NEW INITIATIVES IN WIND EROSION MONITORING

Introduction

Work currently being done in the area of wind erosion modelling is being carried out under " The Soil Quality Evaluation Program", which is a program designed primarily to monitor soil quality.

To monitor soil quality, or in other words to measure changes to soil quality over time, there are essentially two choices:

1) One approach is to a establish a number of so-called **monitoring sites** at which pertinent soil properties deemed to be indicitive of soil quality, such as soil carbon, bulk density, moisture holding capacity and the like are measured at appropriate intervals, such as every five years or so. A problem, of coarse, is that in order to account for the spatial and temporal variability associated with literally hundreds of different soil types each under a variety of land use and management practices, literally hundreds if not thousands of sites are required.

2) The alternative approach is to develop **models** of pertinent soil degradative processes, which are then used to predict changes to soil quality. Actual monitoring consists of measuring changes in such factors as land use and management practices and perhaps climate, factors which when combined with intrinsic soil characteristics serve as model inputs to predict changes in soil quality. Monitoring sites as described above are used to test the integrity of individual models rather than as a comprehensive measure of actual soil quality change, and of coarse are far fewer in number.

   An analogy of this approach would be in the area of fresh water ecology where may be deemed simpler and more reliable to measure the pH of lake water, and use a model to predict its effect on fish populations, rather than to measure fish populations directly.

   The advantage of modelling, apart from its simplicity of application, lies with its predicitive capability which provides at least the opportunity, if model predictions warrant, to address problems before the fact, so to speak.

Wind Erosion Modeling

The Wind Erosion Equation (WEQ), developed by Chepil and Woodruff, is the main erosion prediction technology currently in use, and is described generally as follows:

$$\mathbf{E = (I, C, K, L, V)}$$

where E = potential average annual soil loss in tons per acre per year;

I = soil erodibility in tons per acre per year, determined by the amount of aggregates larger than 0.84 mm in diameter;

C = climatic factor, based on the climate (wind speed, temperature, precipitation) at a standard location (Garden City, Kansas);

K = soil surface roughness, expressed in terms of the height of standard ridges;

L = field width, maximum unsheltered distance across the field along the direction of the prevailing wind;

V = vegetative cover, expressed in relation to an equivalent quantity of flat small grain stubble.

This equation has been used throughout the world to make average annual estimates of soil loss due to wind erosion. In Saskatchewan, it has been used to compile wind erosion risk maps, as well as as an extension tool for comparing the relative merit of selected management alternatives.

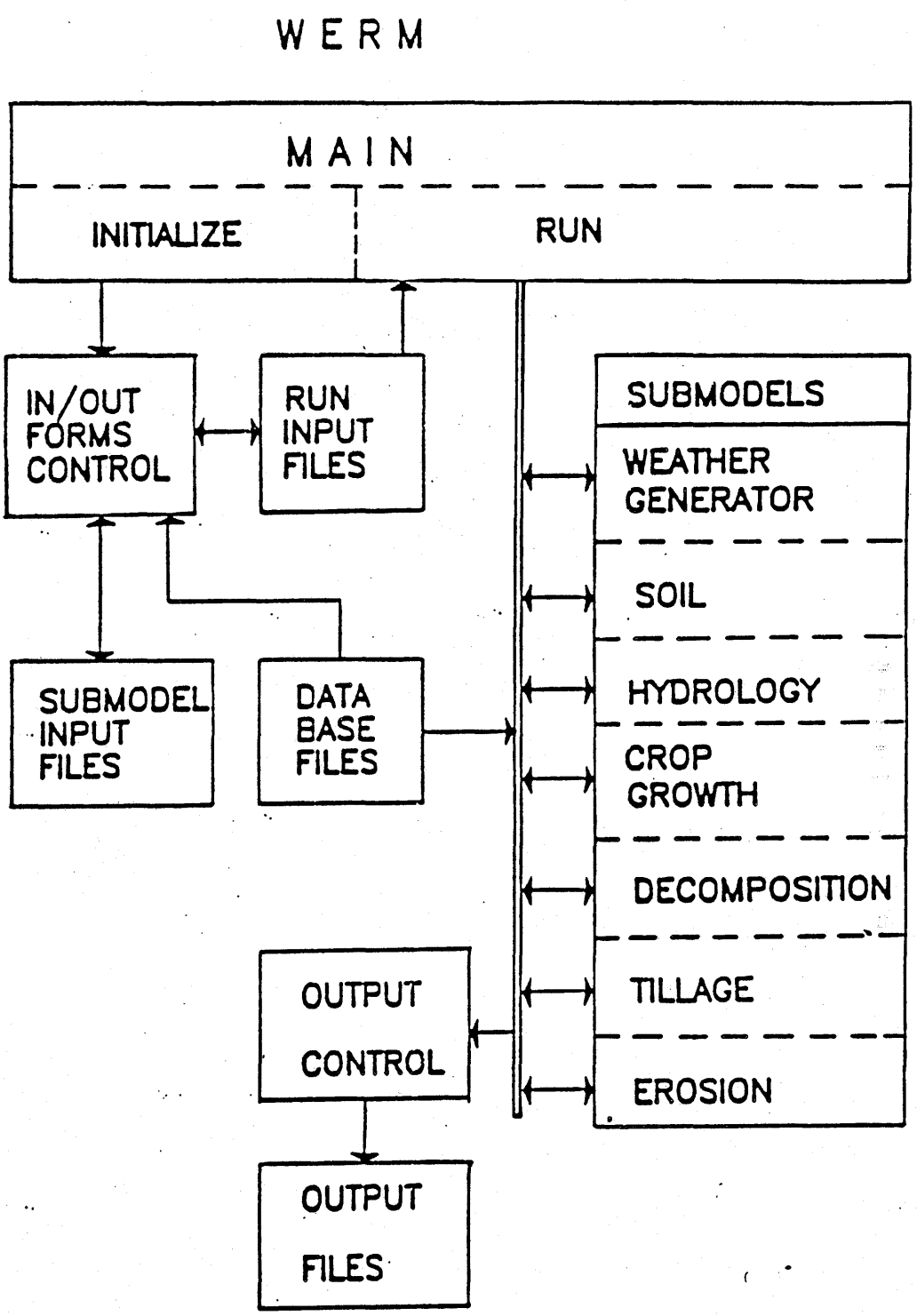
However, since WEQ is an empirical model, its application is somewhat limited. Wind erosion is a dynamic process. Wind forces vary daily. Soil surface conditions (aggregates, crusts, loose erodible material), and vegetation residues that protect the soil from the forces of the wind change daily, seasonally, and yearly in response to tillage and other management practices. This complex and dynamic nature of wind erosion makes erosion prediction using an empirical model particularly difficult.

Moreover, experience has shown that the climate factor of WEQ is often invalid outside the Great Plains where it was developed; the soil surface roughness factor does not account sufficiently for random roughness or surface crust characteristics; and model output, which is expressed in terms of average annual loss, is often unrealistic and difficult to comprehend given the often sporadic nature of wind erosion events. In some documented cases more than 80% of the wind erosion loss, over a 30 year period, occurred in just 3 erosion events, data that cannot be properly interpreted by average annual loss figures.

Wind Erosion Prediction System (WEPS)

To address the documented concerns regarding WEQ, The United States Department of Agriculture, Agriculture Research Service, is currently devloping a new wind erosion prediction system (WEPS) to replace the wind erosion equation.

WEPS is a processed based computer simulation model using fundemental wind erosion principles to, in essence, simulate temporal changes in factors affecting wind erosion and then compute erosion when critical combinations of climatic, soil, and crop conditions occur. Major factors such as changes in weather, crops, residue decomposition, tillage, hydrology, and soil factors are simulated by a series of interconnected submodels.


WERM
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TILLAGE
EROSION
SUBMODEL INPUT FILES
DATA BASE FILES
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Potential Applications

In essence the potential users of WEPS are deemed to be the current users of WEQ, where most applications fall within the categories of (a) conservation planning, (b) project planning, and (c) inventory and assessment. In conservation planning, the major application will be in the prediction of the soil loss/deposition from a specified field or site, expressed in the form of risk or the probabiliy of various erosion levels. Repeated predictions will be used to evaluate sets of alternative conservation practices in order to select the most appropriate conservation management system.

Inventory and assessment activities such as soil quality monitoring are concerned with estimating erosion for areas aggregated at the regional, provincial, or national levels.

Current Wind Erosion Study

The Wind Erosion Study, which forms part of the Soil Quality Evaluation Program, in essence, involves a cooperative effort with the USDA/ ARS in the development and validation of the Wind Erosion Research Model (WERM), with particular emphasis on Canadian conditions. It involves the following initiatives:

WERM validation site.

This site is intended to measure actual erosion and to validate WERM (Wind Erosion Research Model). It has been set up by the Lethbridge Research Station near Lethbridge and consists of circular area about 200 m in diameter. The actual site is located within a stubble field and is managed specifically to induce wind erosion. To date about six erosion events have been monitored. The site is instrumented as follows:

a) Full weather station on site to provide a daily record of such parameters as wind velocity and direction at various heights, solar radiation, precipation, relative humidity etc.

b) Sens-it , which is a device to record the occurence of wind erosion events; also provides data on the direction and amount of moving soil particles.

c) Dust collectors - 13 stacks of dust collecters mounted at several heights and located in a circular pattern around the weather station; 4 near-surface dust collectors to collect saltating soil particles. Samples are collected after each erosion event.

Submodel validation sites

These sites are established to test the soil, the tillage, the hydrology, and the decomposition submodels of WERM, and are in essence an extention of the development and validation network already established in the U.S. Protocols would be similar to that of the American scientists. Submodel validation sites are located at the Agriculture Canada Research Stations at Lethbridge and Melfort and at the University of Manitoba.

Monitoring and Characterization sites

These sites are substantiantly less sophisticated than the validation sites and are designed to collect mainly temporal data over a range of soil, climate, and farming comditions in the region. Characterization of both intrinsic and temporal soil properties are carried out by field techniques.

The purpose of these sites is to assess how well the individual submodels predict temporal soil conditions related to wind erosion such as aggregrate size and stability, surface roughness, crusts, residue cover and the like over the variety of soil, landscape, climate, cropping and cultivation conditions in Western Canada. Dust collectors are used to give some idea as to how much wind erosion is actually occurring. About ten of these sites have been establish across the prairies and are operated with the cooperation of agencies such as PFRA and Alberta Agriculture.

Data Base Compilation

A data base of pertinent soil, landscape, climate and land use parameters at a scale of 1:1M for western Canada is needed to implement the model, and in turn to perhaps update the wind erosion risk maps and provide a quanitative assessment of wind erosion across the prairies as part of an overall soil quality monitoring program.

For conservation planning purposes, data bases at a scale of 1:100,000 for implementation of the model at a field scale is required. This would include, in addition to an appropriate climatic data base, characterization of individual landscapes and soil series in terms of parameters required by the model.