1 **Introduction to Environmental Geology, 5e**
Chapter 17
Soil and Environment

2 **Weathering: summary in haiku form**
Rocks brought to surface
decompose to sediment
and that's weathering.

3 **Case History: Times Beach, MO**
- River town with a population 2,400, west of St. Louis
- In 1983, the town evacuated and purchased by government for $36 million
- Entire town contaminated with dioxin from the oil sprayed on the road to control dust
- Dioxin: Composed of oxygen, hydrogen, carbon, and chlorine, extremely toxic to mammals and being a carcinogen in humans; about 75 types of dioxin
- Controversy concerning the effects of human exposure to dioxin, the evacuation an overreaction?

4 **Soil**
- Supporting plant life: Solid earth materials altered by physical, chemical, and biological processes
- Land-use planning: Soil suitability is large part of land capability and limitation
- Waste disposal: Soil properties are critical
- Impact of natural hazards: Affected by soil properties
- Climatic signal: Clues for the past climate

5 **Soil Profile**
Figure 17.3a

6 **Soil's General Properties**
- Color: Depending on the amount of organic matter, iron oxides, and soil water retention
- Texture: Relative proportions of sand, silt, and clay-sized particles, affect soil's strength and ability to retain water and nutrients
- Structure:
  - Aggregates of soil as peds
  - The more developed with time, the more complex a soil's structure, from granular to blocky to prismatic

7 **Soil Texture**
Figure 17.4

8 **Soil Structure**
Figure 17.5

9 **Soil Profile Development**
- A weakly developed soil profile: *A* horizon directly over a *C* horizon (no *B* horizon or it is very weakly developed), relatively young few hundreds to a few thousands years old

- A moderately developed soil profile: *A* horizon overlying an argillic B_t horizon that overlies the *C* horizon, from at least the Pleistocene (more than 10,000 years old)
- A well-developed soil profile: Redder colors in the B_t horizon, more translocation of clay to the B_t horizon, and stronger structure, may have *K* horizon; older than 40,000 years

10 **Soil Fertility**

- Soil's capability to supply nutrients needed for plant growth, such as N, P, K
- A complex ecosystem in itself, containing millions of living things in a single cubic meter
- Fertility changes
  - Increase: Applying fertilizers or mixing materials to improve soil texture
  - Decrease: Leaching or soil erosion

11 **Soil Water**

- Soil pores filled with air or liquid
- Soil in saturated condition if filled with water; otherwise unsaturated
- The saturation level of soil water changes with climate (hardly saturated in arid climate) and seasons (deficit versus surplus conditions)
- Movement of water: Important in pollution monitoring and management

12 **Soil Taxonomy**

- Soil classification based on physical and chemical properties of the soil profile
- Unified soil classification system: Widely used in engineering practice, based on particle size, abundance of organic material, and odor
- Useful for agricultural, environmental engineering, and land use planning
- Sixfold hierarchy, with soils grouped into Orders, Suborders, Great Groups, Subgroups, Families, and Series

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Table 17.1

14 **Engineering Properties of Soils (1)**

- Strength: Soil's ability to resist deformation, function of cohesive and frictional forces between soil particles
- Sensitivity: Measuring the changes in soil strength from disturbances
- Compressibility: Soils tendency to consolidate or decrease in volume

15 **Engineering Properties of Soils**

Table 17.3a

16 **Engineering Properties of Soils**

Table 17.3b

17 **Engineering Properties of Soils (2)**

- Erodibility: The ease with which soil is removed by wind or water
- Hydraulic conductivity: The ease of water to allow water to move through

-
- Corrosion potential: Depending on the chemistry of soil, water content of soil, and the type of buried materials in the soil

18 **Engineering Properties of Soils (2)**

- Ease of excavation: The degree of ease to remove soil using certain equipment during construction
-
- Shrink-swell potential: Soil's tendency to gain or lose water
  - Expansive soils: Causing significant environmental problems in the United States
  - Changes in moisture content
  - Topography and drainage also significant

19 **Soil Strength**

- Soil strength: The ability of a soil to resist deformation
-
- Function of cohesive and frictional forces
-
- Cohesion due to surface tension caused by the attraction of water molecules to each other at the surface or between soil grain
-
- The total frictional force is a function of the density, size, and shape of the soil particles and of the weight of overlying particles that force the grains together, usually the result of both cohesion and internal friction and vegetation

20 **Rates of Soil Erosion**

- Volume, mass, or weight of soil removed from a specific area during a specific period of time, kilograms per year per hectare
-
- The Universal Soil Loss Equation: A = RKLSCP
  - A: Long-term average annual soil loss for the site
  - R: Long-term rainfall runoff erosion factor
  - K: Soil erodibility index factor
  - L: Hill slope/length factor
  - C: Soil cover factor
  - P: Soil erosion-control practice factor

21 **Soil Erosion**

- Urbanization: Rapid development and construction
-
- Desertification: Over-grazed or disturbed
-
- Deforestation: Forest over-logged or burned
-
- Surface mining: In 2000, 65 percent coal produced from surface mining
-
- Soil erosion and deposition by natural hazards, such as floods

22 **Sediment Pollution Problem**

- Sediment: One of the greatest pollutants
-
- Choking the waterways, burying vegetation, causing dust storms
-
- Adverse impact on water and air quality, land productivity
-
- Preventive measures

  - Conservation practices: Better land-use and urban development planning, sediment control basins

23 **Sediment Control Basin**

Figure 17.14

24 **Land-Use and Soil Problems (1)**

- Influencing the pattern, amount, and intensity of surface-water runoff, erosion, and sedimentation
- Agriculture: Estimated 10 percent of the world best agricultural land damaged due to soil erosion and overuse of soil during the last 50 years
- Better practice to sustain soils
  - Contour plowing
  - No-till agriculture (no plowing)
  - Terracing slopes, retaining walls for steep slopes
  - Planting more than one crop, particularly in tropical areas

25 **Land-Use and Soil Problems**

Figure 17.15

26 **Land-Use and Soil Problems (2)**

- Urbanization: Conversion of agricultural, forest, and rural lands
- Soil scraped off and lost
- Changes of soil properties
- Soil pollution: Use of chemicals
- Changes of surface runoff, sediment yield, and stream dynamics affecting soil and soil erosion

27 **Land-Use and Soil Problems (3)**

- Off-road vehicles: Recreation, tourism, etc.
- In deserts, coastal dunes, forested mountains
- Cause changes in rates of soil erosion, hydrology, habitats of plants and animals
- Impacts from the increased number of mountain bikes in parks, national forests, etc.

28 **Soil Pollution**

- Soil pollution: By any materials detrimental to human and other living organisms, such as organic chemicals, inorganic chemicals, toxic substances
- Intentionally or accidentally applied to soils
- Inappropriate disposal of waste materials
- Treatment: excavation, disposal, incineration, and bioremediation

29 **Bioremediation of Polluted Soil**

Figure 17.22

30 **Soil Survey and Land-Use Planning**

- Soil survey: Providing important information about soils

- Soil properties: Critical for the best use of land; specific soils suitable for certain land use
- Soil's engineering properties: Necessary info for identifying potential problems before construction
- Detailed soil maps: Helpful and important in land use planning

Critical Thinking Topics

- Defend the statement that soil erosion is an environmental problem that could seriously damage, or even cause the collapse of, our civilization.
- What are things an individual citizen can do to prevent soil erosion?
- Does the impact of soil erosion go beyond where it occurs? Explain your answer
- Are the soil problems more severe in developed countries or developing countries?

Chapter 17 figures follow…

68
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76