

5.3 SOILS

The impact of soils on wind erosion is reflected in the (1) erodible fraction, (2) soil crust factor, and (3) soil wetness. (Soil roughness is examined in Section 5.5 with tillage.)

5.3.1 What is a soils file?

The soils file consists of physical (% sand, % silt, and % rock cover) and chemical property data (% organic matter and % calcium carbonate) that can be used to describe the erodibility of a soil. The RWEQ program soil files include the 12 soil texture groups in the soil texture triangle. The physical property values in these files were extracted from the midpoint of each group (APPENDIX E-3). The *OM* and *CaCO₃* values are intended to be changed according to the region and management.

5.3.2 Sources of available data

In RWEQ, the data input from the soils file (% sand, % silt, organic matter, calcium carbonate, and rock cover) are assumed constant within an analysis period. If data are available to support that values differ, they may be updated. For example, a high residue crop rotation may modify the organic matter content over several years. The impact can be tested by updating the organic matter levels and running the erosion estimates. If soil property data are available for a specific field, these values may be used in place of the default values (APPENDIX E-3). If the SOIL INTERPRETATION RECORD is available, it may be used to determine the appropriate soil data. (See APPENDICES E-1 and E-2.) Traditional procedures should be followed in determining the soil erodibility value for the entire field when soil texture varies across the field.

To customize the soil for a specific field the simplest procedure is to overwrite the values in the **Soil Properties** window. To change the generic values for a region it may be more efficient to edit a particular soil file (Section 2.4.1) or create a new soil file (Section 5.3.3).

5.3.2.1 Erodible fraction (*EF*): Erodible fraction (*EF*) is expressed as that portion of the top 25 mm of the soil surface that can be transported by wind. This is assumed to include only particles smaller than 0.84 mm in diameter.

The weather file (TX23005.DAT) and management file (TEST.MAN) were used to estimate erosion for four different soils. The results are summarized in Table 5.3.2.1.1.

Table 5.3.2.1.1 - Estimated erosion for different soils using the client file TEST with different soils.

	sandy clay	sandy loam	loamy sand	sand
<i>EF</i>	0.45	0.51	0.58	0.67
<i>SCF</i>	.1620	.6024	.8080	.9439
Estimated erosion <i>t/ac</i>	66.5	367.2	575.5	786.0

In Table 5.3.2.1.1, there is a range in soil erosion of 66.5 to 786.0 t/ac/yr or 12-fold difference between sandy clay and sand. From the same soil textures with WEQ the soil erosion varies from 56 to 310 t/ac/yr or a 5-fold range.

To illustrate the estimated erodible fraction and soil crust factors for various conditions, a matrix of comparisons have been made and the results listed in Table 5.3.2.1.2.

Table 5.3.2.1.2 Changes in *EF* and *SCF* as influenced by sand and silt content, and for three levels of *OM* and $CaCO_3$.

Sand %	OM %	-----SILT%-----								
		10			30			50		
		-----CaCo ₃ %-----								
		1	5	10	1	5	10	1	5	10
10		SCF = 0.02			SCF = 0.04			SCF = 0.09		
	1	0.30	0.27	0.22	0.34	0.30	0.25	0.37	0.33	0.29
	2	0.28	0.24	0.19	0.31	0.27	0.23	0.35	0.31	0.26
	5	0.20	0.16	0.11	0.23	0.20	0.15	0.27	0.23	0.18
30		SCF = 0.04			SCF = 0.09			SCF = 0.27		
	1	0.37	0.33	0.28	0.40	0.36	0.32	0.44	0.40	0.35
	2	0.34	0.30	0.26	0.38	0.34	0.29	0.41	0.34	0.34
	5	0.26	0.23	0.18	0.30	0.26	0.21	0.33	0.30	0.25
50		SCF = 0.09			SCF = 0.27			Silt - 49 SCF = 0.99		
	1	0.43	0.39	0.35	0.47	0.43	0.38	0.66	0.62	0.57
	2	0.41	0.37	0.32	0.44	0.41	0.36	0.63	0.59	0.55
	5	0.33	0.29	0.24	0.37	0.33	0.28	0.56	0.52	0.47
70		SCF = 0.27			Silt - 25 SCF = 0.86					
	1	0.50	0.46	0.42	0.56	0.52	0.48			
	2	0.48	0.44	0.39	0.54	0.50	0.45			
	5	0.40	0.36	0.31	0.46	0.42	0.37			
90		Silt - 7 SCF = 0.94								
	1	0.65	0.61	0.56						
	2	0.62	0.58	0.53						
	5	0.54	0.50	0.46						

For most agricultural fields, the soil is composed of sand, silt, and clay particles. Organic matter and calcium carbonate are components important in relating soil texture to susceptibility to wind erosion (Fryrear *et al.*, 1994). Using the standard compact rotary sieve (Chepil, 1962)

and a sample of the surface 20 mm of dry topsoil, the erodible fraction (*EF*) of the soil can be determined. This procedure was used on several thousand samples to develop the following equation:

$$EF = \frac{29.09 + 0.31Sa + 0.17Si + 0.33 \frac{Sa}{Cl} - 2.59OM - 0.95CaCO_3}{100} \quad [14]$$

$$r^2 = 0.67$$

where

<i>EF</i>	= erodible fraction	(0.077 to 0.822)
<i>Sa</i>	= percent sand	(5.5 to 93.6)
<i>Si</i>	= percent silt	(0.5 to 69.5)
<i>Cl</i>	= percent clay	(1.2 to 53.0)
<i>OM</i>	= percent organic matter	(0.18 to 4.79)
<i>CaCO₃</i>	= percent calcium carbonate	(0.0 to 25.2)

The range of values in the data set are in parentheses.

With this equation the potential erodibility of a mineral soil can be estimated from the physical and chemical properties. The *EF* equation allows scientists to evaluate changes in *EF* due to cropping, tillage, or weather, and practices on small plots. If the soil surface is covered with erodible material, theoretically, erosion continues as long as the wind speed is above the threshold.

If soil sieving data are available that show an *EF* different than the generic value, it may be overwritten. For example the client file TEST calls in the weather file for Big Spring, Texas and the management file TEST.MAN. The default *EF* value is 0.51 (Figure 5.3.2.1.1) This value may be overwritten with a value based on soil sieving data (e.g. 0.37) and erosion calculated. The estimated erosion is 258.1 t/ac with *EF*=0.37 (Figure 5.3.2.1.2). The *EF* of 0.37 is *not* retained when a management file is saved; it must be entered every time the management file is used. Overwriting the *EF* value has no effect on the *SCF* or the decay of soil roughness.

Figure 5.3.2.1.1

REVISED WIND EROSION EQUATION									
Client: TEST		Weather File: WVTX25							
		Man. File:TEST.MAN							
Soil		Field		EF: 0.51		SCF: 0.6024			
DOABLE SCREEN									
Date	Vegetation	Operation/Event	Barrier	K'	K''	V	Period	Erosion	
01/01/1990	NONE	NONE	No	1.00	1.00	1.00	0.0	0.0	
12/31/1990	NONE	NONE	No	1.00	1.00	1.00	367.2	0.0	
/ /			No	0.00	0.00	0.00	0.0	0.0	
/ /			No	0.00	0.00	0.00	0.0	0.0	
/ /			No	0.00	0.00	0.00	0.0	0.0	
/ /			No	0.00	0.00	0.00	0.0	0.0	
/ /			No	0.00	0.00	0.00	0.0	0.0	
							Total Erosion (t/ac): 367.2		
RWEQ 97									
Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS									
Press F9 for Barrier Information window or <enter> to continue.									

Figure 5.3.2.1.2

REVISED WIND EROSION EQUATION

Client: TEST Weather File: WXXXXX
Man. File: TEST.MAN

Soil DOABLE SCREEN Field EF: 0.37 SCF: 0.6024

Date	Vegetation	Operation/Event	Barrier	K'	K''	V	Period	Erosion
01/01/1990	NONE	NONE	No	1.00	1.00	1.00	0.0	0.0
12/31/1990	NONE	NONE	No	1.00	1.00	1.00	258.1	0.0
/	/	/	No	0.00	0.00	0.00	0.0	0.0
/	/	/	No	0.00	0.00	0.00	0.0	0.0
/	/	/	No	0.00	0.00	0.00	0.0	0.0
/	/	/	No	0.00	0.00	0.00	0.0	0.0
/	/	/	No	0.00	0.00	0.00	0.0	0.0
/	/	/	No	0.00	0.00	0.00	0.0	0.0
							Total Erosion (t/ac):	258.1

RWEQ 97

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Accept or enter the operation date (MM/DD/YEAR)

5.3.2.2 Soil Crust Factor (SCF): The SCF was developed from laboratory wind tunnel tests on the abrasive resistance of soil aggregates (Hagen *et al.*, 1992). The SCF reflects the changes in abrasive resistance of the soil surface when the surface has been modified with rainfall. Depending on soil texture, rainfall on an aggregated surface may decay fragile soil aggregates leaving a very smooth surface covered with loose erodible sand. Based on these laboratory tests, a SCF was developed for RWEQ. The SCF is set to 1 whenever tillage operations disturb the soil surface. As the rough aggregated surface is impacted by raindrops, the surface becomes aerodynamically smoother. For fine textured soils, the resulting surface may be smooth but with few loose erodible particles on the surface. Erosion may be controlled on fine textured soils and may be enhanced on coarse textured soils.

To illustrate the effect of a soil crust the client file TEST-SCF is used. This management file calls for a harrowing each month which sets the SCF to 0.6024 for a sandy loam soil each month. Calculated erosion is 41.4 t/ac. By setting the option to No for modifies roughness (Figure 5.3.2.2.1) for each operation, the soil crust remains for the entire year and the erosion increases to 54.2 t/ac. In Table 5.3.2.2.1 the effect of a soil crust on the estimated erosion for three different soils is listed.

Figure 5.3.2.2.1

REVISED WIND EROSION EQUATION

Client: TEST-SCF Weather File: WXXXXX
Man. File: TEST-SCF.MAN

Soil DOABLE SCREEN Field EF: 0.37 SCF: 0.6024

Date	Vegetation	Operation/Event	Barrier	K'	K''	V	Period	Erosion
01/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
02/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
03/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
04/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
05/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
06/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
07/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0
08/01/1998	NONE	HARROW_S	No	1.00	1.00	1.00	0.0	0.0

<KEY_F5> =Accept Operation/Irrigation Data

Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS

Toggle "yes" or "no" using SPACE BAR key.

Operation/Irrigation Data

Operation: HARROW_S

Operation Modifies Roughness: No

Random Roughness: 0.3 in

Oriented Roughness

Ridge Spacing: 10.0 in

Ridge Height: 0.5 in

Ridge Direction: 0.0 degrees

Kill Crop: No (y/n)

% Flat Retained: 80.0%

% Retained Standing: 0.0%

IRRIGATION INFORMATION

Amount(in): 0.0 Irrigation

Rate(in/hr): 0.0 days: 0.0

Table 5.3.2.2.1 Estimated erosion (t/ac) for 3 different soils with and without soil crusts.

	sandy loam	silt loam	clay loam
<i>EF</i>	0.51	0.41	0.36
<i>SCF</i>	.6024	.5127	.1159
-----t/ac-----			
Crust is formed No - modifies roughness	54.2	32.2	3.0
Crust is disturbed Yes - modifies roughness	41.4	26.4	2.8

Notice that when the crust is disturbed erosion is reduced; the effect being more dramatic for the sandy loam. For a clay loam soil the *EF* is 0.36 and estimated soil erosion with a soil crust is 3.0 t/ac. Without a soil crust estimated soil erosion is 2.8 t/ac. From these examples you cannot separate the effect of a soil crust from soil roughness because they are both influenced by weather.

5.3.2.3 Soil wetness (SW): The soil wetness term was developed for RWEQ and reflects the amount and number of rainfall or irrigation events that impact soil erosion.

5.3.3 Developing and saving a soil file

To create a new file of soil properties that may be added to the choice list, use the DOS editor. At the C:\RWEQ97 > prompt type **EDIT** and the name of the new soil file (*e.g.* AMARILLO). Create a new soil file by using APPENDIX E-1 as a guide to extracting soil properties from a Soil Interpretations Record. (See example in APPENDIX E-2).

In this new file enter the following data given in bold. There are 5 lines of data in a soils data file.

% sand	57
% silt	29
% organic matter	0.75
% CaCO ₃	0
% rock cover	0

SAVE the new soil file and EXIT the editor.

5.3.4 Adding a soil file to choice list

To add a new soil texture to the RWEQ choice list you *must* exit the RWEQ program. A new file of soil properties can be added to the SOIL choice list from DOS. At the C:\RWEQ97 prompt type **EDIT RWEQ.CLS**, page down to “*soil” in the file list. At the end of this line press <enter>. Type the name of the new soil properties file. Select SAVE from the FILE menu. The new version of RWEQ.CLS is saved. Select EXIT from the FILE menu and exit the editor.

