De-Icing Impacts on the Danforth Campus

Sustainability Exchange Spring 2020

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BACKGROUND

What is a De-icer?

- De-icers are salts that **lower** the **freezing point** of water (making it harder to freeze and **easier to melt**)
- Landscaping companies add de-icers to roads and sidewalks to improve walking conditions during the winter

How do De-icers Affect Soil and Groundwater?

- Increases amount of **conductive species** in the pore water of the soil. De-icer salts are ionic - they can easily **conduct** (transmit) electric current through them.
- Commonly used salts for de-icing are chloride salts (NaCl, $MgCl_2$) which dissociate into positively and negatively charged ions. Chloride ions (Cl^-) present in these salts are documented by the EPA 303 D list as a high-priority pollutant in St. Louis
- The concentration of ions in the soil's pore water can be estimated by conductivity measurements - measure of ability to pass electrical flow

How Can We Use Conductivity Measurements?

- They tell us how abundant ions are in the soil's pore water **throughout the semester**.

Spots lacking grass on Mudd Field (partially because of the conductive material from de-icers!)

METHODOLOGY

Instrumentation:

Soil Testing Kit - measures pH levels at each of the 4 testing sites on Danforth campus

Pocket Pro+ - measures pH, temperature, TDS, salinity, and conductivity of all samples from each location

Procedure:

1. Sampling
   - Use an auger to take 5 cm deep samples at 0 cm, 30 cm, and 60 cm away from the sidewalk at each location (Mudd Field, Oak Allee, and East End shown respectively in the map below)
   - Place Soil Testing Kit into soil once at each location and let stabilize for 10 minutes prior to recording data

2. Laboratory Analysis
   - Add 40 mL deionized water to 20 g of soil from each sample of all locations
   - Stir with magnetic stir plate for 5 minutes then remove and let settle for 2 minutes
   - Use Pocket Pro+ to measure data from each sample and record

OBJECTIVES

The overall goal is to understand the environmental impacts of de-icers on WashU's soil. We will accomplish this with the following objectives:

1) Expand on available data by sampling soil under different weather conditions and changes in conductivity
2) Improve the experimental design for soil sampling and testing
3) Develop application to help Focal Pointe track where has been de-iced

DATA

❄ Snow Event

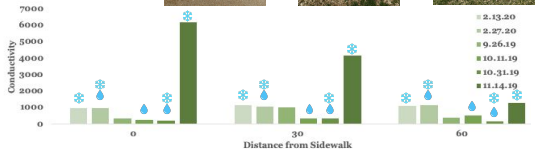
💧 Rain Event

Oak Allee

Mudd Field

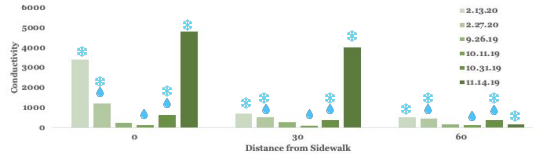
East End

Mudd Field:



Oak Allee:

East End:

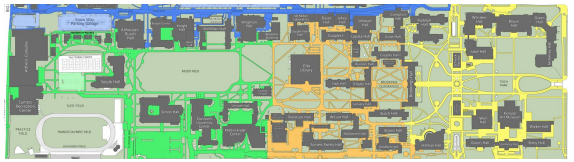


FINDINGS AND ANALYSIS

- De-icers increase the conductivity in the soil pore water, due to an increase in the concentration of ionic species, e.g., sodium (Na^+) & chloride ions (Cl^-)
- Conductivity decreases with increasing distance from sidewalk. This suggests a decreasing concentration profile with the lowest de-icer concentrations farthest from the sidewalk
- Conductivity decreases after rainfall events because the de-icer is diluted and pushed out of the pore water further into the subsurface
- Overall implication: higher conductivity correlates to increasing ionic species in the soil which result in negative impacts to both plant growth and local water quality

APP DEVELOPMENT

- We are developing a beta version of an ArcGIS web app which will allow Focal Pointe to update progress on de-icing operations after a snow event
- We will be using Collector for ArcGIS in conjunction with ArcGIS Online



RECOMMENDATIONS

- Further study on how current de-icing practices impact soil and water quality in order to gain greater cross-seasonal understanding
- A pilot study of the ArcGIS app to inform further customization of the app to fit the specific practices and needs of Focal Pointe
- Additional research on treatment technologies for in-situ reduction of salt adsorption by soil, e.g., biochar and gypsum mixture

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