The Effect of Anthropization on Soil's Physical Properties

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Motivation

The three most important resources for survival are air, water, and soil. Air and water pollution get more attention than soil pollution. Soil pollution increased dramatically with world population after the Industrial Revolution. The only solution to feed everyone is agriculture. For a long time, the main practice for soil treatment was using chemicals, such as pesticides, thinking it would help the soil provide more food, but actually, the chemicals ruin the soil. Our goal is to find issues in the soil so that we can fix them and create the largest amount of the most fertile soil possible in order to feed humanity.

Introduction

The agricultural conventional method is to leave the soil bare. However, when there is a lot of rain, the kinetic energy of the raindrops (equation (1)) compacts the soil, forming a crust on the top layer.

(1) $$E_K = P \cdot A \cdot S$$

E_K is the kinetic energy of the raindrop
P is pressure of the raindrop
A is area of the soil
S origin distance of the raindrop

The compacted soil has less porosity which allows for less infiltration of water and nutrients. Since the water does not infiltrate the soil, it slides off as runoff, shifting the water balance of the field. Moreover, the runoff water takes essential nutrients and chemicals with it, eroding the top, most fertile layer. The contaminated water then flows into main water resources (Kaspar & Singer 2011). In order to find the issues with the soil, we are going to compare two kinds of soils from two different environments: one from a forest and one from a field. The forest soil is natural, but the field soil is filled with chemicals and other pollutants. The physical properties of these soils will be compared to examine whether the agricultural process effects the soil's physical properties.

Methods

Soil characteristics depends on percentage of three components : sand, silt and clay. The smaller the particles are, the slower the water will infiltrate, and therefore the longer it will stay in the soil. In order to know how effective the soil is, three characteristics were observe: composition, water holding capacity, and porosity. We are testing these characteristics in two environments - wild soil and human-touched soil, to investigate the effect of anthropization on the soil fertility.

Figure 1: Determining the type of soil.

Soil Texture by Feel - Determine Type of Soil (Figure 1)

It is a simple test, but it is not always accurate because the test relies on human senses.

Hydrometer - determines the percentages of sand, silt, and clay in the soil by calculating the particle size (Figure 2)

This method depends upon Stokes' Law (equation (2)).

(2) $$X = \theta * t^{-1/2}$$

θ is the sedimentation parameter ; $t^{-1/2}$ is a function of the hydrometer settling depth, solution viscosity, and particle and solution density (Dane & Topp 2002)

Figure 2: Blank hydrometer on the right, soil hydrometer on the left.

Figure 3: Taking water content samples in the field.

Water Content- measuring the soil's water content (Figure 3)

After irrigating the research area, we're taking soil samples and calculate the soil's water content each 10 minutes. This was done to compare the soil's holding capacity between the two different soils (results are in Figures 6 & 7).

Porosity- measuring the porosity of the soil (Figure 4)

Using an undisturbed sample so it will keep the soil's structure (equation (3)).

(3) $$N = 1 - \frac{\rho_b}{\rho_s}$$

$$\begin{cases} \rho_b = m_p / V_t \\ \rho_s = m_s / V_s \end{cases}$$

(Hillel 1998)

m_p - the mass of dried soil
m_s - the mass of the solid in the beaker
V_t - the total volume of the soil
V_s - the volume of the soil in the beaker
ρ_b - the dry bulk density
ρ_s - the density of solids

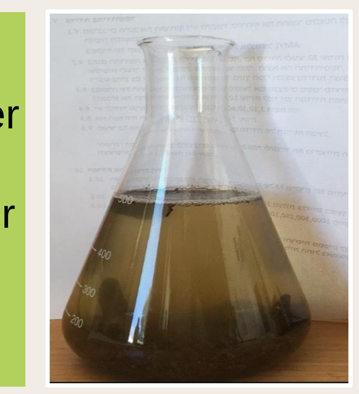


Figure 4: Beaker filled with soil and water for porosity test.

Results and Discussion

Forest: Natural, Mulch-covered soil

Composition

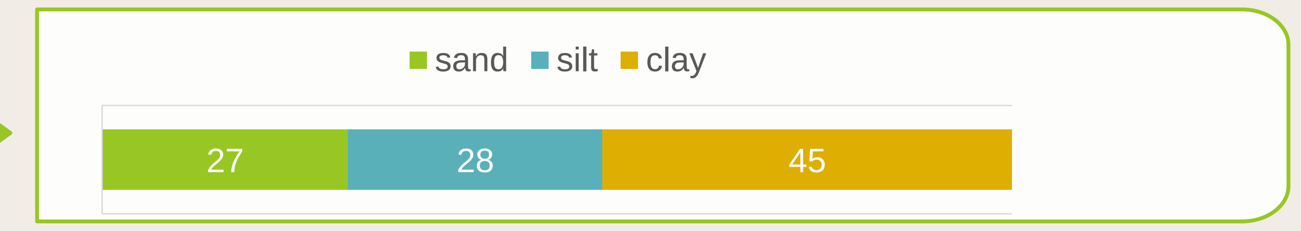
Porosity

Without sieving 94%

With sieving 77%

Figure 5: The two research areas (a) Haifa's forest (b) Field in Mazkeret Batia

Field: Anthropized, Bare Soil



Composition

Porosity

75%

Discussion

- The anthropization of soil makes it less porous (mostly because there is no organic matter in the anthropized soil components).
- Anthropization makes the soil not able to hold water on its top layer as long as the wild soil (Figure 6).
- More evaporation occurs when the soil is bare because it sits directly under the sun.
- Plants need water on the top layer because some of them cannot survive in others conditions.
- The anthropization makes the soil less fertile.

Water content

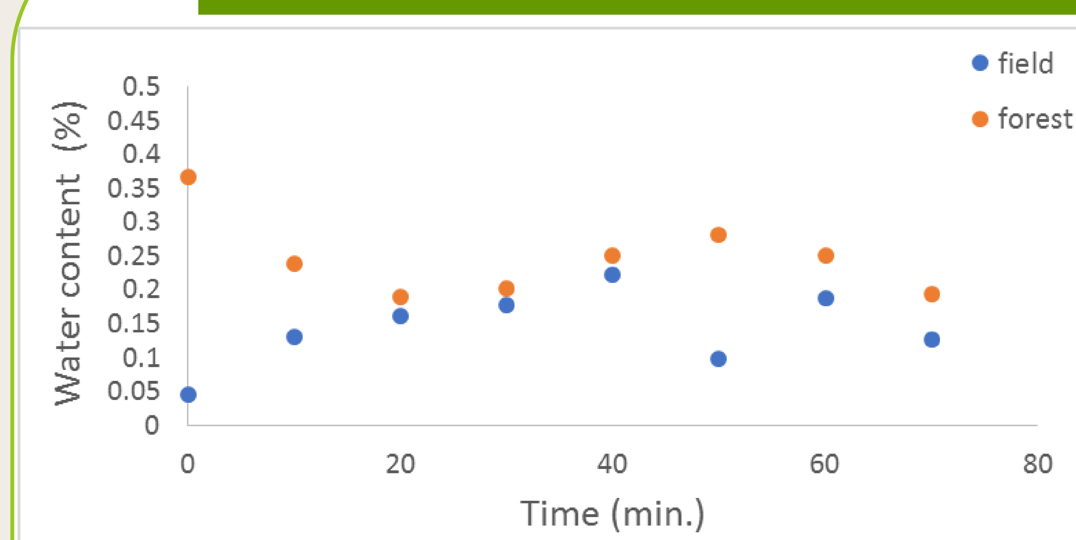


Figure 6: Forest and field soil at 5 cm depth comparison of f(time)=water content

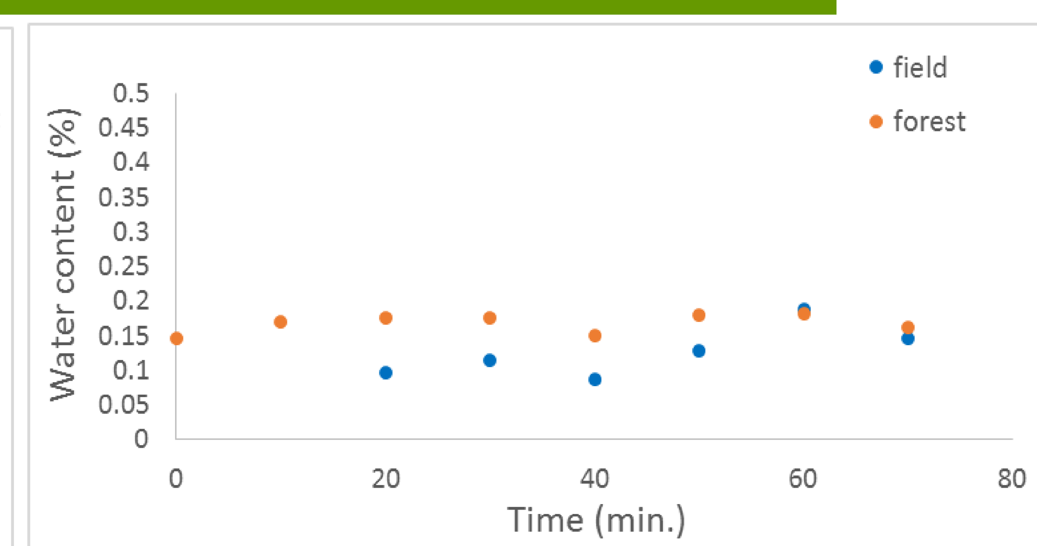


Figure 7: Forest and field soil at 25 cm depth comparison of f(time)=water content

Results

- The composition of the forest soil is inaccurate because of a high organic matter content in the soil.
- The water content is higher for longer in the forest because there is mulch to protect the soil from evaporation.

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