SOIL EROSION AND CONSERVATION: PREDICTION AND MANAGEMENT

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SOIL EROSION IS GLOBAL PROBLEM

- 1/3 WORLD'S ARABLE LAND LOST SINCE 1950
- MOST IN ASIA, AFRICA, S. AMERICA
  - 13-18 t/a/yr
- 30% OF US FARMLAND ABANDONED
  - EROSION
  - SALINIZATION
  - WATER-LOGGING
- 90% OF US CROPLAND LOSING SOIL FASTER THAN IT IS REPLACED
  - >1 t/a/yr

PIMENTEL ET AL., 1995

SIGNIFICANT SOIL LOSS IN THE USA

WATER
3.5×10^9 T/yr

WIND
1.5×10^9 T/yr

EROSION IS A WISCONSIN PROBLEM

- DEGRADATION OF THE RESOURCE
  - FERTILITY
  - ORGANIC MATTTER
  - TILTH
- WATER QUALITY
  - SEDIMENT
  - NUTRIENTS
- PROGRAM COST
  - CHEAPER TO PREVENT
  - STILL EXPENSIVE

Near Blue River

EROSION EFFECTS ON PRODUCTIVITY

- SHALLOW ROOTING ZONE
- LOWER AVAILABLE WATER
- LOSS OF NUTRIENTS AND O.M.
- FARMING THE SUBSOIL
  - POORER TILTH
  - GREATER PENETRATION RESISTANCE
- INCREASED HYDRAULIC COND.
  - “STRONGER” AGGREGATES
- LOWER LAND VALUE
- REQUIRES GRADING TO FILL RUTS

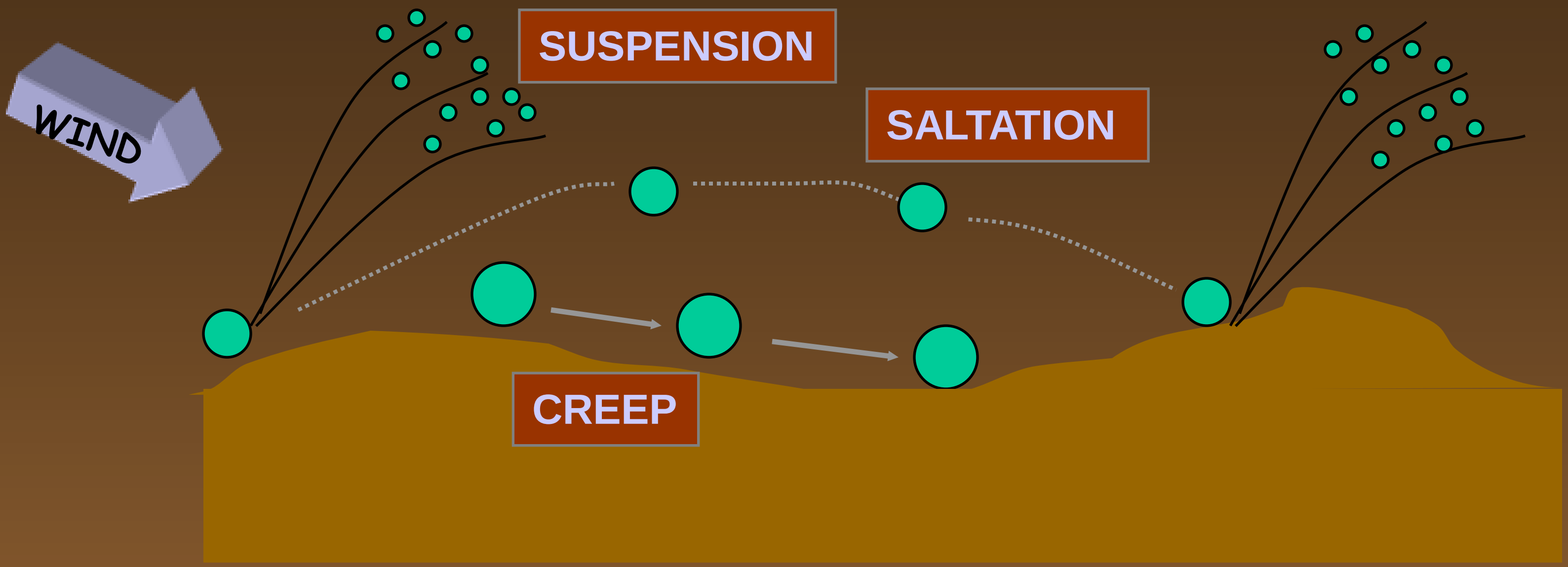
THREE MECHANISMS OF SOIL MOVEMENT

Erosion is the process of detachment and transport of soil particles by erosive agents (Ellison, 1944)

Erosion is a natural geologic process

- WATER EROSION
- WIND EROSION
- TILLAGE TRANSLOCATION

WIND EROSION



- SALTATION DETACHES PARTICLES
- SMALLER PARTICLES SUSPENDED
- LARGER PARTICLES CREEP
- SANDY AND SILTY SOILS MOST SUSCEPTIBLE
- SOIL ACCUMULATION IN DITCHES AND FENCE ROWS

WIND EROSION CAN BE SIGNIFICANT

Near Mitchell, SD

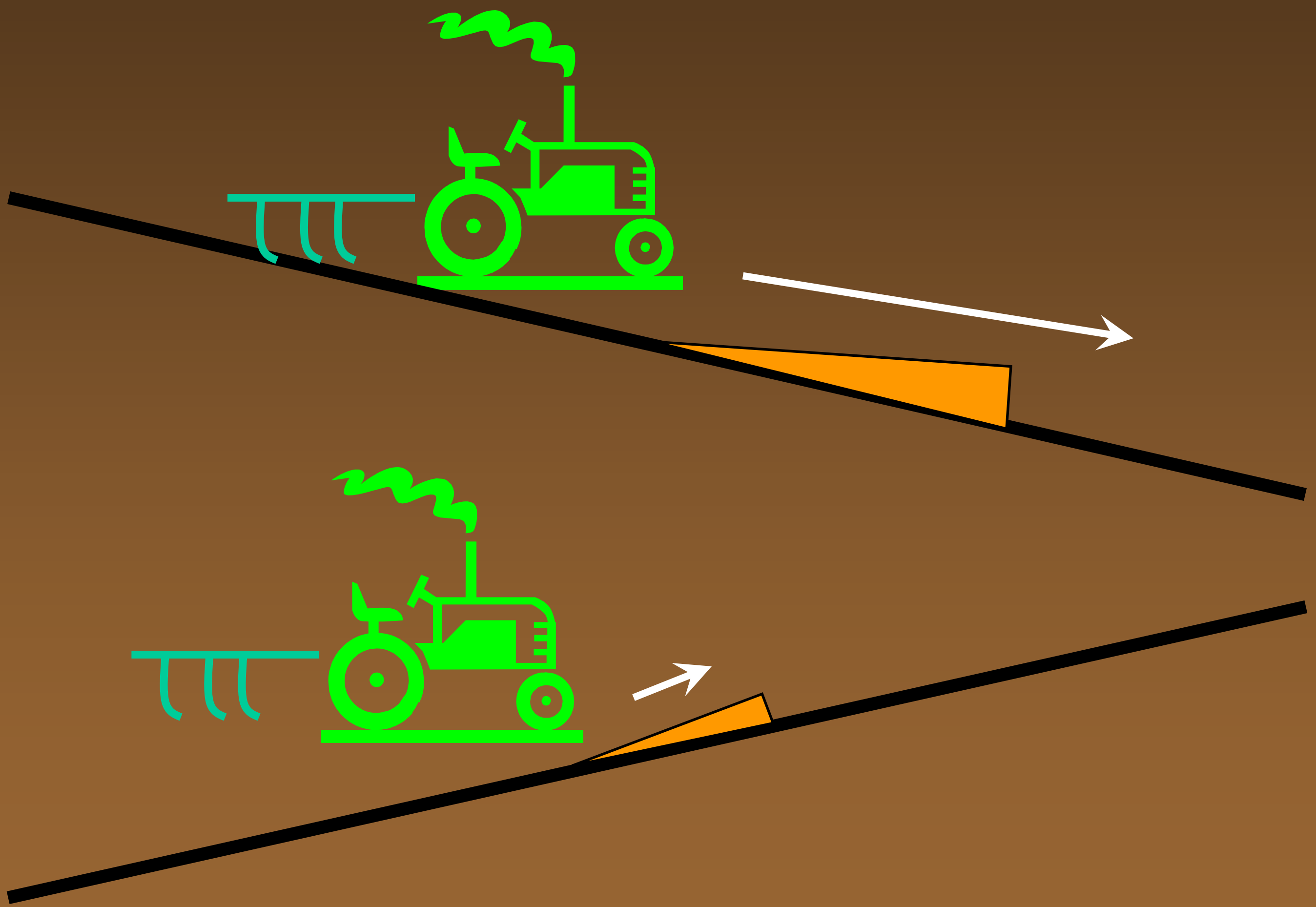
REDUCING WIND EROSION

- MAINTAIN SURFACE COVER
  - CROP RESIDUE
  - COVER CROPS
- INCREASE STUBBLE HEIGHT
- INSTALL WINDBREAKS
  - EFFECTIVE 15x HEIGHT
- IRRIGATE
- STRIP CROPS PERPENDICULAR TO PREVAILING WIND

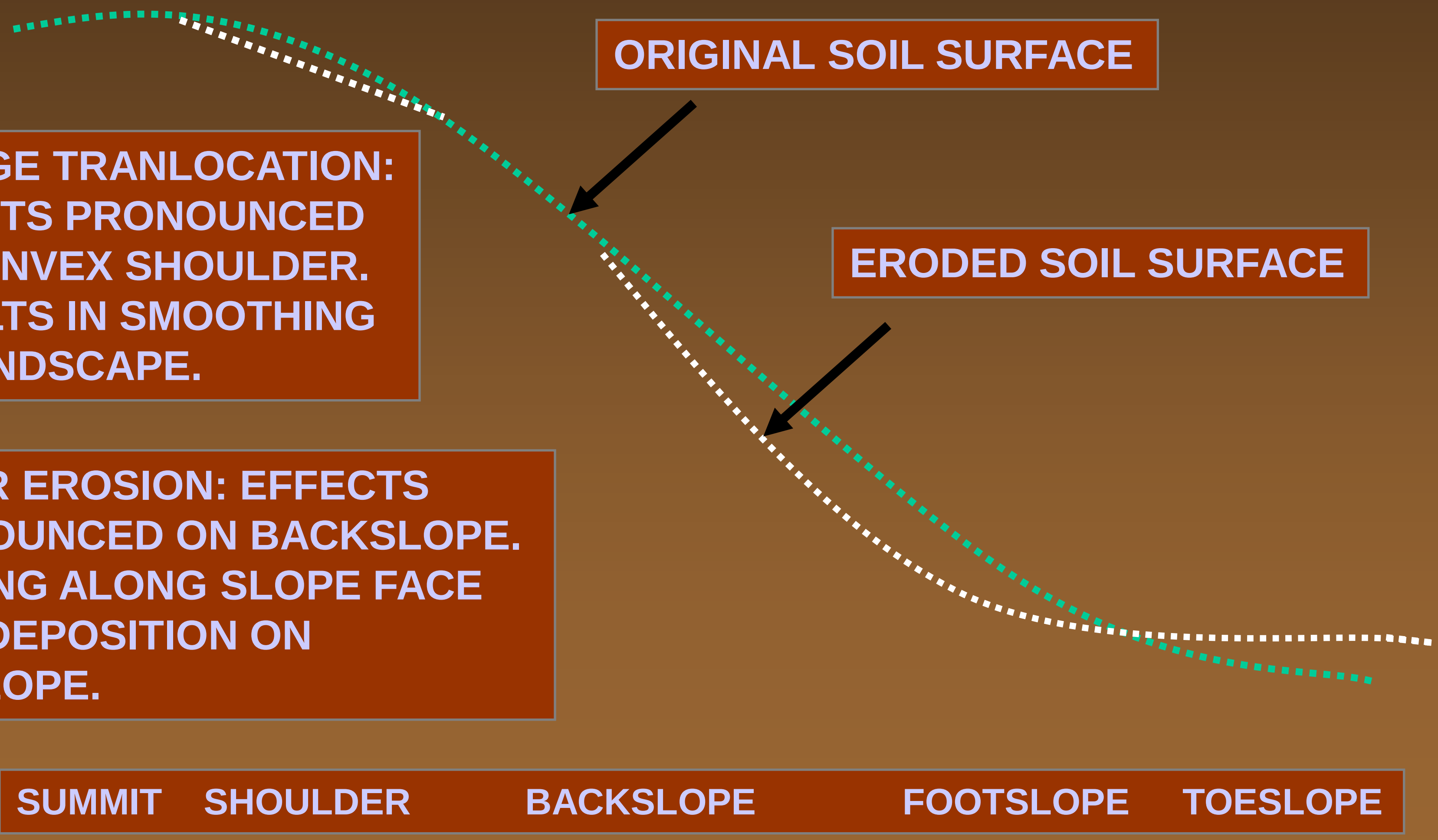
TILLAGE TRANSLOCATION

- NET DOWNHILL MOVEMENT BY TILLAGE
- RESULTS IN SMOOTHING OF SURFACE
- WATER EROSION INCREASES RELIEF INTENSITY
- BOUNDARIES STOP MOVEMENT
- NOT ACCOUNTED FOR BY RUSLE
- INCREASES SOIL VARIABILITY

MECHANISM OF TILLAGE TRANSLOCATION



COMPARING WATER EROSION AND TILLAGE TRANSLOCATION



TILLAGE TRANLOCATION: EFFECTS PRONOUNCED ON CONVEX SHOULDER. RESULTS IN SMOOTHING OF LANDSCAPE.

WATER EROSION: EFFECTS PRONOUNCED ON BACKSLOPE. CUTTING ALONG SLOPE FACE WITH DEPOSITION ON TOESLOPE.

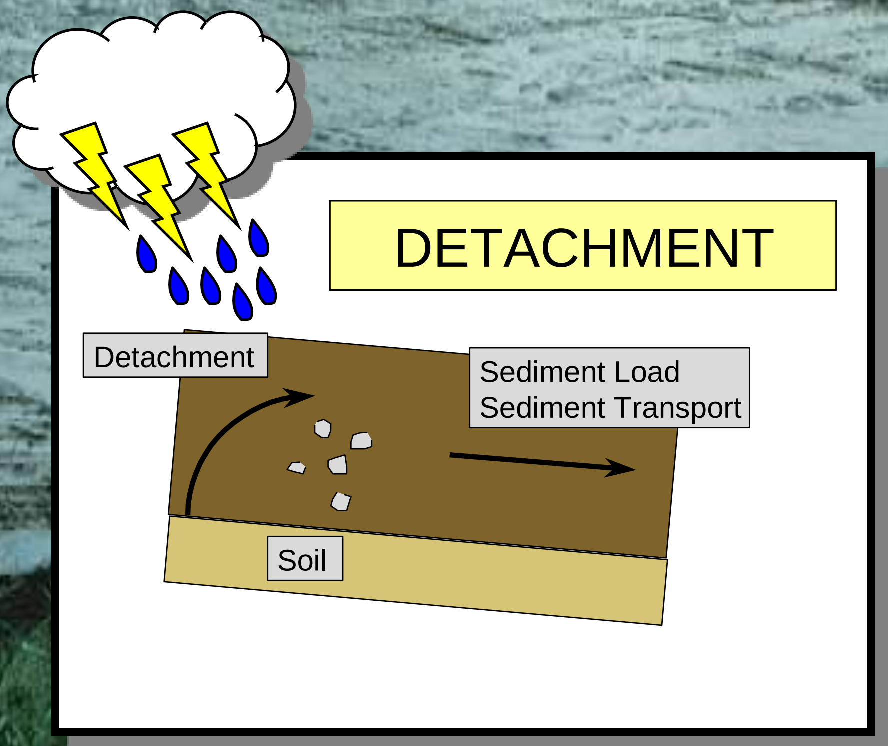
WATER EROSION PROCESS

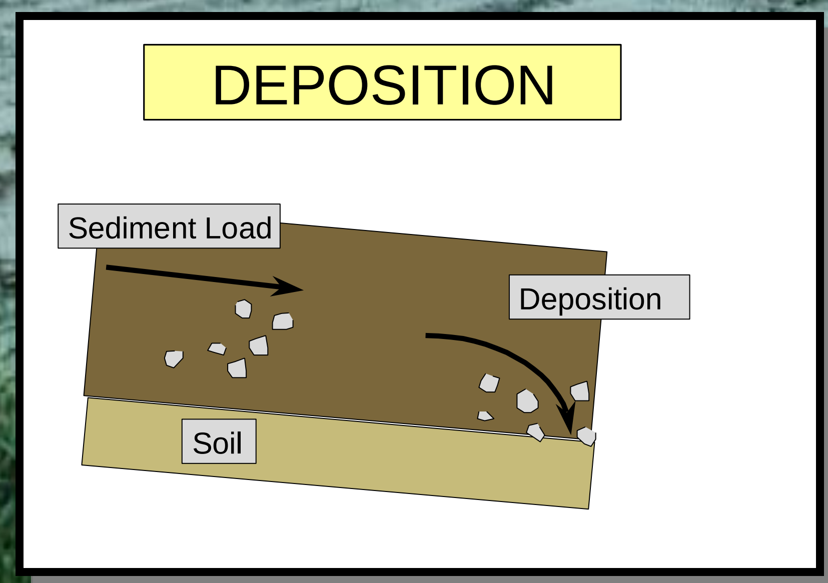
- BEGINS WITH RAINDROPS STRIKING BARE SOIL DISLODGING PARTICLES
- INTENSE RAINS SEAL SURFACE
- WHEN RAINFALL EXCEEDS INFILTRATION WATER IS STORED IN SMALL DEPRESSIONS
- ONCE DEPRESSIONS ARE FILLED, RUNOFF BEGINS

WATER EROSION PROCESS

- INITIALLY WATER FLOWS IN A DISCONTINUOUS SHEET
- EVENTUALLY IT CONCENTRATES INTO SMALL CHANNELS OR RILLS. THE RUNOFF NOW HAS ENERGY TO BREAK OFF PARTICLES AND CUT DEEPER
- THE AMOUNT OF EROSION CAUSED BY SHEET AND RILL EROSION INCREASES WITH SLOPE AND DISTANCE
- RILLS MAY EVENTUALLY FORM GULLIES

THE SOIL WATER EROSION PROCESS





EFFECTS ON ENVIRONMENTAL QUALITY AND PRODUCTIVITY

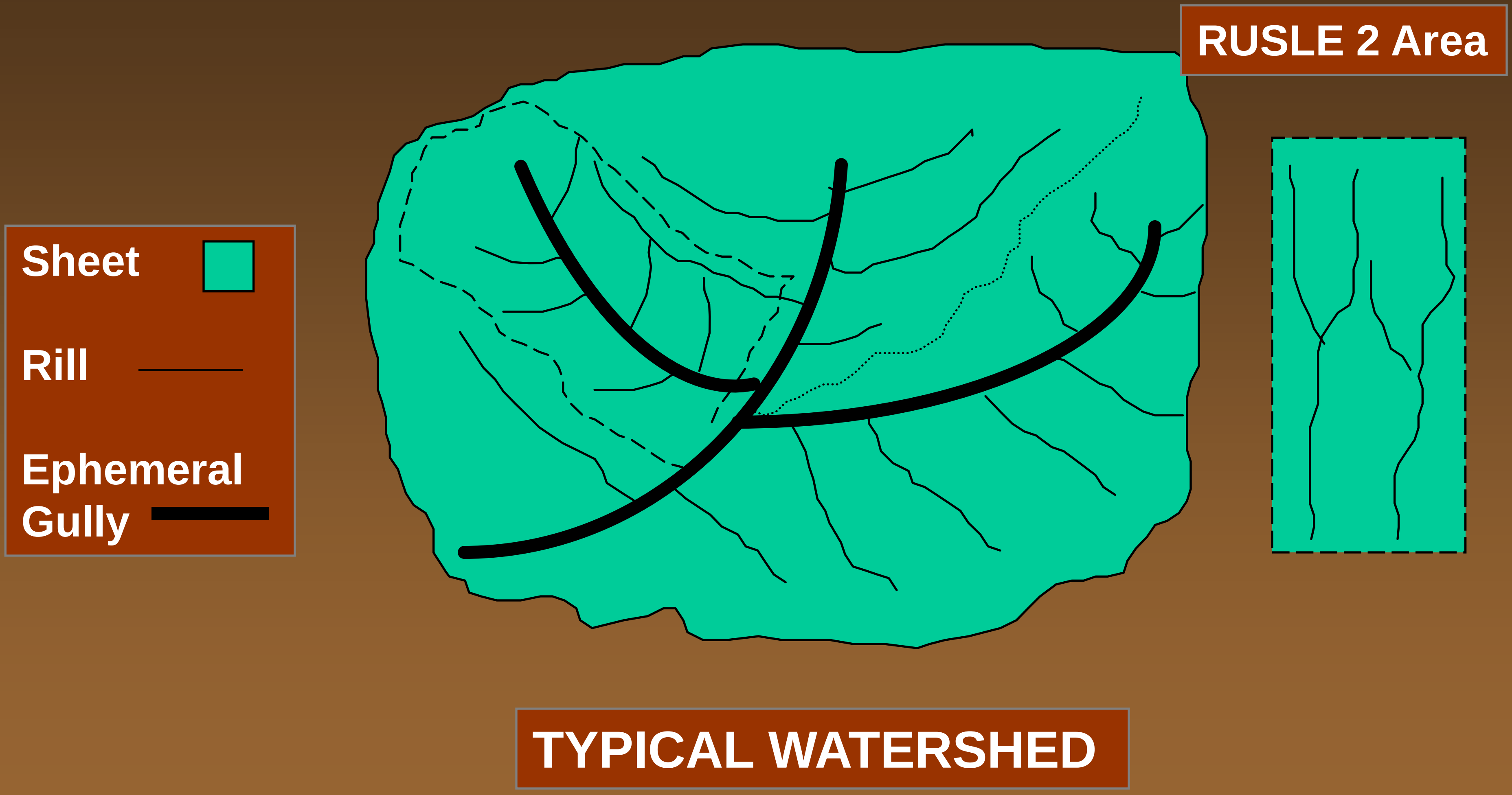
- LOSS OF OM, CLAY, AND NUTRIENTS REDUCES PRODUCTIVITY
- DAMAGE TO PLANTS
- FORMATION OF RILLS AND GULLIES AFFECTS MANAGEMENT
- SEDIMENTATION IN WATERWAYS, DIVERSIONS, TERRACES, DITCHES
- DELIVERY OF NUTRIENTS TO SURFACE WATER

UNIVERSAL SOIL LOSS EQUATION

Soil Loss (t/a) = R x K x LS x C x P

- R = RAINFALL INTENSITY AND AMOUNT
- K = SOIL EROSIVITY
  - TEXTURE
  - STRUCTURE
- LS = SLOPE LENGTH, GRADE, SHAPE
- C = CULTURAL PRACTICES
  - ROTATION
  - TILLAGE
- P = SUPPORTING PRACTICES
  - TERRACES
  - CONTOURS
  - BUFFERS

PREDICTING EROSION



PURPOSE OF EROSION AN PREDICTION MODEL

- DEVELOP A REASONABLE ESTIMATE OF SOIL LOSS BASED ON SCIENTIFIC INFORMATION
- GUIDE MANAGEMENT DECISIONS
- EVALUATE MANAGEMENT IMPACTS
- DETERMINE PRACTICE COST:BENEFIT
- ASSESS RESOURCE INVENTORY

WHAT IS RUSLE 2

- "GREAT GRANDSON" OF USLE
- MODEL TO PREDICT SOIL LOSS
  - WHERE OVERLAND FLOW OCCURS
  - COMPUTES ANNUAL SHEET/RILL EROSION
  - COMPUTES PARTICLE DISTRIBUTION AND RUNOFF
- CROPLAND, FOREST, LANDFILLS, CONSTRUCTION SITES, SURFACE MINES
- WINDOWS "PULL DOWN" MENUS

WHO AND WHAT OF RUSLE 2

- USDA-ARS, USDA-NRCS, VARIOUS UNIVERSITIES
- ON-GOING PROCESS OVER 70 YEARS
- THOUSANDS OF RESEARCH DATA
- SET UP WITH VARYING LEVELS OF COMPLEXITY
- COMPUTER REQUIREMENTS
  - WINDOWS 98
  - INTERNET EXPLORER BROWSER
  - 64 MB RAM
- DOWNLOAD
  - HTTP://BIOENGR.AG.UTK.EDU/RUSLE2/

APPLICABILITY OF RUSLE 2

- ESTIMATES INTER-RILL AND RILL EROSION
- ESTIMATES SEDIMENT YIELD FROM OVERLAND FLOW AND TERRACE CHANNELS
- DOES NOT ESTIMATE EPHEMERAL OR PERMANENT GULLIES, MASS WASTING, OR STREAM CHANNEL EROSION
- BEST SUITED TO CROPLAND, BUT IS USEFUL FOR CONSTRUCTION SITES, LANDFILLS, RECLAMATION PROJECTS, AND DISTURBED FOREST LAND

APPLICABILITY OF RUSLE 2 (cont.)

- BEST WHERE RAINFALL IS REGULAR AND EXCEEDS 20"/YR.
- MEDIUM-FINE TEXTURED SOILS
- SLOPES 3-20% AND LESS THAN 600 FT.
- BEST AT CALCULATING "AVERAGE ANNUAL SOIL LOSS", NOT RECOMMENDED FOR SINGLE STORM EVENTS

RUSLE 2 FACTORS

A = R x K x LS x C x P

- CLIMATE (R) AND SOIL (K) FACTORS ARE SET FOR A GIVEN FIELD
- SLOPE GRADE (S) AND LENGTH (L) CAN BE ADJUSTED WITH DIFFICULTY
- MOST FLEXIBILITY WITH COVER MGT. (C) AND SUPPORTING PRACTICES (P)

CROP RESIDUE IS STILL THE BEST EROSION PREVENTION TOOL

- ✓REDUCED DETACHMENT
- ✓HINDERS OVERLAND FLOW
- ✓IMPROVED INFILTRATION
- ✓ROTATIONS MAINTAIN STRUCTURE

EROSION CONTROL PRACTICES

Structures: diversions, terraces, waterways

- Reduce slope length
- Slow runoff velocity
- Divert excess water safely
- Avoid runoff over barnyard, feedlots, etc.

DIVERSION AND SURFACE INLET

Fond du Lac, Co.
(Note cover crop)

CONTOUR TERRACES

Grant Co.

WATERWAY MANAGEMENT ?

Columbia, Co.

EROSION CONTROL PRACTICES

Management practices

- Cover crops
- Crop residue management
  - 30% residue reduces erosion 50-60%
- Contour tillage
  - Slope < 8% and 300’ long
- Contour strip cropping and buffers
  - Alternating sod strip for steep land

CONTOUR STRIP CROPPING

Crawford Co.

CONTOUR BUFFER STRIPS

Chippewa Co.

WHAT IS A RIPARIAN FILTER STRIP

- A PLANTED OR NATURAL VEGETATIVE BUFFER IN THE AREA THAT LINKS TERRESTRIAL AND AQUATIC HABITATS
- SERVES AS:
  - FILTER
  - TRANSFORMER
  - SINK

FEATURES BENEFITING FROM VEGETATIVE FILTER STRIPS

- **PERENNIAL AND EMPHEMERAL STREAMS OR DITCHES**
- **LAKES AND PONDS**
- **WETLANDS**
- **KARST FEATURES AND CREVICED BEDROCK**
- **WELLS**

FILTER STRIP GOALS

-FILTER SEDIMENT

-STABILIZE BANKS

-WILDLIFE HABITAT

FILTERING SEDIMENT IS THE MOST IMPORTANT FUNCTION

- AS FLOW VELOCITY SLOWS, SEDIMENT SETTLES OUT
- SHEET FLOW REQUIRED
- NEED TO REMOVE SUSPENDED CLAY
- FILTERING AFFECTED BY:
  - SOIL POROSITY
  - VEGETATION TYPE
  - SLOPE
  - AGE
  - MANAGEMENT
  - RUNOFF VOLUME


FILTER STRIPS ARE
A LIVING SILT FENCE

MECHANISMS THAT REMOVE POLLUTANTS IN FILTER STRIPS

- NUTRIENTS STORED IN SOIL
- PHOSPHORUS FIXED ON MINERAL SITES
- NITRATE-N DENITRIFIES
- PLANT UPTAKE
- STORAGE IN PLANT TISSUE (ESPECIALLY TREES)
  - HARVESTED AND REMOVED
  - MAY BE RELEASED FROM VEGETATION
- MICROBES BREAKDOWN ORGANICS


SITE PRIOR TO ESTABLISHMENT
MAY, 1999


CHANNELIZED FLOW
MAY, 1999


FOLLOWING CLIPPING
AUGUST, 1999

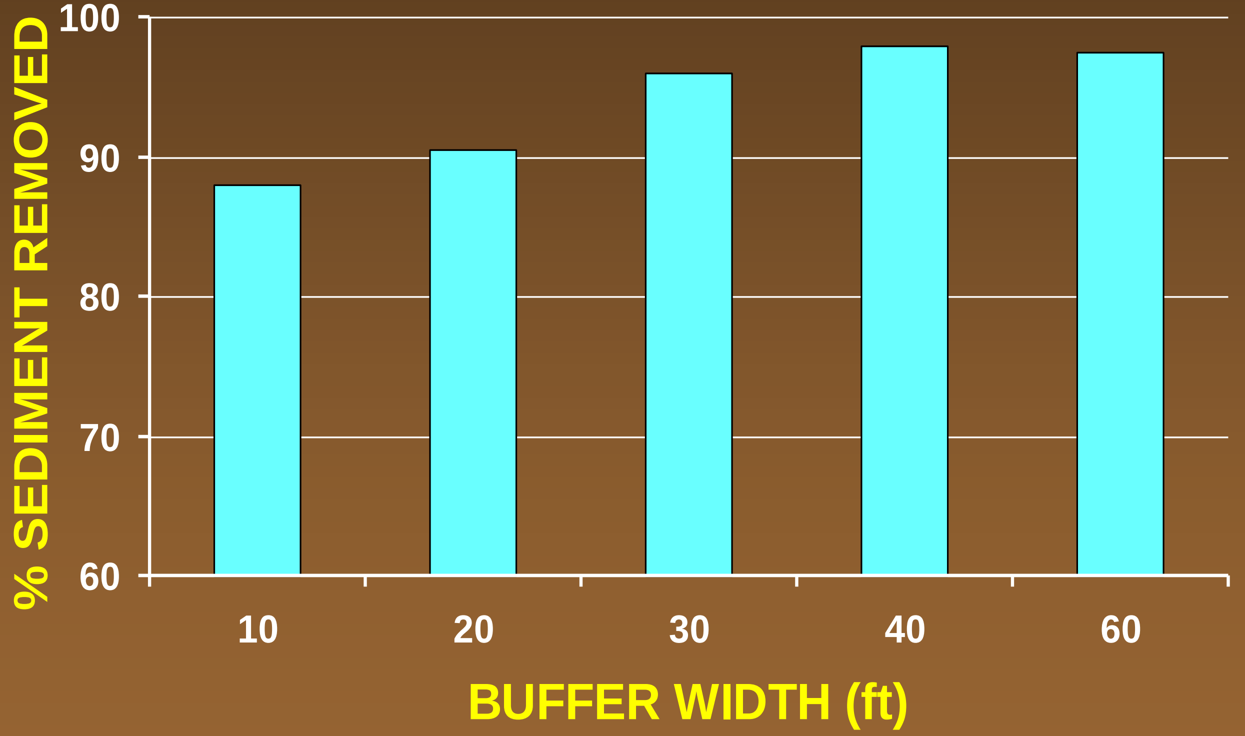

FILTER STRIP
OCTOBER, 2001

Ashwaubenon Creek Tributary, Brown Co. (Source: Bill Hafs)

Before

Two years later

EFFECT OF BUFFER WIDTH ON SEDIMENT DEPOSITION



Smith, 1992

VEGETATION TYPE AND NUTRIENT REMOVAL

WIDTH	GRASS	SEDI-MENT	TOTAL N	TOTAL P	PO_4-P
ft.		----------- % REMOVED -----------			
10	SWITCH	69	32	40	38
	COOL SEASON	62	24	35	30
20	SWITCH	78	51	55	46
	COOL SEASON	75	41	49	39

LEE et al., 1999

MANAGEMENT OF FILTER STRIPS

- PROTECT FROM GRAZING
  - FENCE MAINTENANCE, FLOOD DAMAGE
  - CATTLE CROSSINGS
  - MANAGED GRAZING
- MOW
  - BRUSH CONTROL
  - HARVEST GRASS
- AVOID VEHICLE TRAFFIC IN FILTER STRIP

OTHER CONSIDERATIONS

COMBINE WITH UPLAND PRACTICES

SITE IN THE UPPER PART OF WATERSHEDS