



Introduction to Soil

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Topic 1: Soils and their significance



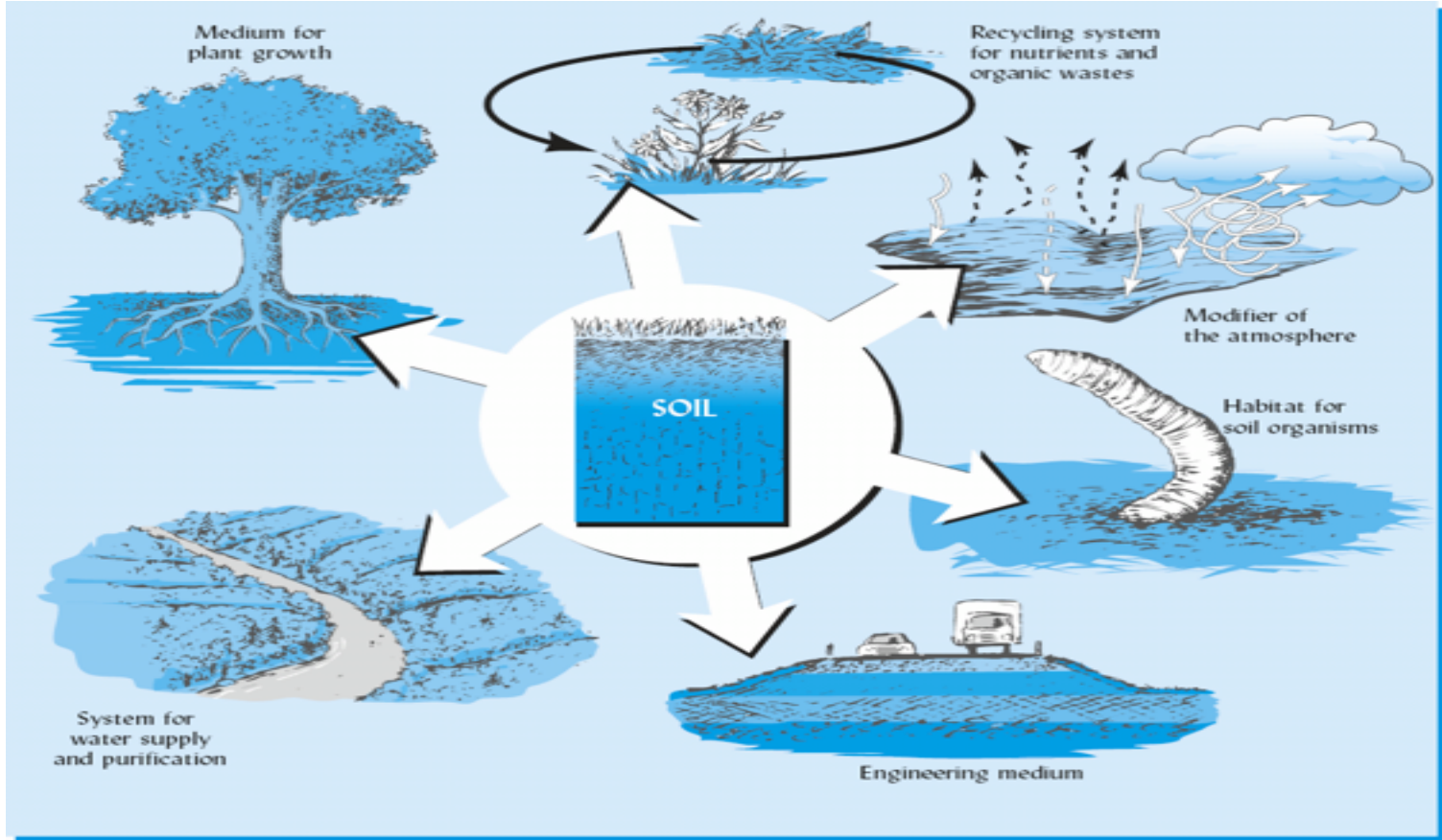
Soils are crucial to life on Earth
Soils supply us with nearly all of our food

Soils are also used to grow biomass
for fuels and manufacturing-
becoming increasingly important





Soils serve many functions



Which can be grouped **into six crucial ecological roles**

What do plants obtain from the soil?

- Physical support
- Air
- Water
- Temperature moderation
- Protection from toxins
- Nutrient elements

Soil as a media for plant growth: **Physical support**

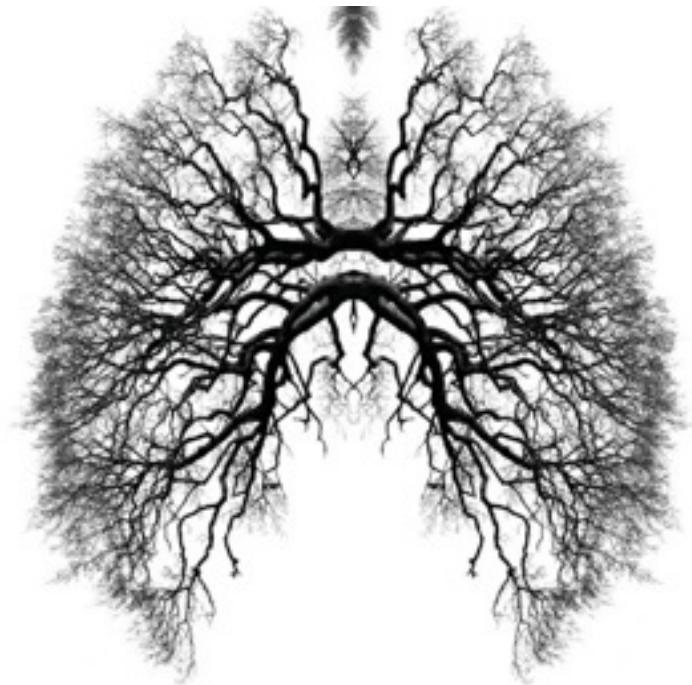


Plants require appropriate soil for proper anchoring

Soil as a media for plant growth:

Air

- **Roots require Oxygen** for respiration
- **Soil must provide adequate ventilation**
 - CO₂ needs to escape and O₂ needs replenishing
 - Accomplished through networks of soil pores

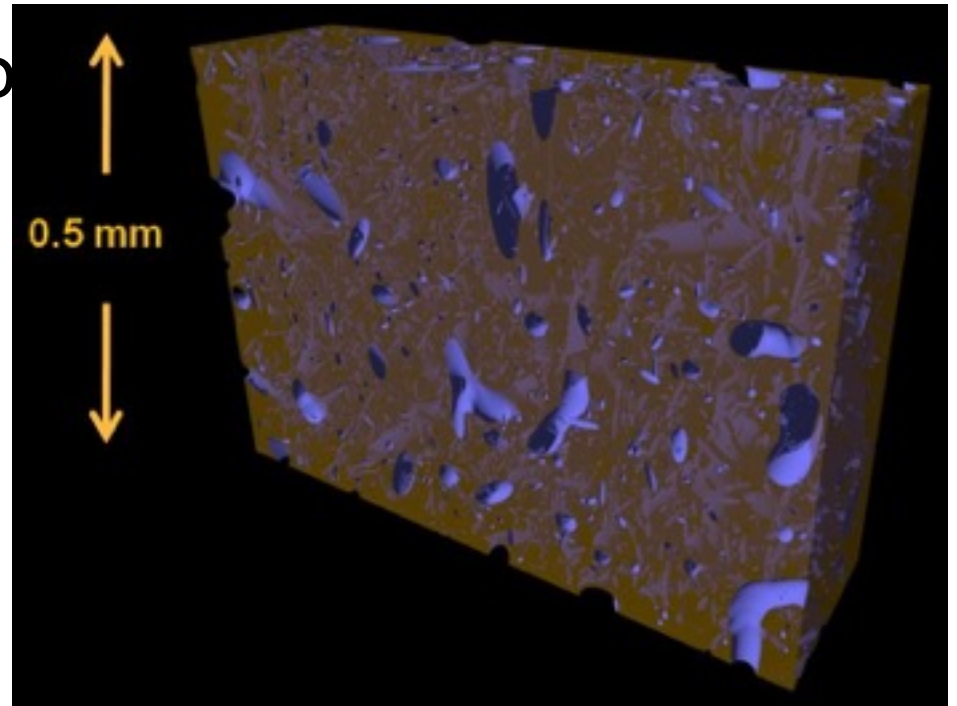


B R E A T H E

Soil as a media for plant growth:

Water

- Soil pores also absorb and store water
- Plants need a continuous supply of water for adequate growth



Soil as a media for plant growth: **temperature moderation**

- Insulating properties of soil protect roots from extreme temperature fluctuations



Soil as a media for plant growth: protection from toxins

- Phytotoxic substances (those toxic to plants)
 - Result from human activity or produced by:
 - Plant roots, microorganisms, natural chemical reactions
- Soils can ventilate gases, decompose or adsorb organic toxins, and suppress toxic producing organisms

Soil as a media for plant growth: nutrient elements

- Fertile soils provide continuous and balanced supply of dissolved mineral nutrients that optimize plant growth
- Of 92 naturally occurring elements:
 - 17 are known as **essential elements**, meaning they are required for plant growth and development:

Macronutrients: **CHOPKNSCa**

and

Micronutrients: **CuZnMoFeClBMnNi**

Essential elements and source

Table 1.1

ELEMENTS ESSENTIAL FOR PLANT GROWTH AND THEIR SOURCES^a

The chemical forms most commonly taken in by plants are shown in parentheses, with the chemical symbol for the element in bold type.

Macronutrients: Used in relatively large amounts (>0.1% of dry plant tissue)		Micronutrients: Used in relatively small amounts (<0.1% of dry plant tissue)
Mostly from air and water	Mostly from soil solids	From soil solids
Carbon (CO ₂)	Cations:	Cations:
Hydrogen (H ₂ O)	Calcium (Ca ²⁺)	Copper (Cu ²⁺)
Oxygen (O ₂ , H ₂ O)	Magnesium (Mg ²⁺)	Iron (Fe ²⁺)
	Nitrogen (NH ₄ ⁺)	Manganese (Mn ²⁺)
	Potassium (K ⁺)	Nickel (Ni ²⁺)
		Zinc (Zn ²⁺)
	Anions:	Anions:
	Nitrogen (NO ₃ ⁻)	Boron (H ₃ BO ₃ , H ₄ BO ₄ ⁻)
	Phosphorus (H ₂ PO ₄ ⁻ , HPO ₄ ²⁻)	Chlorine (Cl ⁻)
	Sulfur (SO ₄ ²⁻)	Molybdenum (MoO ₄ ²⁻)

^a Many other elements are taken up from soils by plants but are not essential for plant growth (see Epstein and Bloom, 2005).

Difference between macro- and micronutrients??

Soil as a regulator of water supplies

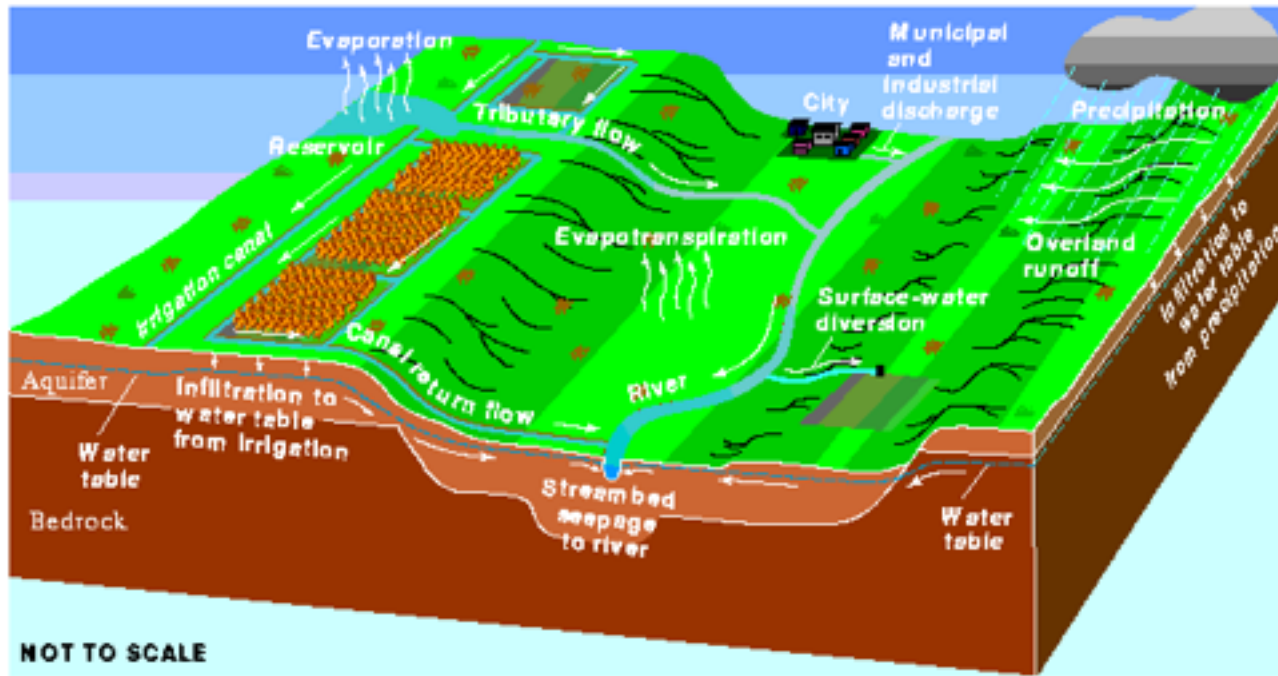
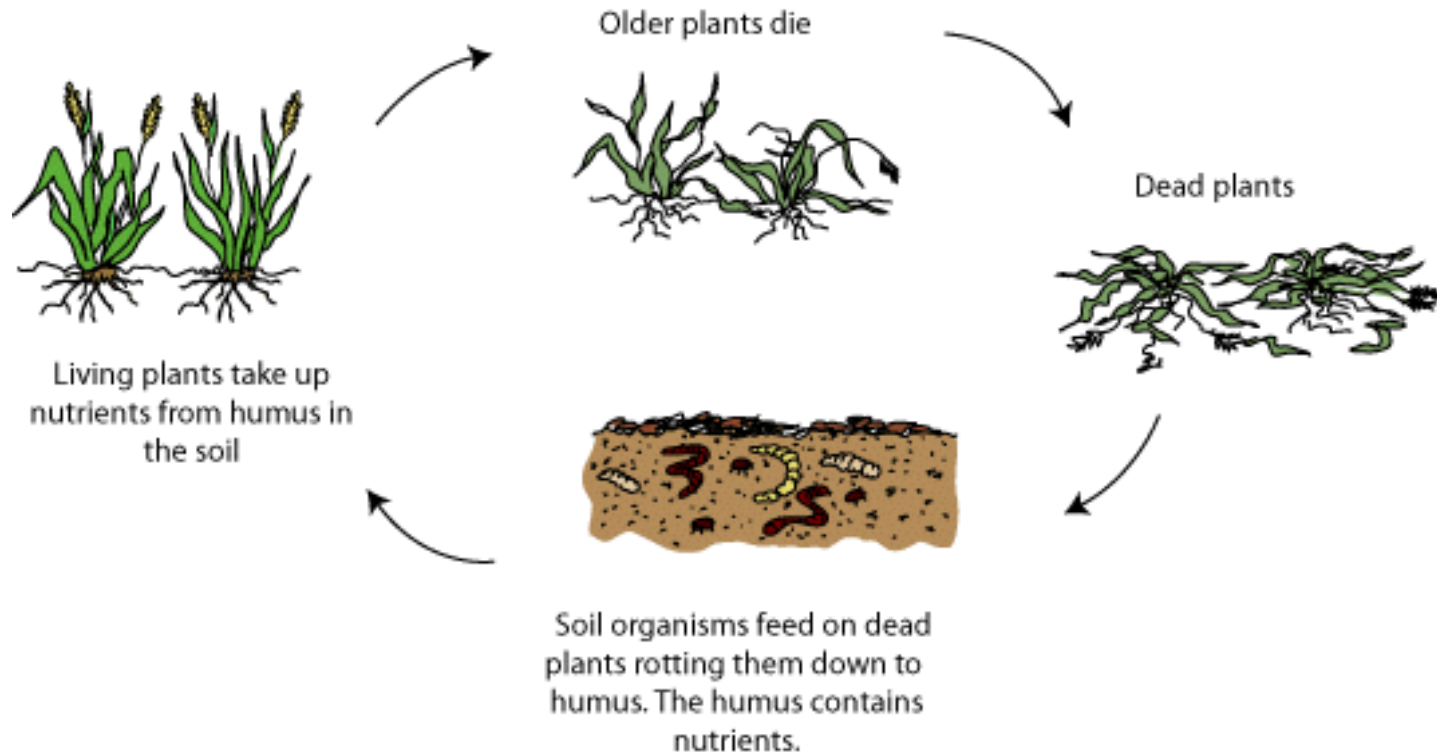


Figure 3. Components of flow in the study area.

As water travels across landscapes, it moves through soil, and it is purified and cleansed by soil processes

Soil as a recycler of raw materials



Recycling of once-living biomass (plant and animal residues) is a critical on-going and cyclical process

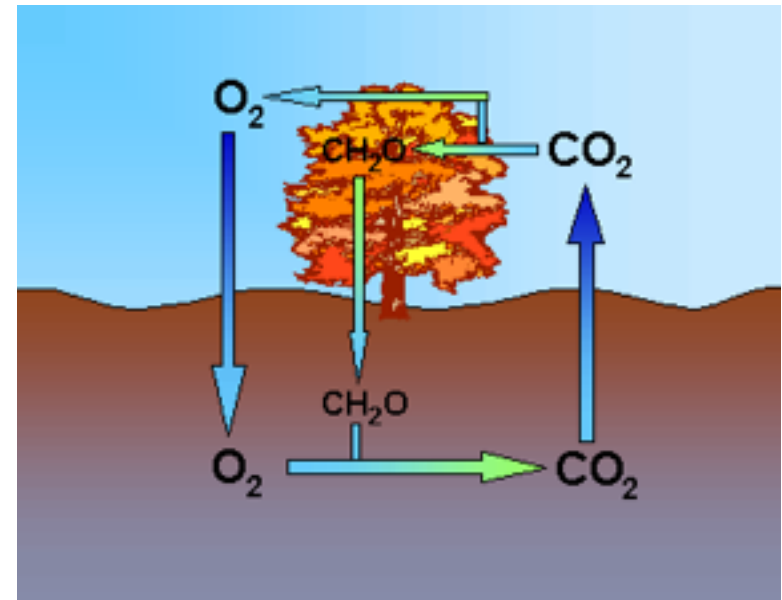
Soil as a modifier of the atmosphere

Soil as dust in the wind



How would we avoid this?

Soil exchanges gases w/
atmosphere



How might soil accumulate Carbon?

Evaporation serves as a major source of atmospheric water vapor

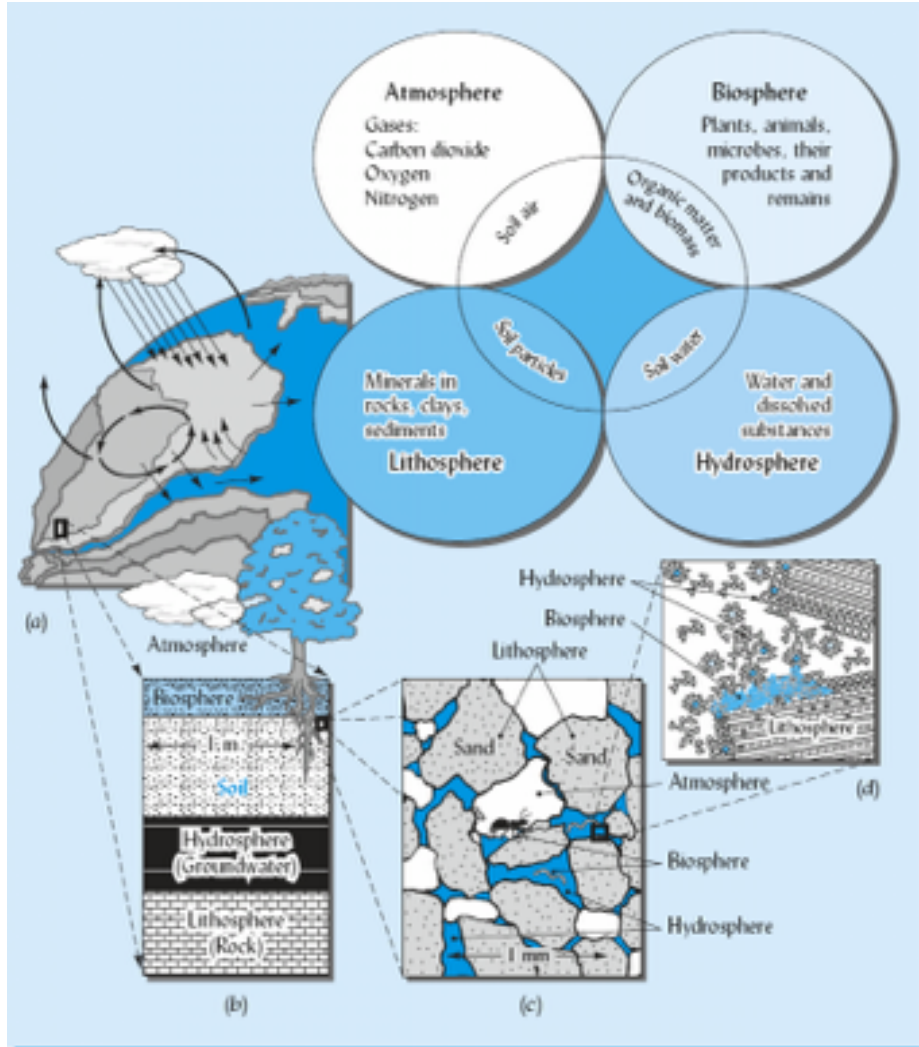
Soil as engineering medium



Nearly half of all people in the world live in soil constructed houses

When used in modern construction, requires detailed knowledge of soil properties

Soils can represent different things at different scales



- A) Kilometer scale
 - Global cycles / ecosystems
- B) Meter scale
 - Soil layer boundaries
- C) millimeter scale
 - Pore space
- D) micrometer scale
 - Charges and reactive surfaces of minerals

Soil, the soil, a soil, soils... what's the difference?

Soil as a material

- ***Soil*** is a material composed of: minerals, gases, H₂O, organic substances, microorganisms
(***what some may call dirt***)

Soil as natural bodies

- A ***soil*** is a 3-D natural body, like a lake or mountain is
- ***The soil*** is the collection of these *different* soil bodies, comprising the terrestrial skin of the earth
- ***Soils*** are natural bodies composed of soil *plus* roots, animals, rocks, artifacts, etc.