5.1 Introduction to Soil Systems

IB ESS
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Thinking Routine: See, Think, Wonder

• Look at the following images.
• For each image write down what you see.
• Then write down what you think.
• Now write down what you wonder.
See, Think, Wonder
See, Think, Wonder
See, Think, Wonder
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Significant Ideas

✓ The soil system is a dynamic ecosystem that has inputs, outputs, storages, and flows.
✓ The quality of soil influences the primary productivity of an area.
Knowledge & Understandings:

✓ The soil system may be illustrated by a soil profile that has a layered structure (horizons).
✓ Soil system storages include organic matter, organisms, nutrients, minerals, air and water.
✓ Transfers of material within the soil including biological mixing and leaching (minerals dissolved in water moved through the soil) contribute to the organization of the soil.
✓ There are inputs of organic material including leaf litter and inorganic matter from parent material, precipitation and energy. Outputs include uptake by plants and soil erosion.
Knowledge & Understandings:

✓ Transformations include decomposition, weathering, and nutrient cycling.

✓ The structure and properties of sand, clay, and loam soils differ in many ways, including: mineral and nutrient content, drainage, water-holding capacity, air spaces, biota and potential to hold organic matter. Each of these variables is linked to the ability of the soil to promote primary productivity.

✓ A soil texture triangle illustrates the differences in composition of soils.
Application & Skills

✓ Outline the transfers, transformations, inputs, outputs, flows, and storages within soil systems.
✓ Explain how soil can be viewed as an ecosystem.
✓ Compare and Contrast the structure and properties of sand, clay, and loam soils, with reference to a soil texture diagram, including their effect on primary productivity.
What is Soil?

• Soil is a complex mixture of
  • Eroded rock
  • Mineral nutrients
  • Decaying organic matter
  • Water
  • Air
  • Billions of living organisms (DECOMPOSERS!!)
Why is Soil Important?

- Ultimately responsible for all the food we consume.
- Provides all nutrients for producers
- Habitat for many organisms
- Filters water
- Recycling nutrients (home to many decomposers and detritivores) so that chemical cycles can occur
What is Soil Made Of?

- **Rock Particles** – from parent rock material
  - Made of gravel, sand, silt, clay, and chalk
  - Contains minerals

- **Humus** - Organic matter made from the decomposition of living things
  - Results in nutrients and minerals returning to soil
  - Absorbs and retains water

- **Water** – held in spaces between soil
  - Dissolves minerals and allows movement through soil and uptake by plants (rapid movement of mineral salts can lead to salinization)
  - Too much water can lead to anoxic conditions and acidification

- **Air** – held in soil grains
  - Well aerated soil provides oxygen for soil organisms and plant roots

- **Soil Organisms** – mostly invertebrates but can be things such as moles
  - Break down large particles (detritivores)
  - Decompose – recycling minerals and nutrients
  - Mix and aerate soil (eg moles, prairie dogs, naked mole rats)
How Does Soil Form?
How Does Soil Form?

Very Slow Process

1. Weathering of rock (mechanical)
2. Deposition of sediments by erosion (mechanical)
3. Decomposition of organic matter (chemical)
## System Diagram

- Construct a system diagram of the following data:

<table>
<thead>
<tr>
<th>Storages</th>
<th>Organic matter, organisms, nutrients, minerals, air, and water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfers within soil</td>
<td>Biological mixing (organism living in soil mix nutrients &amp; minerals in with organic matter), translocation (movement of soil particles in suspension,</td>
</tr>
<tr>
<td>Inputs</td>
<td>Organic material including leaf litter, inorganic matter from parent rock, precipitation, energy</td>
</tr>
<tr>
<td>Outputs</td>
<td>Uptake by plants, soil erosion</td>
</tr>
<tr>
<td>Transformations</td>
<td>Decomposition, weathering, nutrient cycling</td>
</tr>
</tbody>
</table>
Soil Horizon (Layers/Profiles)

- **O - (Organic)** Ecosystem litter, organic matter (humus), soil organisms (bacteria, fungus, etc)
- **A – (Topsoil)** Mixture of partially decomposed organic matter
- **E – (Subsurface)** depleted organic matter & clay
- **B - (Subsoil)** Nutrients leached, clay and minerals such as iron, & aluminum compounds
- **C – (parent material)** loose rocks
- **R – Bedrock**
Soil Profiles Vary by Ecosystem
Soil Particles

Smallest
Clay < 0.002 mm in diameter
Silt 0.002 – 0.05 mm in diameter
Sand 0.05 – 2 mm in diameter

Largest
• **Soil Texture** is determined by the relative amounts of the different types and sizes of mineral particles
• If fairly equal portions of each soil are present the soil is said to be a loam
• Soil texture affects the fertility and primary productivity of an ecosystem
Soil Texture Triangle
Determining Soil Texture

- Rub Soil between finger:
  - Sandy soils fall apart easily
  - Silty soils feel slippery and hold together
  - Clay soils feel thick and sticky, can be formed into shapes

- To determine the soil proportions you can dry out a soil sample and pass through mesh of different sizes (2mm, then 0.05 mm then 0.002 mm)
Soil Permeability

- The rate at which air and water can flow from upper layers of soil to lower layers of soil
- Clay: particles are small, have low permeability and lock minerals in place so makes inaccessible to plants
- Sand: has large pore space which allows drainage but may allow minerals to leach through the soil.
- Loam soils are ideal for agriculture because they have good permeability and have good nutrient content
Acidification of Soils

- Acid precipitation due to industrial pollution has increased the acidity of many soils near urban areas.
- Clay soils often have high acidity due to the absorption of water.
- Acidified soil causes leaching of potassium, magnesium and ammonium (removing these minerals from the ecosystem).
- A decrease in pH causes aluminum and iron to become more available to plants which is toxic to most plants, especially evergreen plants which lose their needles.
Soil Sustainability

• Fertile Soil is a non-renewable resource – it takes a LONG time for soil to form

• Fertile soil has enough nutrients (nitrates, phosphates, and potassium NPK) for healthy plant growth.

• Nutrients are leached from soil as water is moving through

• Nutrients are also lost when crops are harvested

• To replace nutrients, chemical fertilizers are often used

• More sustainable methods of replacing nutrients include crop rotation, planting legumes, and using organic fertilizers (compost, manure)
HOMEWORK

Read pp. 237-243
To Do Box pp. 243-244