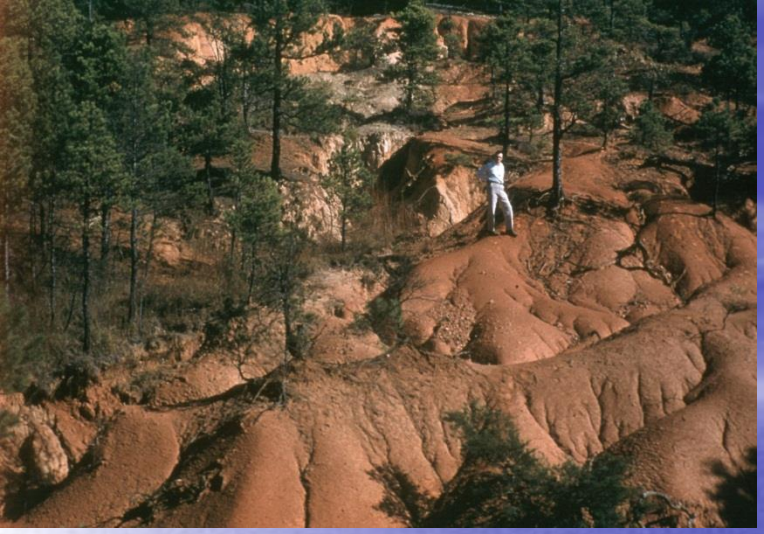
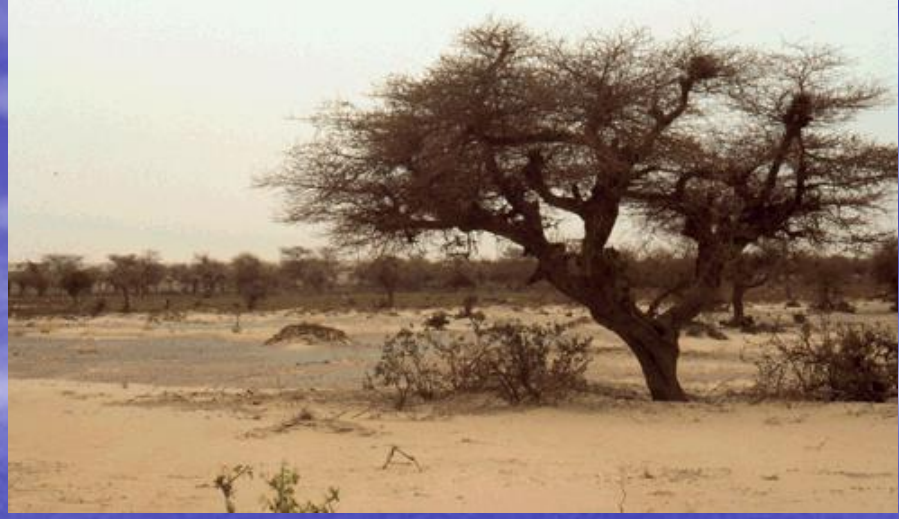




# SOIL EROSION AND ITS CONTROL

# INTRODUCTION

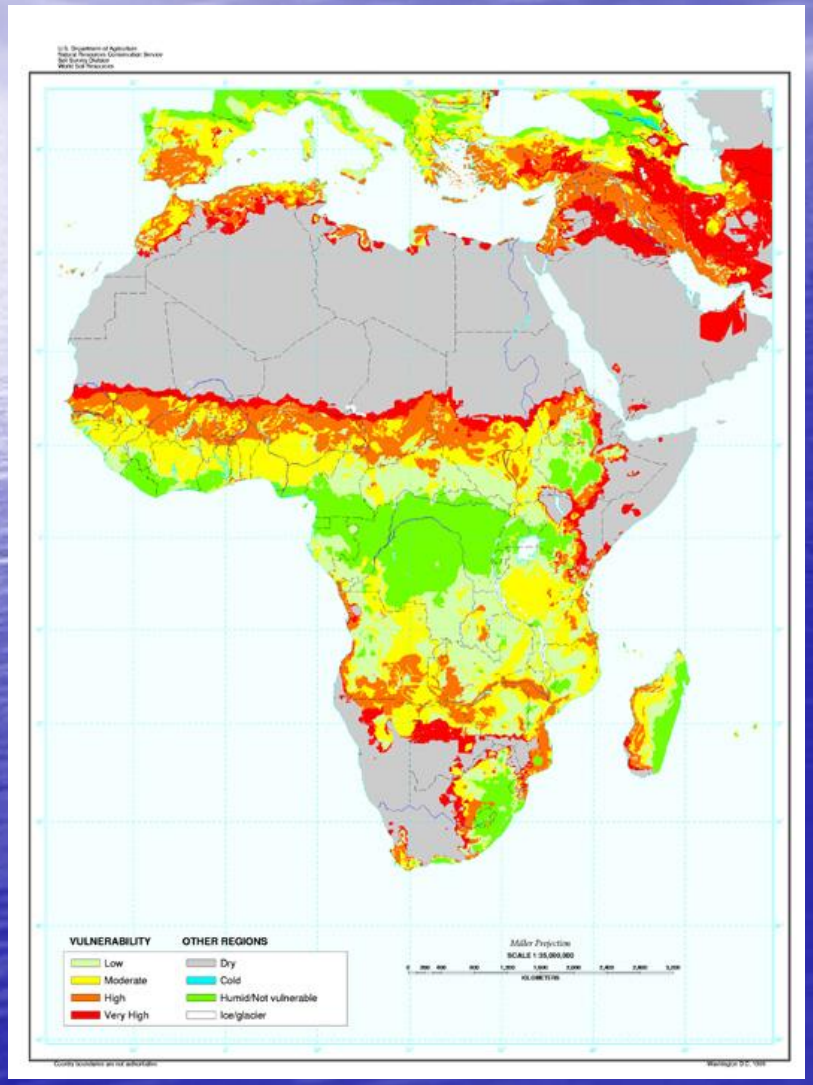
- Most destructive global soil phenomenon
- Contributes to poverty and hunger
- Overpopulation
- Soil particles are deposited in water bodies
- Contributes to air and water pollution

# SOIL EROSION AND LAND DEGRADATION

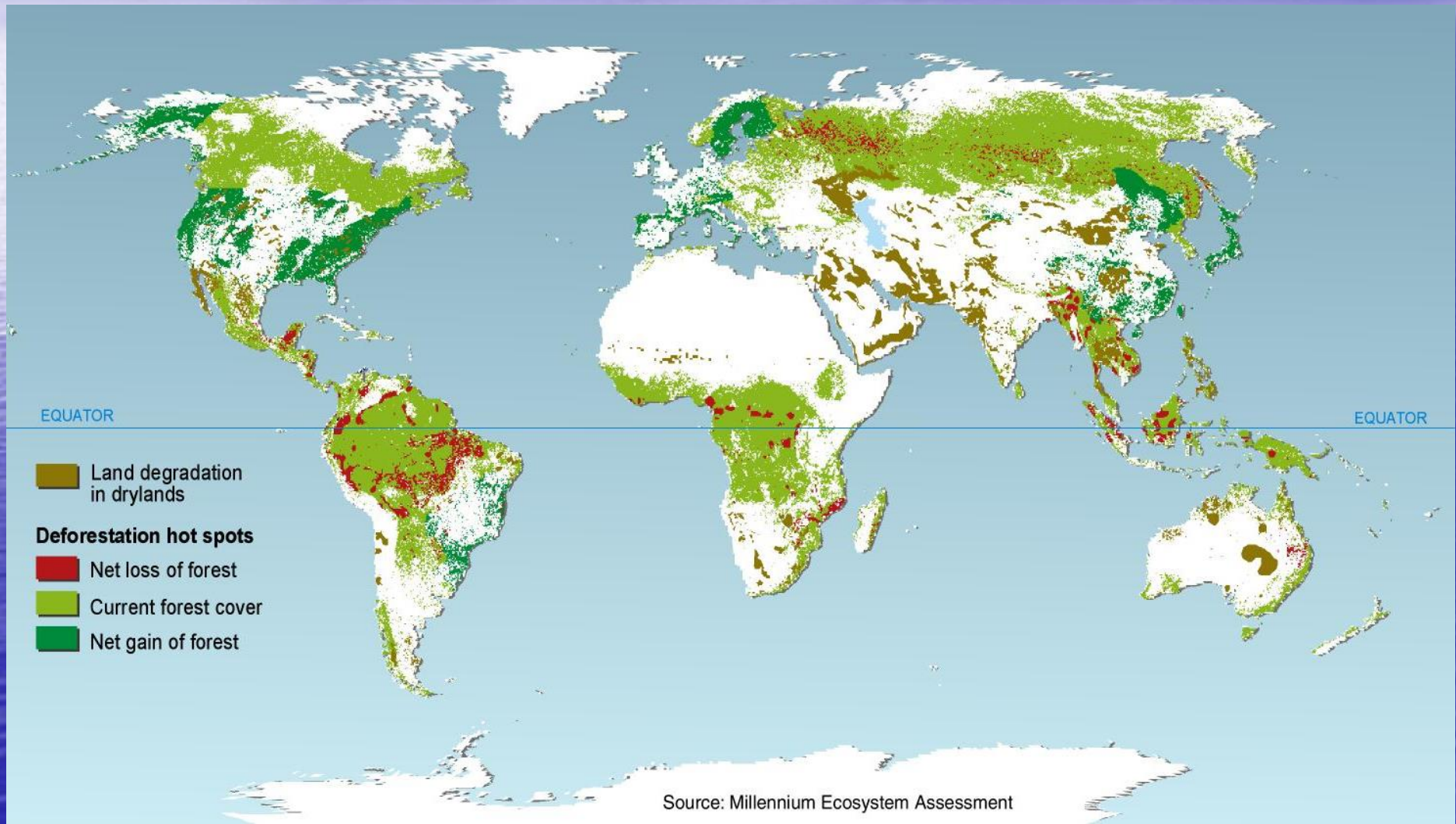
- **Land degradation** – reduces production potential and capacity
  - Damage to soils
  - Damage to plant communities

- **Desertification** – spreading of desert conditions that disrupt semiarid and arid ecosystems (i.e. Ethiopia, Somalia)
  - Overgrazing by livestock
  - Drought

# DESERTIFICATION




# DESERTIFICATION AND DEFORESTATION



# DESERTIFICATION AND DEFORESTATION

# SOIL-VEGETATION INTERDEPENDENCY

- Simplification of once-diverse natural ecosystems

- **Soil degradation** is a major problem
  - Deterioration of **soil physical properties**
  - Deterioration of **soil chemical properties**

# GEOLOGICAL VERSUS ACCELERATED EROSION

- **Erosion** – process that transforms soil into sediment
- **Geological erosion** – erosion that occurs naturally
  - Rate affected by rainfall and parent material
- **Accelerated erosion** – disturbance by humans and/or animals
  - 10 to 10,000 times more destructive

# ONSITE EFFECTS OF ACCELERATED EROSION

- Loss of soil
- Loss of OM and N
- Loss of essential nutrients

# ONSITE EFFECTS OF ACCELERATED EROSION

- Reduced water holding capacity
- Lower CEC values
- Less biological activity
- Spread of soil borne pathogens and insects

# ONSITE EFFECTS OF ACCELERATED EROSION

- Deterioration of soil structure
- Formation of gullies and ravines
- Economics ($4 to $27 billion/year)

# BADLANDS OF SOUTH DAKOTA

# BADLANDS OF SOUTH DAKOTA

# BADLANDS OF SOUTH DAKOTA

# OFFSITE EFFECTS OF ACCELERATED EROSION

- **Sediment pollution** of water bodies
- **Nutrient pollution** of water bodies
- **Chemical pollution** of water bodies
- Damage from sediment deposition

# OFFSITE EFFECTS OF ACCELERATED EROSION

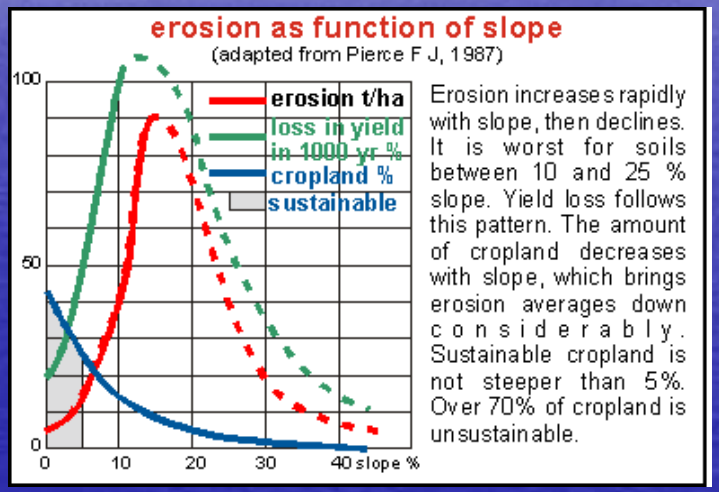
- Promotes **turbidity**
  - Prevents sunlight from penetrating water
  - Reduces photosynthesis of **submerged aquatic vegetation** (**SAV**)
  - Affects fish biology

# OFFSITE EFFECTS OF ACCELERATED EROSION

- Sediment fills in water supplies and irrigation systems
- Wind erosion
- Economic costs ($5 to $17 billion/year)

# OFFSITE EFFECTS OF ACCELERATED EROSION

- Maintenance of soil productivity
  - 20-40% reduction in crop yields on eroded soils




- Rate of decline is affected by:
  - **Effective rooting depth**
  - **Subsoil permeability**

# SOIL-LOSS TOLERANCE

- **Tolerable soil loss** (**T-value**) – the maximum amount of soil that can be lost from water and wind erosion without degrading the soil's productivity
- T-values range from 5 to 11 Mg/ha
  - Soil depth
  - OM content
  - Use of water-control practices

# SOIL-LOSS TOLERANCE

- **US soils** have T values of 11 Mg/ha
  - Maximum soil loss of 0.04 inches/year
  - Would take 225 years to lose 9 inches
  - 33% of cropland has T values > 11
  - 15% of cropland have T values > 22

# MECHANICS OF WATER EROSION

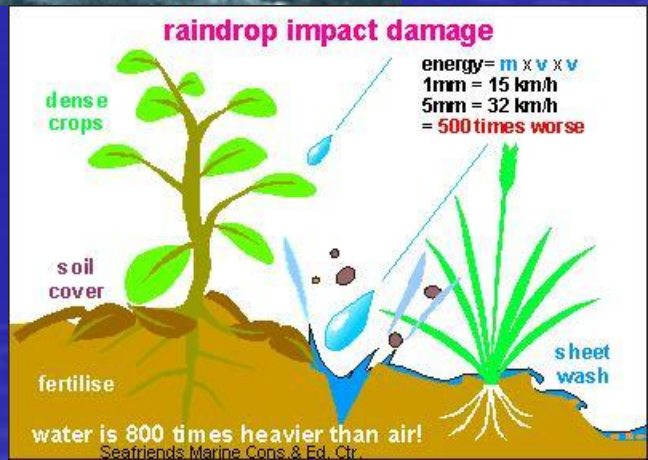
- **Detachment** of soil particles from soil
- **Transportation** of detached particles
- **Deposition** of transported particles

# INFLUENCE OF RAINDROPS

- **Terminal velocity** equals 18 mph
  Detaches soil

- Destroys granulation

- Transports soil



# TYPES OF WATER EROSION

- **Sheet erosion** – splashed soil is removed uniformly

# TYPES OF WATER EROSION

- **Rill erosion** – splashed soil is concentrated into tiny channels
  - Common on bare soil


# TYPES OF WATER EROSION

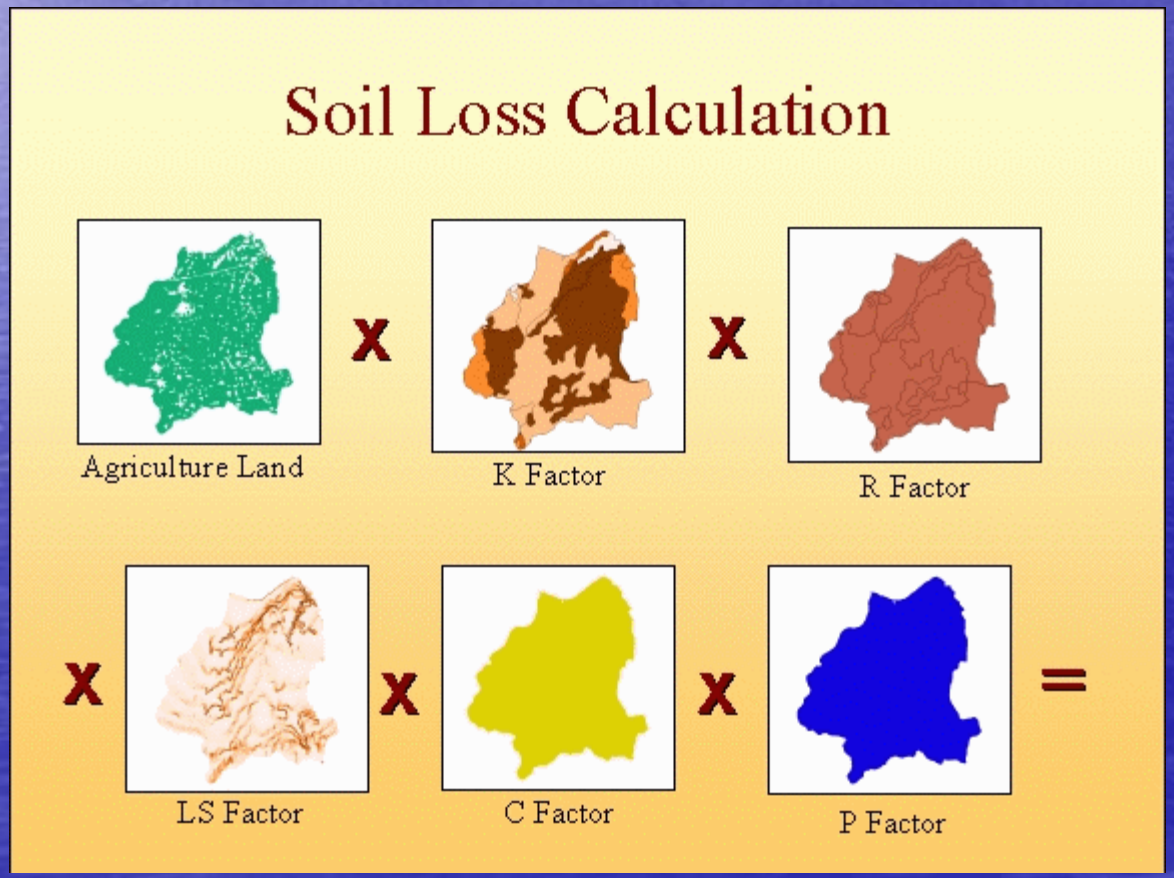
- **Gully erosion** – coalescing of rills into larger channels

- **Sheet and rill erosion are responsible for most of soil movement**

# SOIL DELIVERY RATIO

- **Soil delivery ratio (SDR)** – amount of soil delivered to a stream divided by amount eroded
- **SDR = 0.60** on steep slopes
- **SDR = 0.01** on gentle slopes

# UNIVERSAL SOIL-LOSS EQUATION (USLE)



# UNIVERSAL SOIL-LOSS EQUATION (USLE)

- **A = RKLSCP where:**
  - **A** = predicted soil loss
  - **R** = rainfall erosivity
  - **K** = soil erodiblity
  - **L** = slope length
  - **S** = slope gradient or steepness
  - **C** = cover and management (land mgt.)
  - **P**= erosion control practices (land mgt.)

# UNIVERSAL SOIL-LOSS EQUATION (USLE)

- **Rainfall erosivity (R)**
  - **Driving force for sheet and rill erosion**

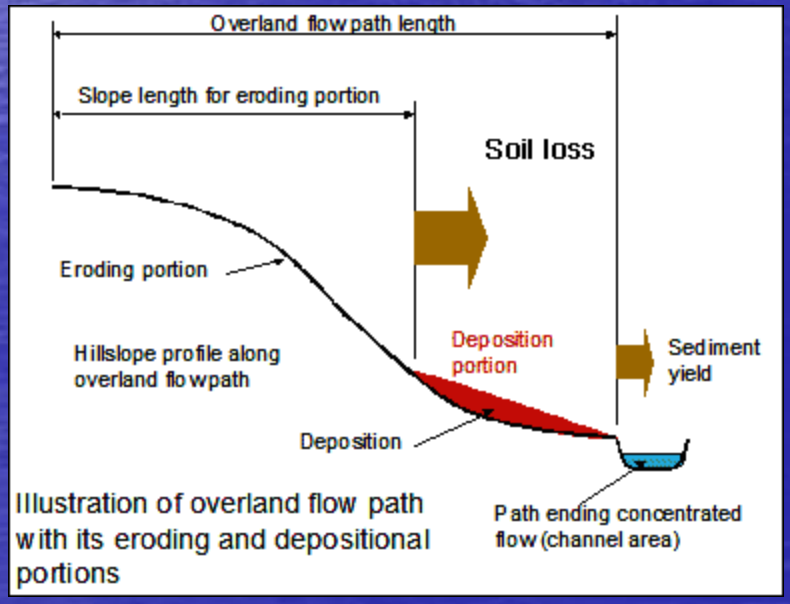



Illustration of overland flow path with its eroding and depositional portions

# UNIVERSAL SOIL-LOSS EQUATION (USLE)

- **Soil erodibility (K)**
  - Soil's inherent susceptibility to erosion
  - Infiltration capacity
  - Structural stability
  - **High K values**: silt and very fine sands, expansive clays, and blocky soil structure
  - **Low K values**: high OM, non-expansive clays, strong granular structure

# UNIVERSAL SOIL-LOSS EQUATION (USLE)

- **Topographic factors (LS)**
  - **Influence of length and steepness of slope on soil erosion**
  - Longer the slope the greater the concentration of runoff water

# UNIVERSAL SOIL-LOSS EQUATION (USLE)

- **Cover and management factor (C)**
  - **Includes vegetative cover and cropping systems**
  - C = 1.0 = very little soil cover (i.e. bare soil)
  - C < 0.1 = dense perennial plant cover

# UNIVERSAL SOIL-LOSS EQUATION (USLE)

- **Support practice factor (P)**
  - **Ratio of soil loss with a given support practice to corresponding loss if crop was planted up and down the slope** (P = 1.0 = no support)
  - Terracing
  - Grass waterways
  - Contour farming (Table 15.5)

# TERRACING AND CONTOUR FARMING

# EROSION AND SEDIMENT CONTROL ON CONSTRUCTION SITES

- Potential erosion can be 100 times that of agricultural land
- State laws
- Clean Water Act of 1992

# EROSION CONTROL GOALS FOR CONSTRUCTION SITES

- To avoid onsite damage
- To retain eroded sediment on site

# PRINCIPLES OF EROSION CONTROL ON CONSTRUCTION SITES

- **Schedule work** for low rainfall periods
- **Divide project** into multiple phases
- **Cover disturbed soils**
  - Mulch
  - **Erosion blankets**

# PRINCIPLES OF EROSION CONTROL ON CONSTRUCTION SITES

- **Control runoff flow**
  - **Perimeter waterways**
  - **Riprap** - large angular rocks
  - **Gabions** - rectangular wire-mesh containers filled with stone

# PRINCIPLES OF EROSION CONTROL ON CONSTRUCTION SITES

- **Control runoff flow**
  - **Geotextile filter cloth** - tough, nonwoven material)
  - Grass sod and **erosion blankets**
  - Vegetation or "**live stakes**"

# CONTROLLING SOIL EROSION

# PRINCIPLES OF EROSION CONTROL ON CONSTRUCTION SITES

- **Trapping sediment**
  - Straw bales
  - Woven fabric silt fences
  - Slopes and channels

# PRINCIPLES OF EROSION CONTROL ON CONSTRUCTION SITES

- **Trapping sediment**
  - **Retention ponds**
  - Sedimentation ponds
  - Wetlands

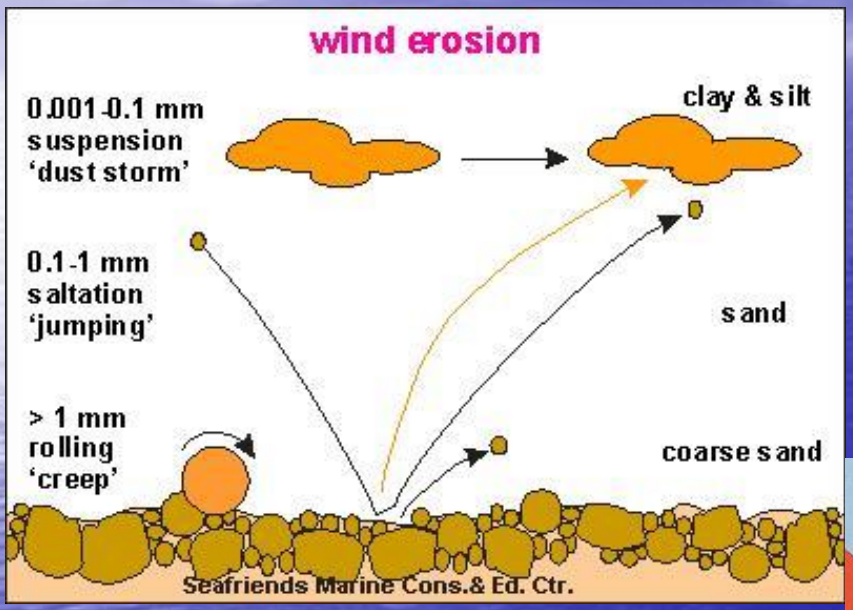
# WIND EROSION

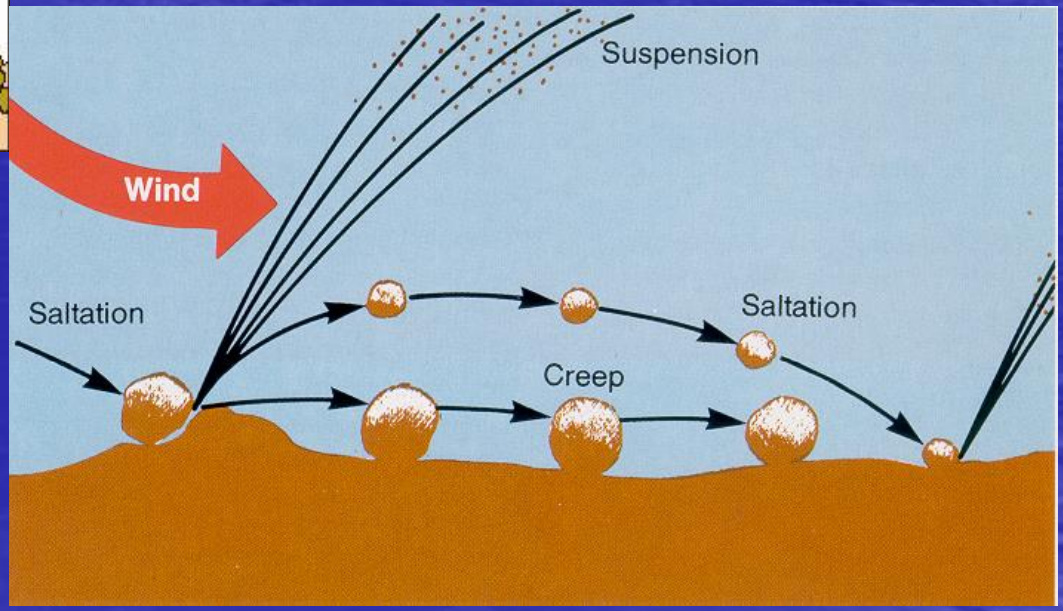
- Common in **arid** and **semiarid** regions
- Finer soil particle are most affected
- Winds can be more powerful in winter
  - Great plains region of US
  - Mixes with snow to form "**snirt**"

# MECHANICS OF WIND EROSION

- Detachment
- Transportation
- Deposition

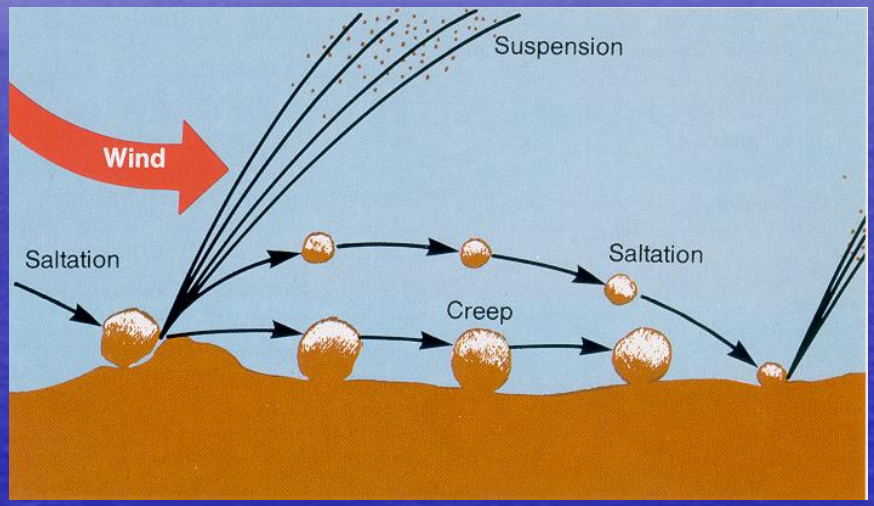
# MECHANICS OF WIND EROSION

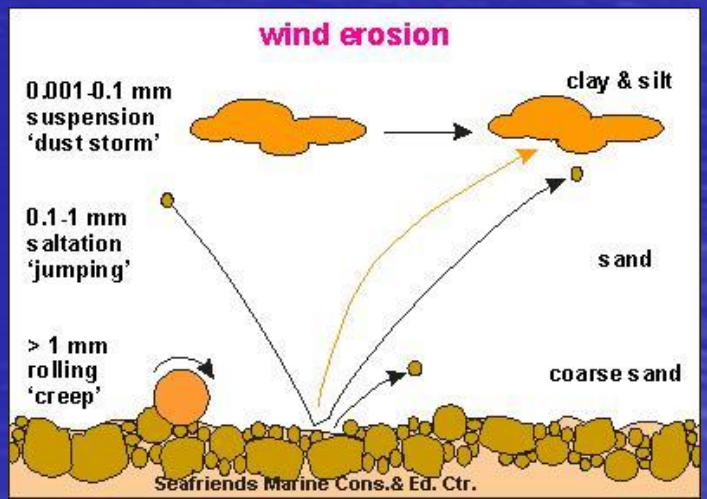


# MECHANICS OF WIND EROSION

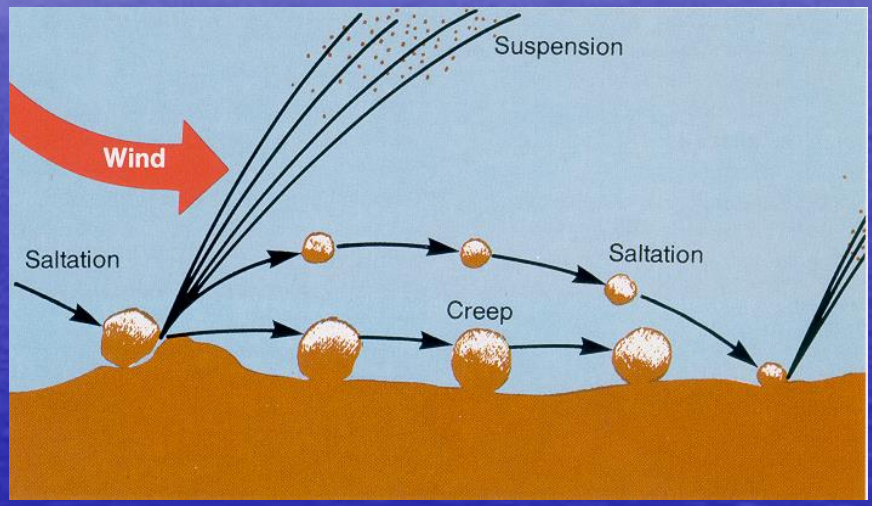
- Transportation
  - **Saltation**
    - **Most important**
    - 50% to 90% of soil movement
    - Movement by short bounces along ground

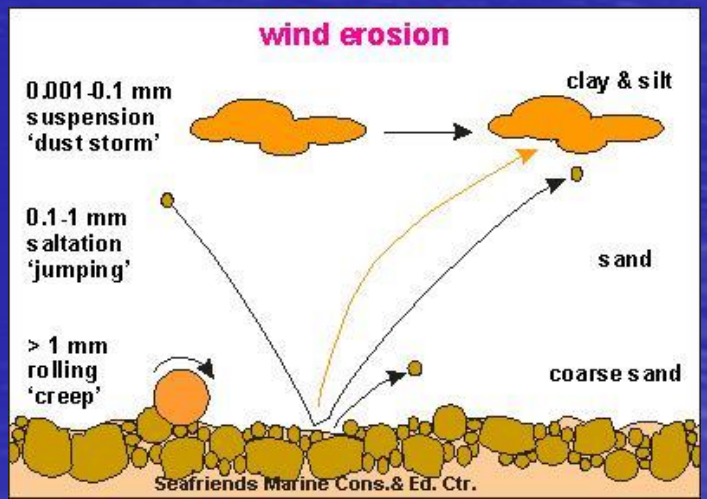


# MECHANICS OF WIND EROSION

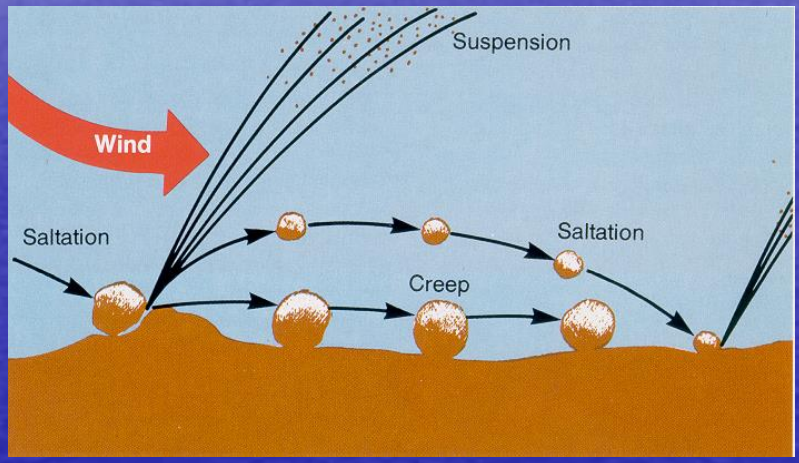
- Transportation
  - **Soil creep**
    - Rolling and sliding along soil surface
    - Accounts for 5% to 25% of soil movement

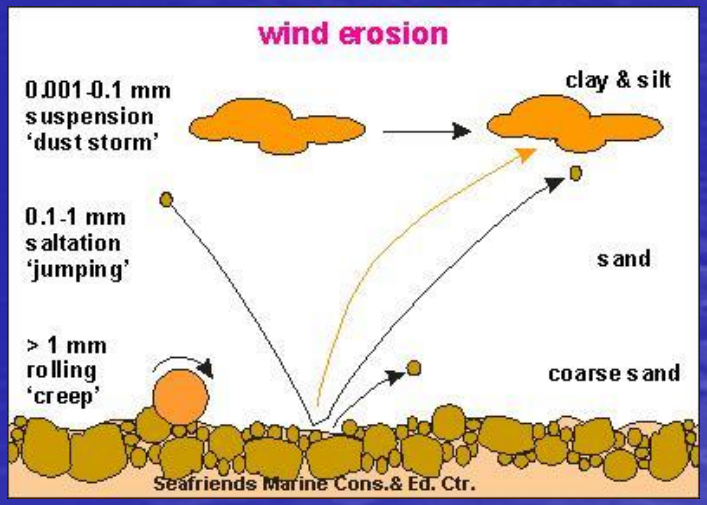


# MECHANICS OF WIND EROSION

- Transportation
  - **Suspension**
    - Most spectacular form of soil movement
    - Accounts for 15% to 40% of soil movement



# FACTORS AFFECTING WIND EROSION

- **Soil moisture**
- **Wind velocity and turbulence**
  - **15 mph** winds initiate soil movement

# FACTORS AFFECTING WIND EROSION

- **Soil properties**
  - Stability of clods and aggregates
  - Stability of soil crusts
  - Bulk density and size of soil fractions
  - Presence of clay, OM and cementing agents
  - Particle size

- **Vegetation**

# CONTROL OF SOIL EROSION

- **Soil moisture and vegetation**
- **Tillage systems**
- **Barriers**
  - **Shelterbelts** and **windbreaks**

# LAND CLASSIFICATION AND CONSERVATION

- **Land capability classes** – indicate the degree of limitation imposed on land uses
  - **Class I –** least limited
  - **Class VIII –** most limited
  - **About 43% of land in US is suitable for cultivation**

# LAND CLASSIFICATION AND CONSERVATION

- Class I: deep and well drained
- Class II: limitations on tillage
- Class III: severe limitations for plants
- Class IV: severe limitations on crops

# LAND CLASSIFICATION AND CONSERVATION

- Class V: not suited for crop production
- Class VI: extreme limitations
- Class VII: severe limitations
- Class VIII: restricted to recreation

# SUMMARY

- Soil erosion and land degradation
- Onsite effects of soil erosion
- Offsite effects of soil erosion
- Mechanic of water erosion

# SUMMARY

- Factors affecting water erosion
- Erosion control on construction sites
- Wind erosion
- Land capability classification