Chapter 1. OVERVIEW OF THE WEPP EROSION PREDICTION MODEL

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1.1 Introduction

The USDA - Water Erosion Prediction Project (WEPP) model represents a new erosion prediction technology based on fundamentals of stochastic weather generation, infiltration theory, hydrology, soil physics, plant science, hydraulics, and erosion mechanics. The hillslope or landscape profile application of the model provides major advantages over existing erosion prediction technology. The most notable advantages include capabilities for estimating spatial and temporal distributions of soil loss (net soil loss for an entire hillslope or for each point on a slope profile can be estimated on a daily, monthly, or average annual basis), and since the model is process-based it can be extrapolated to a broad range of conditions that may not be practical or economical to field test. In watershed applications, sediment yield from entire fields can be estimated. Figure 1.1.1 depicts a small watershed on which the WEPP erosion model could be applied.

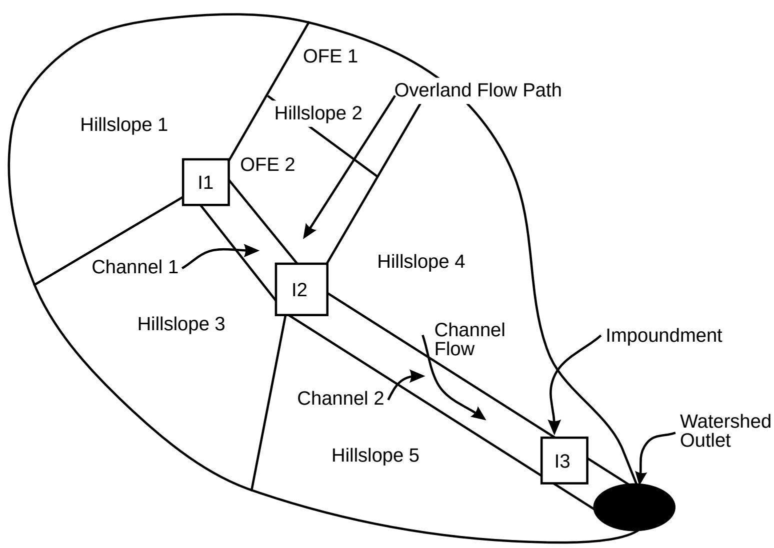

Figure 1.1.1 Schematic of a small watershed which the WEPP erosion model could be applied to. Individual hillslopes (1 to 5), or the entire watershed (composed of 5 hillslopes, 2 channel segments, and 3 impoundments) could be simulated.

Processes considered in hillslope profile model applications include rill and interrill erosion, sediment transport and deposition, infiltration, soil consolidation, residue and canopy effects on soil detachment and infiltration, surface sealing, rill hydraulics, surface runoff, plant growth, residue decomposition, percolation, evaporation, transpiration, snow melt, frozen soil effects on infiltration and erodibility, climate, tillage effects on soil properties, effects of soil random roughness, and contour effects including potential overtopping of contour ridges. The model accommodates the spatial and temporal variability in topography, surface roughness, soil properties, crops, and land use conditions on hillslopes.

In watershed applications, the model allows linkage of hillslope profiles to channels and impoundments. Water and sediment from one or more hillslopes can be routed through a small field-scale watershed. Almost all of the parameter updating for hillslopes is duplicated for channels. The model simulates channel detachment, sediment transport and deposition. Impoundments such as farm ponds, terraces, culverts, filter fences and check dams can be simulated to remove sediment from the flow.

In the following sections an overview of the WEPP erosion model is presented. This chapter briefly describes the model user requirements, the basic concepts involved in the development of the mathematical models, the model components, and the program design and development.

1.2 Model User Requirements

Expected users of the new generation of erosion prediction models include all current users of the Universal Soil Loss Equation (Wischmeier and Smith, 1978). Anticipated applications include conservation planning, project planning, and inventory and assessment. WEPP model overland flow profile simulations are applicable to hillslopes without concentrated flow channels, while watershed simulations are applicable to field situations with multiple profiles, channels (such as ephemeral gullies, grassed waterways, terraces), and impoundments (Foster and Lane, 1987). The length of the representative profile to which the WEPP hillslope model components can be applied depends upon the topography and land use controlling stream channel density. Hillslope profile applications compute interrill and rill erosion and deposition along selected landscape profiles, while watershed applications also estimate channel erosion and deposition, and deposition in impoundments. The procedures do not consider classical gully erosion. Also, model application is limited to areas where the hydrology is dominated by Hortonian overland flow (i.e., rainfall rates exceed infiltration capacity and subsurface flow is negligible). The new erosion prediction technology is designed to be operational on personal computers and operate quickly so that several management schemes can be evaluated in a relatively short period of time. Foster and Lane (1987) describe in detail the model user requirements outlined above and the land uses to which the erosion prediction technology is applicable.

1.3 Basic Concepts

The WEPP erosion model computes soil loss along a slope and sediment yield at the end of a hillslope. Interrill and rill erosion processes are considered. Interrill erosion is described as a process of soil detachment by raindrop impact, transport by shallow sheet flow, and sediment delivery to rill channels. Sediment delivery rate to rill flow areas is assumed to be proportional to the product of rainfall intensity and interrill runoff rate. Rill erosion is described as a function of the flow's ability to detach sediment, sediment transport capacity, and the existing sediment load in the flow.

The appropriate scales for application are tens of meters for hillslope profiles, and up to hundreds of meters for small watersheds. For scales greater than 100 meters, a watershed representation is necessary to prevent erosion predictions from becoming excessively large.

Overland flow processes are conceptualized as a mixture of broad sheet flow occurring in interrill areas and concentrated flow in rill areas. Broad sheet flow on an idealized surface is assumed for overland flow routing and hydrograph development. Overland flow routing procedures include both an analytical solution to the kinematic wave equations and regression equations derived from the kinematic approximation for a range of slope steepness and lengths, friction factors (surface roughness coefficients), soil textural classes, and rainfall distributions. Because the solution to the kinematic wave equations is restricted to an upper boundary condition of zero depth, the routing process for strip cropping (cascading planes) uses the concept of the equivalent plane as described in Chapter 4. Once the peak runoff rate and the duration of runoff have been determined from the overland flow routing, or by solving the regression equations to approximate the peak runoff and duration, steady-state conditions are assumed at the peak runoff rate for erosion calculations. Runoff duration is calculated so as to maintain conservation of mass for total runoff volume.

The erosion equations are normalized to the discharge of water and flow shear stress at the end of a uniform slope and are then used to calculate sediment detachment, transport, and deposition at all points along the hillslope profile. Net detachment in a rill segment is considered to occur when hydraulic shear stress of flow exceeds the critical shear stress of the soil and when sediment load in the rill is less than sediment transport capacity. Net deposition in a rill segment occurs whenever the existing sediment load in the flow exceeds the sediment transport capacity.

In watershed applications, detachment of soil in a channel is predicted to occur if the channel flow shear stress exceeds a critical value and the sediment load in the flow is below the sediment transport capacity. Deposition is predicted to occur if channel sediment load is above the flow sediment transport capacity. Flow shear stress in channels is computed using regression equations that approximate the spatially-varied flow equations. Channel erosion to a nonerodible layer and subsequent channel widening can also be simulated. Deposition within and sediment discharge from impoundments is modeled using conservation of mass and overflow rate concepts.

1.4 Model Components

The WEPP model includes components for weather generation, frozen soils, snow accumulation and melt, irrigation, infiltration, overland flow hydraulics, water balance, plant growth, residue decomposition, soil disturbance by tillage, consolidation, and erosion and deposition. These components are briefly introduced in this chapter. They are discussed in detail in the following chapters. The model includes options for single storm, continuous simulation, single crop, crop rotation, irrigation, contour farming, and strip cropping.

1.4.1 Weather Generation

The climate component (Nicks, 1985) generates mean daily precipitation, daily maximum and minimum temperature, mean daily solar radiation, and mean daily wind direction and speed. The number and distribution of precipitation events are generated using a two-state Markov chain model. Given the initial condition that the previous day was wet or dry, the model determines stochastically if precipitation occurs on the current day. A random number (0-1) is generated and compared with the appropriate wet-dry probability. If the random number is less than or equal to the wet-dry probability, precipitation occurs on that day. Random numbers greater than the wet-dry probability give no precipitation. When a precipitation event occurs, the amount of precipitation is determined from a skewed normal distribution function. The rainfall duration for individual events is generated from an exponential distribution using the monthly mean durations. Daily precipitation is partitioned between rainfall and snowfall using daily air temperatures. Daily maximum and minimum temperatures and solar radiation are generated from normal distribution functions.

A disaggregation model has been included in the climate component to generate time-rainfall intensity (breakpoint) data from daily rainfall amounts. That is, given a rainfall amount and rainfall duration, the disaggregation model derives a rainfall intensity pattern with properties similar to those obtained from analysis of breakpoint data. The breakpoint rainfall data are required by the infiltration component to compute rainfall excess rates and thus runoff. The mathematical equations used in the climate component and storm disaggregation model are presented in Chapter 2.

1.4.2 Winter Processes

The winter processes which the WEPP model simulates are frost and thaw development in the soil, snow accumulation and snow melting. In order to make more accurate predictions, the average daily values for temperature, solar radiation, and precipitation are used to generate hourly temperature, radiation and snow fall values. The soil frost subcomponent is based on fundamental heat flow theory. The frost/thaw subcomponent assumes that heat flow in a frozen or unfrozen soil or soil-snow system is unidirectional. Snow and soil thermal conductivity and water flow components are considered as constants. The soil frost subcomponent outputs values for hourly frost depth, thaw depth and the cumulative number of freeze-thaw cycles. This subcomponent predicts frost and thaw development for various combinations of snow, residue and tilled, and/or untilled soil. Adjustments to infiltration and erodibility parameters are made based on the frost or thaw location in the soil profile, and the soil moisture content.

The snow accumulation subcomponent estimates the depth of the snow on the ground on a daily or hourly basis. Snow fall increases the snow pack, while warming temperatures and rainfall consolidate (increase the density) of the snow pack. Snow drifting calculations are not made in the current WEPP model version.

The snow melt subcomponent is based on a generalized snow melt equation developed by the U.S. Army Corps of Engineers (1956, 1960), as modified by Hendrick et al. (1971), to adapt it for use with readily available meteorological and environmental data. This equation was further modified by Savabi et al. (see Chapter 3) to make it compatible with a grid-based model. The snow melt equation incorporates four major energy components of the snow melt process: air temperature, solar radiation, vapor transfer, and precipitation. The following assumptions are made for snow melt calculations: 1) any precipitation that occurs on a day when the maximum daily temperature is below 0°C is assumed to be snowfall; 2) no snow melt occurs if the maximum daily temperature is below -2.8°C; 3) the snowpack does not melt until the density of the snow is greater than 0.35 $g \cdot cm^3$; 4) the surface soil temperature is 0°C during the melt period; and 5) the albedo of melting snow is approximately 0.5.

1.4.3 Irrigation

The irrigation component of the WEPP hillslope profile version accommodates stationary sprinkler systems (solid-set, side-roll, and hand-move) and furrow irrigation systems. Four irrigation scheduling options are available: 1) no irrigation, 2) depletion-level scheduling, 3) fixed-date scheduling, and 4) a combination of the second and third options. The first option is the default option for irrigation in WEPP. For the second option, the decision of whether irrigation is necessary is determined by calculating the available soil water depletion levels for the entire soil profile and for the current root depth and comparing to an allowable depletion level. This is conducted on a daily basis. For the fixed-date scheduling option, specific irrigation dates are read into the model from a user-created data file. The fourth option is included primarily to allow a pre-planting irrigation and leaching of salts from the root zone. Parameters for depletion-level and fixed-date scheduling are read from individual data files. The irrigation component is presented in Chapter 12.

1.4.4 Infiltration

The infiltration component of the hillslope model is based on the Green and Ampt equation as modified by Mein and Larson (1973), with the ponding time calculation for an unsteady rainfall (Chu, 1978). The infiltration process is divided into two distinct stages: a stage in which the ground surface is ponded with water and a stage without surface ponding. During an unsteady rainfall, the infiltration process may change from one stage to another and shift back to the original stage. Under a ponded surface the infiltration process is independent of the effect of the time distribution of rainfall. At this point the infiltration rate reaches its maximum capacity and is referred to as the infiltration capacity. At this stage rainfall excess is computed as the difference between rainfall rate and infiltration capacity. Depression storage is also accounted for. Without surface ponding, all the rainfall infiltrates into the soil. The infiltration rate equals the rainfall intensity, which is less than the infiltration capacity, and rainfall excess is zero. The mathematical equations used in the infiltration component are presented in Chapter 4. The procedures for estimating the soil parameters that affect infiltration are presented in Chapters 4 and 7.

1.4.5 Overland Flow Hydraulics

Surface runoff is represented in two ways in WEPP hillslope model applications. First, broad sheet flow is assumed for the overland flow routing and hydrograph development. Overland flow routing procedures include both an analytical solution to the kinematic wave equations and an approximate method. The approximate method uses two sets of regression equations, one for peak runoff rate and one for runoff duration. These regression equations were derived from the kinematic approximation for a range of slope gradients and lengths, friction factors (surface roughness coefficients), soil textural classes, and rainfall distributions. Because the solution to the kinematic wave equations is restricted to an upper boundary condition of zero depth, the routing process for strip cropping (cascading planes) uses the concept of the equivalent plane described in Chapter 4. Once the peak runoff rate and the duration of runoff have been determined from the overland flow routing, or by solving the regression equations to approximate the peak runoff rate and duration, steady-state conditions are assumed at the peak runoff rate for rill erosion and transport calculations.

The proportion of the area in rills is represented by a rill density statistic (equivalent to a mean number of rills per unit area) and an estimated rill width. Representative rill cross sections are based on the channel calculations for equilibrium channel geometries similar to those used in the CREAMS model (Knisel, 1980) and width-discharge relationships derived from Gilley et al. (1990). Depth of flow, velocity, and shear stress in the rills are calculated assuming rectangular channel cross sections. The erosion calculations are then made for a constant rate over a characteristic time to produce estimates of erosion for the entire runoff event. Details on the runoff calculation are given in Chapter 4 and on the flow hydraulics in Chapter 10.

1.4.6 Water Balance

The water balance and percolation component of the hillslope model is based on the water balance component of SWRRB (Simulator for Water Resources in Rural Basins) (Williams and Nicks, 1985), with some modifications for improving estimation of percolation and soil evaporation parameters. The water balance component maintains a continuous balance of the soil moisture within the root zone on a daily basis. Redistribution of water within the soil profile is accounted for by the Ritchie evapotranspiration model (Ritchie, 1972) and by percolation from upper layers to lower layers based on a storage routing technique (Williams et al., 1984). The water balance component uses information generated by the weather generation component (daily precipitation, temperature, and solar radiation), infiltration component (infiltrated water volume), and plant growth component (daily leaf area index, root depth, and residue cover). Details on the mathematical equations used in the water balance component are given in Chapter 5.

1.4.7 Plant Growth

The plant growth component simulates plant growth for cropland and rangeland conditions. The purpose of this component is to simulate temporal changes in plant variables that influence the runoff and erosion processes. The cropland plant growth model is based on the EPIC model (Williams et al., 1984) and predicts biomass accumulation as a function of heat units and photosynthetically active radiation. Potential growth is reduced by moisture and temperature stress. Crop growth variables computed in the cropland model include growing degree days, mass of vegetative dry matter, canopy cover and height, root growth, leaf area index, plant basal area, etc. The cropland plant growth model accommodates mono, double, rotation, and strip cropping practices.

The rangeland plant growth model estimates the initiation and growth of above- and below- ground biomass for range plant communities by using a unimodal or a bimodal potential growth curve (Chapter 8). Range plant variables computed in the rangeland model include plant height, litter cover, foliar canopy cover, ground surface cover, exposed bare soil, and leaf area index. Range management practices such as herbicide application, burning and grazing may be simulated.

1.4.8 Residue Decomposition

The residue decomposition component estimates decomposition of flat residue mass (residue mass in contact with the soil surface), standing material (residue mass standing above ground), submerged residue mass (residue mass that has been incorporated into the soil by a tillage operation), and dead root mass. Decomposition parameters must be specified in the management input file. The decomposition component partitions total residue mass at harvest into standing and flat components based upon harvesting and residue management techniques. The model also sets the initial stubble population at harvest equivalent to the plant population calculated in the plant growth component. Details on the cropland and rangeland decomposition models are presented in Chapter 9.

1.4.9 Soil Parameters

Soil parameters that influence hydrology and erosion are updated in the soil component, and include: 1) random roughness, 2) oriented roughness, 3) bulk density, 4) wetting-front suction, 5) hydraulic conductivity, 6) interrill erodibility, 7) rill erodibility, and 8) critical shear stress. Random roughness is most often associated with tillage of cropland soil, but any tillage or soil disturbing operation creates soil roughness. Random roughness decay following a tillage operation is predicted in the soil component from a relationship including a random roughness parameter and the cumulative rainfall since tillage. A random roughness parameter is assigned to a tillage implement based upon measured averages for an implement. Oriented roughness results when the soil is arranged in a regular way by a tillage implement. In WEPP hillslope applications, oriented roughness is the height of ridges left by tillage implements, which can vary by a factor of two or more depending upon implement type. Ridge decay following tillage is computed from a relationship including a ridge height parameter and the cumulative rainfall since tillage. A ridge height value is assigned to a tillage implement based on measured averages for that implement.

Bulk density reflects the total pore volume of the soil and is used to update several infiltration related variables, including wetting front suction. Adjustments to bulk density are made due to tillage operations, soil water content, rainfall consolidation, and weathering consolidation. The approach to account for the influence of tillage operations on soil bulk density is a classification scheme where each implement is assigned a surface disturbance value ranging from 0 to 1, which is similar to the approach used in EPIC (Williams et al., 1984).

Effective hydraulic conductivity is a key parameter in the WEPP model that controls the prediction of infiltration and runoff. Chapter 7 provides a detailed description of the procedures to estimate the baseline hydraulic conductivity, as well as the adjustments which are made to the baseline value.

The interrill erodibility parameter is a measure of the soil resistance to detachment by raindrop impact. Because the soil is disturbed for the cropland erodibility tests and not for rangeland tests (Laflen et al., 1987; Simanton et al., 1987), algorithms for adjusting the interrill erodibility parameter are different for cropland and undisturbed rangeland soils. Adjustments to the interrill erodibility parameter on croplands are made to account for root biomass, freezing and thawing, canopy cover, residue cover, and sealing and crusting. Adjustments to the interrill erodibility parameter on rangeland are made to account for freezing and thawing.

The rill erodibility parameter is a measure of the soil resistance to detachment by concentrated rill flow and is often defined as the increase in soil detachment per unit increase in shear stress of the flow. Critical shear stress is a threshold parameter defined as the value above which a rapid increase in soil detachment per unit increase in shear stress occurs. As for the interrill erodibility parameter, different relationships are used for adjustment of the rill erodibility parameter and critical shear stress on cropland and rangeland soils. These adjusting equations include the effects of incorporated residue and roots, sealing and crusting, and freezing and thawing (Chapter 7).

1.4.10 Hillslope Erosion and Deposition

Soil erosion is represented in two ways for WEPP overland flow profile applications: 1) soil particle detachment by raindrop impact and transport by sheet flow on interrill areas (interrill delivery rate), and 2) soil particle detachment, transport and deposition by concentrated flow in rill areas (rill erosion). Calculations within the erosion routines are made on a per unit rill width basis and subsequently converted to a per unit field width basis.

Interrill delivery rate is modeled as proportional to the product of rainfall intensity and interrill runoff rate. The mathematical function describing interrill delivery rate also includes parameters to account for the effects of soil roughness, slope steepness, and adjusted soil erodibility on interrill detachment and transport. Detachment due to rainfall occurring during periods when infiltration capacity is greater than rainfall intensity is not considered to contribute to interrill detachment.

Rill erosion is modeled as a function of the flow's capacity to detach soil, transport capacity, and the existing sediment load in the flow. Net soil detachment in rills occurs when hydraulic shear stress exceeds critical shear stress and when sediment load is less than sediment transport capacity. Net deposition occurs when sediment load is greater than sediment transport capacity. Sediment transport capacity and sediment load are calculated on a unit rill width basis. Sediment load is converted to a unit width basis at the end of the calculations. Sediment transport capacity is calculated as a function of x (distance downslope) using a simplification of a modified Yalin (1963) equation.

Conditions at the end of a uniform slope through the endpoints of the given profile are used to normalize the erosion equations. Distance downslope is normalized to the total slope length. The slope at a point is normalized to the uniform slope. Shear stress is normalized to shear stress at the end of the uniform slope. Sediment load is normalized to transport capacity at the end of the uniform slope.

The erosion and deposition component has four dimensionless parameters: one for interrill sediment delivery to rills, two for rill detachment, and one for rill deposition. The normalized sediment continuity equation is solved analytically when net deposition occurs but it is numerically integrated when detachment occurs. A more complete description of the erosion and deposition component is given in Chapter 11.

1.4.11 Watershed Channel Hydrology and Erosion Processes

The WEPP watershed model is a process-based, continuous simulation model built as an extension of the WEPP hillslope model. The model was developed to predict erosion effects from agricultural management practices and to accommodate spatial and temporal variability in topography, soil properties, and land use conditions within small agricultural watersheds. Hillslope OFE hydrologic and erosion output (e.g., runoff volume, peak runoff rate, and sediment concentration) is stored in a hillslope-to-watershed pass file and then read in and used by the channel component. The watershed model is capable of: 1) identifying zones of sediment deposition and detachment within constructed channels (e.g., grassed waterways or terraces) or concentrated flow (ephemeral) gullies; 2) accounting for the effects of backwater on sediment detachment, transport, and deposition within channels; and 3) representing spatial and temporal variability in erosion and deposition processes as a result of agricultural management practices. It is intended for use on small agricultural watersheds (up to 260 ha) in which the sediment yield at the outlet is significantly influenced by hillslope and channel processes.

The channel component can be divided into the hydrology and erosion components. The channel hydrology component computes infiltration, evapotranspiration, soil water percolation, canopy rainfall interception, and surface depressional storage in the same manner as the hillslope hydrology component. Rainfall excess is calculated using a Green-Ampt Mein-Larson (GAML) (Mein and Larson, 1973) infiltration equation. Two methods are provided for calculating the peak runoff rate at the channel (sub-watershed) or watershed outlet: 1) a modified version of the Rational equation similar to that used in the EPIC model (Williams, 1995); or 2) the equation used in the Chemicals, Runoff, and Erosion from Agricultural Management Systems (CREAMS) model (Knisel, 1980). Channel water balance calculations are performed after the channel runoff volume has been computed. The channel water balance and percolation routines are identical to those used in the hillslope component. Input from the climate, infiltration, and crop growth routines are used to estimate soil water content in the root zone, soil evaporation, plant transpiration, interception, and percolation loss below the root zone.

The watershed model erosion component assumes that watershed sediment yield is a result of detachment, transport, and deposition of sediment on overland (rill and interrill) flow areas and channel flow areas, that is, erosion from both hillslope areas and concentrated flow channels must be simulated by the watershed version. Flow depth and hydraulic shear stress along the channel are computed by regression equations based on a numerical solution of the steady-state spatially-varied flow equation. Outlet conditions for the channel are assumed to be controlled by a downstream uniform flow, critical depth, or a structure having a known rating curve (e.g., an experimental flume). Subcritical flow is assumed unless the user specifies that slope of the energy gradeline (friction slope) equals the channel (bed) slope. Channel computations are made assuming triangular, or naturally eroding channel sections, however, the actual channel must be approximated by a triangular channel to compute the friction slope. The triangular channel section may have cover, but the naturally eroding channel section is assumed to be bare with no cover.

The movement of suspended sediment on rill, interrill, and channel flow areas is based on a steady-state erosion model developed by Foster and Meyer (1972) that solves the sediment continuity equation. Detachment, transport, and deposition are calculated by a steady-state solution to the sediment continuity equation. Relationships for the detachment capacity of channel erosion are computed using expressions developed from an experimental and analytical rill erosion study by Lane and Foster (1980). The flow detachment rate is proportional to the difference between: 1) the flow shear stress exerted on the bed material and the critical shear stress; and 2) the transport capacity of the flow and the sediment load. Net detachment occurs when flow shear stress exceeds the critical shear stress of the soil or channel bed material and when sediment load is less than transport capacity. Net deposition occurs when sediment load is greater than transport capacity. A nonerodible boundary is assume to exist at some depth below the bottom of the channel. When a channel erodes to the nonerodible boundary, the channel widens and erosion rate decreases with time until the flow is too shallow to cause detachment. A more complete description of the watershed application channel component is given in Chapter 13.

1.4.12 Watershed Impoundment Component

Impoundments can significantly reduce sediment yield by trapping as much as 90% of incoming sediment, dependent upon particle size, impoundment size, and inflow and outflow rates. Typical impoundments include terraces, farm ponds, and check dams. The watershed model impoundment component calculates outflow hydrographs and sediment concentration for various types of outflow structures suitable for both large (e.g., farm ponds) or small (e.g., terraces) impoundments including culverts, filter fences, straw bales, drop and emergency spillways, and perforated risers. Hydrologic inputs to the impoundment component include precipitation event generated runoff volume and flow rate. Sedimentologic inputs include the sediment concentration, particle size diameter for five particle size classes (clay, silt, sand, small aggregates, and large aggregates), and the fraction of each particle size in the incoming sediment.

The impoundment component contains both hydraulic and sedimentation simulation sections. The hydraulic simulation section numerically integrates an expression of continuity using an adaptive time step which increases when the inflow and outflow rates are relatively constant. A predicted outflow hydrograph including the time, stage, and outflow at each time step is then generated. The sedimentation simulation section determines the amount of sediment deposited and the outflow sediment concentration for each time step. Deposition of sediment in the impoundment is calculated assuming complete mixing and later adjusted to account for stratification, nonhomogeneous concentrations, and the impoundment shape. Conservation mass balance and overflow rate concepts are used to predict sediment outflow concentration. Impoundment component outputs include: 1) peak outflow rate and volume leaving the impoundment; 2) peak sediment concentration and the total sediment yield leaving the impoundment for the five particle size classes; and 3) the median particle size diameter of the sediment leaving the impoundment for the five particle size classes.

1.5 Program Design and Development

The WEPP erosion model and interface programs have been developed and tested on IBM/compatible personal computers running under MS-DOS 5.0+ operating system environments.

The computer program has been developed in a modular fashion, integrating in a top-down design all the specialized modules (program units) which perform the basic computations. This modular structure has been designed to facilitate substitution of different components and/or subroutines as improved technology is developed. No restrictions have been imposed on the input data length, the only limitation being due to the storage capacity of the hardware support. The source code is written in ANSI FORTRAN 77 for efficiency and portability, especially among personal computers. Work continues on code analysis and reprogramming to a standard coding convention to improve WEPP model maintainability and performance. Figure 1.5.1 shows the major calculation blocks and decision sequences in the current version of the computer program.

1.6 Summary

The USDA Water Erosion Prediction Project erosion model represents a new generation technology for estimating soil erosion on and sediment delivery from hillslope profiles and small watersheds. The erosion processes of detachment and transport by raindrop impact on interrill areas, detachment, transport, and deposition by overland flow in rill channels, detachment, transport, and deposition by concentrated flow in channels, and deposition in impoundments are simulated by the WEPP erosion model. The continuous simulation model also includes components which mimic climate, surface and subsurface hydrology, winter processes, irrigation, plant growth and residue decomposition. The WEPP computer program calculates spatial and temporal distributions of soil loss, as well as sediment delivery and sediment particle characteristics.

Also included as part of the WEPP erosion prediction system are user interface programs, input file building programs, a climate database, a soil database, a crop parameter database, and a tillage implement database. These additional programs and databases make the WEPP model a very powerful tool for users involved in natural resource conservation and environmental assessment.

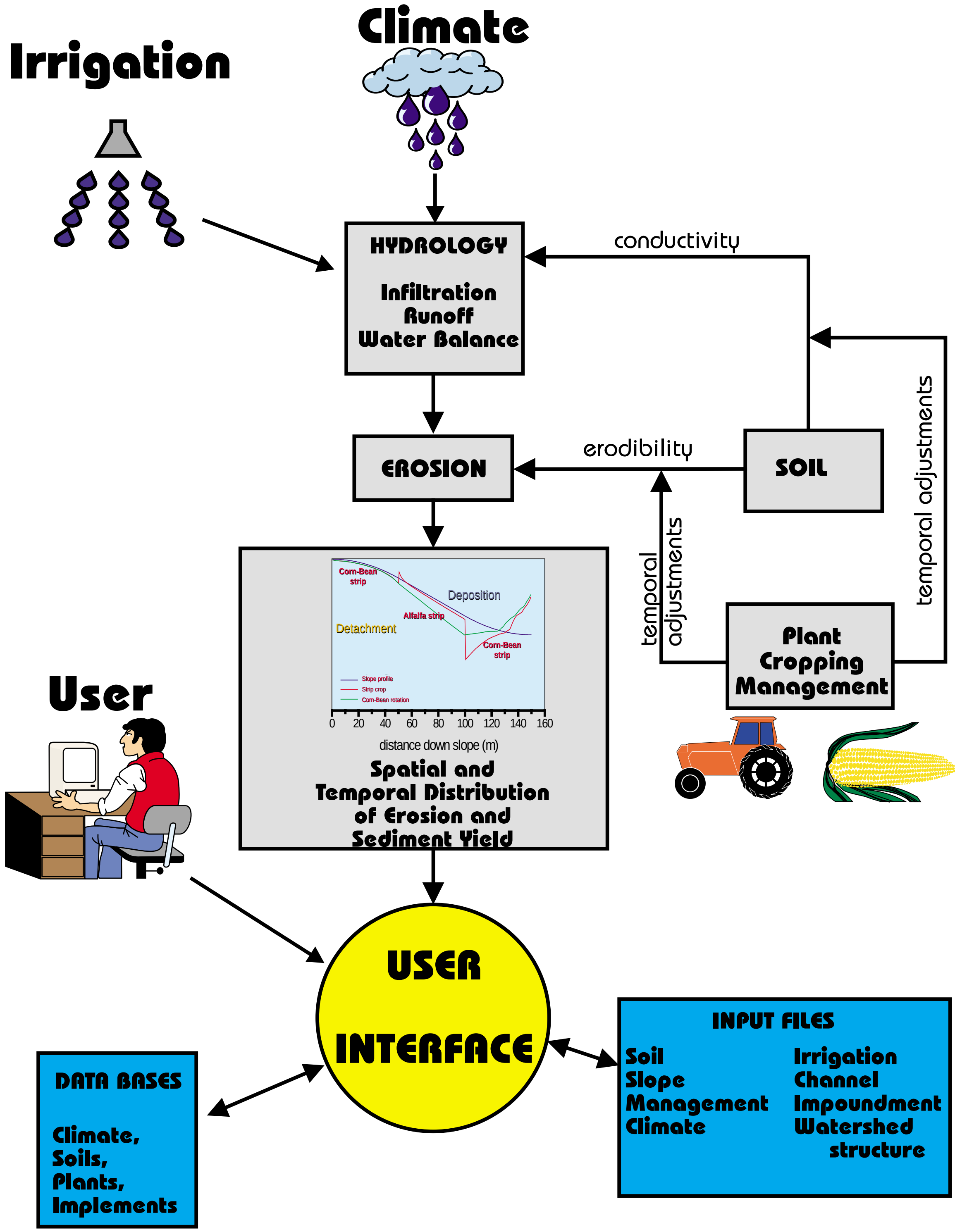

Fig. 1.5.1. Flow chart for the WEPP erosion prediction model system.

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