Thus, the soil will tend to return to its natural state, causing the measured characteristics to mimic those of the natural plot.

Methods

Loss on Ignition (LOI)
•This method was used to determine the amount of volatile organic matter.

pH
•Soil slurries were prepared to determine the pH of the samples collected.
•Area 1, newly built, is the most basic amongst the four areas Area 1 is approximately 2 times more basic than the Park, 1.5 times more basic than Area 2, and finally 1.6 more basic than Area 3.

Titration
•The Titration test is a volumetric analytical method used to determine an unknown alkaline concentration in a known substance.

Thermogravimetric Analysis
•To determine the relative amount of organic matter by composition for each sample, we used the Thermogravimetric Analysis at 800°C to obtain water loss at low temperatures, organic matter loss during the 40 to 200 °Celsius range, and calcium carbonate loss above 600°C.

Elemental Analysis
•We ran an Elemental Analysis (EA) on our samples using an elemental analyzer, specifically we looked at carbon, hydrogen, nitrogen, and sulfur.

Isotope-ratio Mass Spectrometry
•In order to determine the abundance of elemental isotopes in our soil samples, Isotope-Ratio Mass Spectrometry (IRMS) was used.
•These samples were sent off to be analyzed at Baylor University lab in Waco, Texas.

UV Vis Analysis
•Spectrophotometry is the use of electromagnetic radiation (light) to measure chemical concentrations. The spectrophotometer uses a monochromator to select a narrow band of wavelengths to use to measure those concentrations.

ICP- OES
•Inductively Coupled Plasma - Optical Emissions Spectroscopy (ICP-OES) is performed by liquid samples being aspirated through vinyl tubing and eventually being introduced to a flame that breaks molecules apart to atomize samples and measure the concentration of ions with a mass spectrometer.
•This process was used to determine the amount of phosphorus in our samples.

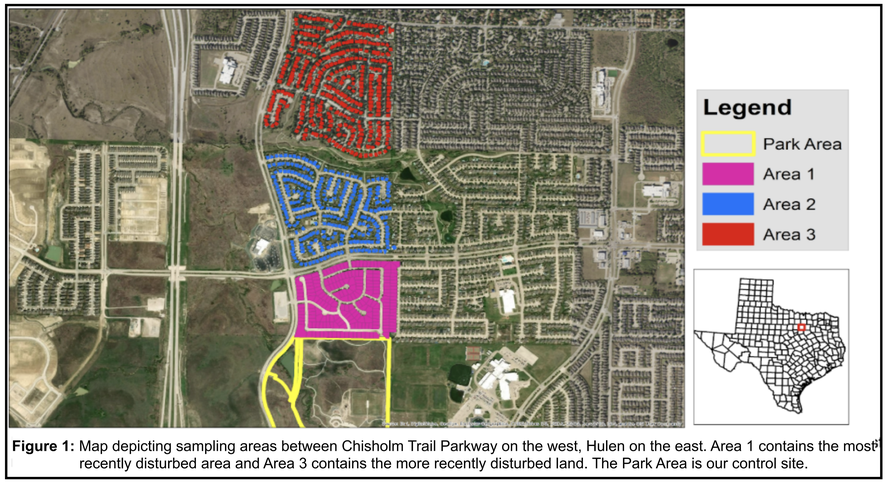

Figure 1: Map depicting sampling areas between Chisholm Trail Parkway on the west, Hulen on the east. Area 1 contains the most recently disturbed area and Area 3 contains the more recently disturbed land. The Park Area is our control site.

Research Findings

•The average pH values across the four areas of study are basic, but are close to the neutral point on the pH scale.

•Urban soils tend to have elevated pH values, near to neutral, because of the release of calcium from the weathering of building rubble comprised of masonry, cement, plaster, and the irrigation of vegetation with calcium-enriched water (Craul 1986).

•Years of lawn care activities within older areas reduce soil pH

•Our samples indicate constant changes in the level of cations as the sample sites moved from the natural area to developed areas, with Area 1 having the highest amount of exchangeable acidity: 4.48 cMol/kg.

•The TGA results yielded a trend of increasing organic matter loss between 250-500°C with an increase in age and the lowest organic matter content at the park location.

• The EA results, with the exception of sulfur, demonstrated a similar sinusoidal trend that supports our hypothesis, shown in **Figure 2**.

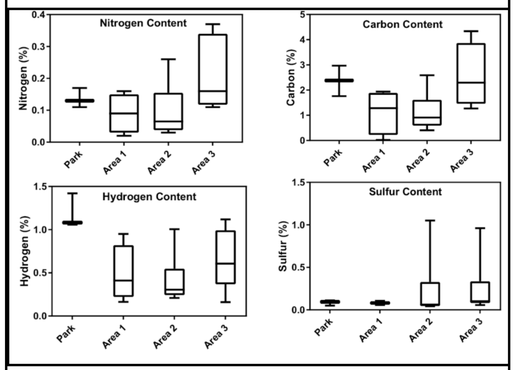

Figure 2: Results of Elemental Analysis of Nitrogen, Carbon, Hydrogen, and Sulfur. We begin to see a trend towards the natural Park conditions.

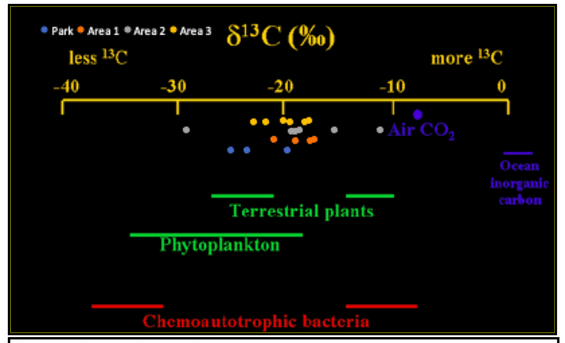

Figure 3: Our $d^{13}C$ values for each of our study areas expressed in relation to various organic materials. This figure was taken from the University of Arizona while our data points were created and plotted on top. (*What Are Stable Carbon Isotopes?*)

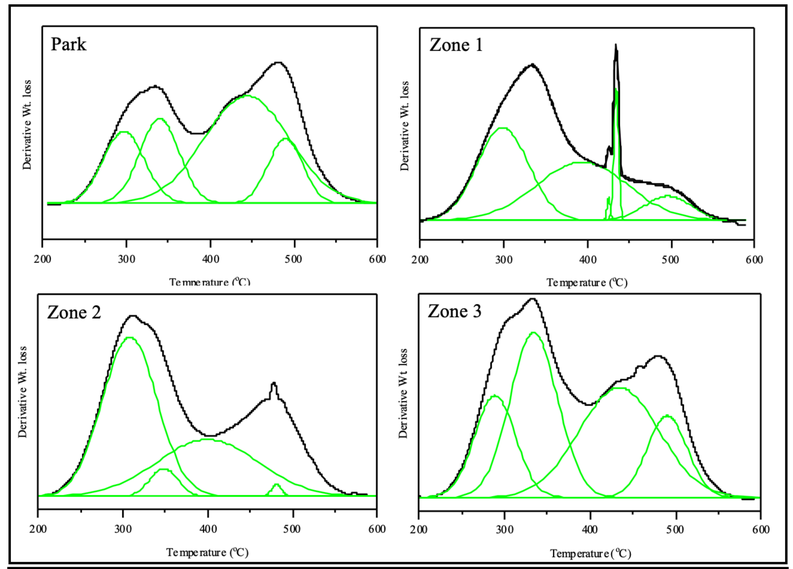

Figure 4: Oxidizable carbon levels as temperature increases. Shown, oxidizable carbon begins to return to its natural state; the conditions observed in the Park.

Research Findings Continued

•The LOI results do not show a trend that supports our initial hypothesis of recovery nor agrees with the trend we found using other methods of increased organic matter content corresponding to age of house.

•As shown in **Figure 3**, the $d^{13}C$ values of our samples range between -10% and -29%. Most terrestrial plants are categorized as C3 plants with $d^{13}C$ values ranging from -24 to -34% (Kendall et. al. 2004).

•**Figure 3** shows that as the age of suburban land increases, we begin to see a trend towards the natural state when compared to the Park.

•The results from the UV Vis shows that the highest rate of absorption took place at the 280 nm at all four areas and also indicates a slight increase in overall absorption at each wavelength.

•Therefore, time does not seem to play a role in returning the absorption levels back to normal.
•Areas 1 and 2 show a buildup of phosphorus. Area 3 had the most phosphorus due to the area having over 30 years for this to accumulate.

•However, the developed areas Phosphorus content compared to the natural area shows that there is no indication of the soil "recovering" to the phosphorus content in the Park.

•The results from **Figure 4** show the amount of oxidizable carbon begins to increase as the age of the property increases.
•This means that as the property ages, we begin to see a return to the Park's natural conditions.

Future Work

•Future studies would ideally consist of a longer time range

•Application of these research methods to different urbanized land areas could provide detail into how urbanization affects the soil.

•More soil samples will be taken with a more continuous time range to determine the points where the most change happens.

•Taking the landform shape into account is important because changes in relief cause downward slopes that can change water flow direction and intensity.

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