PART II

PREDICTING WIND EROSION LOSSES

SECTION A

THE FOLLOWING SECTION CONTAINS INFORMATION NEEDED TO CALCULATE WIND EROSION BY BOTH THE CRITICAL PERIOD METHOD AND THE MANAGEMENT PERIOD METHOD.

I. THE WIND EROSION EQUATION

The wind erosion equation is used to predict soil loss by wind erosion. The equation is expressed symbolically as follows:

$$E = f(IKCLV)$$

where:

E = the estimated average annual soil loss by wind erosion in tons per acre per year.

f = an indication that the equation includes functional relationships that are not straight-line mathematical calculations.

I = the soil erodibility index, is the potential annual wind erosion for a given soil under a given set of field conditions. This factor is expressed as the average annual soil loss in tons per acre per year from a field area that is isolated, unsheltered, wide, bare, smooth, level, loose, and non-crusted, and at a location where the climatic factor is 100.

K = the ridge roughness factor, is a measure of the effect of ridges made by tillage and planting implements. 1/

C = the climatic factor, characterizing climatic erosivity, specifically windspeed and surface soil moisture. The factor for any given locality is expressed as a percentage of the "C" factor for Garden City, Kansas, which has a value of 100. "C" factors in Wyoming range from 20 to 120.

L = the unsheltered distance along the prevailing wind erosion direction across the field, where no surface creep or saltation occurs and ends at the downwind edge of the area evaluated. 1/

V = the vegetative cover factor which considers the kind, amount, and orientation of vegetation on the surface. Vegetative cover is expressed in Flat Small Grain Equivalent (SGe) lbs./acre. 1/

1/ Value assigned is to express expected field conditions during specific time period selected for erosion estimates.

II. DETERMINING THE WIND EROSION PERIOD

The wind erosion period is the time of year when the greatest amount of wind erosion would be expected to occur from the unprotected (unsheltered, smooth, bare, wide, loose, or non-crusted) field and the highest occurrence of erosive winds. It is best understood as the occurrence of a set of conditions which include expected windstorm occurrence and the vulnerability of unprotected field surfaces to windstorm events.

III. DETERMINING FACTOR VALUES FOR THE WIND EROSION EQUATION

I - Obtained from Section II of the FOTG, Cropland Interpretations. Adjustments can be made for knolls, surface crusting, clod-forming tillage and irrigation using Tables 3, 4, and 5 Pages C-4, C-5, and C-6, Erosion Prediction, Part II, Section C.

K - Obtained from Table 7, Pages C-9, C-10, or C-11, Erosion Prediction, Part II, Section C, when actual field conditions are known, or estimated from Table 2, Page C-3, Erosion Prediction, Part II, Section C, when actual field conditions are unknown. Adjustments to K for Random Roughness can be made from Table 6, Page C-7, Erosion Prediction, Part II, Section C and from Figure 2, Page C-8, Erosion Prediction, Part II, Section. FOCS WEQ will also generate "K" values.

C - Obtained from Figure 1, Page C-1, Erosion Prediction, Part II, Section C. This value can also be obtained from the National Agronomy Manual.

L - Measured along the prevailing wind direction beginning at a stable area, where no surface creep or saltation occurs and ends at the downwind edge of the area to be evaluated. See Table 1, Pages B-4 through B-8, Erosion Prediction, Part II, Section B, and Table 1, Page C-2, Erosion Prediction, Part II, Section C. FOCS WEQ will also generate "L" values.

V - Obtained from calculations and converted to flat small grain equivalent (SGe) from Chart 1, Flat Small Grain Equivalents, Pages D-2 to D-29, Erosion Prediction, Part II, Section D, appendix. FOCS WEQ will also generate "V" values.

A. SOIL ERODIBILITY FACTOR "I"

For conservation planning purposes, named soils are assigned an "I" value and a Wind Erodibility Group (WEG). The "I" value for named soils within each county is found in the FOTG, Section II, Cropland Interpretations. The "I" value is obtained from the pages labeled "Cropland Interpretations for Erosion Prediction" (located in the header of each page). If the "I" factor is not known, contact the state agronomist or state soil scientist to determine the WEG and "I" value.

When considering "I", the soil erodibility index, the following conditions apply:

* Isolated - Saltating soil particles are not entering the field.

* Unsheltered - Barriers are not present.

* Wide - The distance at which the flow of eroding soil reaches its maximum and does not increase with increased field size.

* Bare - Vegetative cover is not present.

* Smooth - Patterned ridge roughness is not present.

* Level - Knolls are not present.

* Non-crusted - Soil aggregates on the soil surface are not bound together and the soil surface is not sealed.

Adjustments to "I"

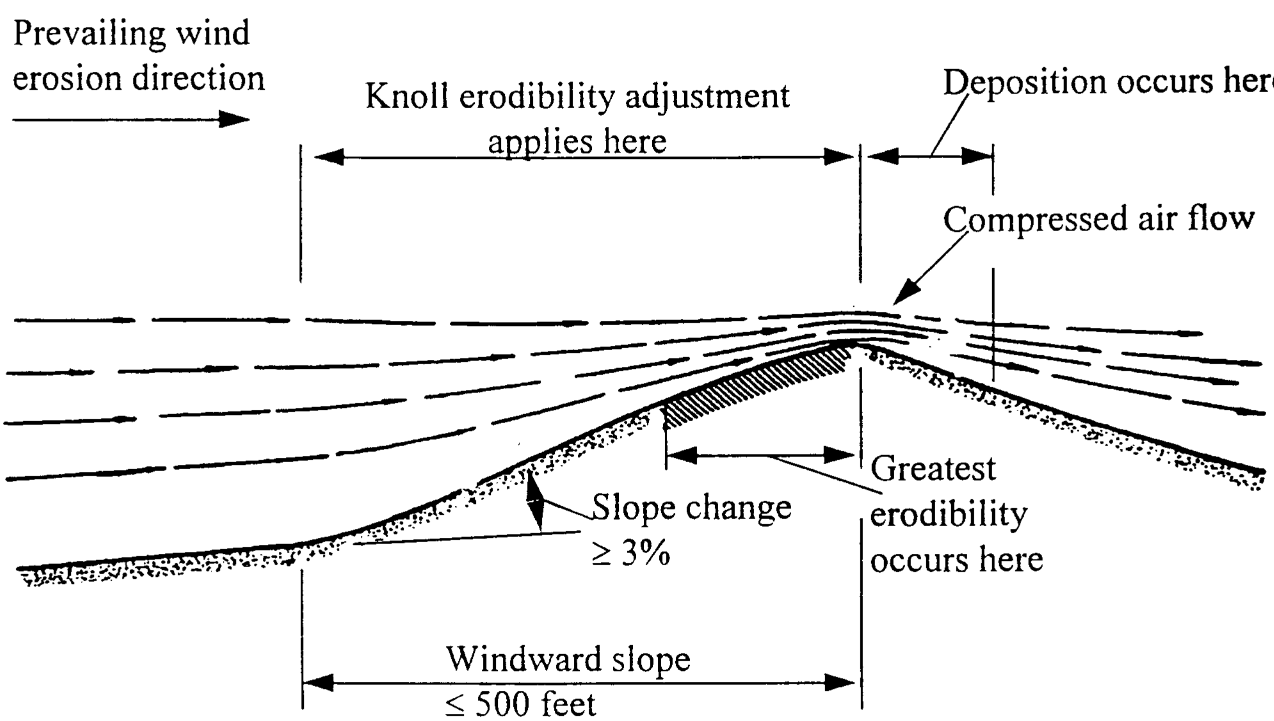
Adjustments to "I" factors can be made for knolls, surface soil crusting, and cloddiness created by tillage operations designed to bring non-erodible clods (>0.84 mm) to the soil surface. In addition, an adjustment can be made for irrigated soils. Adjustments for knolls will increase "I factors, while adjustments for crusting, cloddiness and irrigation will decrease "I".

I. Adjustments to "I" - Knolls

Adjustments should be made to the Soil Erodibility Index "I" on windward facing knolls where the windward facing slope is less than 500 feet long and the increase in slope gradient from adjacent landscape is 3 percent or greater. Both slope length and slope gradient change are determined along the direction of the prevailing erosive wind. The adjustment should be completed if the planner determines the knoll will have a significant effect on the site.

The remainder of the field downwind from a knoll may have increased erosion due to the knoll effect. No method has been developed to estimate the increased amount of erosion on that portion of the field (See diagram below).

KNOLL ERODIBILITY



Contact the state agronomist if you need further assistance on how to use the knoll erodibility adjustment for wind erosion.

Table 3, Page C-4, Erosion Prediction, Part II, Section C, contains knoll erodibility adjustment factors for the Soil Erodibility Index "I." The "I" value for the Wind Erodibility Group is multiplied by the factor shown in Column A. This adjustment expresses the average increase in erodibility along the knoll slope.

II. Adjustments to "I" - Surface Crusting

A surface crust forms when a bare soil is wetted and dried. Although the crust may be so weak that it has virtually no influence on the size distribution of dry aggregates determined by sieving, it can still make the soil less erodible.

A fully crusted soil will erode an average of only one-sixth as much as non-crusted soil. However a smooth crusted soil with loose sand grains on the surface is more erodible than the same field with a cloddy or ridged surface.

Because of the temporary nature of crusts, no adjustment for crusting is made for annual predictions based on the critical wind erosion period. Crust characteristics may be estimated and an adjustment to "I" may be made for management period estimates when no traffic, tillage or other disruption of crusts is anticipated. Table 4, Page C-5, Erosion Prediction, Part II, Section C contains crust adjustment factors for the Soil Erodibility Index "I".

III. Adjustments to "I" - Clod-forming Tillage

In some situations, there is the need to manage for erosion control on fields with little or no vegetative cover, where the surface crust has been destroyed, or where loose grains are on the surface and can abrade an existing crust. Emergency or planned tillage to roughen the soil surface can increase the non-erodible clods on the soil surface and reduce the erosion hazard. This is accomplished by :

- Working the surface to create a ridge-furrowed configuration (ridge roughness). This usually forms clods (random roughness) in the process.

- Working the soil surface to create clods.

- Deep plowing to bring up finer textured soil material that will from persistent clods.

Research has established the expected change in the non-erodible surface fraction during certain management periods, and a procedure has been developed by researchers to include the effects of random roughness in reducing erosion. The random roughness credit is given through an adjustment to the "K" factor value. Studies to adjust "I" should be made systematically and include all related soils in a given area. Multiple-year sieving data is required before adjustments are to be considered. Any adjustment to "I" for clod-forming tillage must not exceed the limits for crusting. This adjustment applies only to the management periods when the soil surface is influenced by the clod-forming tillage. Refer to the National Agronomy Manual for sampling protocol and adjustment procedure.

IV. Adjustments to "I" - Irrigation

Data is limited on the amount of decrease in soil erodibility due to irrigation. NRCS field personnel have long observed this decrease in erodibility when the soil is wet This relationship applies to all soils except the fine and very fine sands. Table 5, Page C-6, Erosion Prediction, Part II, Section C, shows the adjustments that should be made on irrigated soils only. The table also includes the necessary information to adjust the Erosive Wind Energy (EWE) or irrigation. This proposed adjustment will be discussed in the "C" factor materials. The irrigation adjustment to "I" is to be applied year-round, but is not to be applied on supplemental irrigation.

C. RIDGE ROUGHNESS FACTOR "K"

"K" is a measure of the effect of ridges made by tillage and planting implements. Ridges absorb and deflect wind energy and trap moving soil particles. Too much roughness, however, causes turbulence which may accelerate particle movement. Use Table 7, Pages C-9, C-10 and C-11, Erosion Prediction, Part II, Section C, to determine ridge roughness "K" factor when actual field conditions are known, and Table 2, Page C - 3, when field conditions are unknown.

Adjustments to "K"

Adjustments to "K" factors can be made for random roughness.

I. - Adjustments to "K"- Random Roughness

Random roughness is the non-oriented surface roughness that is sometimes referred to as cloddiness. It is usually created by the action of tillage implements. Random roughness is defined as the standard deviation of elevation from a plane across a tilled area, after oriented roughness is accounted for. Random roughness values are represented as the standard deviation of roughness heights.

Random roughness (inches) from the machine operations database in RUSLE can be used to determine random roughness values. These values are given in Table 6, Page C-7, Erosion Prediction, Part II, Section C. It is important to remember that these RUSLE values were determined from medium textured soils tilled at optimum moisture conditions for creating roughness. Under most circumstances, random roughness should be determined by comparing a field surface to the random roughness photos in Agriculture Handbook 703, *Predicting Soil Erosion by Water: A Guide to Conservation Planning With The Revised Universal Soil Loss Equation (RUSLE)*. These same photos appear on pages D-30 to D-37 of the Appendix, Erosion Prediction, Part II, Section D.

When both random roughness and ridge roughness are present in the field, they are complimentary. Random roughness, particularly in furrows, reduces wind erosion which occurs along wind directions parallel to the ridges. Therefore, when both are present, the K factors for ridge roughness and random roughness are multiplied together to obtain the total roughness K factor value.
See Table 6, Page C-7, Erosion Prediction, Part II, Section C to determine K random roughness values, or (preferred method) the random roughenss photos on pages D-30 to D-37 of the appendix. Once K random roughness values are determined, they are converted to K_{rr} values from Figure 2, Page C-8, Erosion Prediction, Part II, Section C. K_{rr} values are then multiplied by K factors for

oriented ridge roughness to determine overall K values. **Note that "I" values greater than 134 do not receive random roughness adjustments.**

D. CLIMATIC FACTOR "C"

The Climatic Factor is based on the average wind velocity and the precipitation-evaporation index for that location based on official weather records. Use annual "C" from Figure 1, Page C-1, Erosion Prediction, Part II, Section C.

Adjustments to "C"

Adjustments to the climatic factor "C" can be made for irrigated situations.

I. - Adjustments to "C" - Irrigation Factor

Wetting of soil by irrigation makes it less erodible. This effect can be accounted for by adjusting the Erosive Wind Energy (EWE). Research has shown that wet, bare soil remains non-erodible about 1 day for coarse textured soils, 2 days for medium textured soils, and about 3 days for fine textured soils. Soils are given a Texture Wetness Factor (TWF) of 1, 2, or 3 for coarse, medium, and fine textured soils respectively (see Table 5, Page C-6, Erosion Prediction, Part II, Section C). This factor will only be applied only during times when irrigation is actually occurring.

The irrigation factor adjustment to "C" is determined by multiplying the management period EWE by the fraction of the management period when the soil is considered non-erodible from being wetted by irrigation. The "IF" is calculated with the following equation:

IF = # of days in period - (# of irrigations in period x TWF)/# days in period

Example: A fine textured soil was irrigated 3 times during a 45 day period. Assume that 12% of the EWE occurred during this 45 day period. Therefore:

IF = 45 - (3 x 3)/45 = 0.80

The adjusted EWE for this period would be: 0.80 x 12% = 9.6%

The current version of FOCS WEQ does not support this modification.

E. UNSHELTERED DISTANCE "L"

The "L" factor represents the unsheltered distance along the prevailing wind erosion direction for the field or area to be evaluated. "L" begins at a point upwind where no saltation or surface creep occurs and ends at the downwind edge of the area being evaluated (Refer to the National Agronomy Manual). To be considered a stable area, the area should be a minimum of 12-1/2 feet wide, and capable of trapping and storing any expected saltation and surface creep originating upwind.

Field direction factors make it possible to convert back and forth from "L" to actual field widths in various directions. To select the correct wind erosion direction factor from Table 1, Page B-4 through B-8, Erosion Prediction, Part II, Section B, the angle of deviation between the prevailing wind erosion direction and a line perpendicular to the long side of the field or strip must be determined. The angles of deviation for north to south or east to west fields are in Table 1, Page C-2, Erosion Prediction, Part II, Section C. In addition, the field length to width ratio and the preponderance value for the period being evaluated must be determined.

To determine "L", multiply the wind erosion direction factor from Table 1, Pages B-4 to B-8, Erosion Prediction, Part II, Section B , by the **field width**, or measure the actual distance of the field along the prevailing wind erosion direction across the field in the direction of the prevailing wind. If the conversion factor is used, "L" cannot exceed the longest possible measured distance across the field (refer to the National Agronomy Manual).

If you want to convert "L" to an actual field width, divide the "L" by the appropriate direction factor (dependent on the field's angle of deviation.)

Barriers

If a barrier is present, subtract 10 times the height of the barrier from the calculated or measured "L" to determine the distance to use in the equation for "L." A barrier can be a row of trees, a perennial planted grass barrier, or an annually planted crop barrier (12-1/2 feet width is not needed to function as a barrier.)

F. VEGETATIVE COVER FACTOR "V"

The vegetative Cover Factor "V" combines three conditions:

1. The kind of residue.

2. The quantity of residue.

3. The orientation of the residue.

The "V" value is expressed as a flat small grain equivalent in pounds/acre. Because of the nature of the wind erosion equation, it is necessary to relate the effectiveness of any particular type and orientation of crop residue to the equivalent effectiveness of flat small grain residue (refer to the appropriate Chart 1, Pages D-2 to D-29, Erosion Prediction, Part II, Section D, appendix).