

1. INTRODUCTION

Technology currently not being used to estimate wind erosion has been incorporated into a Revised Wind Erosion Equation (RWEQ) which estimates soil eroded and transported by wind between the soil surface and a height of two meters. Fine sediment is transported as suspended load and travels much greater distances than the coarse sediment transported as creep and saltation. Thus, RWEQ is not applicable for those problems where suspended, fine sediment above two meters is the concern. RWEQ is most applicable for problems of erosion from the field but also provides information on erosion rate effects within the field. This revision improves estimates of erosion, allows more flexibility in inputs, and enhances output. The basic assumption of RWEQ is that wind limits total erosion. A general diagram of RWEQ is illustrated in Figure 1.

RWEQ utilizes monthly weather data, soil and field data, and management inputs. The management inputs include cropping systems, tillage and operation dates, windbarrier descriptions, and, where applicable, irrigation information. Time periods from the management input file are used to partition the weather factor for each 1-15 day time period. The dominant wind direction for each period is determined, and the wind factor is computed for four directions based on preponderance and positive parallel ratio values from the weather files. Adjustments are made in wind for hill and wind barrier effects, snow cover, and soil wetness. Operation dates are also used to determine time periods for computations of residue decay, soil roughness decline, and soil erosion. Residue decomposition is computed for each period based on weather conditions and accumulated decomposition days since crop harvest. Soil roughness is decayed for each time period based on rainfall characteristics and clay content.

Whenever tillage operations are performed, standing residues are flattened according to the standing retained coefficient. The mass going from standing to flat is added to the existing flat mass pool and buried according to the flat retained coefficient.

Tillage roughness, both random (clods) and oriented (ridges), varies between geographic regions, soil conditions, and operator experience. No single value is equally suited for all regions of the country. The residue and soil roughness values at the end of each 1-15 day period are used to estimate transport mass for the time period. The transport mass (between soil surface and a height of 6.6 feet) is divided by the length of eroding field to determine the average soil erosion for that field length.

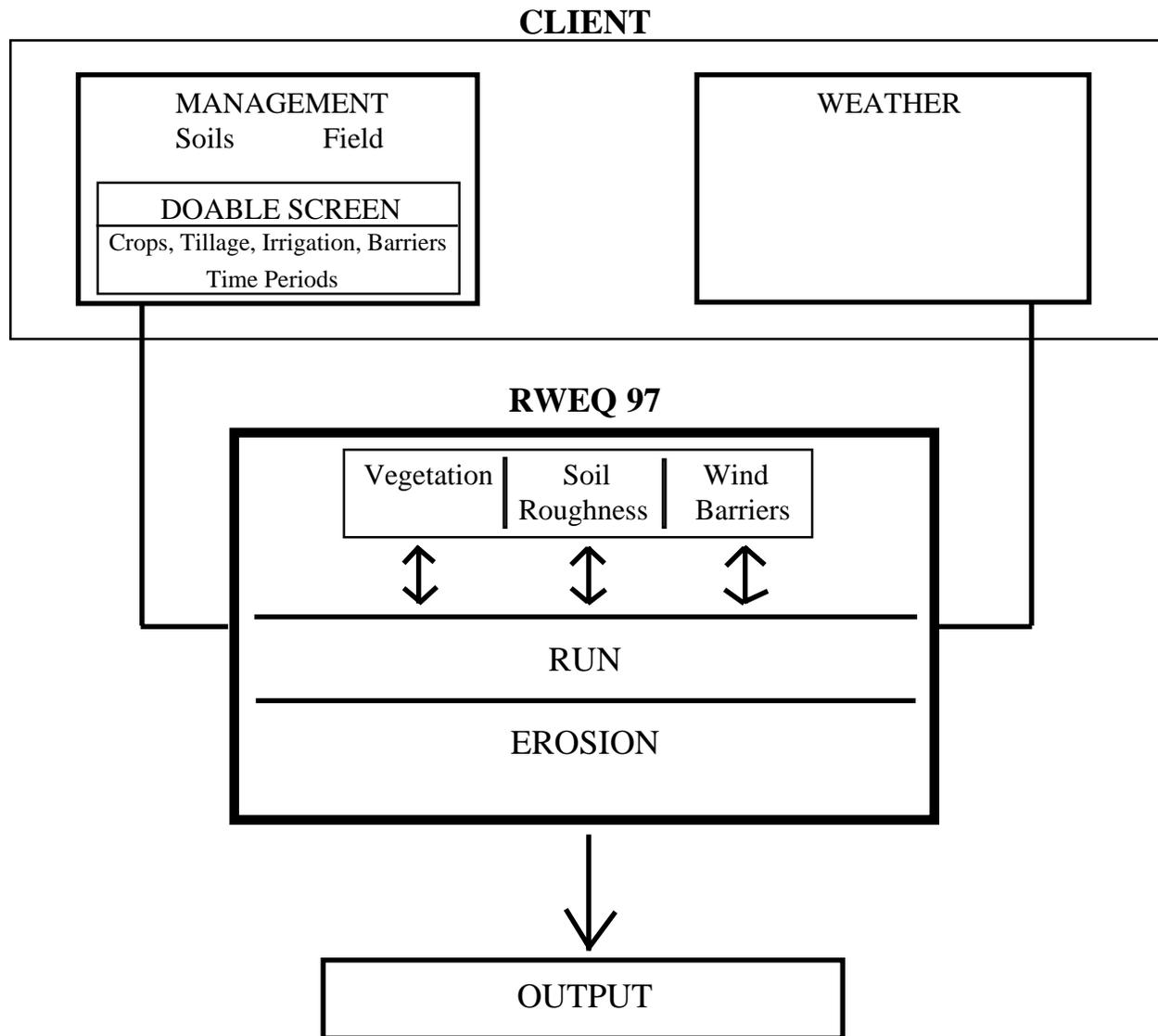
To validate RWEQ, transport mass samples of eroded soil were collected from twenty-two sites in 11 states. These sites represent major wind erosion regions of the United States. The majority of the data are from standard 6.5-acre circular fields. Limited erosion data from 320-acre rectangular, 160-acre square and 130-acre circular fields are included in the validation tests.

To expedite file development, input information can be saved under a CLIENT filename. The CLIENT file can be brought into the RWEQ program, modified to represent a different field and saved under a new CLIENT filename. This facilitates developing a management template that

can be tested with different crops, tillage dates, types of tillage operations, or any other modifications of the basic input data.

RWEQ is not intended for time intervals shorter than one day. Routines are not available to describe the relationships between transport mass and fine dust emissions. Routines are not included to modify soil roughness or adjust erodibility due to freeze/thaw effects.

Figure 1. Generalized flow diagram of RWEQ.



1.1 GETTING STARTED

1.1.1 Loading RWEQ

The RWEQ program and 602 weather data files are on a single computer diskette.

Turn the computer on! At the C:\>prompt, type **MD RWEQ97** to create a subdirectory for RWEQ. At the C:\> prompt, type **CD RWEQ97** to move to the new subdirectory.

Insert the RWEQ program diskette in the proper drive (*e.g.* A:). At the C:\RWEQ97> prompt, type **COPY A:*. *** to copy the RWEQ program and associated files from the diskette to the RWEQ97 subdirectory. At the C:\RWEQ97> prompt, type **INSTWE** to install the program and weather files.

1.1.2 Running RWEQ

Anytime after the RWEQ program has been loaded and installed, simply go to the RWEQ97 subdirectory to run RWEQ. At the C:\> prompt, type **CD RWEQ97**. At the C:\RWEQ97> prompt type **RWEQ** to begin the program.

1.2 RWEQ INPUT FILES AND DATA

In the RWEQ program, the user is prompted for client, weather, management, soil, field, crop, tillage, and barrier information that is essential to estimating soil erosion. The input data may be saved in RWEQ which minimizes data input time and maximizes flexibility in evaluating wind erosion control strategies.

1.2.1 Client

Use of a client file is not essential; however, it is convenient. The client file contains the names of a management file and a weather data file. The client filename can be any combination of characters (up to 8 with an optional extension of 3 characters) that identifies the specific field being evaluated. For example, farmer Smith may have several different fields. The fields may be identified as Smith1, Smith2, Smith3, etc. Each client file may contain different weather, field, crop, soil, and/or tillage system data.

1.2.2 Weather

The weather input file contains the monthly climatic data that includes the wind, rainfall, solar radiation, temperature, and snow cover data. Weather files are provided for 602 sites. The weather filenames and locations are listed in APPENDIX-D. They carry a “.DAT” filename extension in the C:\RWEQ97\W subdirectory.

1.2.3 Management

A management file contains the soil properties, field geometry, farming operations and dates, and data for field roughness, irrigation, windbarriers, and soil cover (bare, growing crop, residue crop, or a combination of these). A management file may be a multiple year rotation system or a combination of one year in irrigation and the next year dryland. The main function of the management file is to input decisions the farmer can make that impact erosion. Because of the extreme variability in crops and operations, it is impossible to provide management files for all combinations of crops, soils, and tillage practices. Examples of field management systems are provided in Section 4.3.

1.2.3.1 Soil properties In RWEQ, generic files are provided for 12 soil textures. (See listing in APPENDIX E-3.) These files provide percent sand, silt, organic matter, calcium carbonate, and rock cover to estimate erodible fraction. Soil properties data can be changed within the program. RWEQ does not modify the soil's physical properties with long-term crop rotation systems. **NOTE:** Rock cover is combined with residue cover to compute a soil loss ratio coefficient for flat nonerodible elements.

1.2.3.2 Field geometry To estimate soil erosion the size, shape, and orientation of the field must be entered. Data on slope gradient and slope length are used to quantify the effect of hills on wind speeds and soil erosion. Until more complex input data systems are available, a hill starts at the upwind boundary of the field. If this is not the case, the field should be divided and the erosion from the hill calculated separately.

1.2.3.3 DOABLE SCREEN Operating decisions that are “doable” are entered in this screen. These decisions include tillage dates and operations, residue crops, growing crops, irrigation, and windbarriers.

1.2.3.3.1 Vegetation data: In addition to economic yields most crops produce residues that remain in the field after harvest. RWEQ computes residue cover and silhouette area of standing stubble from yield, crop and harvest heights, and stem number.

In RWEQ, residues are expressed as flat or standing. Within each crop file are residue decomposition coefficients (APPENDIX B-1) that decay residues based on air temperatures and soil wetness. While available for a limited number of crops, additional research is underway to develop coefficients for essential crops.

When crops are planted, the crop canopy development routine is initialized. The crop canopy coefficients (APPENDIX B-2) reflect the effect of a developing crop canopy on soil erosion as a function of “days after planting”. Canopy effects continue until the crop is harvested.

CAUTION! Flat residue cover is normally calculated from crop yield data. Flat residues may be added through the “Flat Residue Cover” input in the **Residue and Growing Crop Information** window.

1.2.3.3.2 **Operation/Event [Tillage] data:** The effects of farm tillage operations are expressed with coefficients for soil ridge roughness and random roughness. Each operation that disturbs the soil surface destroys the soil crust. In addition, tillage operations also bury and flatten crop residues (APPENDIX C-1). Since burial or flattening is dependent upon soil texture, residue type, implement used, and moisture condition operators should customize tillage files for their specific region.

1.2.3.3.2.1 **Irrigation data:** The impact of irrigation water is included in the decomposition of plant residues, the decay of soil roughness, and the development of soil crust. All irrigation systems are assumed to have an effect similar to natural rainfall or sprinkler irrigation.

1.2.3.3.3 **Barrier data:** For each line in the **DOABLE SCREEN** the operator describes a vegetated barrier if one has been established. At this time RWEQ does not *grow* a barrier. Height, density, spacing and orientation changes must be entered for each line.

Barriers are described with optical density. The protected zone downwind is related to barrier characteristics, wind speed and soil surface conditions.

1.3 WATCH YOUR STEP!

When editing a file from DOS remember that filenames are limited to no more than 8 characters with an optional 3 character extension after the period. In RWEQ management files have “.MAN” extensions; output, “.OUT”; original weather files, “.DAT”; and modified weather files, “.W1”; There are no file extensions for soils, tillage and crop files - the filenames are listed in the second columns of APPENDICES E-3, C-1, B-1 and B-2.

Use of an arrow key after a value has been changed gives the appearance of a changed value; however, the new value is *not entered into the program* unless the <enter> key is used.

1.3.1 Vegetation

In the **Residue and Growing Crop** window it is important to understand that residue may be introduced into the program in two ways. The first uses economic yield, stem number, crop height before harvest and height of standing residue after harvest as inputs to the RWEQ program to estimate flat and standing residue masses. The second uses measured, observed, or estimated percent of flat residue cover as an input.

1.3.1.1 **Residues from harvested crops** This first method is usually for residue producing crops. Select the residue crop name from the F2 choice list. RWEQ brings in coefficients associated with that crop to distribute and decompose crop residue (APPENDIX B-1). The economic yield of the harvested crop entered at the “Yield” prompt and the stem number are used to determine the mass of flat and/or standing residue after harvest. When stem number is entered, the program computes silhouette based on crop harvest height and stem number.

1.3.1.2 Adding flat residue cover The second method is usually for residues that are hauled into the field. Estimated residue cover from a harvested crop can be input in lieu of yield and stem number. At the Crop prompt under “Residue” select a crop from the F2 choice list. The crop decomposition coefficients are called into the program. Do not enter a value for yield. Proceed to the “Flat Residue Cover” prompt and enter the percent of the surface covered with residue. Only enter a value for “Flat Residue Cover” when the residues are added to the field. All residues added are considered *flat* residues.

1.3.1.3 Choosing the growing crop At the Crop prompt under “Growing Crop”, if NONE is chosen from the F2 choice list a “No” is automatically entered next to the Growing Crop prompt. If a crop is selected from the F2 choice list a “Yes” is automatically entered and the canopy development coefficients are brought into the program.

At the Growing crop prompt a “Yes” initializes the canopy development routine at planting. It should remain “Yes” during the entire growing season. It should be “No” at harvest or whenever there is no growing crop.

1.3.2 Operation/Event

When the operation or event is highlighted and flashing under “**Operation/Event**”, press F9 to access the **Operation/Irrigation Data** window. Press F2 to see a choice list of tillage operations. Highlight the desired operation and press <enter>. If there is no operation, choose NONE. *NEVER* leave the operation name blank.

Selecting a tillage operation brings generic values for random roughness, for ridge height and spacing, and for residue burial and flattening coefficients into the F9 screen. These generic values may be changed if a “yes” is answered for “Operation Modifies Roughness”. A “yes” indicates that an operation destroys the soil surface crust and initializes the soil crust development routine.

If a “Yes” is answered to “Kill Crop”, the canopy development routine is terminated and the residue decomposition routine is initialized. Normally answer “Yes” at harvest.

1.3.3 Output

“Total Erosion” is the sum of the erosion values in the “Period Erosion” column of the **DOABLE SCREEN**. For example, the erosion period may be for months or years depending on the management system.

1.4 SPECIAL FUNCTION KEYS

In the RWEQ program there are special function keys that enable the operator to develop or modify the management file and expedite estimates of erosion.

1.4.1 F1 Field Help

Brings in specific help for the current position of the cursor. Press F1 a second time for a second help screen describing the special function keys. To return to the first help screen, press <Esc>. To return to the program from the first help screen, press <Esc>.

From either the first or second of these help screens press Alt-F1 to view a larger window. Press Alt-F1 again to return to the smaller window.

1.4.2 Shift-F1 General Help

Accesses a general help menu with a choice of descriptions of the variables in the tabular output, of the special function keys, or of the RWEQ program and its authors. Make a selection and press F1. As in the field help menus, press Alt-F1 to view a larger window and Alt-F1 to return to the smaller window.

1.4.3 F2 Choice List

Brings in a choice list available to the operator from the **Soils Properties, Field Geometry, Residue and Growing Crop Information, or Operation/Irrigation Data** windows. Additional options can be added to these choice lists following the “Adding to choice list” instruction with each input file.

1.4.4 F3 DOS Edit

Press while in the RWEQ program to go to the DOS editor to modify, edit or generate an input file. To return to RWEQ from DOS, press Alt, F, and X. Reboot the system for file to be in the program.

1.4.5 F4 Graphs

After erosion has been calculated and the output has been saved, the operator can view a graphic display of the erosion, soil roughness, vegetation and weather factor by time periods. Selecting the PRINT option allows the operator to print a graph of these variables. To exit the graphics screen press Ctrl/C.

1.4.6 F5 Save and Exit

When pop-up screen *default* values are correct, the operator may save the information and exit the pop-up screen by pressing F5.

1.4.7 Shift-F5 Insert line in DOABLE SCREEN

While in the **DOABLE SCREEN**, to insert a new data line within an existing *saved* management file, move the cursor to the extreme left of the “date start” column on the line with the date that should *follow* the new date. Press Shift-F5. RWEQ creates a blank line beginning with the same

date as the following line. Type over the date and complete the vegetation, operation, and barrier inputs.

1.4.8 **F6** **Input/Output Save**

If a client file was named at the beginning, the name is automatically recalled in the “Saving Input/Output Files” window. To accept the name press <enter> or type a new client name.

The management filename is automatically recalled in the “Saving Input/Output Files” window. To accept the name press <enter> or type a new management filename if you want to save the changes as a separate file. DO NOT use the same name for both management and client files without the filename extension of “.man” to distinguish a management file. When prompted, press <Esc> to advance to output file.

If erosion has been estimated, the operator may save the output by naming the output file. Again, a different filename extension (*e.g.* “.out”) is suggested to distinguish an output file.

1.4.9 **Shift-F6** **Delete line in DOABLE SCREEN**

While in the **DOABLE SCREEN**, to delete a line of data from an existing *saved* management file, move the cursor to the extreme left of the “Date Start” column of the line to be deleted. Press Shift-F6. **WARNING:** When Shift-F6 is pressed, the line is immediately deleted from the management file. It cannot be undeleted or recalled!

1.4.10 **F7** **Previous Input**

This key enables the operator to move “backward” through the input information screens.

1.4.11 **F9** **Pop-up Windows**

Pop-up windows are available to input data for soil properties, field geometry, vegetation, operations, or barriers. Press <enter> to advance through the window.

1.4.12 **F10** **Run Menu**

Press F10 key and select “Compute Erosion” to compute erosion for the entire management period or “Tabular output” to view the output of erosion and input coefficients for each time period in table form. If “Compute Erosion” is chosen, erosion is calculated. Press <Esc> to transfer the results to the DOABLE SCREEN. In the tabular output or the DOABLE SCREEN the arrow keys are used to move up and down..

1.4.13 **Esc** **Exit**

To exit the program press <Esc> and answer yes (“y”) to the question at the bottom of the screen.

1.4.14 **Ctrl-Break** **Exit**

Press this key combination and <enter> to exit the program from anywhere in the program. Type **CLS** to clear the screen.