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Text
There is no Lab Manual. Lab instructions will be posted in the course web site.

• Web site:
  - http://envsci.rutgers.edu/courses/index.shtml
    (follow the link “Soils and Water”).
• Grades:
  - Homeworks  10%
  - Assignments 20%
  - Final Exam   25%
  - Final Project 20%
  - Laboratory  25%

Questions
• How do societies benefit from soils?
• What is the difference between soil and dirt?

THE FAMILY CIRCUS

"Dirt is what is left after earth was removed from it."

Lecture 1: Introduction to Soils
Concepts Related to Soils

- Medium for plant growth: *production of food and fibers*
- Construction material
- Environmental Filter
- Other uses:
  - Medicinal: pharmaceutical, treat gastrointestinal disorders, soils are a source of antibiotics (e.g., *streptomycin*)

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.
Soils and Societies

• Societies greatly depended on soils for their development.
• Perception changed when the population of industrialized countries concentrated in cities: soils became a nuisance associated to diseases and death (“Dirt, Disease, and Death”).
• Today’s perception about soil is negative overall. The roots for this can be traced to the nature of soils as well as to cultural issues.

Agriculture and Soils

Urbanization and Soils
Urbanization in the USA

- Impervious surfaces alter the basic functions of soils:
  - Energy storage and exchange ("heat islands").
  - Reduce carbon sequestration (less vegetation).
  - Increase runoff (less infiltration).
- In the USA:
  - Population increases at a rate of 3 m/year.
  - $418 billion in construction spending.
  - About 6% of urban land were 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 18% of the surface of the State.


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
Geomorphic Cycle

Definition

• 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.”

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.
Soils and Water, Spring 2008

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 2008

Soils and Ecosystems


Soils and Ecosystems


Natural Color Mosaic of North America

Source: http://visibleearth.nasa.gov/
Soils and Water, Spring 2008

Ecosystem Distribution (USA)

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

Soil Types (USA)
Soil-landscape relationship

Gains < losses

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

- O: Zone of maximum activity
- E: Eluviation (washing out)
- B: Zone of accumulation (illuviation)
- C: Zone of minimum activity
Soil Morphology

- Soil morphology can be studied at different scales

![Soil Morphology Diagram](image)

Concept of Soil Structure

- Structured: "blocky"
- Structureless
- Tilled soil

![Concept of Soil Structure Diagram](image)

Soil Structure

![Soil Structure Diagram](image)

*Figure 4.25 in *Elements of Nature and Properties of Soils* (Diagram courtesy of R. Weil).*
Prismatic

Structureless

• Single grain

• Massive

Where in the Profile?
Soils and Water, Spring 2008

Lecture 1: Introduction to Soils

An ideal soil is only 50% solid material!

Volume Percentages of Soil Components

<table>
<thead>
<tr>
<th>Comp.</th>
<th>Vol. cm³</th>
<th>Dens. g/cm³</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>17</td>
</tr>
<tr>
<td>Min.</td>
<td>45</td>
<td>2.65</td>
<td>119.3</td>
<td>81.3</td>
</tr>
<tr>
<td>Org.</td>
<td>5</td>
<td>0.5</td>
<td>2.5</td>
<td>1.72</td>
</tr>
<tr>
<td>total</td>
<td>100</td>
<td>---</td>
<td>146.8</td>
<td>100</td>
</tr>
</tbody>
</table>

Concept of Soil Structure

- Soil Aggregates
- Tilled soil
- Structureless
- Structured "blocky"
Overview

- Soils are porous material composed by 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 micro organisms.
  – 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.

Soil Composition

• 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.