Questions

• Do you have prior knowledge on soils, or is there anything in particular about soils that interest you?
• How relevant is a general knowledge of soils in your field of studies?

Agriculture and Soils

Urbanization and Soils
Urbanization in the USA

- Impervious surfaces alter the basic functions of soils:
  - Energy storage and exchange (“heat islands”).
  - Carbon sequestration (less vegetation).
  - Increase runoff (less infiltration).
- In the USA:
  - Population increases at a rate of 3 million/year.
  - $418 billion in construction spending.
  - About 6% of urban land was converted in the period from 1982 to 1997 (6,750 km²).

Area Covered With Turf Grasses

- According to Milesi et al. (2005), 1.9% of the surface area of the USA is covered with lawns (residential, industrial, and recreational). This area is 3 times larger than any single irrigated crop.
- In New Jersey, the estimated area covered with turf grasses is about 4,000 km² or 1% of surface of the State.

Concepts Related to Soils

- Soils as a:
  - Medium for plant growth
  - Weathered rock
  - Natural body
  - Construction material
  - Environmental Filter
Roles of Soil

- Supporting plant growth:
  - food production (agriculture)
  - recreation (golf greens)
- Recycling waste products:
  - nature
  - society
- Providing habitat for a large variety of organisms.
- Controlling flow of water.
- Construction material.

The Geological Cycle

Magma rises to the surface and solidifies.

The rock reaches the surface. Soil on the surface of the rock is non-existent or very thin.

Erosion wears away the rock.

Source: Singer and Munn. 1999. Soil: An Introduction

Geomorphologic Cycle

Source: Singer and Munn. 1999. Soil: An Introduction
Definitions

- Soil is “the unconsolidated mineral or material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.”
- Soil is “the unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of parent material, climate (including water and temperature effects), macro- and microorganisms, and topography, all acting over a period of time and producing a product—soil—that differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics.”

Introduction to Soils

- The soil as an open system.
- Soil morphology/composition.

Ecosystems and Soils

- An ecosystem is an aggregate of plants, animals, and microbes plus the environment in which they live.
- We only deal with finite ecosystems with arbitrary boundaries.
- Terrestrial ecosystems are those that include soil within their boundaries.
- Aquatic ecosystems do not include soil.
The Soil as an Open System

Mass and energy fluxes through a soil result in layers parallel to the soil surface: HORIZONS

Chatsworth, NJ

Eastern Montana, MT
Soils and Water, Spring 2006

Lecture 1: Introduction to Soils

Soils and Ecosystems


Soils and Ecosystems

Natural Color Mosaic of North America
Ecosystems

Source: The State of the Nation’s Ecosystems
(http://www.heinzctr.org/ecosystems/report.html)

Soil-landscape relationship

Gains < losses
Overview

• Soils exchange matter and energy with the surrounding environment, i.e., atmosphere, biosphere, hydrosphere, and lithosphere.
• The development of soil profile is determined by a balance (gains vs. losses) between input and output of matter and energy.
• Concepts to remember: horizons, soil profile.

Soil Description

Soils are described by exposing a vertical plane and describing various features for each horizon.
Soil Morphology

- Soil morphology can be studied at different scales

Concept of Soil Structure

- Structured: "blocky"
- Structureless
- Tilled soil
Soil Structure

Figure 4.25 in Element of the Nature and Properties of Soils. (Diagram courtesy of R. Weil).

Granular

Blocky
Soils and Water, Spring 2006

Lecture 1: Introduction to Soils

Platy

Prismatic

Structureless

• Single grain
• Massive
Where in the Profile?

- Air
- Water
- Mineral
- Organic

An ideal soil is only 50% solid material!

Volume Percentages of Soil Components

<table>
<thead>
<tr>
<th>Comp.</th>
<th>Vol. cm$^3$</th>
<th>Dens. g/cm$^3$</th>
<th>Mass g</th>
<th>% total mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Water</td>
<td>25</td>
<td>1.0</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Min.</td>
<td>45</td>
<td>2.65</td>
<td>108</td>
<td>80</td>
</tr>
<tr>
<td>Org.</td>
<td>5</td>
<td>0.5</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>total</td>
<td>100</td>
<td>0.5</td>
<td>135.5</td>
<td>100</td>
</tr>
</tbody>
</table>
Soils are porous material composed of solid (i.e., mineral and organic matter) and pore space. The pore space contains either air or water. Concepts to remember: soil aggregates, soil particles.
Soil Composition: Minerals

<table>
<thead>
<tr>
<th>Property</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size range (mm)</td>
<td>2.0-0.05</td>
<td>0.05-0.002</td>
<td>&lt;0.002</td>
</tr>
<tr>
<td>Surface activity</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
</tbody>
</table>

Soil Composition

- Soil organic matter
  - includes living and nonliving macro and microorganisms.
  - great influence in the physical, chemical, and biological soil properties.
  - **Humus** is stable organic material that has been transformed by soil microorganisms.
  - Microorganism population is very diverse. It is estimated that about 4000 different bacterial species can be found in a gram of soil.

- Air
  - several times more concentrated in CO₂ than atmospheric air.
  - amount and composition of soil air determined mainly by soil water content and biological activity.

- Soil solution
  - the soil solution (a.k.a. soil water) contains a large amount of dissolved substances.
  - soil water is the major transport agent of substances in the soil.