Soil Properties influencing Erodibility

- Soil Properties that influence detachment and runoff
  - Texture
  - Structure
  - Aggregation
  - Density/compaction
  - Wettability
  - Antecedent soil moisture
  - Organic Matter

Texture

- Sandy soils
  - Sands are easily detacted
  - However, sand particle require the most energy for transport
  - Sandy soils also have low runoff

Texture (Cont.)

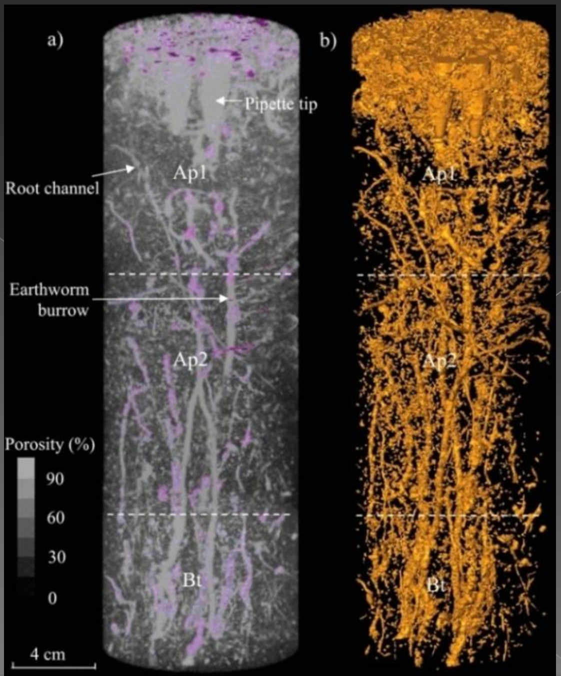
- Clayey soils
  - Well aggregated clays require tremendous energy for detachment
  - Clays produce high runoff
  - Once detached they can be transported long distances

Texture (Cont.)

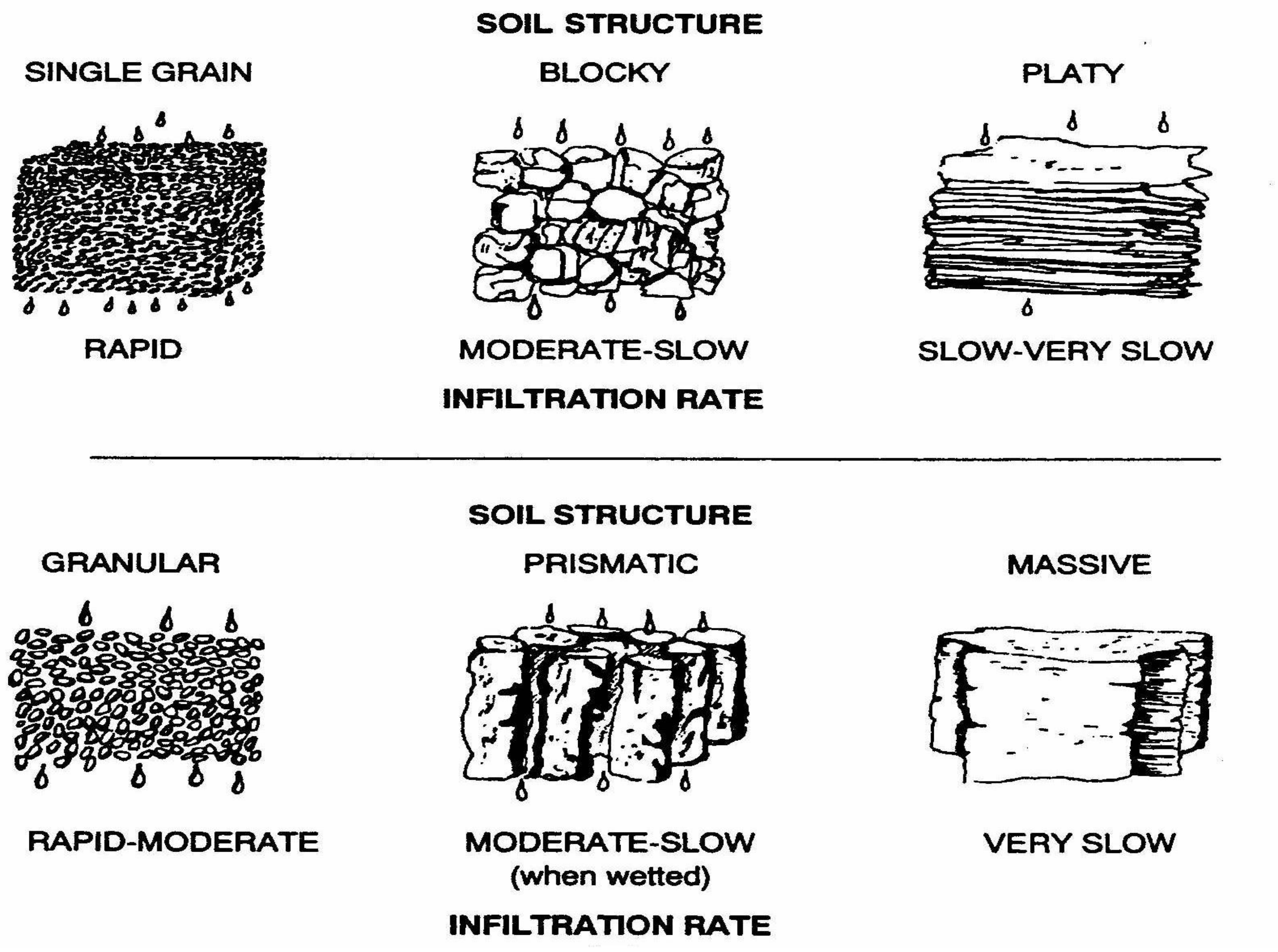
- Silty soils
  - Easily detached and transported
  - Very silty soils can have poor structure and low permeability causing rapid runoff, adding to the problem.
  - Sitly soils are the most erodible!

Soil Structure

- Soil Structure describes the arrangement of sand, silt, and clay particles
- Structure influence the macroporosity of a soil.
- Macropores are larger than 75 μm and allow for differential flow of water



Soil Structure



Crusting (Surface Sealing)

- Results from raindrop impact and dispersion of surface
- Clay particles move down and plug macropores or off in runoff
- Layers of sand and silt are left at the surface
- In clayey soils the crust will contain sufficient clay to crack or peal upon drying

Crusting (Surface Sealing)

- Dramatically decrease infiltration
- A soils susceptibility to crusting is influences by texture, sodium content, organic matter, and crop residue
- Prevention of crusts is the first soil quality improvement resulting from no-till

Aggregate Stability

- Ability of aggregate to resist applied force.
- Stable aggregates resist dispersion and crusting
- A function of
  - Texture (clays are most stable)
  - organic matter content (increasing OM increases stability)
  - CEC (high CEC = high stability)
  - cementing agents increase stability
  - Tillage decreases stability
  - Sodium decreases stability

Density/Compaction

- Compaction results in a decrease in the size and/or number of macropores
- All else being equal, high density or compacted soils are more prone to erosion due to increased runoff

Wettability

- The ability of a soil to absorb water
- Coatings of organic matter can cause soils to repeal water
- Moderate water repellency is beneficial because it reduces slaking and increases aggregate stability
- High repellency increases runoff, resulting in increased erosion

Slaking

- The breakdown of large, air-dry soil aggregates (>2mm) into smaller microaggregates (<0.25mm) when they are suddenly immersed in water.
- Internal stresses caused by rapid water intake cause aggregates to explode
  - Differential swelling of clay, rapid release of heat, escaping air, mechanical action of moving water
- Video

Antecedent Moisture

- Runoff will be initiated faster on wet soils
- Less kinetic energy is required to detach particles from a saturate soil compared to a soil at field capacity
- However, slaking of dry soils will cause dispersion and rapid detachment.
- Can influence runoff from small rainfall events
- Usually not significant during intense events

Soil Organic Matter

- Plant and animal tissues in various stages of decomposition
- Important in the development and persistence of stable aggregates
- Provides three forms of binding agents
  - Temporary
  - Transient
  - Persistent

Temporary agents

- Consist of plant roots, mucilages, mycorrhizal hyphae, bacterial cells and algae
  - Enmesh mineral particles
  - Important in the prevention of compaction

Transient Agents

- Consist of polysaccharides and organic mucilages exuded from plants and through microbial processes
- Important for microaggregation
- Must be continuously supplied through decomposition or organic residues.

Persistent Agents

- Highly decomposed humic compounds
- Found inside microaggregates forming clay-humic complexes
- Important for microaggregation

Surface residues

- Addition and/or maintenance of surface residues protects the soil surface from the bombardment of rainfall
- Also, concentrates organic matter near the surface to provide benefits to the surface

Modeling Water Erosion

- Important to understand the process of erosion
- Allows for the identification of appropriate management to reduce erosion
- Provides estimates of on and off-site impacts
- Allows for assessment of erosion control efforts

Water Erosion Models

- Empirical models
  - Universal Soil Loss Equations (USLE)
  - Revised USLE (RUSLE)
  - Modified USLE (MUSLE)
- Processed based models
  - Water Erosion Prediction Project (WEPP)
  - Ephemeral Gully Erosion Model (EGEM)

Universal Soil Loss Equation

- Predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, crop system and management practices
- Predicts Sheet and Rill erosion on a single slope
- Developed for cropland but can be useful for construction sites
- Used to compare soil loss to "tolerable soil loss" rates (T value)

Universal Soil Loss Equation

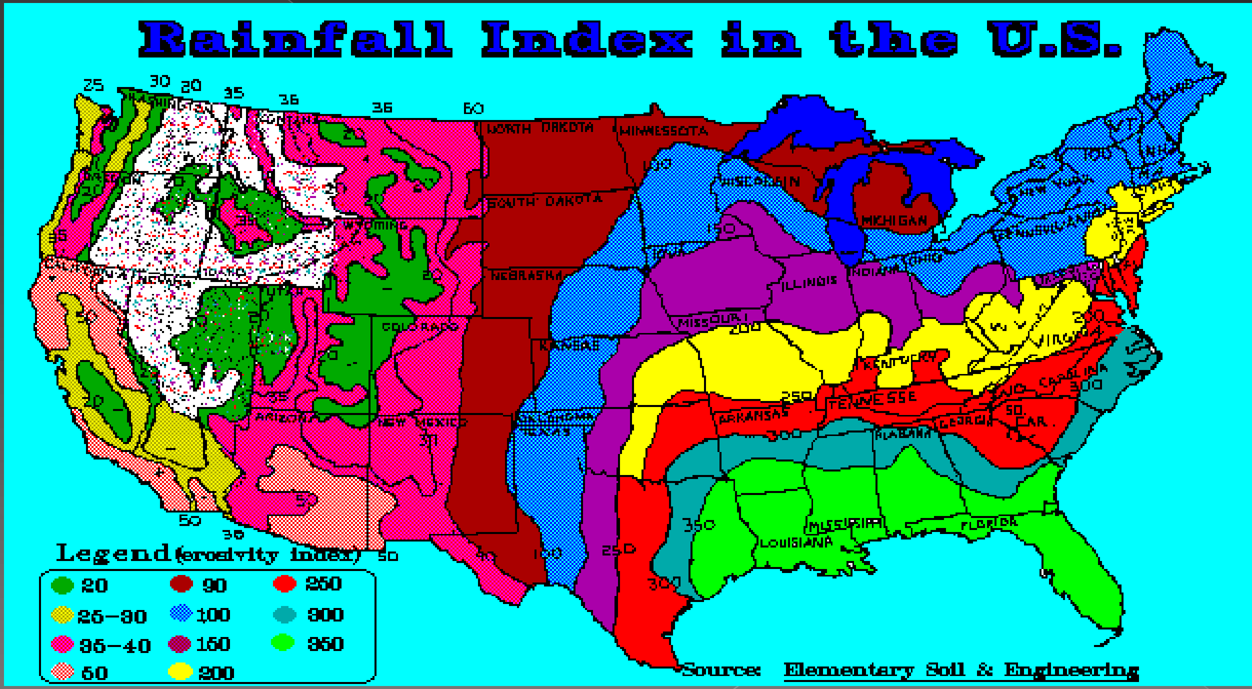
- Can not be used to:
  - Estimate nutrient and soil loss on watershed or field-scale basis (does not provide edge of field loss)
  - Estimate soil loss on an event or daily basis
  - Estimate interrill, rill, gully, or streambank erosion
- Is very useful to understand the process affecting erosion
- Useful for comparing consequences of management options

Universal Soil Loss Equation

- A=R x K x LS x C x P
  - A=average soil loss (Tons acre-1)
  - R=Rainfall and runoff factor (100s of ft-tons/acre-yr)
  - K=soil edibility factor, Soil loss per unit of rainfall erosivity from bare fallow on a 9% slope 72.6ft long (Tons of soil/100 ft-tons of rainfall)
  - LS=Slope length and steepness factor (dimensionless)
  - C=Cover-management factor (dimensionless)
  - P= Supporting practice factor (dimensionless)

R Factor (Rainfall and Runoff Erosivity)

- Dependent on the energy and intensity of rainstorms
- 4000 location-years of rainfall records were analyzed to provide iso-erodent map of U.S.



K Factor (Soil Erodibility)

- Inherent erodibility of soil
- Rate of soil loss on a standard plot
  - 9% slope, 72.6 ft long, kept fallow with periodic tillage up and down slope
- Many were obtained from small plots using a rainfall simulator
- Extrapolated to all soil mapping units based on soil survey data

LS Factor (Slope Length and Steepness)

- Ratio of soil loss expected per unit area from a particular slope condition compared to what would occur on a 9% slope 72.6 ft long.

C Factor (Cover Management)

- Corrects soil loss for differences in residue cover and crop type
- Incorporates difference in the growth pattern and canopy geometry of different crops
- Developed from thousands of plot-years of runoff and soil loss data.

P Factor (Supporting Practices)

- Incorporates influence of special practices such as:
  - Contour cultivation
  - Contour strip cropping
  - Terraces are not included in USLE. They only influence the length of slope