



Soil

APES 2011

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Soil is what allows for life.

- ~ Key component of Earth's natural capital
- ~ Supplies most nutrients needed for plants growth
- ~ Purifies and stores water
- ~ Removes CO₂ from atmosphere (climate control) and storing as carbon compounds

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What is soil?

- ~ Complex mixture:
 - ~ Eroded rock
 - ~ mineral nutrients
 - ~ decaying organic matter
 - ~ water
 - ~ air
 - ~ billions of organisms (mostly decomposers)

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How is it created?

- ~ Weathering - slow process of breaking down bedrock by physical, chemical, and biological processes

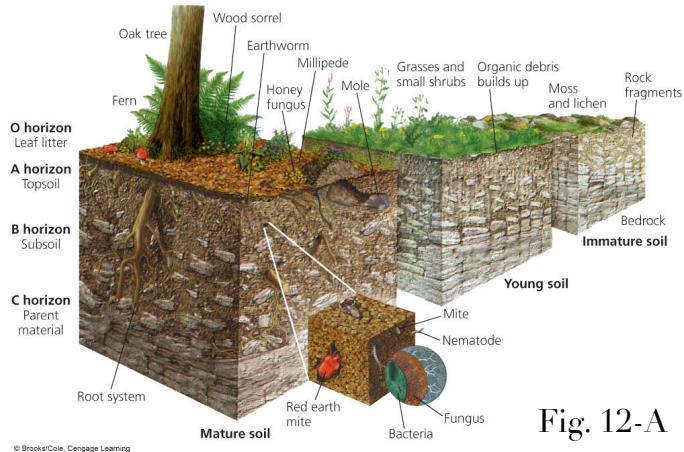


Fig. 12-A

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Mature Soils

- ~ Soils that have developed over a long period of time and contains layers
- ~ Horizons - layers of a mature soil
 - ~ Each horizon has a distinct texture and composition that varies with different types of soils

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Horizons

- ~ O horizon (organic layer)
- ~ A horizon (topsoil)
- ~ B horizon (subsoil)
- ~ C horizon (parent material)

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Upper Layers

- ~ O horizon and A horizon
- ~ Where roots of most plants and most organic matter exists
- ~ High levels of bacteria, fungi, earthworms, small insects
- ~ Bacteria and other decomposers found by billions in top layers
- ~ Humus - porous mixture of partially decomposed bodies of dead plants and animals
- ~ Contains inorganic molecules (clay, silt, sand)
- ~ These factors working together allow for retaining moisture

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Lower Layers

- ~ B horizon and C horizon
- ~ Contains mostly inorganic matter (broken down rock with mixtures of sand, silt, clay, and gravel)
- ~ Water transports inorganic materials from the upper layers which is often stopped by the bedrock (parent material)

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Pores

- ~ Spaces between the solid organic and inorganic particles that contain air (nitrogen and oxygen) and water
- ~ Roots need oxygen for cellular respiration
- ~ Pores act as a sponge for water in soils where plant roots anchor the soil

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Renewable Resource?

- ~ Can be renewed
- ~ TAKES A VERY LONG TIME
 - ~ This means it can be depleted
- ~ One centimeter of mature soil can take hundreds of years to form, but can be destroyed in an instant

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Soil Erosion

- ~ Movement of soil components from one place to another by actions of wind and water (flowing water is the greatest contributor)
- ~ Can be natural or caused by human activities
- ~ Roots of plants help to anchor soil. This causes soil to not be lost faster than it is formed.
- ~ Humans impact this by destroying natural biodiversity
 - ~ Monoculture farming, clear-cut logging, over-grazing, off-road vehicle use

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Concerns

- ~ Estimates are that a third of cropland is losing soil faster than new soil forms
- ~ Saharan Africa - dust-storms are now commonplace
- ~ At least 862 million people try to survive on soils suffering from erosion

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Global Soil Erosion

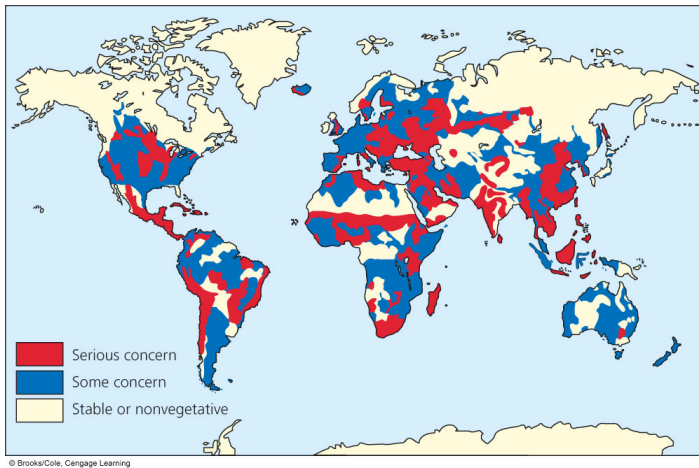


Fig. 12-11

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Soil Erosion Harmful Effects

- ~ Loss of soil fertility (depletion of nutrients)
- ~ Water pollution because of soil sediment
 - ~ Even worse when eroded soil contains fertilizers and pesticides

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Desertification

- ~ Protective potential of soil is reduced by 10% or more because of drought and human activities that reduce topsoil
- ~ Moderate - 10-25% drop in productivity
- ~ Severe - 25-50% drop
- ~ Very Severe - more than 50% drop
- ~ Only creates deserts in extreme cases, but can expand existing deserts
- ~ Drylands used for agriculture are threatened by desertification (mostly in Africa and Asia)
- ~ Climate change is expected to lead to prolonged drought and increase desertification

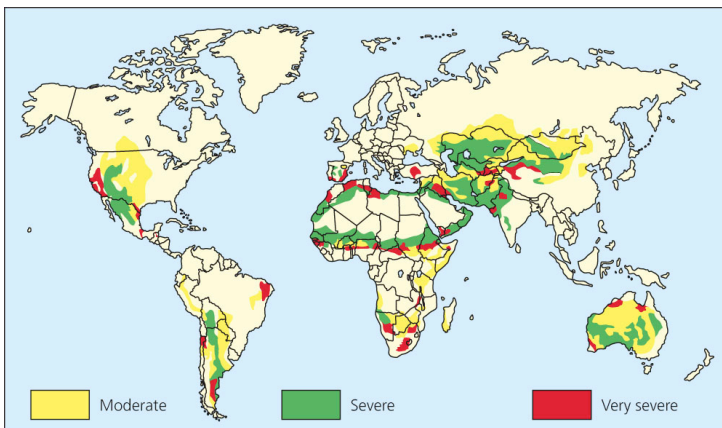
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Desertification



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Fig. 12-13

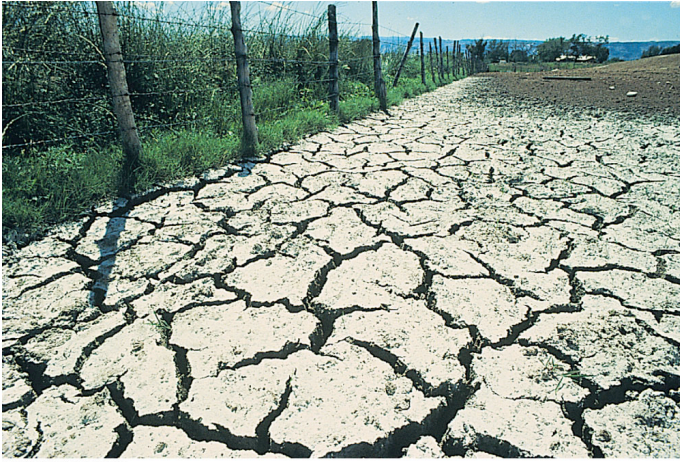
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Irrigated Lands

- ~ Amount of irrigated land has tripled in about 60 years which has increased food production
- ~ Salinization - Irrigated water is a dilute solution of salts picked up as the water flows. Water that is not absorbed leaves a salt crust on the soil that accumulates.
 - ~ Stunts crop growth
 - ~ Lowers crop yields
 - ~ Eventually kills plant life
 - ~ Happens mostly in China, India, Middle East
 - ~ Also affects one-fourth of US irrigated croplands

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Salinization



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Waterlogging

- ~ Water accumulates underground and gradually raises the water table
- ~ This can cause salt to envelop roots, lowering productivity and eventually killing the plants

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SOLUTIONS

- ~ Reduce Soil Erosion
- ~ Restore Soil Fertility
- ~ Reduce Soil Salinization

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Reduce Soil Erosion

- ~ Soil Conservation - using a variety of ways to reduce erosion and restore fertility mostly by keeping the ground covered with vegetation

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Methods



(a) Terracing



(b) Contour planting and strip cropping



(c) Alley cropping



(d) Windbreaks

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Methods

- ~ Terracing - grow vegetation on steep slopes without depleting topsoil
 - ~ Broad, nearly level terraces
 - ~ Controls runoff



(a) Terracing

Fig. 12-24

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Methods

~ Contour Planting

- ~ Used when the ground has a significant slope
- ~ Planting crops in rows across the slope
- ~ Each row acts as a dam to hold topsoil and slow runoff



(b) Contour planting and strip cropping
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Fig. 12-24

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Methods

- ~ Strip Cropping - plant alternating strips of a row crop (such as corn or cotton) and a cover crop that covers the soil (alfalfa, clover, rye...)



Fig. 12-25
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Methods

- ~ Alley Cropping (agroforestry) - crops planted in strips between trees and shrubs

- ~ Provides shade that reduces water loss to evaporation
- ~ Retains and slowly release soil moisture



(c) Alley cropping
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Methods

- ~ Windbreaks (shelterbelts) - trees around crop fields to reduce wind erosion

- ~ Trees retain soil moisture, supply wood for fuel, increase crop productivity (5-10%), habitats for birds and pest eating insects



(d) Windbreaks
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Conservative-Tillage Farming

- ~ Special tillers and planting machines that drill seeds through crop residues to undisturbed soil
 - ~ Can increase crop yields (usually requires some herbicides)
 - ~ Reduces climate change by storing more carbon in the soil
 - ~ Lowers use of water and fuel

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U.S. Soil Erosion

- ~ One third of topsoil is gone and much of the rest is degraded (loses topsoil 17 times faster than it is formed)
- ~ Poor farming practices and prolonged drought caused the "Dust Bowl"
- ~ 1935 - Soil Erosion Act - Established the Soil Conservation Service (now called the Natural Resources Conservation Service)
- ~ 1985 - Food Security Act (Farm Act) - Farmers participating in Conservation Reserve Program receive a subsidy for not using highly erodible land and planting topsoil saving grasses and trees (cut soil loss by 40%)
- ~ Recently farmers have stopped doing this because corn subsidies are so lucrative

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Restore Soil Fertility

- ~ Soil needs to be conserved (best way to save it)
- ~ If conservation is not possible, plant nutrients that have been washed, blown or leached away need to be restored
- ~ Organic fertilizers - from plants and animal wastes
- ~ Commercial organic fertilizers - produced from minerals
- ~ Commercial inorganic fertilizers - contain nitrogen, phosphorus, and potassium
 - ~ nutrient runoff can pollute bodies of water
 - ~ do not replace organic matter

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Organic Fertilizers

- ~ animal manure - improves soil structure, adds organic nitrogen, stimulates beneficial bacteria and fungi
- ~ green manure - freshly cut green vegetation that is plowed into the topsoil to increase organic matter and humus
- ~ compost - when microorganisms in soil break down organic matter in the presence of oxygen

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Reduce Soil Salinization

SOLUTIONS

Soil Salinization

Prevention

Reduce irrigation

Switch to salt-tolerant crops (such as barley, cotton, and sugar beet)

Cleanup

Flush soil (expensive and wastes water)

Stop growing crops for 2-5 years

Install underground drainage systems (expensive)

Fig. 12-28

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Reducing Desertification

- ~ Can not control droughts caused by natural factors
- ~ What can help:
 - ~ Control population
 - ~ Reduce overgrazing and deforestation
 - ~ Sustainable farming
 - ~ Planting trees and anchor grasses