Natural Resources
Conservation Service

RUSLE2

REVISED UNIVERSAL SOIL LOSS EQUATION-Version 2

Predicting Soil Erosion By Water:

A Guide to Conservation Planning

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USDA-NRCS
KANSAS

OBJECTIVES

- Overview of Erosion
- RUSLE2
  - Factors
  - Applications
  - Download procedures
  - Interface and output

EROSION

- Definition
- Processes
- Types
- Why erosion is a concern
- Where erosion can be a problem

EROSION

"Erosion is a process of detachment and transport of soil particles by erosive agents."

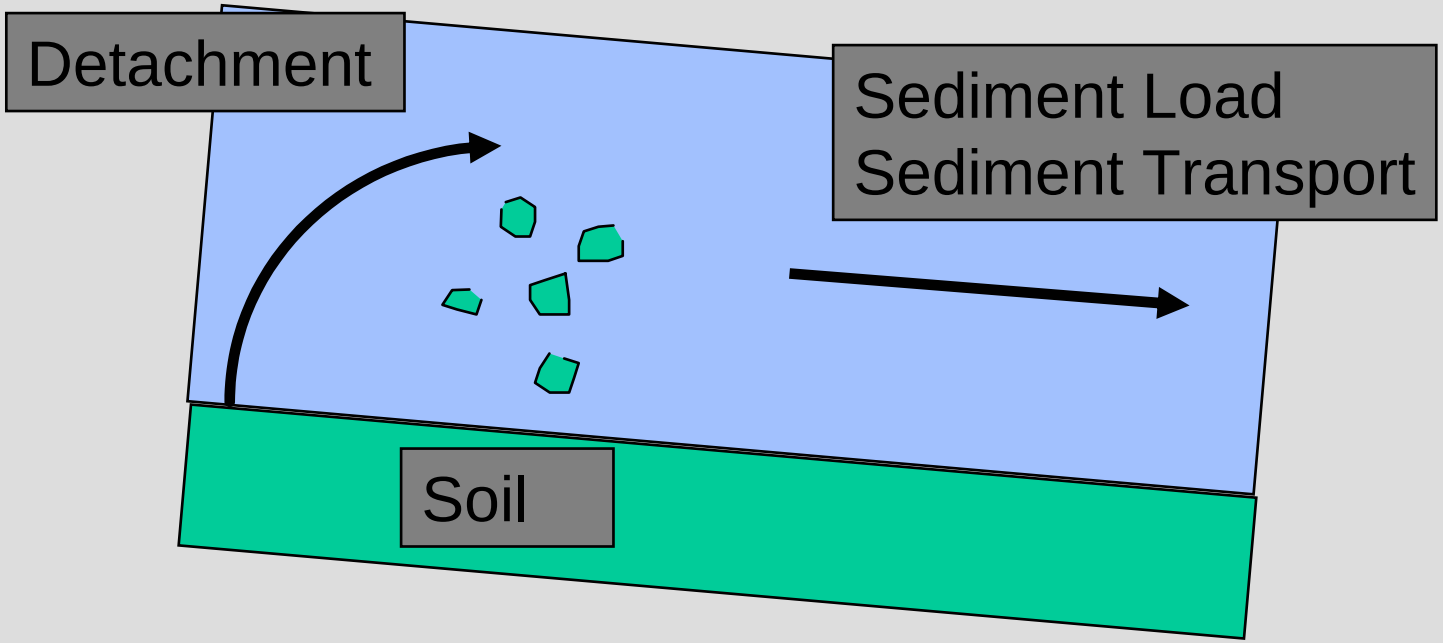
Ellison, 1944

- Erosive Agents
  - Raindrop impact
  - Overland flow surface runoff from rainfall

DETACHMENT

- Removal of soil particles from soil surface
- Adds to the sediment load
  - Sediment load: Rate sediment is transported downslope by runoff

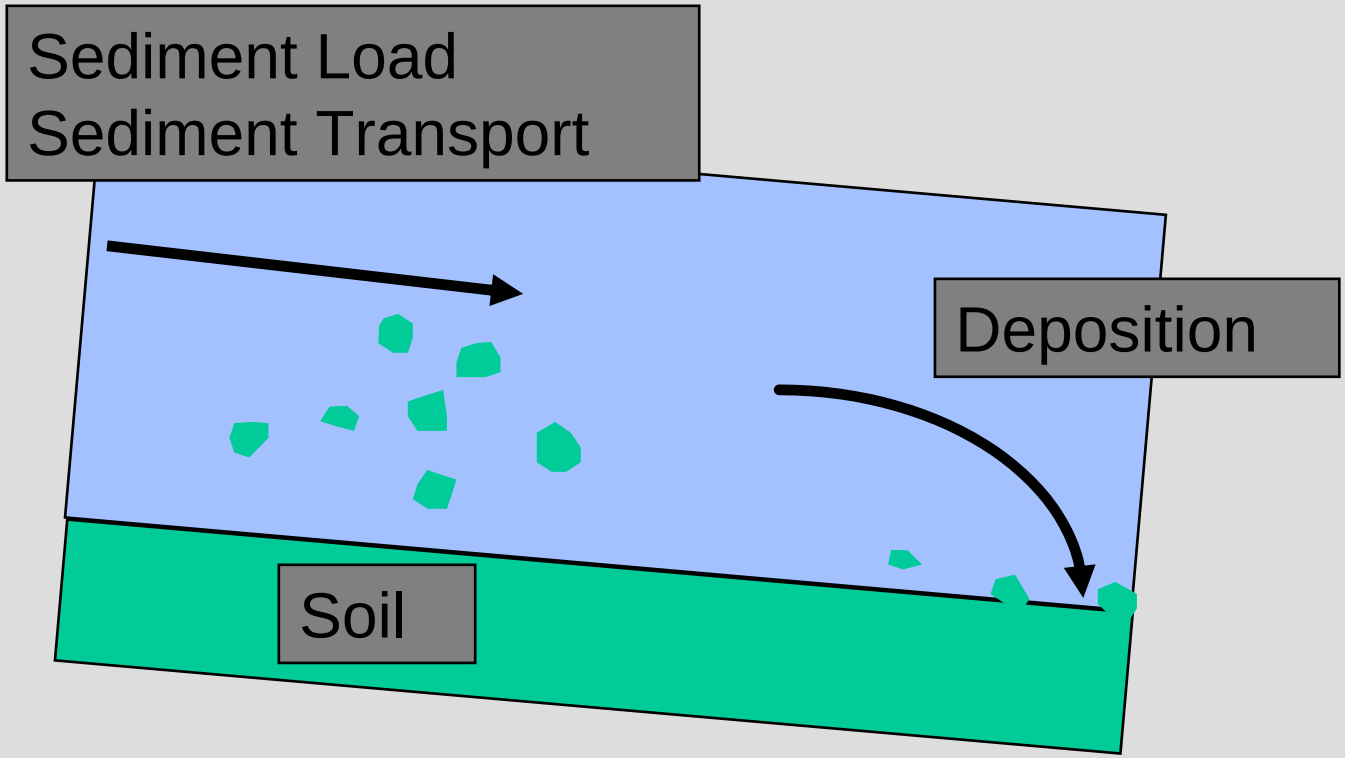
DETACHMENT



DEPOSITION

- Reduces the sediment load
- Adds to the soil mass
- Local deposition
  - Surface roughness depressions
  - Row middles
- Remote deposition
  - Concave slope
  - Strips
  - Terraces

DEPOSITION

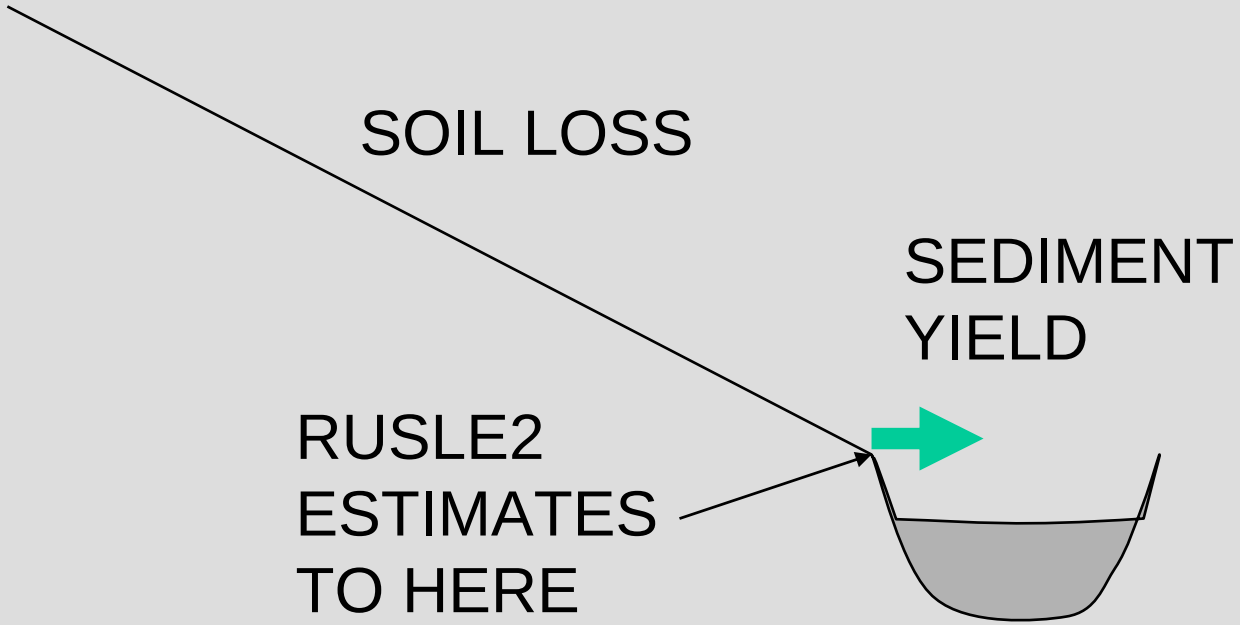


TYPES OF EROSION

- Interrill and rill (sheet-rill)
- Ephemeral gully
- Permanent, incised (classical) gully
- Stream channel

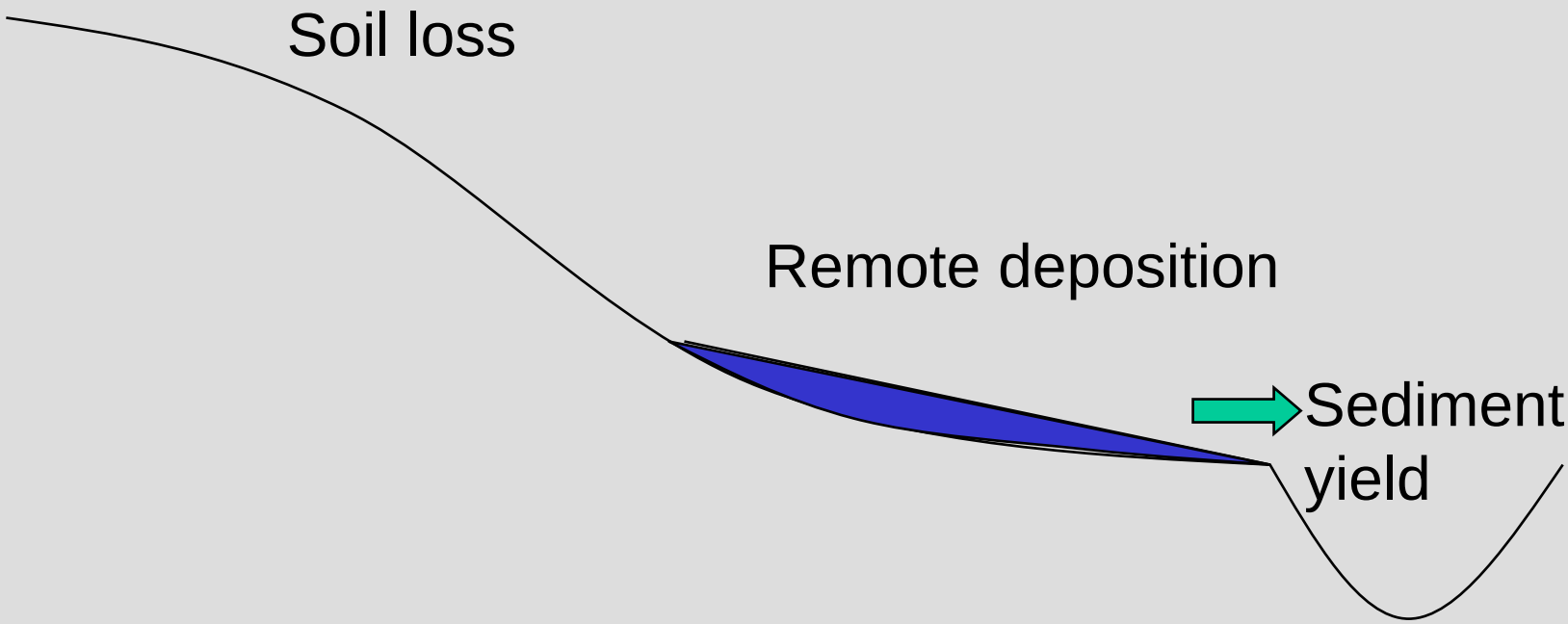
DEFINITIONS

Simple Uniform Slope



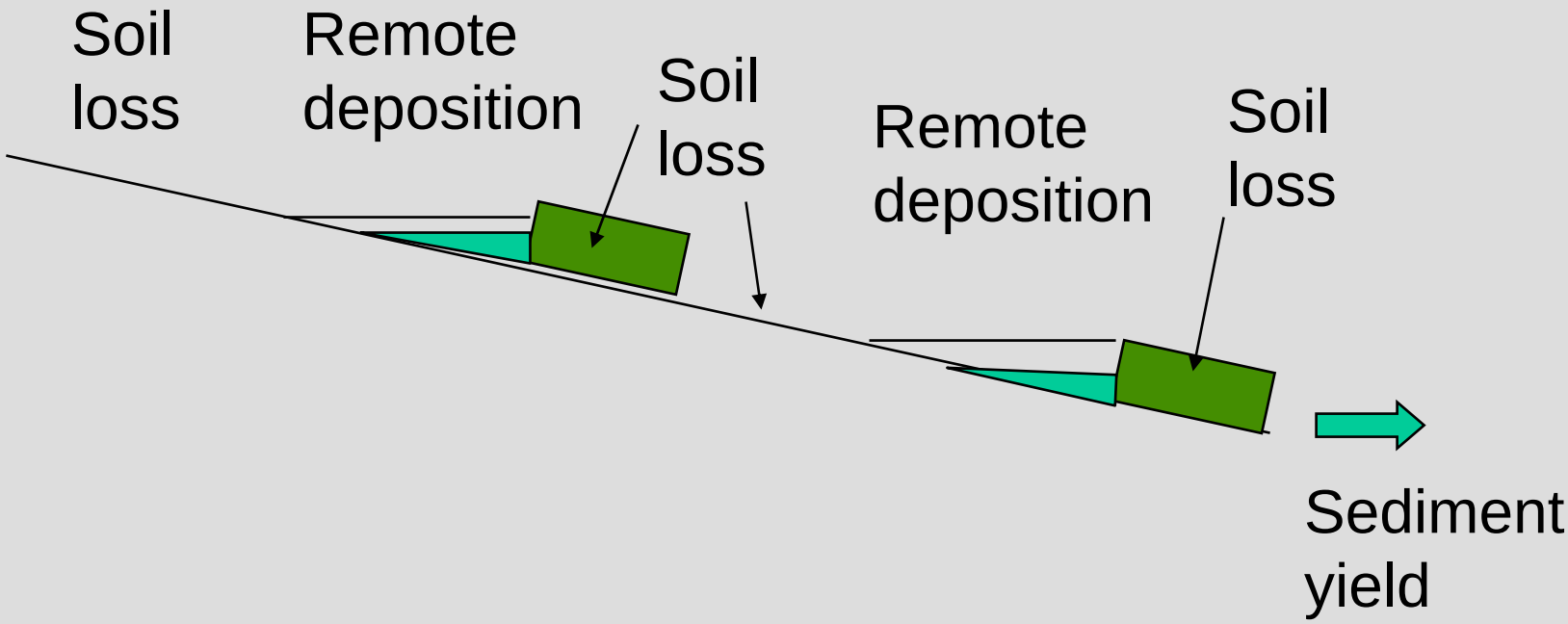
DEFINITIONS

Complex Slope



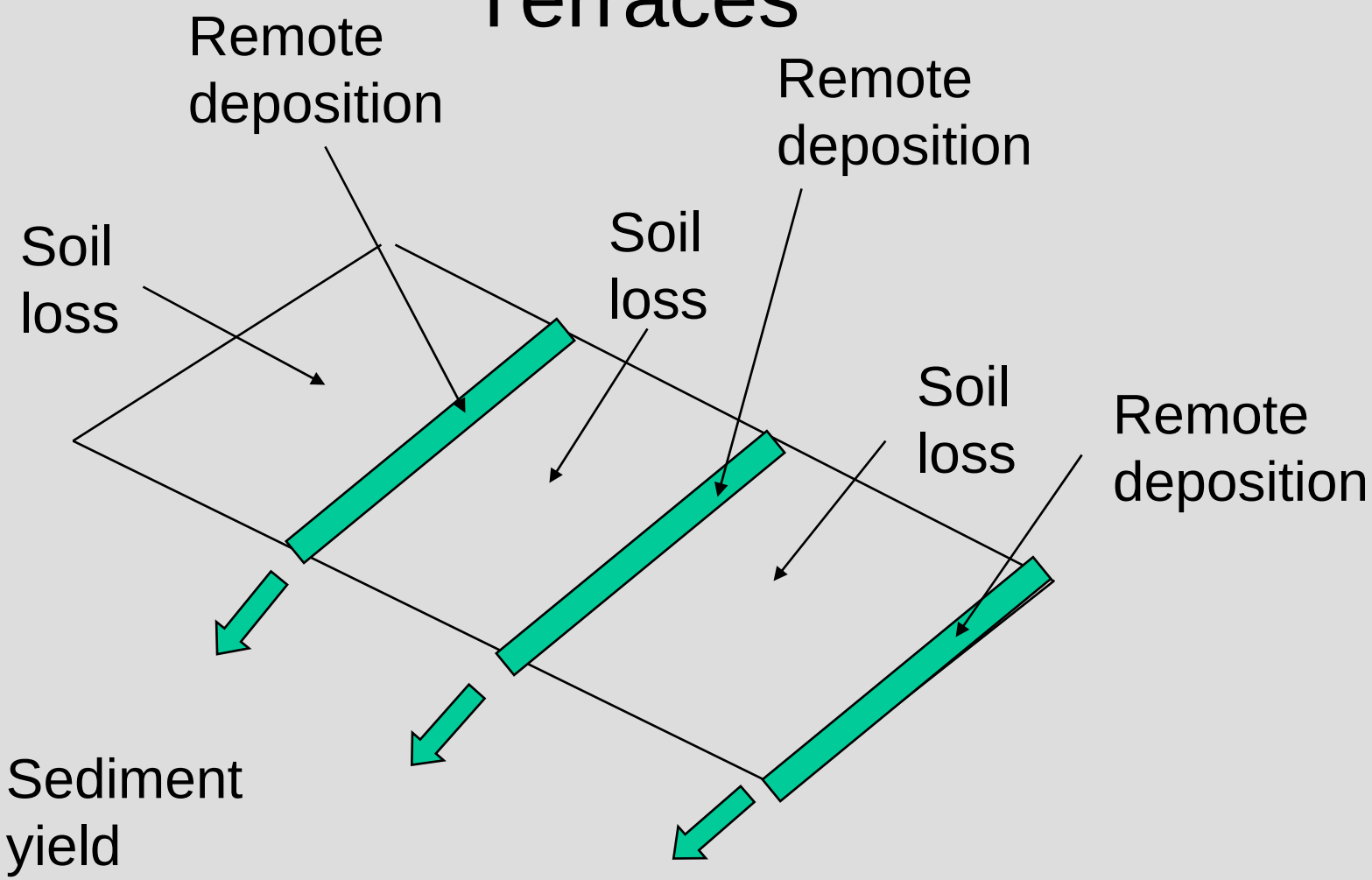
DEFINITIONS

Strips



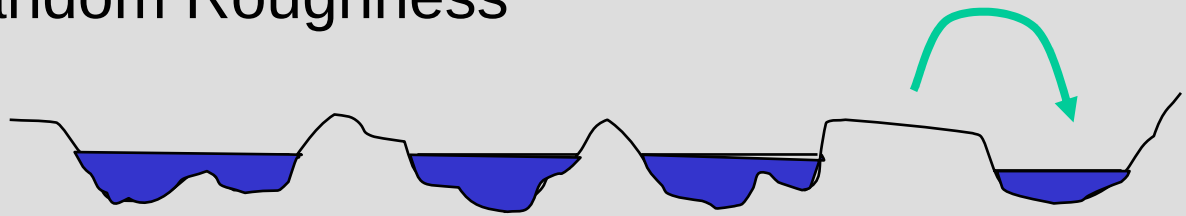
DEFINITIONS

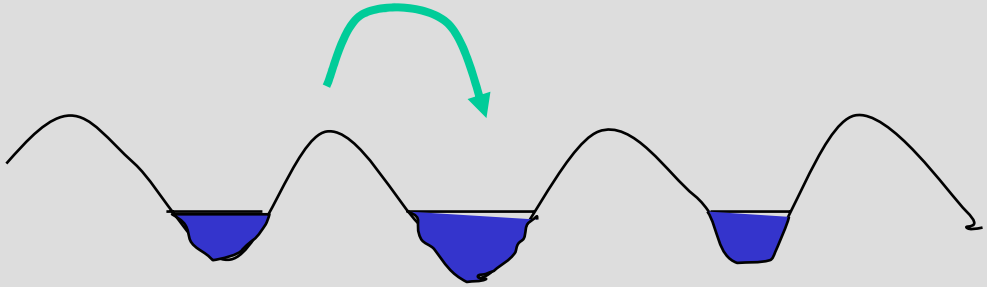
Terraces



LOCAL DEPOSITION

Random Roughness





Ridges-Furrows

EROSION IS A CONCERN

- Degrades soil resource
  - Reduces soil productivity
  - Reduces soil organic matter
  - Removes plant nutrients
- Causes downstream sedimentation
- Produces sediment which is a pollutant
- Produces sediment that carries pollutants

WHERE EROSION CAN BE A PROBLEM

- Low residue crops
- Conventional tillage
- Rows up/down steep slopes
- Overgrazed pasture
- Disturbed land with little cover

OVERVIEW OF RUSLE2

- Where RUSLE2 applies
- Major factors affecting erosion
- RUSLE2 factors
- Confidence

Landscape

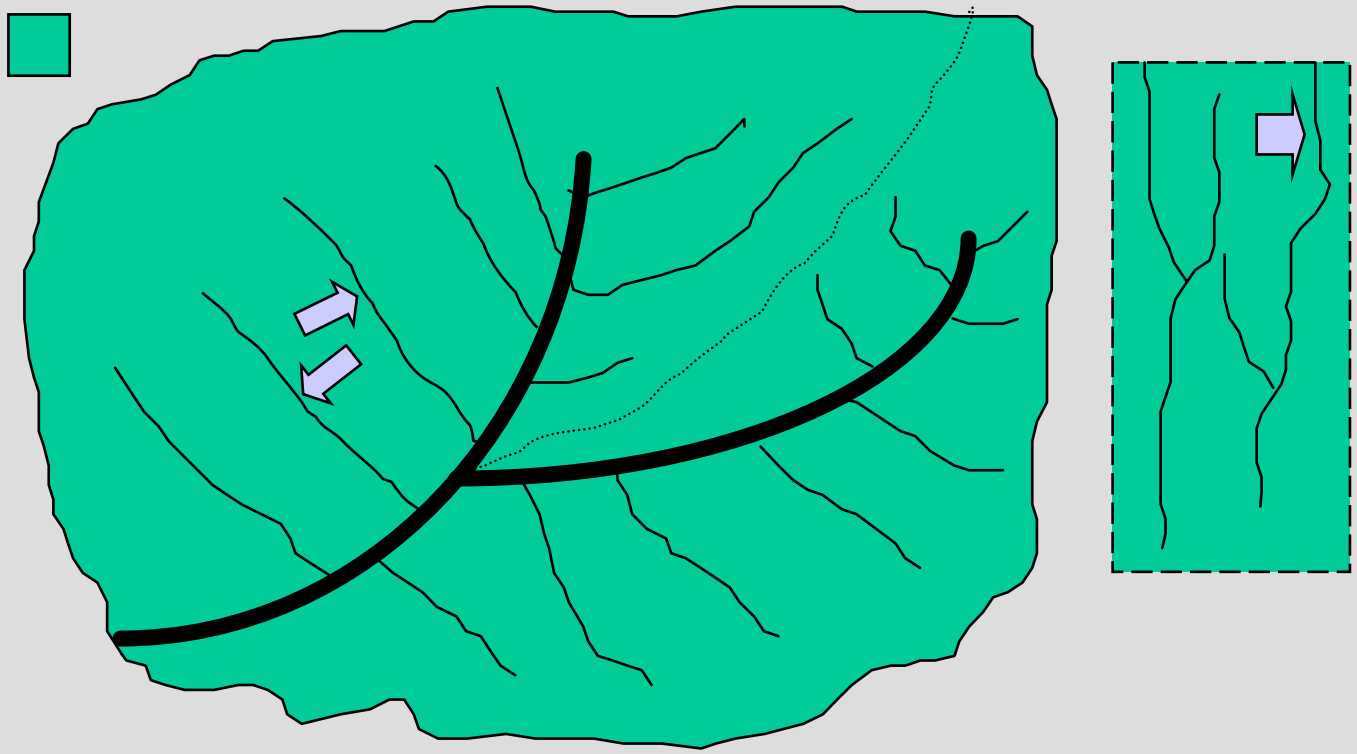
RUSLE2 Area

Overland flow

Interrill

Rill

Ephemeral Gully (Concentrated flow)



Erosion Types

I like long walks, especially when they are taken by people who annoy me.

FACTORS AFFECTING INTERILL-RILL EROSION

- Climate
- Soil
- Topography
- Land use
  - Cultural practices
  - Supporting practices

RUSLE2 FACTORS

Daily Soil Loss

$$a = r\ k\ l\ s\ c\ p$$

r - Rainfall/Runoff

k - Soil erodibility

l - Slope length

s - Slope steepness

c - Cover-management

p - Supporting practices

Average annual soil loss = sum of daily soil loss values

EROSIVITY - R

- Single storm
  - Energy x 30 minute intensity
  - Fundamentally product of rainfall amount x intensity
- Annual-sum of daily values
- Average annual-average of annual values
- Daily value=average annual x fraction that occurs on a given day

EROSIVITY - R

Measure of erosivity of climate at a location

Las Vegas, NV	8
Phoenix, AZ	22
Denver, CO	40
Syracuse, NY	80
Minneapolis, MN	110
Chicago, IL	140
Richmond, VA	200
St. Louis, MO	210
Dallas, TX	275
Birmingham, AL	350
Charleston, SC	400
New Orleans, LA	700

SOIL ERODIBILITY - K

- Measure of soil erodibility under standard unit plot condition
  - 72.6 ft long, 9% steep, tilled continuous fallow, up and down hill tillage
- Independent of management
- Major factors
  - Texture, organic matter, structure, permeability

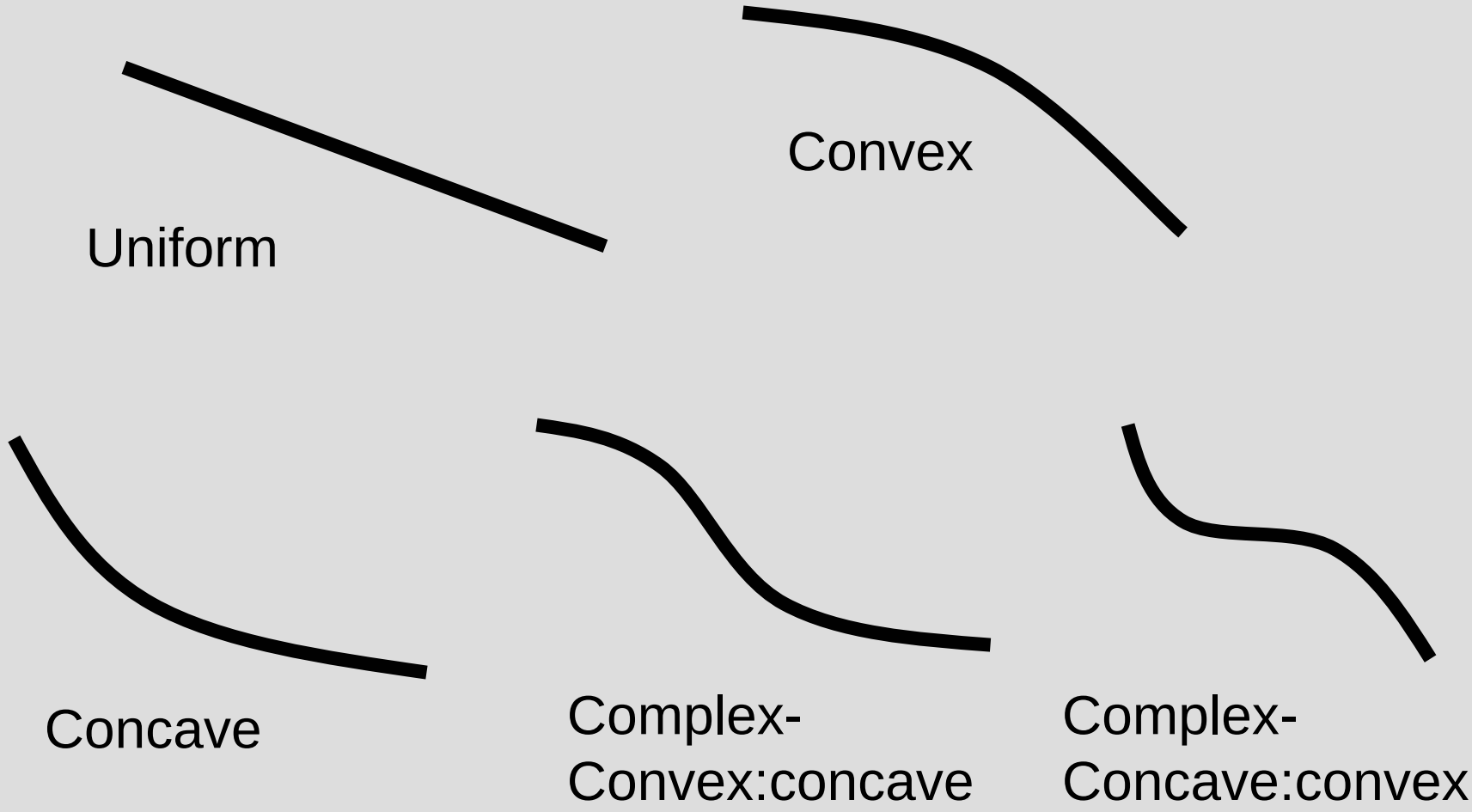
SOIL ERODIBILITY - K

- Effect of texture
  - clay (0.1 - 0.2) resistant to detachment
  - sand (0.05 - 0.15) easily detached, low runoff, large, dense particles not easily transported
  - silt loam (0.25 - 0.35) moderately detachable, moderate to high runoff
  - silt (0.4 -0.6) easily detached, high runoff, small, easily transported sediment

TOPOGRAPHY

- Overland flow slope length
- Slope lengths for eroding portions of hillslopes
- Steepness
- Hillslope shape

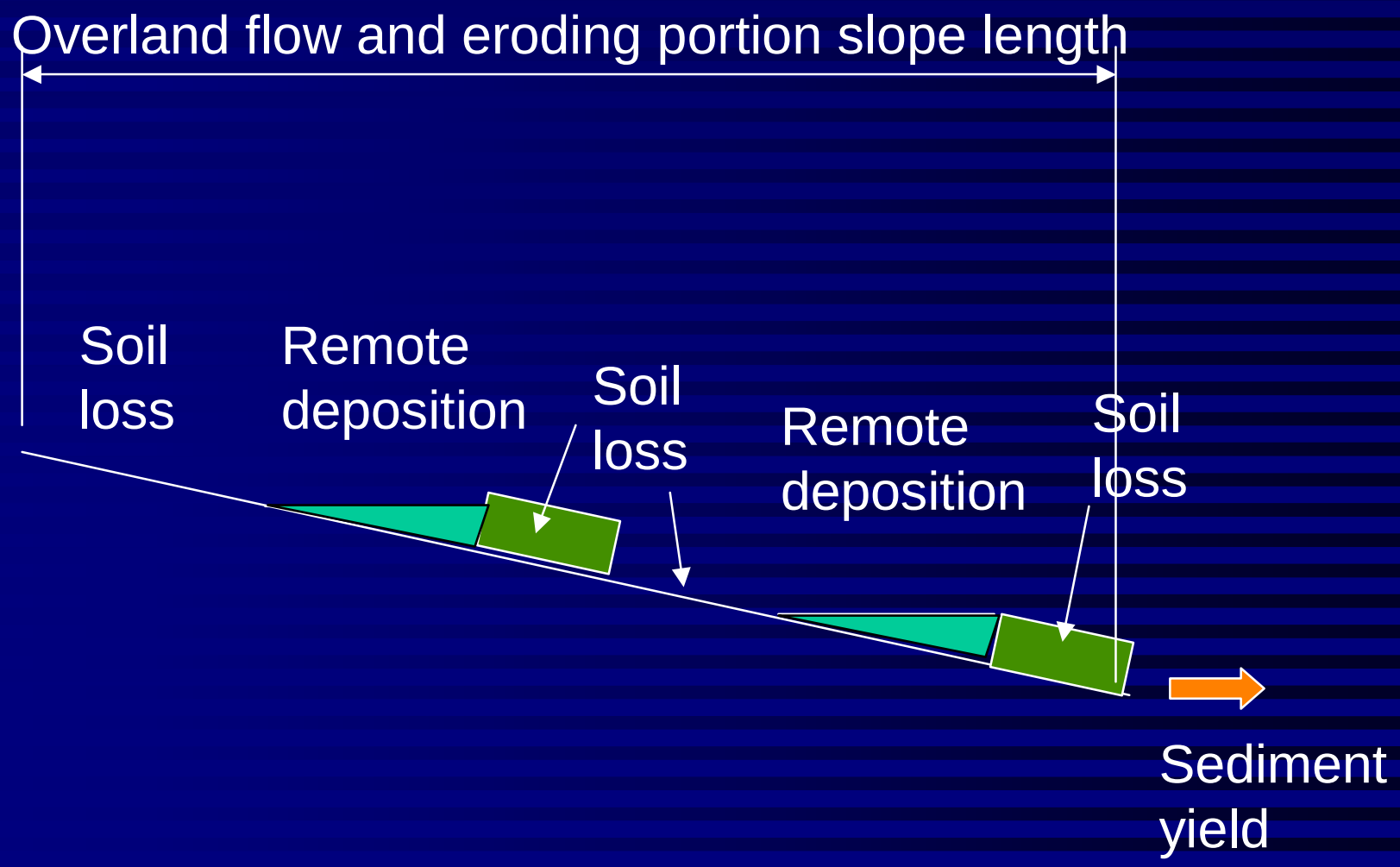
Hillslope Shape



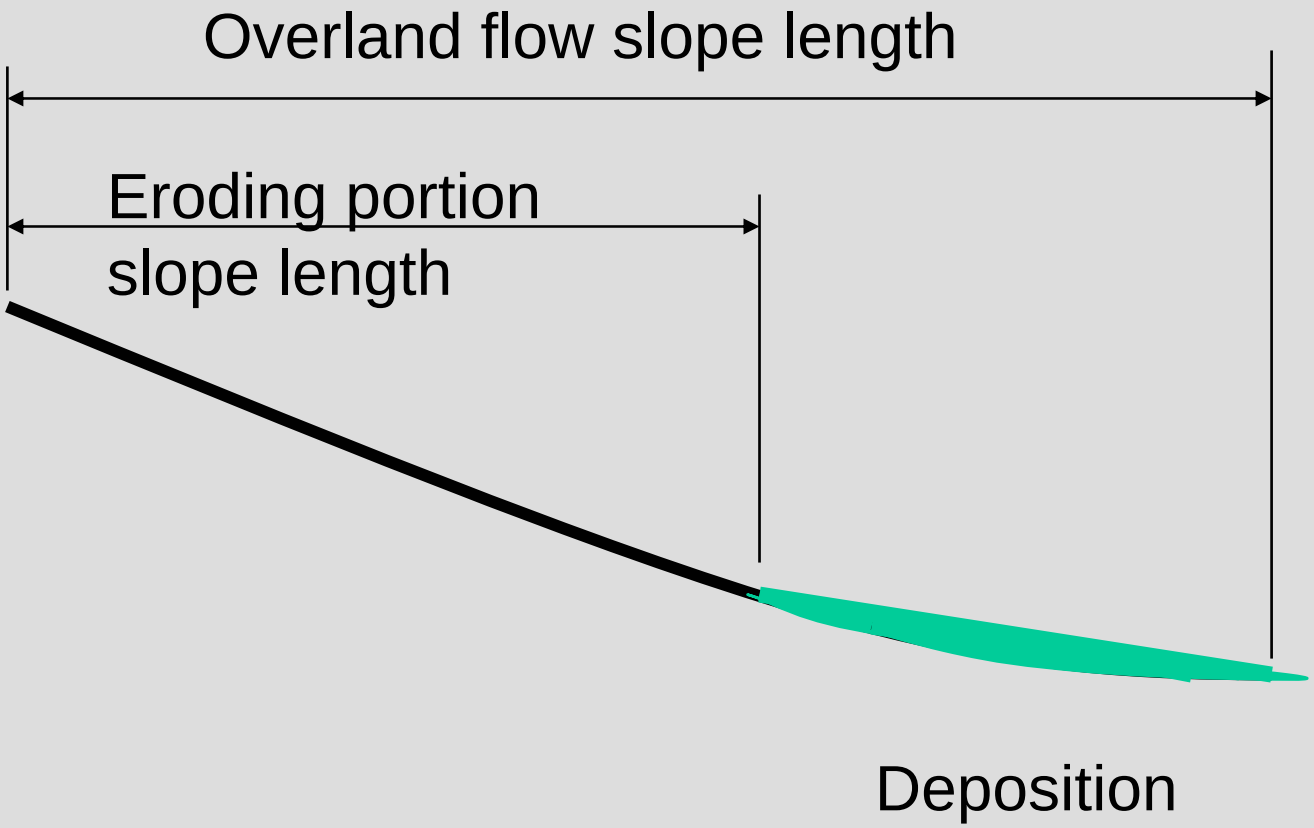
Slope Length for Eroding Portion of Slope

- Only works for simple slopes
- Traditional definition
  - Distance from origin of overland flow to concentrated flow or to where deposition begins
  - Definition is flawed for strips and concave:convex slopes
- Best approach: Use overland flow slope length and examine RUSLE2 slope segment soil loss values

Slope Lengths for Strips



Slope Length for Concave Slope



Rule of Thumb for Deposition Beginning on Concave Slopes

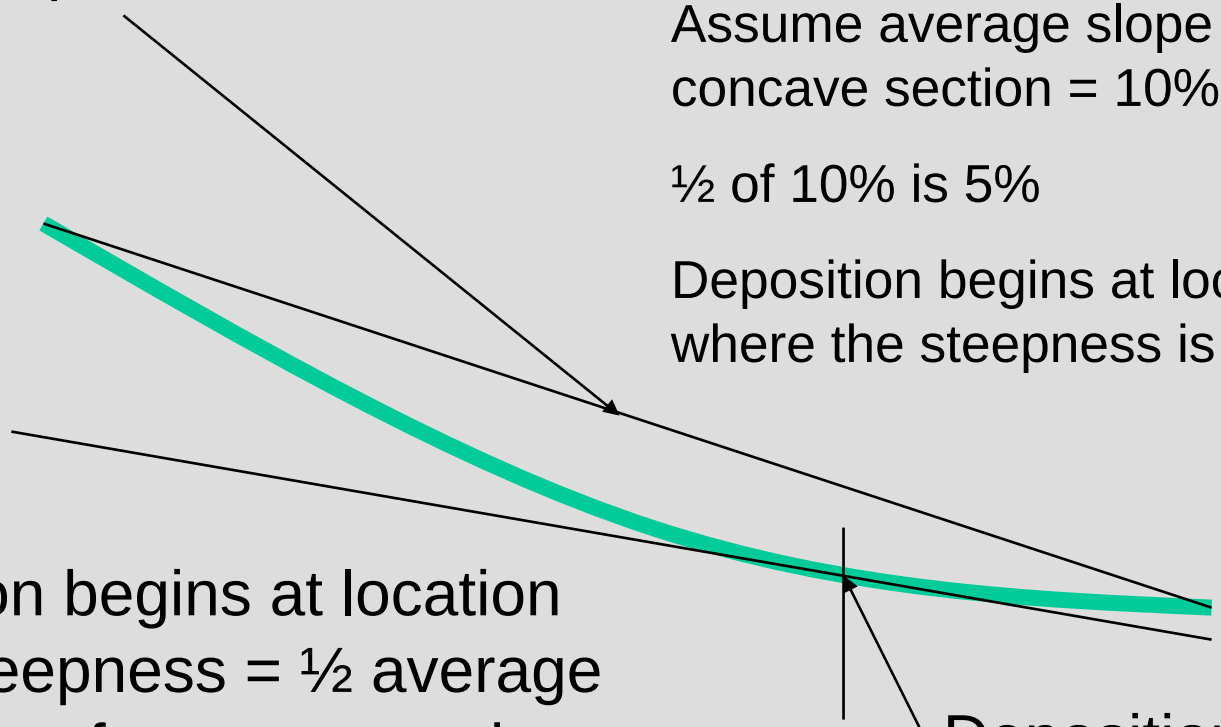
Average steepness of concave portion

Example:

Assume average slope of concave section = 10%

½ of 10% is 5%

Deposition begins at location where the steepness is 5%



Deposition begins at location where steepness = ½ average steepness of concave portion

Deposition begins

Standard Slopes and Lengths for Planning

% Slope	Length
0-5	250 ft
6-10	200 ft
11	175 ft
12-13	150 ft
14-15	125 ft
16	110 ft
17-18	100 ft
19	90 ft
20	80 ft

Frank & Ernest
JUST THINK HOW WELL I'D BE PLAYING IF I WEREN'T TOO SICK TO GO TO WORK TODAY.
THAVES 9-19
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Land Use

- Cover-management
- Supporting practices

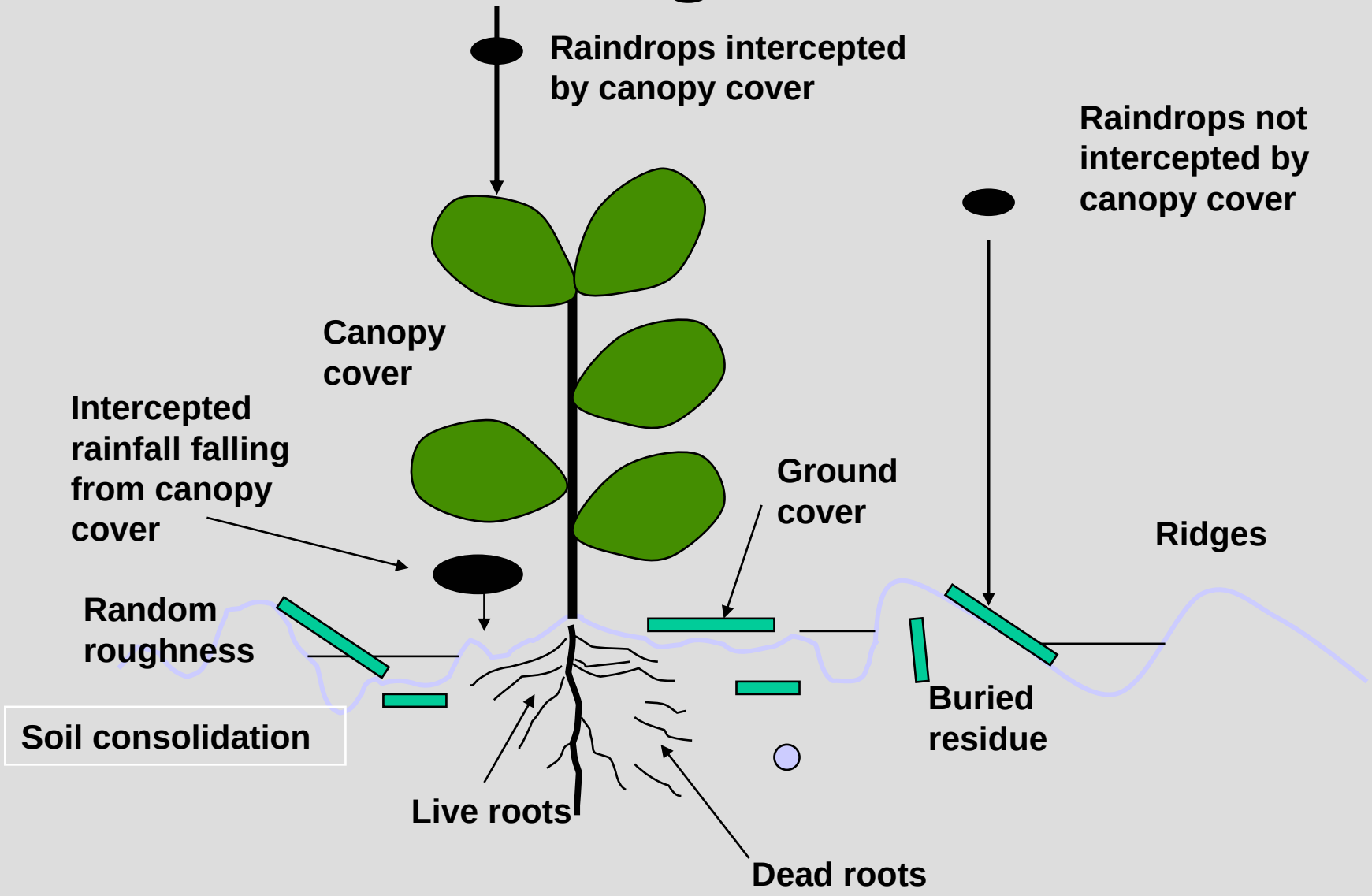
Cover-Management

- Vegetative community
- Crop
- Crop rotation
- Conservation tillage
- Application of surface and buried materials (mulch, manure)

Cover-Management Subfactors

- Canopy
- Ground cover
- Surface Roughness
- Ridges
- Below ground biomass
  - Live roots, dead roots, buried residue
- Soil consolidation

Cover-Management Effects



Canopy

- Cover above soil surface that intercepts rainfall but does not touch soil surface to affect surface flow
- Main variables
  - Percent of surface covered by canopy
  - Effective fall height

Ground Cover

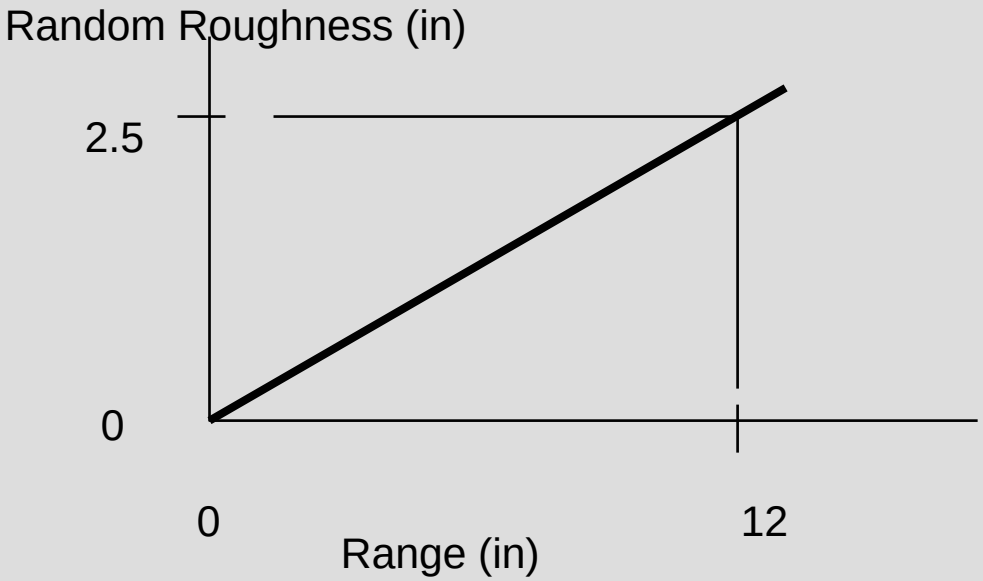
- Cover directly in contact with soil surface that intercepts raindrops, slows runoff, increases infiltration
- Examples
  - Live plant material
  - Plant residue and litter
  - Applied mulch
  - Stones

Random Roughness

- Creates depressions
- Usually creates erosion resistant clods
- Increases infiltration
- Increases hydraulic roughness that slows runoff, reducing detachment and transport capacity

Random Roughness

- Standard deviation of micro-elevations
- Roughness at tillage function of:
  - Implement
  - Roughness at time of disturbance and tillage intensity
  - Soil texture
  - Soil biomass
- Decays with:
  - Rainfall amount
  - Interrill erosion



Below ground biomass

- Live roots
  - Distributed non-uniformly within soil
- Dead roots
- Buried residue
  - Half of material decomposed on surface is added to upper 2 inches
  - Incorporated biomass

Soil Consolidation

- Overall, freshly tilled soil is about twice as erodible as a fully consolidated soil
- Erodibility decreases with time
  - Seven years in the Eastern US
  - Depends on rainfall in Western US, up to 25 years

Supporting Practices

- Contouring
- Strip systems
  - Buffer, filter, strip cropping, barriers
- Terrace/Diversion
- Impoundments
- Tile drainage

Supporting Practices

- Contouring/Cross-slope farming
- Strips/barriers
  - Rotational strip cropping, buffer strips, filter strips, grass hedges, filter fence, straw bales, gravel bags
- Terraces/diversions
- Impoundments

Contouring

- Redirects runoff
- May not have much effect using long slope lengths
- Effectiveness depends on ridge height
  - (no ridge height, then no contouring effect)

Contouring (continued)

- Function of:
  - Ridge height
  - Row grade
  - Cover-management
  - Hydrologic soil group
  - Storm severity (10 yr EI)
- Varies with time
  - Tillage that form ridges
  - Decay of ridges

Critical Slope Length

- If slope length longer than critical slope length, contouring fails allowing excessive rill erosion
- Function of:
  - Storm severity, slope steepness, cover-management, EI distribution
- Critical slope length extensions below strips depend on degree that strip spreads runoff
- Terraces are used if changing cover-management or strips are not sufficient
- Soil disturbance required to restore failed contouring

Buffer/Filter Strips

- Narrow strips of dense vegetation (usually permanent grass) on contour
  - Effective by inducing deposition (partial credit) and spreading runoff
  - Most of deposition is in backwater above strip
- Buffer strips
  - Multiple strips
  - Water quality-must have strip at bottom and this strip twice as wide as others
- Filter strip-single strip at bottom

Rotational Strip Cropping

- Equal width strips on contour
- Strips are rotated through a crop rotation cycle
- Offset starting dates among strips so that strips of close growing vegetation separate erodible strips
- Benefit:
  - Deposition (full credit)
  - Spreading runoff
  - Reduced ephemeral gully erosion not credited in RUSLE2

Terraces

- Ridges and channels periodically placed along hillslope that divides hillslope into shorter slope lengths except for widely spaced parallel terraces that may have not effect on slope length
- Benefit:
  - Shorten slope length and trap sediment
  - Runoff management system
- Evenly spaced
  - May or may have a terrace at bottom
- Maintenance required to deal with deposition

Diversions

- Ridges and channels placed at strategic locations on hillslope to shorten slope length
  - Reduce runoff rate and rill erosion
- Generally designed with a steepness sufficiently steep that no deposition occurs but not so steep that erosion occurs

Significant Change

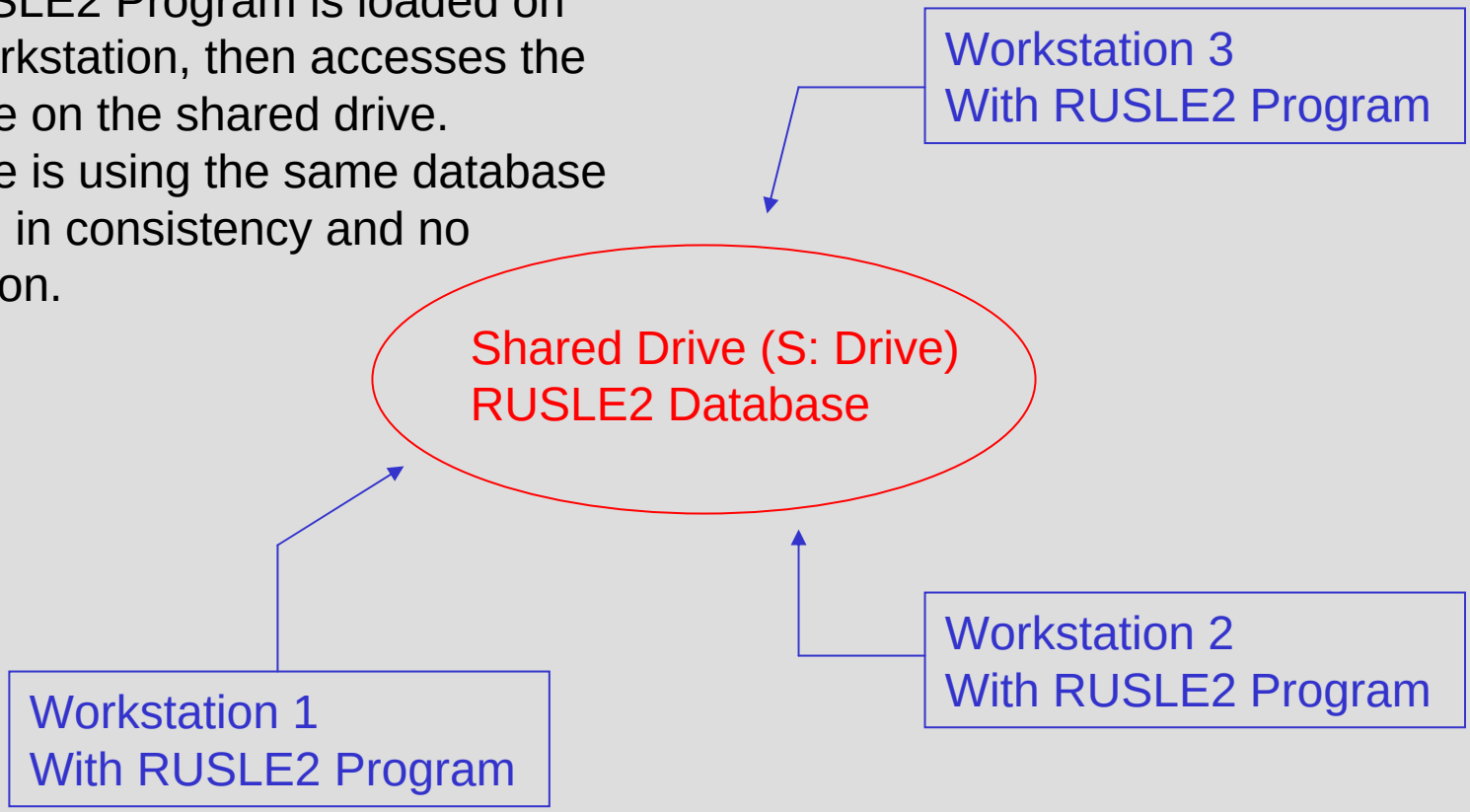
- Rule of thumb:
  - A change in a RUSLE2 soil loss estimate by more than 10% is considered significant and meaningful in terms of representing main effect.
  - Any change less than 10% is not considered significant in general
- The accuracy for RUSLE2 representing how main effects affect soil loss is much better than the absolute accuracy for RUSLE2 estimating soil loss at any particular location and landscape condition.

TEMPORAL APPLICABILITY

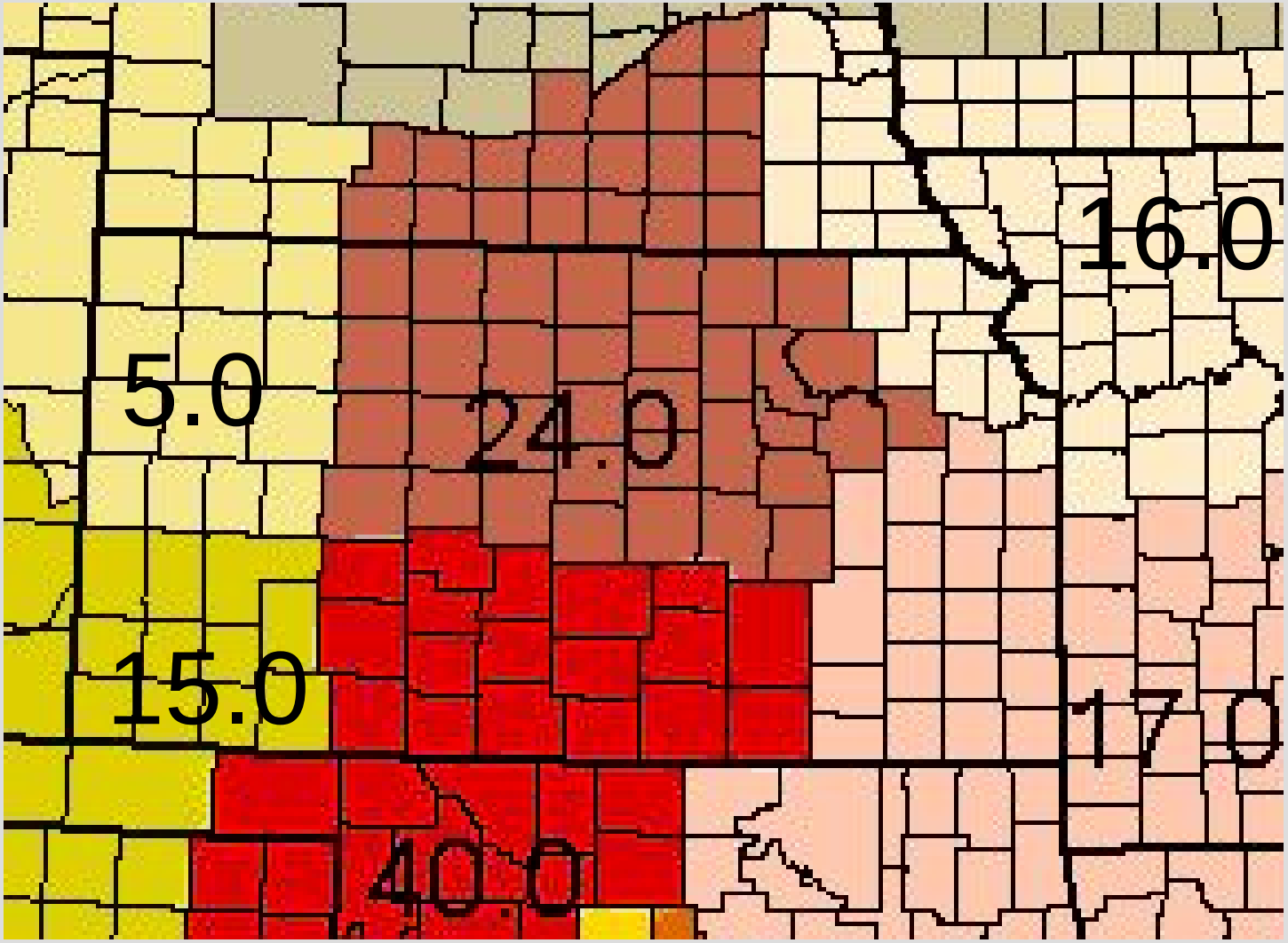
- Best: Average annual, average annual season, average annual single day
- Least: Single storm provided great care used, generally not recommended

RUSLE2 FO Setup

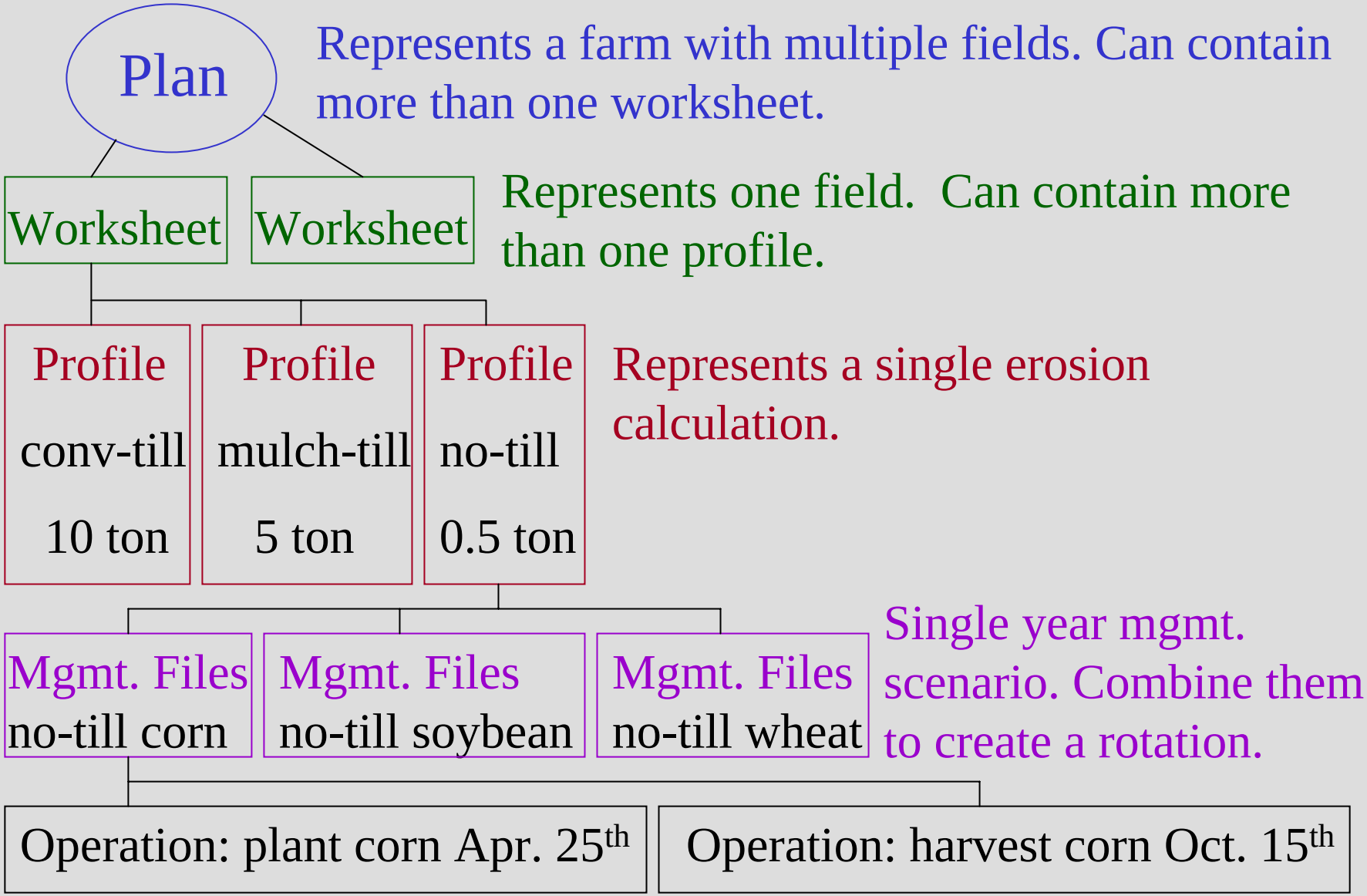
The RUSLE2 Program is loaded on each workstation, then accesses the database on the shared drive. everyone is using the same database resulting in consistency and no duplication.



Workstations with RUSLE2 loaded on it will vary with each FO depending on need.



RUSLE2 Crop Management Zones (CMZ) Map


Plan
Represents a farm with multiple fields. Can contain more than one worksheet.
Worksheet
Worksheet
Represents one field. Can contain more than one profile.
Profile
conv-till
10 ton
Profile
mulch-till
5 ton
Profile
no-till
0.5 ton
Represents a single erosion calculation.
Mgmt. Files
no-till corn
Mgmt. Files
no-till soybean
Mgmt. Files
no-till wheat
Single year mgmt. scenario. Combine them to create a rotation.
Operation: plant corn Apr. 25th
Operation: harvest corn Oct. 15th

RUSLE2 Version 1.15.2.0 (Feb 5 2004)

File Database Edit View Options Window Help

Auto update

Change Database

Autofix -- automatically fix broken links based on name

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- climates
- contour-systems
- deep-soil-drain-systems
- erosivities
- hydraulic-element-flow-paths
- hydraulic-element-systems
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- managements
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- plans
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- residues
- soils
- strip-barrier-systems
- structures-barriers
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Close

For Help, press F1

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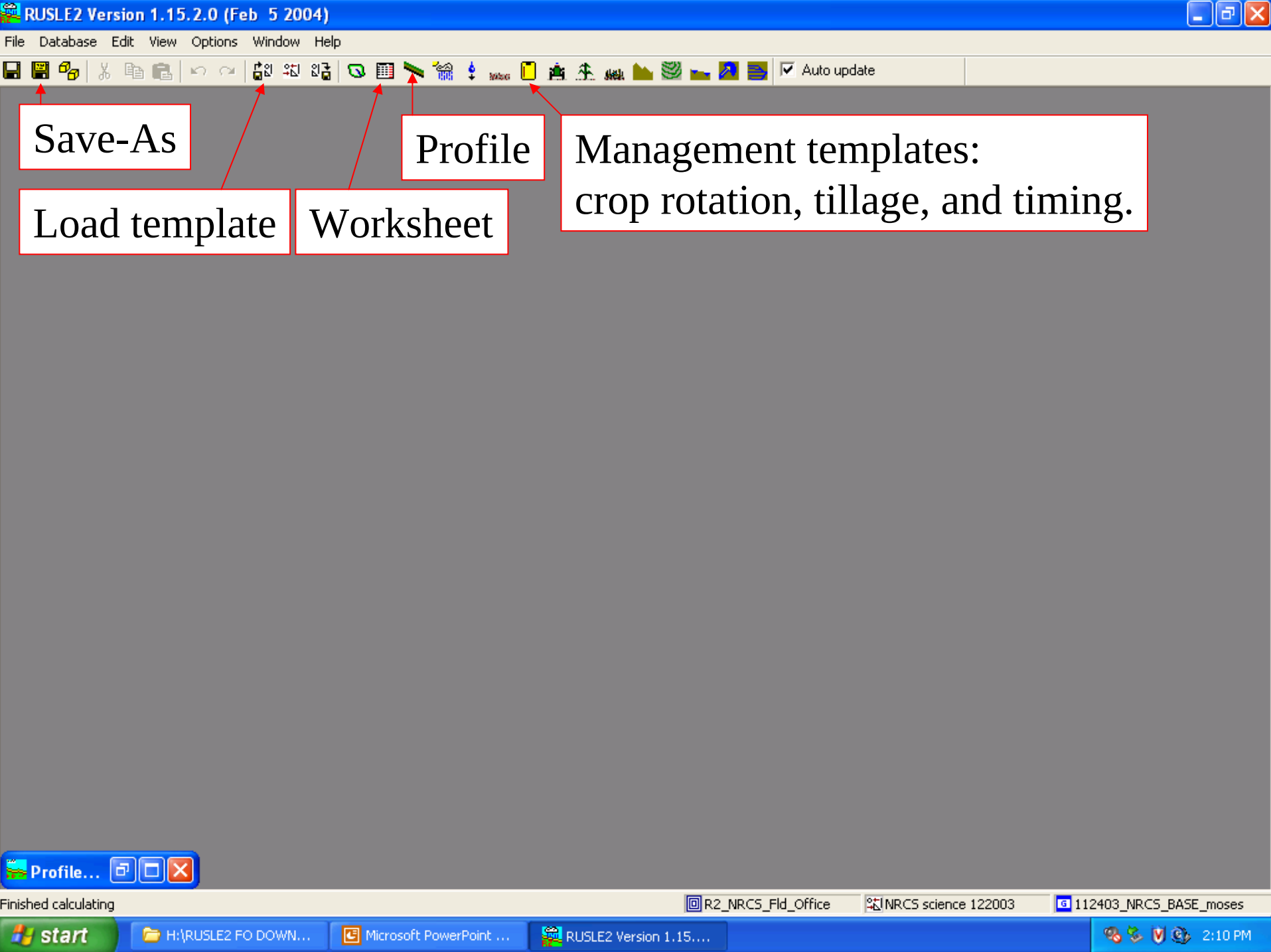
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File Database Edit View Options Window Help
Auto update
Save-As
Load template
Worksheet
Profile
Management templates:
crop rotation, tillage, and timing.
Profile...
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