# A Web-Based BMP Tool for Minimizing Pesticide Transport in Agricultural Watersheds

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## Introduction

Best management practices (BMPs) can reduce pesticide transport to surface water and groundwater if designed according to site-specific hydrological processes. Soil and water managers are in need of a BMP selection tool that is:

(1)easy-to-use and requires little time to calibrate

(2)Includes both infiltration excess runoff (i.e. Hortonian flow) and saturation excess runoff processes.

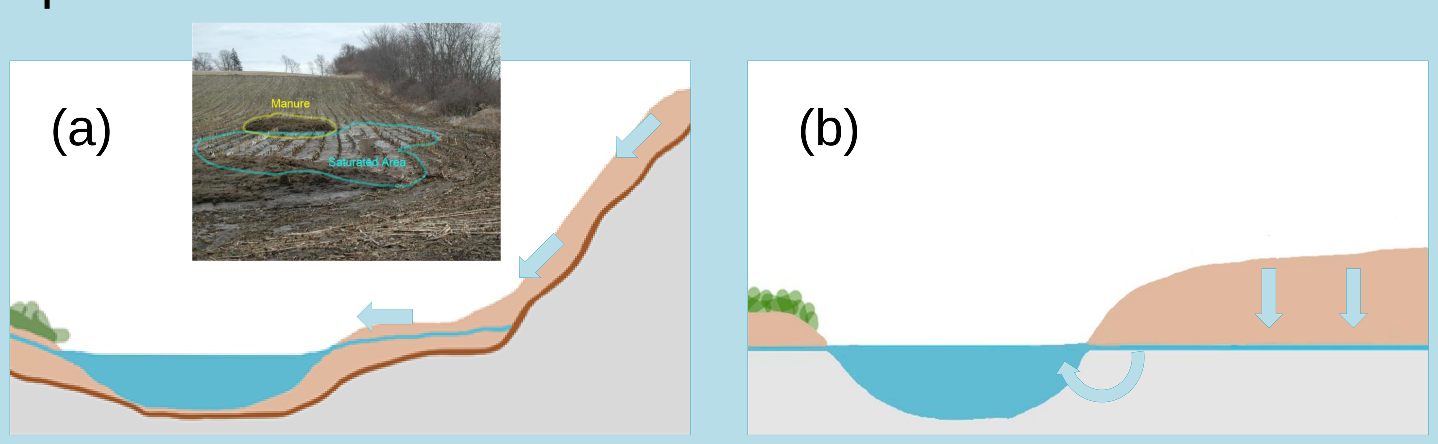


Figure 1. Example landscape types and associated hydrologic processes. (a) Lateral and overland flow converge to form saturated areas at the toe-slope in landscapes with steep slopes and an underlying clay-pan. (b) Percolation dominates in landscapes with shallow slopes and deep soil profiles.

## Objectives

We present a simple web-based BMP selection tool that can be used to characterize hydrological processes and pesticide transport mechanisms for a variety of landscapes, climates, and crops. We evaluate the tool by comparing modeled atrazine loads against field data from the Goodwater Creek Experimental Watershed (GCEW) of northeastern Missouri.

## Methods

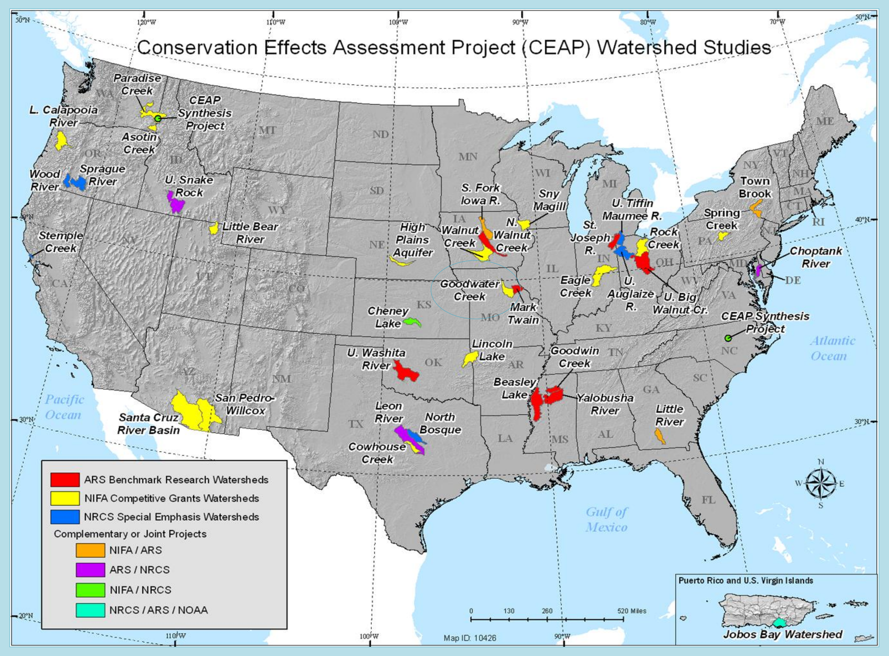


Figure 2. Location of the 13 Conservation Effects Assessment Project (CEAP) watersheds. In this study, we look at the Goodwater Creek, MO watershed (circled on the map).

### *Study Site*

The study site was located in the CEAP-GCEW of north-central Missouri (figure 2). Mulch till (MT) and no till (NT) plots planted in a corn-soybean rotation were 189 m by 18 m long and had an average slope of 0-2%. Sols were poorly drained Mexico silt-clay-loam with a clay-pan at 20 cm, 10 cm, and 30 cm for the top-slope, mid-slope, and toe-slope respectively.

## Methods (continued)

### *Model Description & Web Tool*

The web-based Hydrological Characterization Tool (HCT; figure 4) for pesticides couples the Watershed Erosion Prediction Project University of Idaho (WEPP-UI) model[1] with a pesticide transport module (figure 3)[2].

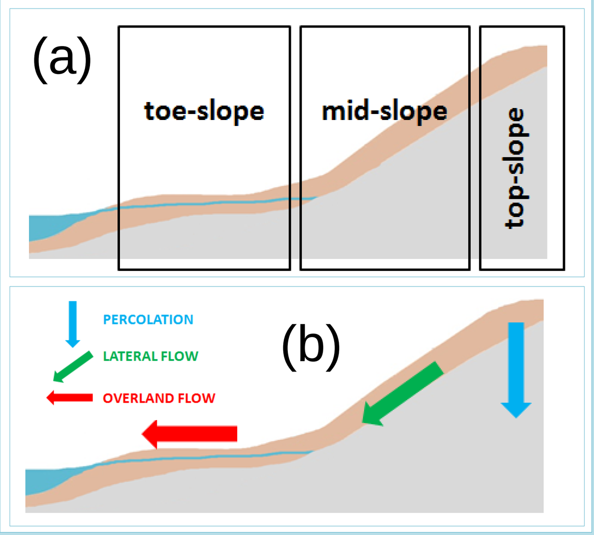


Figure 2. (a) WEPP-UI overland flow element (OFE) delineation. (b) Hydrological processes represented in the WEPP-UI model.

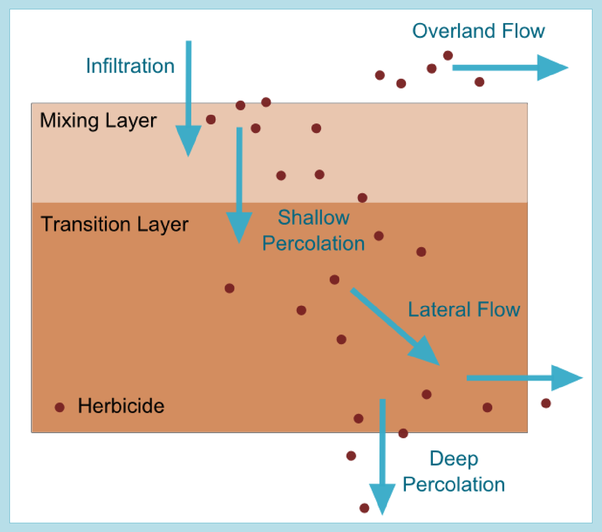


Figure 3. Schematic of hydrological transport processes included in the WEPP-UI pesticide model. Circles indicate dissolved or sediment bound pesticides and the blue arrows indicate water flows.

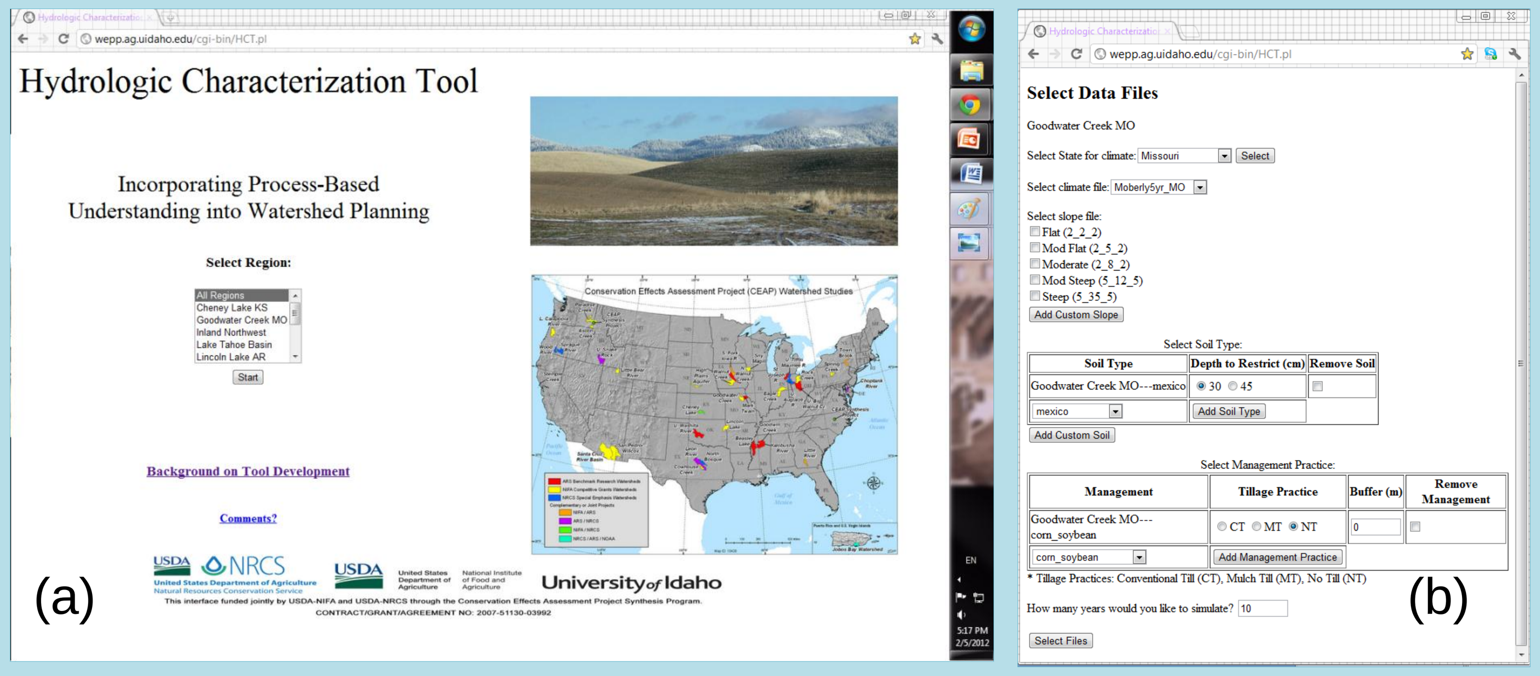


Figure 4. Sample HCT web pages. (a) Main web page. (b) Web tool simulation selection.

### *Model Simulations*

Table 1. Tillage and atrazine application rate for each model simulation.

| Simulation | Number of Years in Simulation | Management | Rotation | Application Rate (kg/ha)[a] |
|---|---|---|---|---|
| 1 | 5 | MT | Corn-Soy | 2.24 |
| 2 | 5 | MT | Soy-Corn | 2.24 |
| 3 | 5 | NT | Corn-Soy | 2.24 |
| 4 | 5 | NT | Soy-Corn | 2.24 |

Abbreviations: MT (mulch till), NT (no till)
[a] Atrazine was only applied to corn year rotations.

Table 2. Mexico silt loam soil properties used in model simulations.

| Depth (mm) | $\rho_b$ (g/cm$^3$) | $k_{sat,v}$[a] (mm/hr) | $k_{sat,h}$ Factor | FC | WP | Percent Sand | Percent Clay | Percent OM | CEC (meq/ 100g) |
|---|---|---|---|---|---|---|---|---|---|
| 180 | 1.45 | 17.4[b] | 50 | 0.29 | 0.14 | 9.1 | 19.5 | 1.9 | 13 |
| 200 | 1.55 | 9.72 | 50 | 0.33 | 0.2 | 9.4 | 29.9 | 1.2 | 14 |

Abbreviations: $\rho_b$ (bulk density), $k_{sat}$ (hydraulic conductivity), FC (field capacity water content), WP (wilting point water content), OM (organic matter), CEC (cation exchange capacity)
[a] For MT plots ksat,v below 200 mm was set to 0.005 mm/hr and for NT plots ksat,v was set to 0.05 mm/hr.
[b] ksat,v = 17.4 mm/hr for MT simulations and 32.4 mm/hr for NT simulations.

Table 3. GCEW tillage, plot number, application, and planting dates[3].

| Year | Tillage | Plot Numbers | Application and Planting Date |
|---|---|---|---|
| 1997 | MT | 19, 22 | May 13 |
| | NT | 13, 24 | May 12 |
| 1998 | MT | 11, 23 | May 21 |
| | NT | 18, 21 | May 21 |
| 1999 | MT | 19, 22 | Jun 03 |
| | NT | 13, 24 | Jun 03 |
| 2000 | MT | 11, 23 | May 16 |
| | NT | 18, 21 | May 16 |
| 2001 | MT | 19, 22 | May 16 |
| | NT | 13, 24 | May 16 |

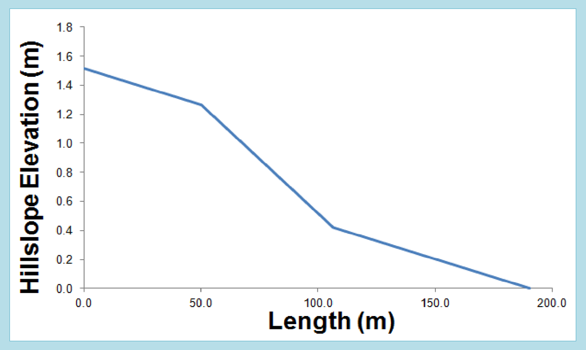


Figure 5. Hillslope profile used for all model runs (0.5%, 1.5%, 0.5%).

## Results

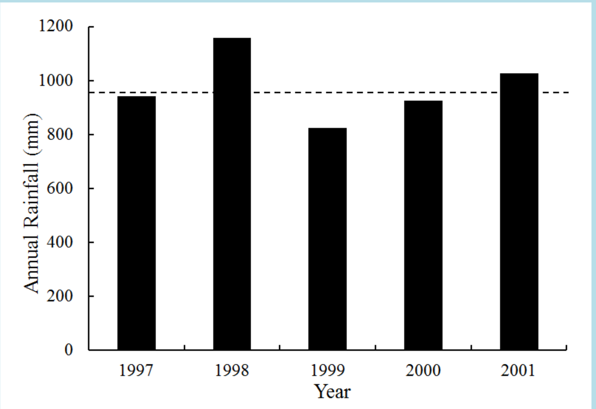


Figure 6. Observed rainfall used to initiate the HCT simulations.

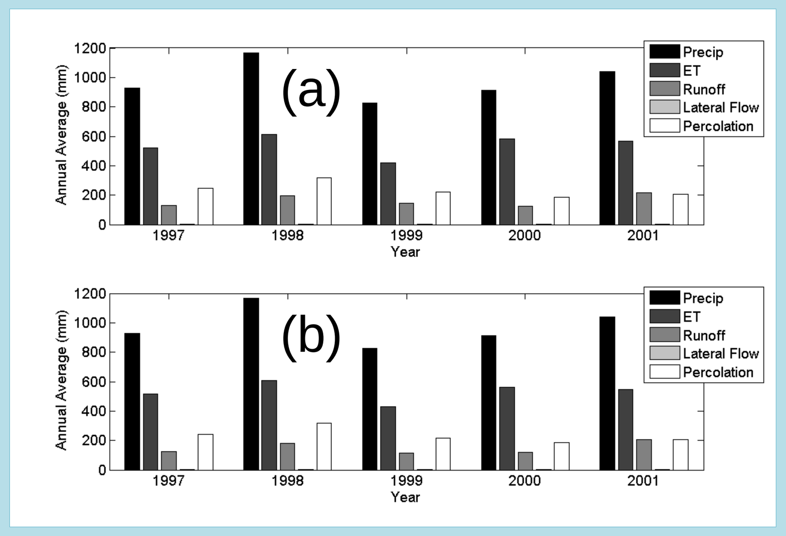


Figure 7. Rainfall and yearly averaged HCT outputs for (a) MT and (b) NT simulations.

Table 3. Model evaluation metrics for dissolved atrazine loads from mulch till and no till plots.

| Runoff (mm) | | | |
|---|---|---|---|
| Tillage | NSE | $R^2$ | Slope |
| MT | 0.83 | 0.84 | 1.09 |
| NT | 0.63 | 0.64 | 0.93 |
| **Atrazine Loss (ppb)** | | | |
| Tillage | NSE | $R^2$ | Slope |
| MT | 0.20 | 0.26 | 1.88 |
| MT Adjusted | 0.76 | 0.76 | 0.96 |
| NT | 0.56 | 0.58 | 0.85 |

Table 4. Model evaluation statistics for model simulations (see Figures 8 and 9).

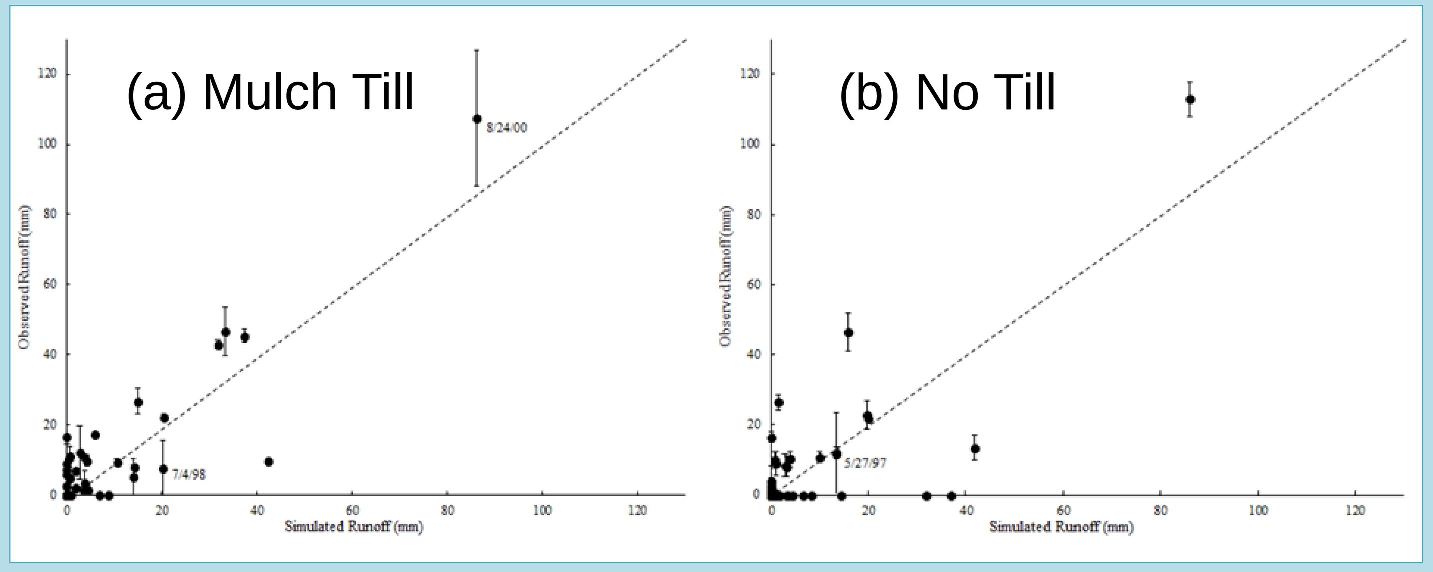


Figure 8. Comparison between simulated and observed runoff during the growing season (planting to harvest) for (a) MT and (b) NT.

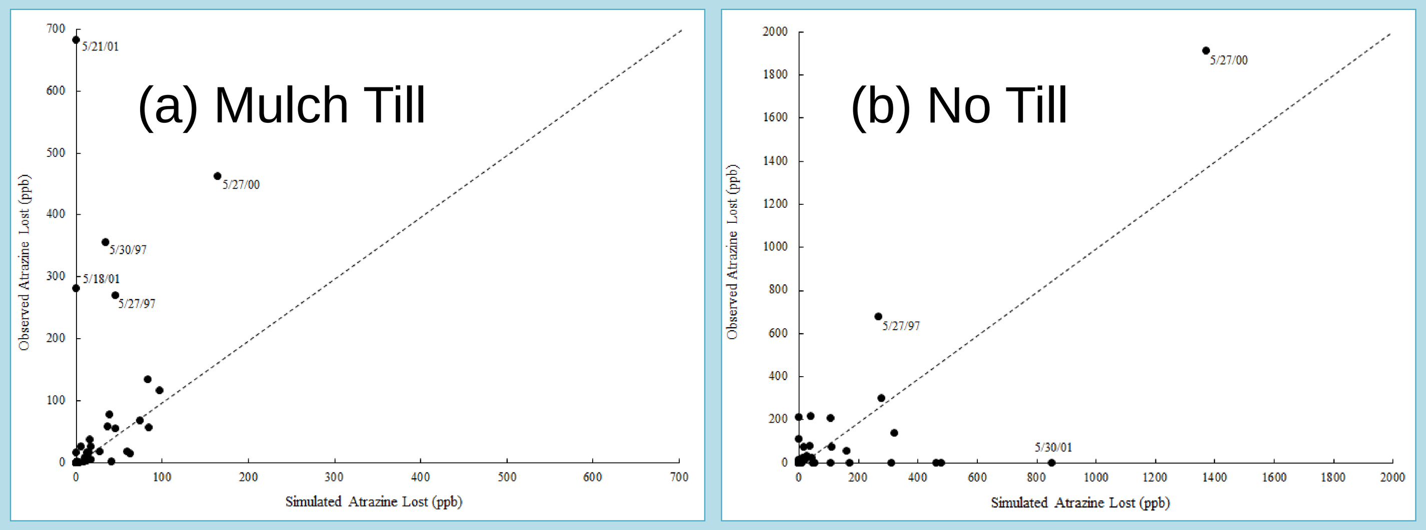


Figure 8. Comparison between simulated and observed atrazine loss during the growing season (planting to harvest) for (a) MT and (b) NT.

## Discussion & Conclusions

- Despite a great deal of variation in observed data, the yearly simulated atrazine loads appear reasonable for MT and NT plots.
- More extensive field testing is needed to validate this model for other regions, for particulate bound contaminants, and for other BMPs (e.g. vegetated buffer strips)
- Future research will introduce nitrogen and phosphorus modules into the HCT web tool.

**References**

[1]Brooks and Boll, 2011. *International Symposium on Erosion and Landscape Evolution Proceedings, ASABE*. [2]Steenhuis and Walter, 1980. *Transactions of ASABE*. [3]Ghidey et al., 2005, *Soil and Water Conservation Society*.

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