The Water Erosion Prediction Project (WEPP) Model
**Why Predict Soil Erosion?**

- **Conservation Planning** – evaluate land management alternatives to reduce soil erosion to acceptable levels.
- **Resource Inventories** – estimate current and projected erosion levels and their impact on natural resource base.
- **Estimate sediment generation and delivery off-site**, and evaluate management strategies to minimize sediment losses and impacts.
WEPP Description

- Process-based
- Distributed parameter
- Continuous simulation
- Erosion prediction model implemented on personal computers
- User-friendly interfaces & input creation utilities
- Large databases for U.S.
WEPP can be used to –

- Predict sheet & rill erosion, sediment deposition, and sediment delivery from hillslopes.

- Estimate erosion & deposition in channels such as ephemeral gullies and grass waterways.
WEPP can be used to –

- Determine impacts of impoundments
- Predict runoff & sediment delivery from small watersheds
Predict Runoff and Sediment Delivery in Subareas of Larger Watersheds
Sediment Delivery to Streams and Lakes
Sediment Delivery to Streams and Lakes
Cropland Applications

- Determine erosion and sediment yield rates based upon current land management
- Evaluate various management strategies, including various
  - Crop rotations
  - Tillage alternatives
  - Strip cropping
  - Waterways
  - etc.
Rangeland Applications

- Determine impacts of present range management
- Predict effects of changing management –
  - Grazing level
  - Burning
  - Herbicides
Forest Applications

- Forest Planning
- Impacts of:
  - Timber harvesting
  - Road construction
  - Road maintenance
  - Road traffic
  - Controlled burning
- Off-site impacts
  - Stream water quality
  - Fish spawning areas
WEPP Advantages

- Temporal and spatial estimates of soil erosion.
- Estimates of sediment deposition and delivery from hillslope profiles
- Estimates of detachment and deposition of sediment in ephemeral gullies and other small channels.
- Prediction of sediment deposition in impoundments.
WEPP Advantages

- Models the important physical processes governing erosion (climate, infiltration, runoff, ET, detachment by raindrops, detachment by flowing water, deposition, etc.).
- Simulation of nonuniform slope, soils, cropping/management.
- Large U.S. databases for climate, soils, and crops.
WEPP Disadvantages

- Use currently limited to hillslope profiles and small watersheds
  - Limited to rainfall/snowmelt/irrigation water inputs that result in overland flow runoff
  - No perennial stream processes
  - No classical gully processes

- Large number of model inputs are required due to the many model components. Databases must be populated if WEPP is to be easily used by field level conservationists.
Climate Simulation
Surface & Subsurface Hydrology
Water Balance & Percolation
Soil Component (Tillage impacts)
Plant Growth & Residue Decomposition
Overland Flow Hydraulics
Hillslope Erosion Component
Channel Hydrology & Hydraulics
Channel Erosion
Surface Impoundment Element
WEPP science

- Stochastic weather generator (CLIGEN)
- Daily updating of soil, plant, residue params.
- Infiltration predicted using a Green–Ampt equation modified for unsteady rainfall.
- Runoff volume is predicted from rainfall excess adjusted for depressional storage.
- Peak runoff rates using kinematic wave eqn.
- Steady–state sediment continuity equation.
- Detachment function of rain intensity, excess flow shear stress, adj. erodibilities, crit shr.
- Modified Yalin equation for sed. trans. cap.
Model Validation Studies

- Natural runoff plots (Zhang et al., 1996)
- Small watersheds (Liu et al., 1997)
- Other studies, including natural runoff plots, rainfall simulator studies, small watersheds, both within and outside the United States.
Natural runoff plots

- Thousands of plot years of data, from USLE repository
- $r^2 = 0.85$, Nash–Sutcliffe ME $= 0.88$ for average annual soil loss
WEPP Inputs

- Slope File
- Soil File
- Climate File
- Management File
- Irrigation File (optional)
- Watershed structure file (watershed)
- Channel parameter file (watershed)
- Impoundment parameter file (watershed)
Types of WEPP Output

- Daily, monthly, annual, and/or average annual runoff, soil loss, sediment yield
- Spatial distribution of soil loss and graphical depictions on profiles
- Graphical viewing of daily parameters and model output values (list of 92 variables)
- Special text output files with info on plant growth, soil, water balance, etc.
Profile depicted graphically in 2-D/3-D. Graphic image “hot” and allows viewing & editing of underlying parameters. Can copy, cut, paste, & delete soil or mgmt. regions. Erosion & deposition rates shown in shades of red & green in center profile layer.
Background image can be used, such as a scanned photo.

Project can be scaled to known landmarks on image.

Graphic is “hot” and allows viewing/editing of underlying input parameters.

Top view of erosion & deposition in shades of red & green can show trouble areas needing treatment.
Watershed Simulation of Terraces

- Terraced hillslope, 1% terrace channel slopes, fallow, corn management.

<table>
<thead>
<tr>
<th>Result Name</th>
<th>Value</th>
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<tbody>
<tr>
<td>Discharge Vol (m^3/yr)</td>
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<td>Sediment Yield (tonne/yr)</td>
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<td>Sediment Yield (T/ha/yr)</td>
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<td>Contributing Area (ha)</td>
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<td>Sediment Delivery Ratio</td>
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<td>Precip vol in Contributing Ar</td>
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</table>

*Soils*  
*Results*
Geospatial interface to WEPP allows easy access to commonly available DEM (digital elevation model) and DRG (digital raster graph) data from the Internet.

Users may also access their own data, if better quality from another source.

GeoWEPP users TOPAZ and DEM data to outline channel networks in region of interest.

Based on user’s selection of outlet point, sub-basins are automatically generated.
WEPP can be run based on “representative” profile for each sub-basin that is created based upon all flow paths in sub-basin. This quicker approach allows rapid problem identification.

Other alternative is to run WEPP hillslope simulations for every flow path – more time-consuming but allows detailed graphical depiction of soil loss and deposition in GIS.
WEPP Web Browser Interface

http://milford.nserl.purdue.edu