Introduction

Name_____

What Soil is:

Soil is a natural body made up of minerals (rock), organic (living and dead) materials, air, and water. Soil has living and dead parts in it.

There are three main types of soils called textures. They are: sand, silt, and clay. Sand has the largest particles and clay has the smallest.

Soil is the loose material found in the upper crust of the Earth. It is both living and non-living.

Soil is naturally found in horizons, or layers, each with its own unique composition and characteristics.

Soil = Organic Matter + Minerals + Air + Water

A soils' physical & chemical properties include:

*bulk density (strength)
*porosity (aeration and drainage)
*texture (type of soil)
*pH
*cation exchange capacity (CEC)

Physical properties can quickly and easily be changed both short and long term under certain conditions. The soil can be tilled or amended to alleviate bulk density and increase porosity and to change the overall texture.

Chemical properties are not as easy to change. A soils' pH can be modified by adding lime to make it more alkaline or an acid to make it more acidic, but in both cases the natural process of weathering and leaching will eventually restore the original pH status. A soil's CEC can also be changed by modifying the physical characteristics or by changing the pH.

1. Soil Texture

This refers to the proportion of sand, silt, and clay particles that make up a soil. Soil texture determines water and nutrient holding capacity.

Physical and Chemical Properties of Different Soil Textures

2. Soil Structure

This refers to how the soil particles are arranged. Various processes cause the soil to aggregate into clumps creating macropores. These large pores are important for drainage and aeration of the soil. Compacted soils have poor structure.

3. Soil pH

A soil's pH determines its nutrient availability. Some species have very specific pH requirments. Chlorosis (leaf yellowing) is a sign that the pH is too high for that species. Urban environments usually have high pH.

4. Soil Drainage (Porosity)

Slowly draining soils limit the oxygen available to the roots because soil pores are filled with water rather than air.

* Gray or blue soils indicate poor drainage.
* Compacted soils have poor drainage.

Soil , Dirt

It is NOT correct to refer to a soil-based growing medium as dirt!

Soil as a Resource

A resource is a material that has been taken from its natural setting and used to satisfy human needs. Examples of resources include animals, plants, minerals, gases and other natural substances. Resources can be broken down into two types: renewable and non renewable.

A renewable resource is one that can eventually be replenished by natural processes without human intervention. A non-renewable resource is one that can not be replenished because it was "used up" by humans.

In either case, over-usage can deplete the resource to the point of non-availability. Some renewable resources can take thousands of years to "renew", thus becoming unavailable in the meantime.

Conservation of Matter dictates that matter is neither created nor destroyed. However, it can be irreparably changed as to never resemble the initial form and function. When a tree is burned down it is no longer a tree. The tree is gone!

Soil is classified as a renewable resource, even though it takes approximately 500 years for nature to make one inch of it! Is this truly renewable? Should we be concerned about depleting it?

Ithaca High School SOIL SCIENCE Unit

Angie Rivenshield

Focus:

To make students aware of (urban) soil related issues on a local and global scale.

Day One: Introduction

1. Basic Soils Science
2. Definitions and Key terms
3. Visuals and Demos
4. Handouts
    a. soil history and morphology
    b. comparison of urban and natural soils
    c. discussion of local and global issues

Day two:Physical and Chemical Properties of Soil

1. Texture
2. Structure
3. Porosity
4. Density
    a. sand versus clay
    b. organic versus mineral
    c. porosity and density issues

Day three: Anthropogenic Manipulation of Soil

1. Compaction
2. Pollution
3. Erosion
4. pH
    a. compacted versus non-compacted
    b. erosion factors (cover, roots, etc.)
    c. acid rain
    d. vegetation and remediation

Day Four: Anthropogenic Manipulation of Soil (Continuation)

1. Remediation
2. Drainage
3. Cover
4. Economic

Days five (optional): Discussion

1. Slides
2. Samples
3. Opinion versus Fact
4. Debate

POROSITY

Name: _____

Porosity refers to how many pores, or holes, a soil has. Remember that a good portion of soil is air and water. The air and water is in pores that form between individual particles and between clumps of particles. There are large pores, called MACROPORES and there are small pores, called MICROPORES. Keep in mind that most of the pores found within a soil are microscopic and can not be seen by the naked eye.

Micropores are those pores most responsible for holding water. Macropores are those responsible for holding air. Water drains through the macropores, and settles into micropores where the water is held very tightly.

1. Run the texture by feel test on the sand and clay samples. This will allow you to become comfortable with what these two "pure" types of soils feel like. Such characteristics as whether the soil balls and ribbons, and how gritty it feels will become clear from this exorcise.

Questions to ask yourself:

Which soil will feel grittier? Why?

What determines grittiness of a soil?

Is this a useful quality? Why or why not?

Which soil will ribbon best? Why?

A soil that will ribbon is said to be plastic.

Is being "plastic" a good quality for a soil to have?

When would this quality be most useful?

2. Run the texture by feel test on the unknown soil sample you have been given. Follow the texture by feel handout.

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Macropores Hold Air & Micropores Hold Water

Testing Porosity

Sponges are like soil. The pores within the sponges are just like the pores within a soil. There are both large pores and small pores present and they drain just like macropores and micropores in a soil. There are three main moisture levels within a soil. They are:

*Saturation
This happens when all of the pores are full of water.

* Field Capacity
This happens when water is removed by gravity.
The soil is still wet. This is best for most plants.

*Permanent Wilting Point
This happens when all water has been removed EXCEPT for the water held tightly in the smallest pores.
Plants cannot remove water from the soil at this point.

Testing Porosity Lab

1. Run a porosity test on the sand and the clay.

Step 1
Fill two prepared cores; one with sand and one with clay. Do not pack the soil into the cores, but try to fill the cores keeping the soil loose.

Step 2
Pour 100 ml of water into each sample at the EXACT same time. Record that time.

Step 3
Wait for the water to drain, then record the time for each sample. After five minutes, measure the amount of water that drained from each sample.

Step 4
Record your results.

2. Run the porosity test on your unknown.

Soil Type	Start Time Drainage	Amount Water Drained
Sand		
Clay		
Unknown		
Home		

Urban Soils

Urban soils do not have horizons.

*The top layer has been removed
*Any subsequent layers have been mixed together

Urban soils have very little structure.

*Due to mixing and moving, the crumbs have been destroyed
*Compaction due to foot and vehicular traffic squashed the pores

Urban soils are sterile.

*Surface organic matter is removed
*Soil macro- and micro-organisms can not live in the destroyed soil

Urban soils have high pH.

*Due to concrete buildings and sidewalks, lime leaches into the soil
*Most plants prefer a neutral or slightly acidic pH for nutrient uptake

Focus: Compaction & Remediation

Name:

Soil compaction is one of the leading causes of tree death in urban areas. It is usually the result of construction and heavy traffic within the city. Compaction ruins the soil by destroying pores (especially macropores) and reducing structure.

Compaction of soil is not always a bad thing. In the case of construction sites and building foundations, the soil must be compacted to hold the weight of the structure without caving in. Unfortunately, the damage is usually spread beyond the actual site and becomes a problem for trees and other plants, not to mention animals and plants that live in the soil.

There are other negative effects of compacted soils within a city. Runoff is a huge problem. Water can not penetrate the soil surface and runs off taking contaminants (usually lawn pesticides) with it. Soil temperature is affected by the fact that water can not easily penetrate causing more damage to an already stressed ecosystem.

There are currently three ways to fix (REMEDIATE) a destroyed soil:

1. Replace it.
This is expensive and labor intensive. Most cities refuse to do this.

2. Cover it up.
This hides the problem but does not fix it. New problems will arise. Unfortunately, this is what most cities do.

3. Amend it.
By amending the soil you are actually attempting to bring it back to it's natural state. Amending a soil changes the physical and chemical properties and , if done properly, will allow the soil to begin to heal itself. Some cities are starting to do this.

Compaction Exercise:

1. Compact your samples

a. Proctor hammer simulates urban construction
b. Hands simulate pigeon feet
c. Stick or mallet simulates high heel shoes

2. Test for porosity

a. At the given time:
*Add 500 ml H_2O to sample. Record the time.
*Time how long it takes until the H_2O starts to drain.
*Record how much H_2O drained from each sample.

3. Test for Root Penetration

a. Use penetrometer
b. Try to push your finger through

4. Discussion and Results:

What did the compactive effort do to the soil?

What physical properties have you changed?

Will this affect the chemical properties?

What can be done to alleviate the problem?

Evaluation:

Please answer the following questions honestly and with some thought. The answers will help me fine-tune the unit for future students. Thanks!

Ask Yourself....

Did I learn anything NEW about soils?

Did I learn anything NEW about other aspects of science?

Will the knowledge I have gained from this unit benefit me in the "real world"? How?

Did I enjoy the unit?

Would I like to have more units like this one in the future? If yes, in what subjects?