Water Erosion Prediction Project (WEPP): Continuous Model Improvement, Testing, and Applications for Watershed Assessment and Restoration

Joan Q. Wu[1], William J. Elliot[2], Dennis C. Flanagan[3], Donald K. McCool[4], Markus Flury[1], Shuhui Dun[1]

[1]Department of Biological System Engineering, Washington State University, Pullman, WA 99164-6120

[2]USDA Forest Service Rocky Mountain Research Station, Moscow, ID 83843

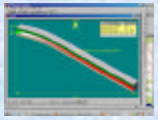
[3]USDA-ARS National Soil Erosion Research Laboratory, West Lafayette, IN 47907

[4]USDA-ARS Pacific West Area, Pullman, WA 99164

Water Erosion and the WEPP Model

Protecting and improving the quality of water resources in agriculturally managed watersheds are major goals of the CSREES National Water Quality Program. For many watersheds, sediment is the greatest pollutant. In watershed assessment, it is essential to understand the sedimentation processes and their impact on water quality. Similarly, for successful implementation of erosion control BMPs, it is necessary to determine the spatiotemporal distribution of sediment sources and the long-term effectiveness of sediment reduction by the BMPs prior to implementation.

The USDA's WEPP (Water Erosion Prediction Project) model is a process-based erosion prediction technology built on the fundamentals of hydrology, plant science, hydraulics, and erosion mechanics (Laflen, 1991; Flanagan et al., 1995). WEPP's most notable advantages include its capabilities for estimating spatial and temporal distributions of soil detachment and deposition on an event or continuous basis. WEPP, in its GIS form (GeoWEPP), can be used to predict watershed responses to management practices, thereby serving as an efficient tool for BMP assessment.



Recent, Major Changes to WEPP

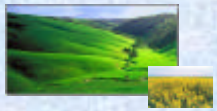
In the last few years, significant efforts have been devoted to continually improving and testing the WEPP model by researchers at WSU in close collaboration with USDA ARS and Forest Service (Wu et al., 2002, 2004a,b). The recent release (v2004.7) features the following important improvements:

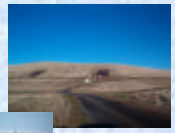
- Corrected modeling of hydraulic structures in small agricultural watersheds;
- Corrected and improved water balancing for complex application conditions;
- Added Penman-Monteith method, an international standard for ET estimation;
- Improved subsurface flow routines that adequately predict lateral flows along low-permeability layers and locally occurring saturation-excess overland flow.

Continuous Development, Application and Testing of WEPP

The new release of WEPP was first tested using nearly 50 sets of data from the WEPP database. In addition, several major WEPP application and assessment efforts have been carried out at differing geographic locations. These study locations include:

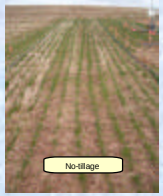
- Small, forested watersheds in the Boise National Forest, SE Lowman, ID;
- Field experimental runoff and erosion plots at the USDA Palouse Conservation Field Station near Pullman, WA;
- Experimental plots and watersheds at the USDA Columbia Plateau Conservation Research Center in Pendleton, OR;
- Research experimental plots of University of Bologna near Bologna, Italy.

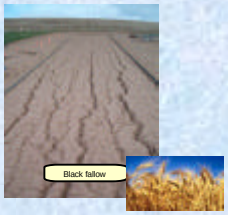


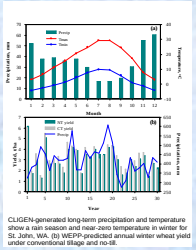


Using WEPP to Evaluate Integrated Environmental and Economic Impact of Flex-Cropping: Case Application 1

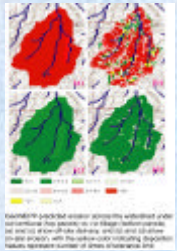
Water availability is the primary factor determining crop performance in the Pacific Northwest dryland region. A common practice to conserve water is the traditional summer fallow. Summer fallow, however, is inefficient with respect to soil water storage and is a major contributor to soil erosion. Improvements in soil water use efficiency and reductions in soil erosion and sediment delivery could be realized by reducing the frequency of summer fallow in rotation and also by using conservation tillage and/or chemical means to fallow. Given the significant year-to-year fluctuation of precipitation, these options must be evaluated in terms of both environmental and economic effects. Such a task can be most effectively by using a erosion and crop growth model such as WEPP.







CLIGEN-generated long-term precipitation and temperature show a rain season and near-zero temperature in winter for St. John, WA. (b) WEPP-predicted annual winter wheat yield under conventional tillage and no-till.



Summary

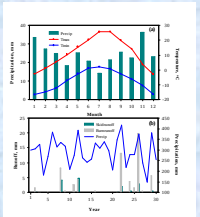
Significant efforts have been devoted to continually improve, test, and apply the USDA's WEPP model for use in watershed erosion prediction. The recent release, **v2004.7** (accessible to the public at the USDA's National Soil Erosion Research Laboratory http://topsoil.nserl.purdue.edu/nserlweb/index.html) includes a number of important improvements. An improved winter hydrology routine is expected to be included in the year 2005 release. Several major efforts have been initiated to corroborate the model using experimental research data collected at different geographic locations.

For any detailed information, please contact Dr. Joan Wu at

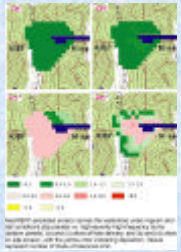
Department of Biological Systems Engineering
Washington State University
Pullman, WA 99164-6120
Phone: (509) 335-5996
Email: jwu@wsu.edu

Using WEPP as an Erosion Prediction Tool in Forest Resources Management: Case Application 2

Soil erosion in an undisturbed forest is typically very low (less than 1 t/ha/yr). Natural and human disturbances, such as wild- and prescribed fires and timber activities, however, can increase erosion significantly. Timber harvest operations influence soil erosion through the construction of roads, skid trails and log landings as well as the removal of vegetation. Prescribed fire is a management tool commonly used following timber harvest to reduce accumulated debris and the potential fire hazard, meanwhile facilitating planting and natural regeneration and the elimination of disease and insects. Soil erosion in a forested area is thus depends on multi-factors. WEPP is valuable for evaluating the numerous management alternatives.



(a) CLIGEN-generated long-term precipitation and temperature for Stanley, ID in the Boise National Forest. (b) WEPP-predicted runoff under two scenarios: high-severity-high-frequency burn and skid trails without burning.



Current and Future Efforts

Current efforts are focused on testing and incorporating an improved winter hydrology routine. Additionally, we are collecting and using field-measured forest and cropland ET data to test the newly incorporated Penman-Monteith method.

Future efforts include (i) to examine and compare the WEPP crop growth component against other existing crop models and (ii) to examine the possibility to adapt the WEPP model for application to larger (roughly greater than 260 ha) watersheds.

Acknowledgements

The study is supported through the funding of US Forest Service RMRS, US Geological Survey/State of Washington Water Research Center, and USDA CSREES NRI. Numerous scientists from the USDA-ARS-CPCRC and USDA-ARS-PWA have provided support and help. We especially thank Dave Robertson, Daryl Haasch, and John Morse for their tremendous help in the field work.

References

Flanagan, D.C. et al. 1995. Overview of the WEPP erosion prediction model. In USDA Water Erosion Prediction Project: Hillslope Profile and Watershed Model Documentation, ed. D.C. Flanagan and M.A. Nearing, Ch. 1, *NSERL Rep. 10*, USDA-ARS NSERL, West Lafayette, IN.

Laflen, J.M. et al. 1991. WEPP— A next generation of erosion prediction technology. J. Soil Water Cons. 46:34–38.

Wu, J.Q. et al. 2004a. Modification and testing of the evapotranspiration (ET) routines in the WEPP Model, presented at the 2004 ASAE Meeting, Ottawa, Canada, Aug 1–4, 2004.

Wu, J.Q. et al. 2004b. Subsurface water flow routines in the WEPP model: Modification and validation, presented at the 2004 ASAE Meeting, Ottawa, Canada, Aug 1–4, 2004.

Wu, J.Q. et al. 2002. Adapting WEPP (Water Erosion Prediction Project) for forest watershed erosion modeling, *Proc. 12th Int. Soil Conserv. Organization Conf.*, Beijing, China, May 26–31.