Soil: Foundation of Forest Ecosystems

• Objectives
  – Overview of soils as the foundation for forest ecosystems and their management
    • Soil development and formation
    • Physical properties of soils
    • Chemical properties of soils
    • Biological properties of soils

  – First: thoughts, insights or questions from the reading assignment
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• Soils & Forest Management
  – Soils are a major determinant of site productivity
    • Soils largely determine forest growth & management
  – Forest management often on low fertility sites
  – Adverse vs. beneficial management activities
  – Soil stability, compaction, roads, etc.
  – SOM, nutrients, and soil chemistry
  – Soil temperature

One of the essential education requirements for foresters… must surely be a sound working knowledge of soils (Kimmins 2004).
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- Soil Composition

土壤成分比例图
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- Soil Development

Soil development = \( f(\text{climate}, \text{parent material}, \text{topography}, \text{biota}, \text{time}) \)
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- Soil Formation

Soil formation = $f(\text{development, erosion, deposition})$
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- Parent material
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• Climate
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- Topography
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• Biota
  – Physical weathering (plant roots)
  – Chemical weathering (carbonic acid)
    • $\text{H}_2\text{O} + \text{CO}_2 \leftrightarrow \text{H}^+ + \text{HCO}_3^- \leftrightarrow \text{H}_2\text{CO}_3$
  – Productivity $\rightarrow$ organic matter quantity and quality
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- Time
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- Soil Profile Development
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- Soil Physical Properties
  - Texture
  - Structure
  - Bulk density
  - Water-holding capacity
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- Soil Physical Properties - Texture

Clay: <0.002mm
Silt: 0.002 – 0.02mm
Sand: 0.02 – 2.0mm
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• Soil Physical Properties - Structure
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- Soil Physical Properties – Bulk Density
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• Soil Physical Properties – Water Holding Capacity (WHC)
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• Soil Chemical Properties
  – Redox potential
  – pH
  – organic matter content
  – Ion exchange capacity (CEC and AEC)
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- Soil Chemical Properties - pH
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- Soil Chemical Properties - Organic Matter
Soil Chemical Properties - CEC & AEC

**CEC:** $\text{Al}_{3}^{+} > H^{+} > \text{Ca}_{2}^{+} > \text{Mg}_{2}^{+} > K^{+} \approx \text{NH}_{4}^{+} > \text{Na}^{+}$

**AEC:** $\text{PO}_{4}^{3-} > \text{SO}_{4}^{2-} > \text{Cl}^{-} > \text{NO}_{3}^{-}$
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- Soil Biological Properties
  - (1) Roots; (2) Microflora (bacteria, archaea, fungi, actinomycetes); (3) Microfauna (nematodes, protozoa); (4) Macrofauna (earthworms, rodents)
    - Microbially mediated transformations (C, N, S, P, etc.)
    - Mixing of soil layers
    - Rhizosphere processes
    - Symbioses (Mycorrhizae, N-fixation)
    - Soil-borne pathogens
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