



Soil and its most important problems:

erosion and pollution of the soil

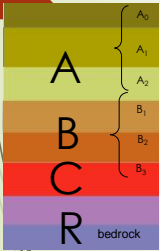
What is soil?

- solid earth material that has been altered by physical, chemical and organic processes so that it can support rooted plant life
- engineering definition: anything that can be removed without blasting
 - part of the natural environment: ensures the circulation of materials
 - natural resource: in close contact with wildlife and constantly renewed if this process is not disturbed by anything
 - the soil condition and the process of soil conversion may change due to anthropogenic effects, which may be temporary or permanent, favorable or unfavorable

- these different horizons are not the result of geological structure, but the result of chemical processes in the soil

- the thickness of the different horizons varies, from a few centimeters to a few meters
- in any particular soil there may be more or fewer and in some soils horizons are not easily distinguished at all



- soils vary according to the rock from which they derived
- this affects
 - the size of their mineral grains, ranging from coarse sand (600-2000 μm) to silt (2-60 μm) and clay (less than 2 μm)
 - their chemical characteristics

Distribution of major soil types in the world

The central unit is the soil type grouping soils that were believed to have developed under similar soil forming factors and processes. The major soil types are the highest category which groups soils based on climatic, geographical and genetic bases.

The soil map and the main soils of Hungary according to WRBare

The current Hungarian Soil Classification System (HSCS) was developed in the 1960s, based on the genetic principles of Dokuchaev.

Soil is

- a living, dynamic system with organic and inorganic components
- a product of its environment and parent material

Components: by volume

- 45% mineral
- 5% organic material
- ~ 50% space (air/water)

By mass?

- air
- 18% water
- 80% mineral
- 2% organic material

©The COMET Program

Factors of soil formation

- climate**
temperature and precipitation, indirect controls (e.g., types of plants), rate of weathering
The greater the rainfall amount, the more rapid the rate of both weathering and erosion
- parent material:** material on and in which soil develops
- organisms
- topography
- time

Factors of soil formation

- climate
 - parent material
 - **organisms**
 - topography
 - time
- living (primarily decomposers): forms of life
 - Earthworms
 - Insects
 - Bacteria
 - Fungi
 - Other organisms

decomposer activity depends on:

- climate: vegetation, litter (amount type), rate of decomposition (hot, wet, cold, dry)
- soil moisture conditions: hot, wet preference of decomposers (respiration, nutrient recycling)
- micro-environmental factors (relief, drainage): slope aspect affects temperature, drainage affects anaerobic/aerobic decomposition

Factors of soil formation

- climate
 - parent material
 - organisms
 - **topography**: ground slope, elevation, aspect (e.g., north facing vs. south facing slopes)
 - time
- the steeper the surface slope, the more likely any eroded material is to be transported out of the system
 - soils on hillslopes reach an equilibrium thickness, often about 1 m

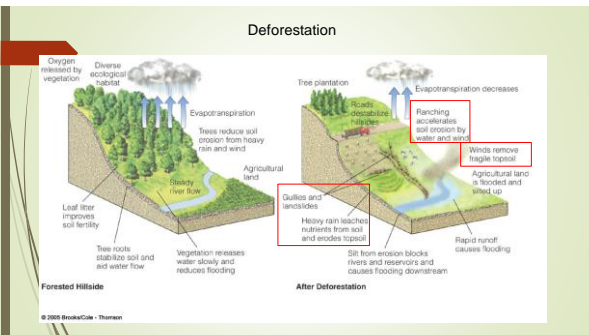
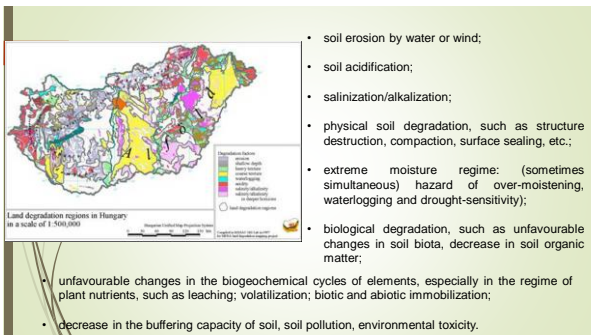
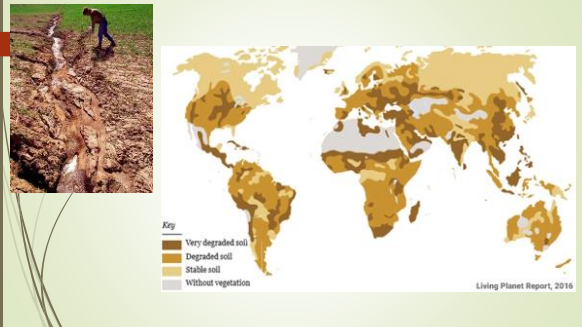
Factors of soil formation

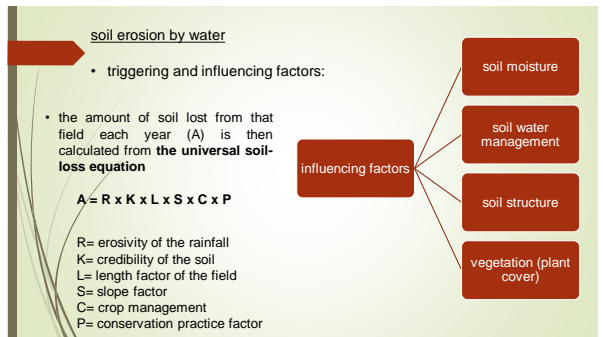
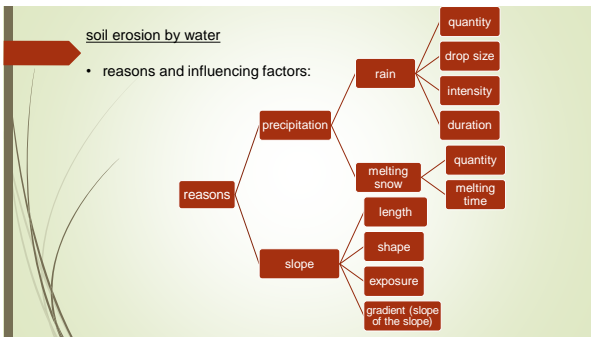
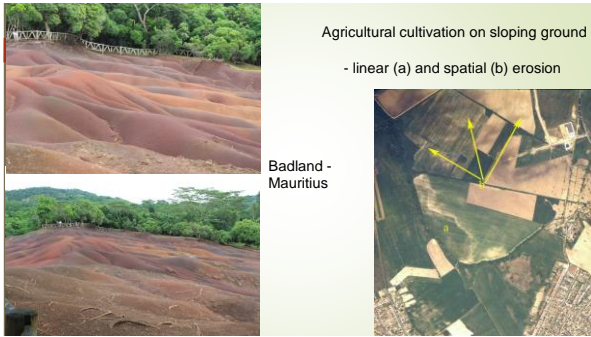
- climate
 - parent material
 - organisms
 - topography: ground slope, elevation, aspect (e.g., north facing vs. south facing slopes)
 - **time**
- development and destruction of soil profiles
 - typical reaction rates are slow, the longer a rock unit has been exposed, the more likely it is to be weathered

Forms of soil damage

1. **soil destruction / degradation:** water, wind and ice and a combinations of these factors – decrease in fertility, destruction of soil

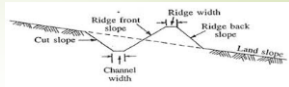
- geological degradation (natural): low speed, the effects can be noticed later
- accelerated soil destruction (human): deforestation, overgrazing, water and wind erosion caused by improper field cultivation, effects occur within a short time



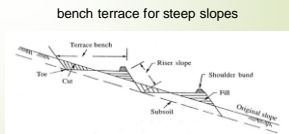


Defense options:

- change the slope parameters (length and slope)



broad-based terrace for shallow slopes



bench terrace for steep slopes

soil protection through crops and agricultural cultivation:

- the correct choice of cultivation branch: grapes of fruit growing on slopes than 25%, over 40% forests
- contour ploughing, in which the plough follows the contours of the land, produces parallel furrows oriented at right angles to the slope
- planting trees (alley), shrubs and bushes for soil protection



Coastal destruction of intensively cultivated areas



erosion by wind – deflationary processes

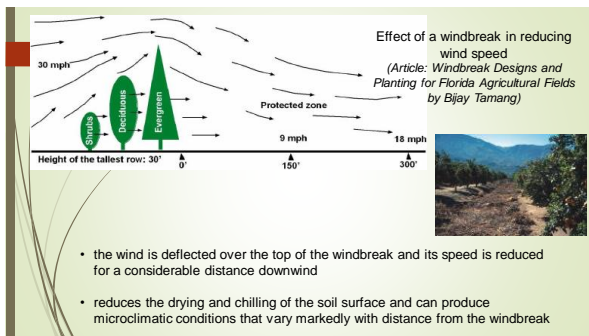
- causes – wind speed and whirling motion of wind

Influencing factors:

- grain composition of soil
- soil structure
- soil organic matter content
- terrain properties (eg. soil surface moisture, length of area affected by wind erosion, surface vegetation cover)



- damage caused eg.:
 - decrease in fertility
 - „sand beating“



secondary salinisation

- by the incorrect irrigation
 - use poor quality, high salt water – salt accumulates on the soil surface
 - high salinity groundwater levels increase as a result of over-irrigation

soil cover by human activity

- as urbanization increases, the proportion of built-up area increases

improper tillage

- soil uses in agriculture
 - cropland
 - grazing land
 - forest
- agriculture depends on soil to grow food, fiber, and ornamental plants
- problems:
 - improper machine cultivation
 - inadequate soil moisture regulation
 - inadequate organic matter management
 - overuse

Challenges for Sustainable Agricultural Production and Farming Systems

- abundant food insecurity (FAO, 2006)
- demand for food will increase (Evans, 2009, and others)
- unsustainable use of natural production factors such as soil, biological diversity and water (Pimentel et al., 1995; FAO, 2003)
- 60 % of ecosystem services are degraded (Millennium Ecosystem Assessment, 2005)
- intensive agriculture is depends on high energy but could be energy self-reliant and could mitigate GHG emission considerably (Smith et al., 2007)
- agriculture is insufficiently prepared to cope with unpredictability and adaptation to climate change (Lobell et al., 2008)

Main challenge "increased productivity of agriculture in a SUSTAINABLE MANNER"

- 70% of the world's poor live in rural areas
- widespread subsistence production in isolated and marginal locations with low levels of technology
- widespread food insecurity in spite of sufficient food being produced at global level food
- thus.....



Organic principles may contribute to a valuable framework for a future sustainable agricultural production!

Niels Halberg & Lise Andreasen
International Centre for Research in
Organic Food Systems

Soil degradation and food security

- soil degradation
 - erosion
 - compaction
 - crusting and salinization
 - nutrient mining
 - loss of soil organic matter
-
- food security
 - yield reduction
 - efficiency of input use reduced
 - micro nutrient deficiency



Need for paradigm shift in land husbandry and in principles and practices for soil management (R. Lal, Food Security journal, 2009)

Nonagricultural uses of soil

- recreation: playgrounds, sports fields, jogging paths, golf courses, parks, campgrounds
- foundations: buildings have to have solid base
- waste disposal
- building materials

2. Soil pollution

- soil pollution is defined as the presence of materials in the soil which are harmful to the living beings when they cross their threshold concentration levels



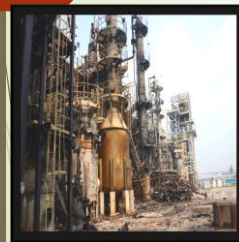
- soil contamination or soil pollution is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment
- contamination is correlated with the degree of industrialization and intensity of chemical usage
- in North America and Western Europe that the extent of contaminated land is best known
- developing countries tend to be less tightly regulated

Causes of soil pollution

- corrosion of underground storage tanks
- application of pesticides and fertilizers
- mining
- oil and fuel dumping
- disposal of coal ash
- leaching from landfills
- direct discharge of industrial wastes to the soil
- drainage of contaminated surface water into the soil

Human influence

- soil pollution starts with the flawed concept of throwing trash on the side of a road and throwing out your dustbin on the road
- besides the tons household plastic, industrial dumping of man-made chemicals is also done
- not just restricted to developing countries, but highly developed and advanced countries as well
- agricultural advancement has also played a part in laying many a green pastures barren



- **soil is a non-renewable resource** with more potential to degrade
- most countries have very little control over soil pollutant dumping
- in U.S. alone, millions of tons of chemical waste is being dumped in the soil and sea, and spewed in air resulting in long-term adverse implications on life in general
- developed and developing countries have now put a major legal framework and clean-up program in place, to deal with soil pollution

Soil pollution solutions

- reduction of acid rain: sulfur dioxide emissions can cause acid rain and forest destruction
- reduce waste
- consider the amount of needlessly generated waste
- improve agriculture
- wetland restoration
- help restore polluted wetlands
- reduction of human impact

„How do you see it...?“

Arman-Kazakhstan: it is necessary **to develop appropriate laws and regulations, programmes and related activities** and to take measures to prevent rapid land degradation, desertification and deterioration of the environmental situation, and to start to restore soil fertility

Adel-Kazakhstan: I believe that to avoid the aftermath of soil erosion, **the government should tighten the laws** regarding the soil use

Boniface-Kenya: The government **needs to take a strong stand** regarding environmental conservation. Politicizing every issue is a common practice in Kenya, but **strict punishment should be enacted into law** for those found guilty of obstructing environmental conservation laws.

Nyambayar-Mongolia: parliament approves a lot of laws, but **the implementation of new laws is very poor**

Zhang_Sicong: ...with the acceleration of urbanization, **the urban area has become larger and larger**. And the land she cultivated **has been constantly adjusted by developers and the government**, and the area is getting smaller and smaller.

Ibrahim-Jordan: ...**the prevailing poverty of the people** that is forcing dryland farmers and herders **increasingly to adopt non-sustainable land use practices to produce more food in order to meet their needs**

...**insufficient knowledge of the socio-economic contexts**, incorrect identification of the causes of arid land problems and ineffective management of natural resources

Nyambayar-Mongolia: (amendments to the Law on Sanitation were approved) new requirements and standards should have been followed to implement the newly amended version of the law, **but people struggling to make a living are finding it very difficult to follow the new standards for buying new sanitation facilities and other equipment**

Food and Agriculture Organization of the United Nations -

<http://www.fao.org/home/en/>

- <https://www.youtube.com/watch?v=invUp0SX49g>

This animated film tells the reality of soil resources around the world, covering the issues of degradation, urbanization, land grabbing and overexploitation; the film offers options to make the way we manage our soils more sustainable.

Learning:

http://www.sze.hu/~radicsa/Dr_Kozma_Katalin/Environmental_protection/

presentations and a book to learn from:

Michael Allaby: Basics of Environmental Science, pp.1-135.