RUSLE2

REVISED UNIVERSAL SOIL LOSS EQUATION-Version 2

UNIT 1

Course Objectives and Topics
OBJECTIVES

- Understand erosion processes
- Learn RUSLE2 and its software
- Learn field office applications of RUSLE2
OVERVIEW OF EROSION

- Definition of erosion
- Erosion processes
- Types of erosion
- Why erosion is a concern
- Uses of erosion prediction tools
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
DEPOSITION

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

- Interrill and rill (sheet-rill)
- Ephemeral gully
- Permanent, incised (classical) gully
- Stream channel
- Mass movement
- Geologic
DEFINITIONS
Simple Uniform Slope

SOIL LOSS

SEDIMENT YIELD

RUSLE2 ESTIMATES TO HERE
DEFINITIONS

Complex Slope

- Soil loss
- Remote deposition
- Sediment yield
DEFINITIONS

Complex Slope

Soil loss

Remote deposition

Soil loss

Sediment yield
DEFINITIONS

Soil loss

Remote deposition

Sediment yield

Soil loss

Remote deposition

Soil loss

Strips
DEFINITIONS

Terraces

Remote deposition

Soil loss

Remote deposition

Soil loss

Remote deposition

Soil loss

Remote deposition

Sediment yield
LOCAL DEPOSITION

Random Roughness

Ridges-Furrows
Credit for Deposition

Local Deposition
  Full credit

Remote Deposition
  Partial credit
  Amount
  Location
  Spacing of terraces
SEDIMENT CHARACTERISTICS

- **Particle Classes**
  - Primary clay, primary silt, small aggregate, large aggregate, primary sand

- **At Detachment**
  - Distribution of classes function of texture
  - Diameter of small and large aggregates function of texture

- **After Deposition**
  - Sediment enriched in fines
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
- Low maintenance pasture
- Disturbed land with little cover
EROSION PREDICTION AS A TOOL

- Guide management decisions
- Evaluate impact of erosion
- Inventory soil erosion
- Conservation planning
EROSION PREDICTION AS A TOOL

- Concept:
  - Estimate erosion rate
  - Evaluate by ranking
  - Evaluate against quality criteria
- Tool: RUSLE2
- Quality Criteria: Soil loss tolerance
PLANNING VARIABLES

- Soil loss on eroding portions of hillslope
- Detachment (sediment production) on hillslope
- Conservation planning soil loss for hillslope
- Ratio of segment soil loss to soil tolerance adjusted for segment position
- Sediment yield from hillslope/terraces
UNIT 3

Overview of RUSLE2
OVERVIEW OF RUSLE2
(Revised Universal Soil Loss Equation-Version 2)

- Where RUSLE2 applies
- Major factors affecting erosion
- RUSLE2 factors
- RUSLE2 background
FACTORS AFFECTING INTERILL-RILL EROSION

- Climate
- Soil
- Topography
- Land use
  - Cultural practices
  - Supporting practices
RUSLE2 FACTORS

Daily Soil Loss

\[ a = r k l s c p \]

Daily Factors

- \( r \) - 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

Different formulation from USLE and RUSLE1
RUSLE FACTORS
(Sediment Production)

- Climate \( r \)
- Soil \( k \)
- Topography \( l_s \)
- Land Use and \( l_{scp} \)

Management
RUSLE FACTORS

\[ A = f(\text{erodibility, erosivity}) \]

- Erosivity – rklscp
- Erodibility - klc
RUSLE FACTORS

(Keep in mind that RUSLE2 operates on a daily basis)

Unit Plot Concept

\[ a = rk \cdot lscp \]

rk - Unit plot soil loss
(dimensions)

lscp - Adjusts unit plot soil loss
(dimensionless)
Relation of deposition to transport capacity and sediment load on a complex slope

Transport capacity = sediment load

Sediment production less than transport capacity

Deposition because sediment production exceeds transport capacity
Relationship of Deposition to Transport Capacity and Sediment Load for a Grass Strip

- Transport capacity
- Deposition region
- Deposition ends where transport capacity = sediment load
- Erodible soil surface
- Dense grass
- Sediment load
How Deposition at a Grass Strip Affects Sediment Characteristics

<table>
<thead>
<tr>
<th>Particle class</th>
<th>Before (%)</th>
<th>After (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary clay</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>Primary silt</td>
<td>24</td>
<td>58</td>
</tr>
<tr>
<td>Small aggreg.</td>
<td>36</td>
<td>14</td>
</tr>
<tr>
<td>Large aggreg.</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>Primary sand</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

SDR = 0.2

Note how deposition enriches sediment in fines.
RUSLE2 BACKGROUND
Combines empirical field data-process based equations
(natural runoff and rainfall simulator plots)

- Zingg’s equation (1940)
- Smith and Whit’s equation (1947)
- AH-282 (1965)
- “Undisturbed land” (1975)
- AH-537 (1978)
- Disturbed forestland (1980)
- RUSLE1 (1992)
- AH703 (1997)
- RUSLE2 (2001)
RUSLE2 APPLICATIONS

- Cropland
- Pastureland
- Rangeland
- Disturbed forest land
- Construction sites
- Surface mine reclamation
- Military training lands
- Parks
- Waste disposal/landfills
SUMMARY

- Factors affecting erosion
- RUSLE2 factors
- RUSLE2 background
Unit 4

RUSLE2 Factors
RUSLE2 Factors

(Keep in mind that factors are on a daily basis)

- r- erosivity factor
- k- erodibility factor
- l- slope length factor
- s- slope steepness factor
- c- cover-management factor
- p- supporting practices factor
EROSIVITY

■ 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
Erosivity Varies During Year

% El on Day

Day in Year
10 yr EI

- Reflects locations where intense, erosive storms occur that have a greater than proportional share of their effect on erosion
  - Effectiveness and failure of contouring
  - Effect of ponding on erosivity
  - Sediment transport capacity
Reduction by Ponding

- Significant water depth reduces erosivity of raindrop impact

- Function of:
  - 10 yr El
  - Landslope
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
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
Time Variable K

- Varies during year
- High when rainfall is high
- Low when temperature is high
- Very low below about 25 oF
Daily Soil Erodibility Value

Time Variable K

Base K value = 0.37

Day in Year

Daily Soil Erodibility Value

CA
SD
MA
TN
TOPOGRAPHY

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

- Uniform
- Convex
- Concave
- Complex-Convex:concave
- Complex-Concave:convex
Overland Flow Slope Length

- Distance from the origin of overland flow to a concentrated flow area
- This slope length used when the analysis requires that the entire slope length be considered.
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

Overland flow and eroding portion slope length

Soil loss
Remote deposition
Soil loss
Remote deposition
Soil loss

Sediment yield
Slope Length for Concave Slope

- Overland flow slope length
- Eroding portion slope length
- Deposition
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
Slope Length for Concave:Convex Slope

Overland flow slope length and slope length for lower eroding portion of slope

Slope length for upper eroding portion of slope

Deposition
Insert figures from AH703 to illustrate field slope lengths
Basic Principles

- Sediment load accumulates along the slope because of detachment.
- Transport capacity function of distance along slope (runoff), steepness at slope location, cover-management, storm severity (10 yr EI).
- Deposition occurs where sediment load becomes greater than transport capacity.
Detachment Proportional to Slope Length Factor

- **Slope length effect**
  - \( I = \left(\frac{x}{72.6}\right)^n \)
  - \( x \) = location on slope
  - \( n \) = slope length exponent

- **Slope length exponent**
  - Related to rill:interrill ratio
  - Slope steepness, rill:interrill erodibility, ground cover, soil biomass, soil consolidation

- **Slope length factor varies on a daily basis**
Slope Length Effects

- Slope length effect is greater on slopes where rill erosion is greater relative to interrill erosion

- Examples:
  - Steep slopes
  - Soils susceptible to rill erosion
  - Soils recently tilled
  - Low soil biomass
Detachment Proportional to Slope Steepness Factor

Not affected by any other variable
Effect of Slope Shape on Erosion

100 ft long, 1% to 19% steepness range

![Graph showing soil loss (t/ac) along the segment along the slope for different slope shapes: Concave, Convex, Uniform. The graph illustrates the impact of slope shape on soil erosion.]
Land Use

- Cover-management
- Supporting practices
Cover-Management

- Vegetative community
- Crop
- Crop rotation
- Conservation tillage
- Application of surface and buried materials (mulch, manure)
- Increasing random roughness
Supporting Practices

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

- Canopy
- Ground cover
- Surface Roughness
- Ridges
- Below ground biomass
  - Live roots, dead roots, buried residue
- Soil consolidation
- Antecedent soil moisture (NWRR only)
Cover-Management Effects

- Raindrops intercepted by canopy cover
- Raindrops not intercepted by canopy cover
- Canopy cover
- Intercepted rainfall falling from canopy cover
- Random roughness
- Soil consolidation
- Live roots
- Antecedent soil moisture (NWRR)
- Ground cover
- Buried residue
- Dead roots
- Ridges
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
Effective Fall Height

Height to bottom of canopy

Canopy height

Effective fall height

Gradient of canopy density

Material concentrated near top
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
Ground Cover Effect

Eff = \exp(-b \times \text{\%grd cov})

b greater when rill erosion more dominant than interrill erosion

![Graph showing the relationship between ground cover percentage and ground cover effect with two curves for different values of b.](image)
Ground Cover

- Live cover depends on type of vegetation, production level, and stage
- Residue
  - Amount added by senescence, flattening, and falling by decomposition at base
  - Decomposition
    - Rainfall amount
    - Temperature
Interaction of Ground Cover and Canopy

- Canopy over ground cover is considered to be non-effective.
- As fall height approaches zero, canopy behaves like ground cover.
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

Graph showing the relationship between Random Roughness and Range (in), with a linear trend line indicating an increase from 0 to 2.5 inches as the range increases from 0 to 12 inches.
Ridges

- Ridges up and downhill increase soil loss by increasing interrill erosion

- Function of:
  - Effect increases with ridge height
  - Effect decreases with slope steepness above 6%

- Ridge height decays with rainfall amount and interrill erosion

- Effect shifts from increasing soil loss when up and downhill to decreasing soil loss when on the contour
Dead Biomass Pools

- Killing vegetation converts live standing to dead standing and live roots to dead roots
- Operations
  - Flatten standing residue to flat residue (ground cover)
  - Bury flat residue
  - Resurface buried residue
  - Redistribute dead roots in soil
  - Material spread on surface
  - Material incorporated (lower one half of depth of disturbance)
- Decomposition at base causes standing residue to fall
Decomposition of Dead Biomass

- Function of:
  - Rainfall
  - Temperature
  - Type of material
  - Standing residue decays much more slowly
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
Effect of Below Ground Biomass

- Roots mechanically hold the soil
- Add organic matter that improves soil quality, reduces erodibility, increases infiltration
- Affect rill erosion more than interrill erosion
- Effect of roots considered over upper 10 inches
- Effect of buried residue over upper 3 inches, but depth decreases to 1 inch as soil consolidates (e.g. no-till)
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
Width of Disturbance

- Width of disturbance taken into account in surface cover, random roughness, and soil consolidation
Antecedent Soil Moisture (NWRR)

- Soil loss depends on how much moisture previous cropping systems have removed from soil.
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/Cross Slope Farming

- Redirects runoff
- Fail at long slope lengths
- Effectiveness depends on ridge height
  - (no ridge height—no contouring effect)
Contouring/Cross Slope Farming (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
  - Either at bottom or not a strip at bottom
  - 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 no 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
Types of Terraces

- Contour line
- Gradient terrace
- Parallel terrace
- Sediment basin into underground tile line
- Grassed waterway
- Gradient terrace
- Parallel terrace
Deposition in Terraces

- Deposition occurs when sediment load is greater than transport capacity.
- Sediment load from sediment entering from overland area.
- Transport capacity function of grade and storm erosivity.
- Deposition depends on sediment characteristics.
- Deposition enriches sediment in fines.
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
Impoundments (Small sediment control basins)

- Deposition by settling process
- Function of:
  - Sediment characteristic of sediment load reaching impoundment
Sequencing of Hydraulic Elements

- Hydraulic elements-channels and impoundments
- Can create a system
- Can put channels-impoundments in sequence
- Examples:
  - Tile outlet terrace—channel:impoundment
  - Impoundments in series—impoundment:impoundment
Benefit of Deposition

- Depends on type of deposition
  - Local deposition gets full credit
  - Remote deposition gets partial credit
- Credit for remote deposition
  - Depends on location on hillslope
  - Deposition at end gets almost no credit
Subsurface Drainage Systems

- Reflects effects of deep drainage systems
  - Tile drainage systems
  - Lateral, deep drainage ditches

- Describe by:
  - Assigning hydrologic soil group for undrained and drained soil
  - Fraction of area drained
Unit 5
Databases

Worksheets
Profiles
Climate
EI distribution
Soil
Management
Operations
Vegetation
Residue

Contouring
Strips
Diversion/terrace, sediment basin systems
Sequence of hydraulic elements
Profiles

- Central part of a RUSLE2 soil loss estimate
  - Profile is reference to a hillslope profile
- Six things describe a profile
  - Location, soil, topography, management, supporting practice, hydraulic element system
- Topography described with profile
  - Can specify segments by length and steepness for topography, segments by length for soil, segments by length for management
- Name and save with a name
Worksheets

- Three parts: Alternative managements, practices; Alternative profiles; Profiles for a field or watershed
- Alternative management, practices
  - Compare alternatives for a single hillslope profile
- Alternative profiles
  - Compare specific hillslope profiles
- Field/Watershed
  - Compute average soil loss/sediment yield for a field or watershed
- Name and save worksheets
Concept of Core Database

- RUSLE2 has been calibrated to experimental erosion data using assumed data values for such things as cover-mass, residue at harvest, decomposition coefficient, root biomass, burial ratios, etc.
- The data used in this calibration are core calibration values
  - Data used in RUSLE2 applications must be consistent with these values
- Core databases were set up for vegetation, residue, and operations
  - NRCS data manager maintains these databases
- Working databases developed from the core databases
Critical RUSLE2 Rules

- RUSLE2 DEFINITIONS, RULES, PROCEDURES, and CORE DATA MUST BE FOLLOWED FOR GOOD RESULTS.

- Can’t independently change one set of data without recalibrating.

- Must let RUSLE2 factors and subfactors represent what they were intended to represent.
  - For example, the K factor values are not to be modified to represent the effect of organic farming. The cover-management subfactors represent the effects of organic farming.

- Don’t like these rules—then don’t use RUSLE2 because results won’t be good.
Climate

- Input values for values used to described weather at a location, county, management zone
- Principal values
  - Erosivity value, 10 yr EI value, EI distribution, monthly rainfall, monthly temperature
- Designate as Req zone and corresponding values
- Data available from NRCS National Weather and Climate Center
- Name and save by location
EI Distribution

- 24 values that describe distribution of erosivity R throughout year
- For a location, county, management zone, EI distribution zone
- Data available from NRCS Weather and Climate Center
- Name and save
Soil

- Data describes base soil conditions for unit plot conditions
- Data include erodibility value, soil texture, hydrologic soil group of undrained soil, efficient subsurface drainage, time to full soil consolidation, rock cover
- Erodibility nomograph available to estimate soil erodibility factor K
- Data available from NRCS soil survey database
- Name and same
Management

- Array of dates, operations, vegetations
- Specify if list of operations is a rotation
  - Rotation is a cycle when operations begin to repeat
  - Rotations used in cropping
  - Rotations often not used immediately after land disturbances like construction and logging during recovery period
  - Length of rotation
- Yield, depth, speeds of operations
- Added materials and amounts
- NRCS databases, Extension Service
- Name and save
Operations

- Operations describe events that change soil, vegetation, and residue conditions.
- Mechanical soil disturbance, tillage, planting, seeding, frost, burning, harvest.
- Describe using effects and the sequence of effects.
- Speed and depth.
- Source of data: Research core database, NRCS core database, working databases.
- Name and save.
Operation Effects

- No effect
- Begin growth
- Kill vegetation
- Flatten standing residue
- Disturb surface
- Live biomass removed
- Remove residue/other cover
- Add other cover
Operation Effects (cont)

■ No effect
  - Primarily used to obtain output at particular times or to add fallow years when not operation occurs in that year

■ Begin growth
  - Tells RUSLE2 to begin using data for particular vegetation starting at day zero
  - Typically associated with planting and seeding operations

■ Kill vegetation
  - Transfers mass of above ground live vegetation into standing residue pool
  - Transfers mass live roots into dead root pool
  - Typically used in harvest and plant killing operations
Operation Effects (cont)

- Flatten standing residue
  - Transfer residue mass from standing pool to flat, ground surface pool
  - Based on a flattening ratio that is a function of residue type
  - Used in harvest operations to determine fraction of residue left standing after harvest
  - Used in tillage and other operations involving traffic to determine fraction of residue left standing after operation
Operation Effects (cont)

- **Disturb surface**
  - For mechanical soil disturbance that loosens soil
  - Tillage type (inversion, mixing+some inversion, mixing only, lifting fracturing, compression) determines where residue is placed in soil and how residue and roots are redistributed within soil
  - Buries and resurfaces residue based on ratios that depend on residue type
  - Tillage intensity (degree that existing roughness is obliterated)
  - Recommended, minimum, maximum depths
  - Initial ridge height
  - Initial, final roughness (for the base condition)
  - Fraction surface area disturbed (tilled strips)
Operation Effects (cont)

- Live biomass removed
  - Fraction removed
  - Fraction of that removed that is “lost” and left as ground cover (flat residue)
  - Used with hay and silage harvest operations

- Remove residue/other cover
  - All surface residues affected or only most recent one?
  - Fraction of standing cover removed
  - Fraction of flat cover removed
  - Used in baling straw, burning operations
Operation Effects (cont)

- Add other cover
  - Fraction added to surface versus fraction placed in soil
  - Unless all mass added to surface, must be accompanied by disturbed soil effect (that is, mass cannot be placed in soil without disturbance)
  - Mass placed in soil is placed between ½ and maximum depth
  - Used to add mulch and manure to surface, inject manure into soil
Vegetation

- Live plant material
- Static variables include:
  - Residue name, yield, retardance, senescence, moisture depletion for NWRR
- Time varying variables
  - Root biomass in upper 4 inches
  - Canopy cover percent
  - Fall height
  - Live ground (surface) cover cover percent
- Source of data: Research core database, NRCS core database, working databases
- Name and save
Yield-Residue Relationship

- Residue at max canopy function of yield

![Graph showing the relationship between yield and residue at max canopy. The graph indicates that as yield increases, the residue at max canopy also increases.]
Yield-Retardance Relationship

- Retardance function of yield, on contour, and up and down hill

- Significant retardance at no yield (wheat)
- No retardance at no yield (grass)
- No retardance at a significant yield (corn)

Yield

Retardance

Retardance at a high yield
Retardance for Up and Downhill

- RUSLE2 chooses retardance based on row spacing and the retardance selected for a strip of the vegetation on the contour
  - How does vegetation slow the runoff?

- Row spacing
  - Vegetation on ridge-no retardance effect
  - Wide row-no retardance effect (> 30 inches spacing)
  - No rows, broadcast-same as strip on contour
  - Narrow row-small grain in about 7 inch spacing
  - Very narrow-same as narrow row except leaves lay in row middle to slow runoff
  - Moderate-about 15 to 20 inches spacing
Residue

- Size, toughness
  - 5 types: small, fragile (soybeans); moderate size, moderately fragile (wheat); large size, nonfragile (corn); large size, tough (woody debris); gravel, small stones

- Decomposition (coefficient, half-life)

- Mass-cover values

- Source: NRCS databases

- Name and save

![Graph showing the relationship between % Cover and Mass per unit area.](#)
Senescence

- Input the fraction of the biomass at max canopy that falls to soil surface when canopy decreases from its max value to its min value.
- Input the minimum canopy value that corresponds to fraction that experiences senescence.
- Mass that falls is computed from difference in canopy percentages and nonlinear relationship between canopy percent and canopy mass.
Contouring/Cross Slope Farming

- To have contouring, must have ridge heights
  - To have ridge height, must have operation
  - Ridge height assigned in operation

- Row grade
  - Relative row grade (preferred) or absolute

- Create contouring practices based on relative row grade (row grade/land slope)
  - Perfect (0%), exceeds NRCS specs (5%), meets specs (10%), Cross slope (25%), Cross slope (50%)

- Name and save contouring practice
Strips/Barriers

- **Types**
  - Filter, buffer, rotational strip cropping
- **Filter**
  - Specify width and management on strip
- **Buffer**
  - Specify number, whether strip at bottom, for erosion or water quality control, width, strip management
- **Rotational strip cropping**
  - Specify number, timing of rotation on each strip
- **Name and save**
Hydraulic Elements and Their Sequence

- Channels
  - Specify grade
- Impoundments
  - Nothing to specify
- Specific order of elements
- Name and save sequence
System of Hydraulic Elements

- System composed of named sequence of hydraulic elements
- Number of systems on hillslope
- Is the last one at the bottom of the slope?
- Name and save systems
Subsurface Drainage Systems

- Represented by:
  - Hydrologic soil group for soil when it is well drained
    • Entered in soil input
  - Fraction of area that is drained

- Name and save
UNIT 6

Applicability
LIMITS OF APPLICABILITY

How well does RUSLE apply to this situation?
- Erosion Processes
- Land Uses
- Geographic Regions
- Temporal Scale
- Uncertainty in computed values
APPLICABLE PROCESSES

- Yes: Interrill and rill erosion
- Yes: Sediment yield from overland flow slope length
- Yes: Sediment yield from terrace channels and simple sediment control basins
- No: Ephemeral or permanent incised gully erosion
- No: Stream channel erosion
- No: Mass wasting
Applicable Land Uses

- All land uses where overland flow and interrill-rill erosion occurs
- Land use independent
- Best: Cropland
- Moderate: Disturbed lands like military lands, construction sites, landfills, reclaimed lands
- Acceptable: Rangelands, disturbed forestlands, parks and recreational areas
Cropland Applications

- Best: Clean tilled corn, soybean, wheat crops
- Moderate: Conservation tillage, rotations involving hay
- Acceptable: Hay, pasture
- Most variable: Support practices, especially contouring
MOST APPLICABLE GEOGRAPHIC REGIONS

- Rainfall occurs regularly
- Rainfall predominant precipitation
- Rainfall exceeds 20 inches
- Northwest Wheat and Range Region (NWRR) special case
- West problem area because of infrequent storms
APPLICABLE SOILS

- Best: Medium Texture
- Moderate: Fine Texture
- Acceptable: Coarse Texture
- NO: Organic
APPLICABLE TOPOGRAPHY

- **Slope Length**
  - Best: 50 - 300 feet
  - Moderate: 0 - 50 ft, 300 - 600 ft.
  - Acceptable: 600 - 1000 feet
  - **NO**: >1000 feet
APPLICABLE TOPOGRAPHY

- **Slope Steepness**
  - Best: 3 - 20%
  - Moderate: 0 - 3%, 20 - 35%
  - Acceptable: 35 - 100%
  - NO: >100%
UNCERTAINTY

Confidence in Result

- **Best (±25%)**: $4 < A < 30$ t/ac/yr
- **Moderate (±50%)**: $1 < A < 4$
  $30 < A < 50$
- **Least (>±100%)**: $A < 1$
  (>±50%): $A > 50$
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.
  - A 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
Sensitivity

- Change in soil loss per unit change in a particular variable
- Select a base condition
- Vary input values for a variables about base condition
- Sensitivity varies according to condition
- Variables with greatest sensitivity require greatest attention
Examples of Sensitivity

- Some variables have a linear effect
  - Erosivity factor $R$
  - Slope steepness
- Effect of most variables is nonlinear
  - Ground cover
  - Below ground biomass
  - Roughness
Examples of Sensitivity (cont)

- Low sensitivity
  - Slope length at flat slopes (0.5%) $A = 4.6$ t/a at $\kappa = 150$ ft, $5.2$ t/a at $\kappa = 500$ ft, $5.5$ t/a at $\kappa = 1000$ ft

- Moderate sensitivity
  - Slope length at steep slopes (20%) $A = 129$ t/a at $\kappa = 50$ ft, $A = 202$ t/a at $\kappa = 100$ ft, $A = 317$ t/a at $\kappa = 200$ ft.
Examples of Sensitivity (cont)

- High sensitivity - Ground cover single most important
  - Adding mulch
- Most variables interrelated
  - Ground cover at planting not as much as expected
- Sequence of operations
  - Effect of depth for a tandem disk
  - Depends on whether proceeded by moldboard plow
SUMMARY

- RUSLE varies in its applicability
- Results from RUSLE must be judged
- Degree of confidence in results varies