

PREDICTING WIND EROSION

A new technology is needed to assess the impact of land management strategies on wind erosion

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Wind erosion is a particularly serious problem on many lands, and human impact on the global environment is an issue of international concern. To adequately predict the consequences of various land management strategies on wind erosion, new technology is needed.

The USDA appointed a multi-disciplinary team of scientists and engineers to take a leading role in developing a Wind Erosion Prediction System (WEPS). The team also includes representatives from potential user groups, such as the U.S. Soil Conservation Service, Bureau of Land Management and the EPA, to help ensure that the technology will meet user requirements.

Following is an overview of WEPS model structure and validation procedures developed to meet user requirements.

WEPS model structure

WEPS is a daily simulation model that runs on a personal computer. The user-interface section provides

Table 1. Temporal soil properties that control soil wind erodibility.

<u>Soil Fraction</u>	<u>Properties</u>
All	Surface Wetness Bulk density Surface microrelief
Aggregates	Size distribution Dry stability Density
Crust	Thickness Dry stability Loose soil above Cover fraction Density

menus to facilitate preparation of user input files. In WEPS, the simulation region is a field or, at most, a few adjacent fields (Fig. 1). WEPS output is average soil loss/deposition over user-selected time intervals and accounting regions within the simulation region. WEPS also has an option to provide users with individual loss components for soil-size fractions in creep, saltation and suspension.

The structure of WEPS is modular and consists of a MAIN (supervisory) program, a user-interface section, seven submodels, and an output section (Fig. 2). Files to run the model can be created by direct input from the keyboard, by recall and editing of prior run files, or by assembly of previously prepared submodel and data base files.

Another important function of the user-interface is to provide a list of user-selectable output options. The structure of WEPS also facilitates model maintenance, as new technology becomes available. In general, the submodels are based on the fundamental processes occurring in the field. Extensive experimental work is being carried out simultaneously with model development to delineate parameter values of the various processes.

Submodel functions

The WEATHER submodel generates meteorological variables to drive the CROP GROWTH, DECOMPOSITION, HYDROLOGY, SOIL and EROSION submodels. Using monthly statistical data in the climate data base, WEATHER generates daily values of duration, intensity and amount of precipi-

tation; maximum and minimum temperature; solar radiation; dew point; and wind direction and maximum wind speed. On days with wind erosion, subhourly wind speeds are also generated.

Biomass accounting in WEPS is accomplished by the CROP GROWTH and DECOMPOSITION submodels (Fig. 3). Crop growth is simulated by a generalized model, which calculates potential growth of leaves, stems, roots and yield components. The potential growth is modified by temperature, fertility and moisture stresses.

The DECOMPOSITION submodel predicts the biomass residues in standing, flat and buried categories. There also is a biomass sink called harvest, initiated by the TILLAGE submodel, which removes biomass from some of the categories.

The CROP data base contains information on a wide range of specific crops and includes parameters on growth, leaf-stem relationships, decomposition and harvest.

The SOIL submodel predicts the temporal soil profile properties (Table 1) between erosion and tillage events. The soil surface is treated as having both oriented and random roughness components, which is updated separately. The SOIL data base consists of intrinsic soil properties that are needed in predicting the temporal soil properties.

The HYDROLOGY submodel simulates the soil water and energy balances, including soil freeze/thaw cycles. Snow melt and redistribution, as well as irrigation, also are simulated in this submodel.

The TILLAGE submodel modifies the soil temporal properties, random surface roughness, and the biomass distribution. Height, spacing, and ori-

entation of tillage ridges are input by the user. The TILLAGE data base consists of parameters for specific tillage and harvesting machines.

The EROSION submodel simulates soil loss and deposition during periods when wind speed exceeds the erosion threshold. Soil transport by the wind is modeled as the conservation of mass of two species (saltation- and creep-size aggregates) with two sources of erodible material (emission of loose soil and abrasion of clod/crust) and two sinks (surface trapping and suspension) (Fig.4).

Validation

The submodels are validated using various methods. The weather series generated by the WEATHER submodel are compared to actual-weather time series to ensure that both produce similar statistical parameters. Recorded weather variables are input to the model, to compare temporal soil properties, water balance, and biomass patterns measured on field plots to those predicted by the SOIL, TILLAGE, CROP GROWTH, DECOMPOSITION and HYDROLOGY submodels.

Finally, the EROSION submodel is validated by instrumenting a series of field-scale sites. This is necessary, because the parameters for quantifying erosion are being developed in laboratory wind tunnels on individual subprocesses, such as trapping, emission, etc. In the field, the subprocesses are combined and operate over large scales. Initial field-scale validation sites have been operated in Texas, Montana, Colorado, Nebraska, Minnesota, Indiana, Washington and Kansas.

Widespread availability

The widespread availability of personal computers offers a unique opportunity to deliver comprehensive WEPS technology to conservation planners and policy makers in the form of computer programs and associated data bases. Initial research versions of WEPS with limited documentation should be available for testing in late 1992. A bibliography of WEPS-related technical articles published by the modeling team is available from the author. ■

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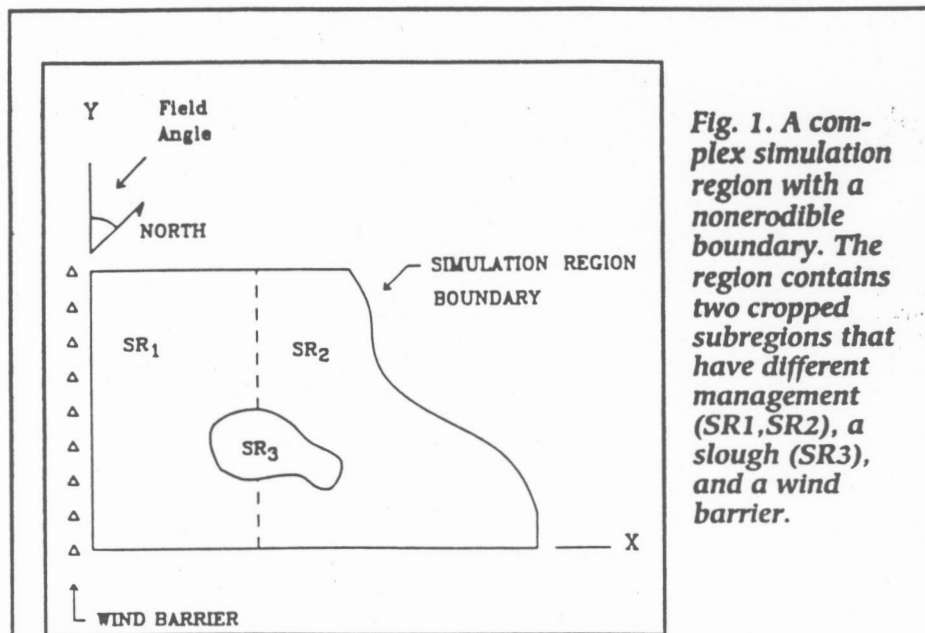


Fig. 1. A complex simulation region with a nonerrodible boundary. The region contains two cropped subregions that have different management (SR1,SR2), a slough (SR3), and a wind barrier.

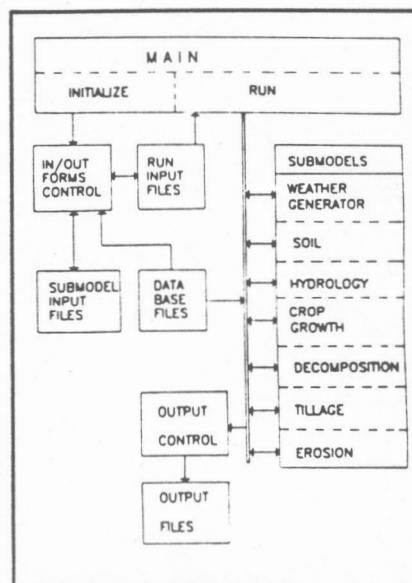


Fig. 2. Wind Erosion Prediction System with associated files, data bases and submodels.

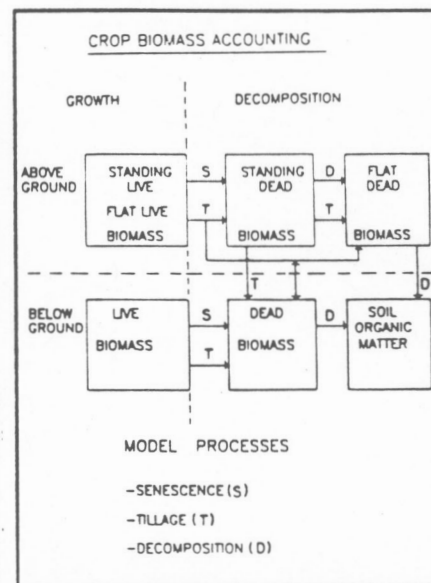


Fig. 3. Biomass accounting in the CROP and DECOMPOSITION submodels.

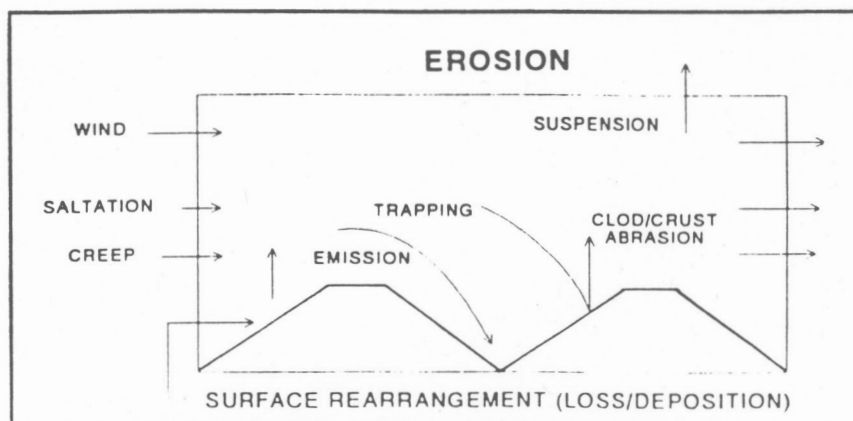


Fig. 4. Erosion subprocesses in the EROSION submodel with a bare soil.