EROSION PREDICTION

WATER EROSION

Scientific planning for soil conservation and water management requires knowledge of the relations among those factors that cause loss of soil and water and those that help to reduce such losses. Controlled studies on field plots and small watersheds have supplied valuable information on these complex interrelations of factors. But the maximum benefits from such research can be realized only when the findings are applied as sound practices on the farms, ranches, and other erosion-prone areas throughout Florida. Specific guidelines are needed for the selection of the control practices best suited to the particular needs of each site. Such guidelines are provided by the procedure for soil-loss prediction presented in this section. The procedure methodically combines research information from many sources to develop design data for each conservation plan. Widespread field experience for more than four decades has proven that this technology is valuable as a conservation-planning guide.

The procedure is founded on the empirical Universal Soil Loss Equation (described in handbooks by Wischmeier and Smith 1965, 1978) that is believed to be applicable wherever numerical values of its factors are available. Research has supplied information from which at least approximate values of the equation's factors can be obtained for specific farm or ranch fields or other small land areas throughout most of the United States.

The Revised Universal Soil Loss Equation (RUSLE) includes analyses of data not available when the previous procedure was prepared. The analyses are documented so that users can review, evaluate, and/or repeat them in the process of making local analyses. Furthermore, the technology was revised to permit the addressing of problems not included or inadequately addressed in earlier versions of the Universal Soil Loss Equation (USLE). The current revision is intended to provide the most accurate estimates of soil loss without regard to how the new values compare with the old values.

This revision updates the content of the earlier handbooks (Wischmeier and Smith 1965, 1978) and incorporates new material that has been available informally or in scattered research reports and professional journals. Some of the original charts and tables have been revised to conform to additional research findings, and new charts and tables have been developed to extend the usefulness of RUSLE. In some instances, expanding a table, chart, or computer program sufficiently to meet the needs for widespread field application required the projection of empirical factor relationships appreciably beyond the physical limits of the data from which the relationships were derived. Estimates obtained in this manner are the best information available for the conditions they represent. These instances are identified in the discussions of the specific erosion factors, tables, charts, and/or computer program.

SOIL-LOSS EQUATION

A. Sheet and Rill Erosion measured by RUSLE

The Revised Universal Soil Loss Equation (RUSLE) is expressed as:

A = **RKLSCP** where,

A is the predicted soil loss
R is the rainfall factor
K is the soil-erodibility factor
L is the slope length factor
S is the slope-gradient factor
C is the cropping management (cover factor)
P is the erosion control practice factor

"A" Soil Losses

"A" is the computed soil loss per unit area. It is usually expressed as tons per acre per year, but may be given as cubic yards per acre per year. Losses may also be calculated for periods of less than one year.

"R" Factors and **"EI"** Values

"R" is the factor that accounts for the damaging effects of rainfall and indicates the erosivity of the rainfall. It is not the average annual precipitation in a locality. An R value is the number of erosion index (EI) values in a normal year's rain. The EI value of a given storm is equal to the kinetic energy of the storm times its maximum 30-minute intensity. The EI values of individual storms may be summed to get an EI value for any period of time. When EI values are summed and averaged over a period of years, they become R values.

The rainfall factor (R factor) for the counties in Florida are shown in Exhibit C, of the Florida Agronomy Field Handbook (FLAGRFH).

The distribution of erosive rains is needed to estimate soil losses for a period of less than one year. The erosion by 15 day increments will be shown in the RUSLE software print out.

"K" Factors

"K" is the factor that accounts for the differences in erodibility of soils. It is the rate of erosion per unit of erosion index from unit plots on a given soil. A unit plot is 72.6 feet long and has a uniform lengthwise slope of nine percent (9%). Unit plots are kept in continuous fallow and freed of vegetation for at least two years or until all crop residue have decomposed before they are used to determine K factors. When measurements are made, the plots are plowed in the spring and prepared for planting corn by conventional methods. Additional tillage may be used

to control vegetation and prevent crusting. All tillage operations are performed up and down the slope. These losses are the basis for determining K factors.

More than 25 characteristics of a soil affect its response to water erosion. These characteristics are grouped into two categories: 1) those that influence infiltration, permeability, and total water holding capacity; and, 2) those that affect dispersion, splashing, abrasion, and transportation of soil particles by surface water runoff. The original K factors reflected the erodibility of the surface layer. Increased interest in soil losses from construction sites has stimulated the determination of K factors for other layers as well. Soil series now have several K factors depending on the profile characteristics in an effort to address sub-surface soil erodibility.

K factors are found in the published soil survey and any changes or updates are found in the county soil legend in Section II of the FOTG (Field Office Technical Guide).

"L" and **"S"** Factors

"L" and "S" are the topographic factors in the equation. L is the length of slope in feet and S is the gradient in percentage ratio of horizontal distance to vertical distance, or degrees of slope. L and S have independent effects on water erosion; however, in this equation they are considered together as the soil loss ratio, or LS factor. This is the computed ratio of soil loss from a field slope to the corresponding loss from a standard unit plot.

LS factors may be obtained from Table 4-1, 4-2, and 4-3 in the FLAGRFH.

Slope length of L is sometimes confused with field slope length. This can be avoided if the slope under consideration meets these criteria:

- It begins where surface water runoff starts.
- It ends where the slope decreases and deposition of soil particles begins, or the surface water runoff enters a well-defined channel.
- It is the horizontal interval between terraces.
- It includes the entire field slope length in contoured or contour strip-cropped fields without terraces or diversions.

Minor irregularities can be ignored, but gradual changes in slope length or steepness may require a new LS factor. Factors are particularly difficult to determine for undulating slopes and averaging LS factors can cause misleading results.

"C" Factors

"C" is the crop factor. It is defined as the ratio of soil loss from land cropped under specified conditions to the corresponding soil loss from tilled continuous fallow. "Cropped under specified conditions" refers to the cropping system being used or considered. "Loss from tilled continuous fallow" is the loss from the unit plot described under K factors. Soil losses due to a cropping system are thus compared with the losses from bare ground in a highly erodible condition.

The C factor takes into consideration two major groups of factors: 1) the amount and timeliness of erosive storms and 2) all factors associated with crop production such as the kind of crops, the sequence of crops in a cropping system, yield levels, planting dates, crop residue management, and tillage. C factors are computed for the most commonly used cropping system.

Exhibit F in the FLAGRFH provides C values for the most common crops using various planting dates and cultivations.

"P" Factors

"P" is the support practice factor, so called because it applies to practices that support the erosion control effort by slowing runoff water thus reducing its ability to detach and transport sediment. The most common support practices are contour farming, contour stripcropping and terraces. Cross-slope farming, which means farming operations are done across the slope but not on the contour also, helps reduce erosion. These practices are most effective on slopes of two to seven percent (2 – 7%). Row crop ridges direct the runoff around the hill to a safe outlet rather than down hill causing sheet and rill erosion.

These support practices become less effective as slope length increases because there is a greater probability that water will concentrate and break over the row ridges on long slopes than on short slopes. The procedure to determine "P" values can be found in Tables 1 through 6 in the FLAGRFH.

Soil Loss Tolerance Values

"T" is the soil loss tolerance value. It indicates the rate of soil loss in tons per acre per year that will allow a high level of crop production to be sustained economically and indefinitely. Any combination of practices that will keep soil losses at or below the T value will provide satisfactory erosion control and will support meeting the quality criteria in Section III of the FOTG.

T values for cropland are from 1.0 to 5.0 tons per acre per year. The T value for a soil is established after considering its depth, slope, prior erosion, and characteristics that affect plant growth.

The allowable soil loss for construction sites depends on factors other than the ability to produce crops economically and indefinitely. T values are not assigned for sediment yields or delivery rate. T values for Florida soils are listed in published soil surveys and in the county soil legend in Section II of the FOTG.

B. Concentrated Flow, Gully, Ephemeral, and Other Erosion not measured by RUSLE

Soil loss caused by seasonal concentrated flows can be calculated by measuring the voided area. The gully erosion formula is shown on the backside of the Determination of Alternative Land Use Treatments form (FL-ECS-11).

Formula: $\mathbf{E} = \mathbf{D} \times \frac{(\mathbf{W} + \mathbf{W_1})}{\mathbf{2}} \times \frac{(\mathbf{V})}{\mathbf{2000}} \times \frac{\mathbf{1}}{\mathbf{Y}} \times \mathbf{L}$, where

E = Annual Erosion in Tons
D = Depth (feet)
W = Top Width (feet)
$\mathbf{W_1}$ = Bottom Width (feet)
L = Length (feet)
V = Unit Weight of Soil (lb/ft^3). Use Table 3 in the Florida Erosion Control Handbook
2000 = Pounds per Ton
Y = No. Years