WATER EROSION PREDICTION PROJECT

The Good, The Bad, and the Ugly

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The WEPP Model

The Water Erosion Prediction Project (WEPP) model is a physically-based soil erosion prediction model. It was cooperatively developed by hundreds of scientists from the USDA Agriculture Research Service (ARS), Natural Resource Conservation Service, The Forest Service, and numerous other state and federal agencies and universities. The Soil and Water Engineering Research Work Unit in the Rocky Mountain Research Station (RMRS), has been the main Forest Service representative in the development of WEPP.

WEPP describes the processes that cause erosion. From a daily climate input, WEPP calculates infiltration, runoff, evapotranspiration, and soil water balances; sediment detachment, transport, deposition, and delivery; plant growth and senescence, residue accumulation and decay; and seasonal variation of soil erosion properties.

Field research plots generally show that the maximum and minimum erosion rates from two identical plots may vary by a factor of two. With this in mind, users should evaluate erosion prediction rates from the WEPP model as ranging from about half to twice the predicted values. The typical predicted erosion values presented in table 1 reflect this range. Erosion research has shown that generally the majority of soil erosion occurs from just a few severe hydrologic events, often when the soil is wet. Erosion modelers should keep this in mind when interpreting average or extreme erosion values whether predicted or observed.

WEPP can be obtained from the author or downloaded from the ARS National Soil Erosion Laboratory WWW site (Table 2).

Current Versions

Currently WEPP is available as a hillslope version or a watershed version. RMRS scientists have developed road and fire risk templates for both versions. Well over 100 Forest Service employees have been trained to run the hillslope version over the past four years. The hillslope version provides a comprehensive description of soil erosion impacts and allows users to determine such factors as length of deposition plumes below roads, soil water balances, and the distribution of erosion events during the period of modeling. It is also useful for validating the model for either simulated or natural rainfall events. Table 1 presents some of the details of soil erosion available from the hillslope version.

The watershed version interface is difficult to use, but it allows users to combine hillslopes and channels to determine whether there is deposition or erosion occurring in upland channels. The current watershed version is limited to watersheds where it can be assumed that the climate is the same throughout watershed, and that surface hydrology dominates the system. It is generally limited to about one square mile. RMRS has found that the watershed version works well in modeling insloping road processes (Typical results shown on Table 1) and post-fire erosion risk prediction. It does not work well on large (over several square miles) forest watersheds where subsurface hydrology tends to dominate the system. The watershed version predicts a greater sediment yield because it assumes that the sediment-laden water from the road prism is concentrated within a channel rather than dispersed on a hillside, the generally recommended practice.

Table 1. Characteristics of predicted erosion rates from DRAIN, WEPP:Road, and WEPP Hillslope and WEPP watershed versions for a road with a width of 20 ft, a len between cross drains of 200 feet, a gradient of 4%, and distance of 130 feet from the stream, and a slope of 25% between the road and the stream for a sandy loam soil ne Wickiup, OR.

Model and prediction	Interpreted range of prediction
X-DRAIN	
Sediment Yield	20-80 lbs
WEPP:Road	
Road Erosion	100-400 lbs
Sediment Yield	30-120 lbs
Add gravel yield	17-70 lbs
Rock ditch yield	6-24 lbs
Outslope road yield	0 lbs
WEPP Hillslope	
Road Erosion	400-1600 lbs
Sediment Yield	25-100 lbs
Erosion risk	3 years in 10
Sed. plume length	~ 60 feet
Max saturation	
of buffer soil	0.30 of total
of road prism	0.22 of total
WEPP Watershed	
Travelledway ero.	35-140 lbs
Cutslope erosion	0 - 3 lbs
Ditch erosion	800-3200 lbs
culvert deposition	5 - 20 lbs
waterway deposit.	700-2800 lbs
sediment yield	130-500 lbs

The watershed version should have the ability to incorporate sediment control structures such as culverts, silt fences and check dams. Currently there are programming errors in the model, however, and these routines do not always work.

RMRS is developing some cooperative linkages to try and correct both the limitations to small watersheds, and the problems with structures in the future. As there is no GIS version of WEPP, plans are also being formulated to link the erosion and hydrology capabilities of WEPP to Forest Service GIS capabilities.

X-DRAIN

In cooperation with the Engineering Technology and Development Committee, and in response to agency needs, simplified variations of WEPP have been developed by RMRS. The X-DRAIN program is an easy to use interface to access the results of 50,000 WEPP runs for 33 different climates, five different soils, roads with five different cross drain spacings and four different gradients, and four different slopes and steepnesses from the road to the stream across a forested buffer zone (Figure 1). X-DRAIN predicts the amount of sediment from a road entering a stream after crossing a forest buffer. An example prediction is shown in Table 1.

X-DRAIN can run on Windows 3.x and Windows 95 interfaces, or over the Internet from the site listed in Table 2. It will be released by the San Dimas Technology and Development Center during the summer of 1998, or can be downloaded at any time, along with the documentation from the X-DRAIN World Wide Web (WWW) address given in Table 2.

WEPP:Road

The WEPP:Road interface is an interface under development by RMRS specifically for modelling road erosion. It is a Windows 95 interface which will allow the user to select any climate that can be generated (currently 1200

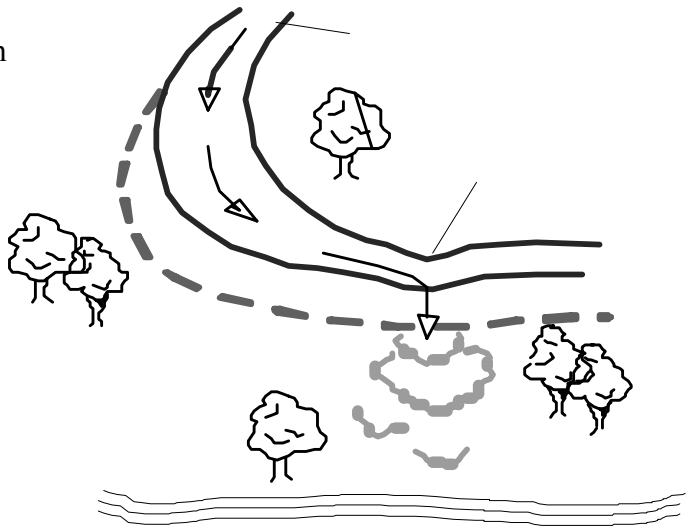

Figure 1. Template for X-DRAIN runs

climates are available on the WEPP CD).

WEPP:Road allows the user to select from four different soils, a number of different road cross-sectional shapes, and to add gravel to the travelledway or ditch. The user can specify any cross drain spacing and road gradient, and any buffer distance and steepness for a wide range of conditions.

An alpha test version of the interface is scheduled to be released in the summer of 1998. Feedback from the field tests will be incorporated, and a beta test version released a year later, nationwide. It is expected that a third release incorporating as many user suggestions as possible will be released a year after that.

Slope Stability

In a recent study, we applied the stability model XSTABL to over 3000 different topographic, soil, and water conditions to study the sensitivity of road prism to road stability. As expected, soil water content was one of the key drivers identified. Regression equations were developed to predict the factor of safety based on the key site conditions. Generally, information on the road material and topography is available, but water content is not known.

One of the outputs of the WEPP hillslope version is the water content of the elements that make up the hillslope. Table 1 shows that maximum predicted road prism water content and maximum forest buffer area water content that were observed during a ten-year run. Based on the assumed site conditions presented in Table 1, our regression equations predict a factor of safety of 1.3 for a road that is 22 percent saturated. The 30 percent saturation in the buffer soil resulted in a higher factor of safety of 1.65

Climate Generation

Plans are under development to offer an alternative stochastic climate generation technology. The engineering Technology and Development committee have provided additional financial support for this activity.

Climate generating options under consideration are to allow the use of SNOTEL stations for basic climate statistics, the use of a wider database of coop weather stations, or the use of locally observed climate data.

Selected References

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Elliot, W. J., M. Ballerini, M. Remboldt, and T. Koler. 1998. A graphical tool to aid in road stability assessment. Draft. Moscow, ID: Rocky Mountain Research Station.

Elliot, W. J., S. M. Graves, and D. E. Hall. 1998. Cross-drain spacing/sediment yield model (X-DRAIN). Draft. Moscow, ID:Rocky Mountain Research Station.

Table 2. Useful addresses.

RMRS, Moscow Forestry Sciences Lab:
1221 South Main, Moscow, ID 83843
Tel: 208 882 3557 Fax: 208 883 2318

X-DRAIN model and documentation WWW:
http://forest.moscowfsl.wsu.edu/4702/x-drain.html

Run X-DRAIN over the network
http://forest.moscowfsl.wsu.edu/4702/xds/xds.html

email addresses:
ibm system: welliot/rmrs,moscow
internet: belliot@forest.moscowfsl.wsu.edu
Forest WEPP files and other information from Soil and Water Engineering:
http://forest.moscowfsl.wsu.edu/4702/

WEPP Home page at the National Soil Erosion Lab: http://soils.ecn.purdue.edu/~wepp/wepp.html

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