SAVING KANSAS SOIL: QUANTIFYING SOIL LOSSES AND EVALUATING AGRICULTURAL BEST MANAGEMENT PRACTICES WITH GEOSPATIAL AND PHYSICALLY-BASED MODELING

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INTRODUCTION

Soil erosion is a major environmental challenge in agricultural regions worldwide. In Kansas, rainfall-driven sheet and rill erosion affects nearly every aspect of sustainable farming, from crop yield and fertilizer efficiency to sediment delivery into streams and reservoirs. Managing soil losses is essential for soil health and preserving reservoir water storage capacity, while predicting where and when erosion occurs improves efficacy of targeted conservation practices. Effectiveness of agricultural practices varies with local soil, slope and climate conditions.

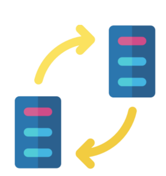
The **Water Erosion Prediction Project (WEPP)** model provides a physically based approach to simulate runoff, soil detachment, and sediment transport across agricultural hillslopes. Unlike empirical models such as RUSLE, WEPP can capture event-based erosion processes and account for variations in soil type, topography, and management practices along the hillslope.

This study applies the WEPP model to **quantify soil losses** and to **evaluate the effectiveness of Best Management Practices (BMPs)** such as no-till, conventional till, mulch cover in reducing erosion and sediment delivery.

OBJECTIVES

Create a set of representative hillslopes for sheet & rill erosion

Apply WEPP model to quantify soil loss and sediment yield



Compare **BMP** (Best Management Practices) effectiveness

Create regional soil loss map for Kansas

WEPP MODEL

WEPP simulates soil erosion as a sequence of physical processes along a representative hillslope flowpath:

- Hillslope area represented by a flowpath and a set of topographic, soil, land management, and weather conditions
- Infiltration and runoff generated with the **Green–Ampt** approach and **a Kinematic Wave** equation.
- Rill and interrill erosion modeled by sediment continuity and excess shear stress equations
- Sediment transport and deposition occurred along the slope controled by sediment transport capacity

The model computes soil detachment Df and sediment deposition rates at each point along the flowpath

$$\frac{dG}{dx} = D_f + D_i$$

$$D_f = K_r(\tau_f - \tau_c)\left(1 - \frac{G}{T_c}\right)$$

$$T_c = K_t(\tau_f)^{\frac{3}{2}}$$

Df = net rill detachment or deposition,
Di = interrill sediment input.
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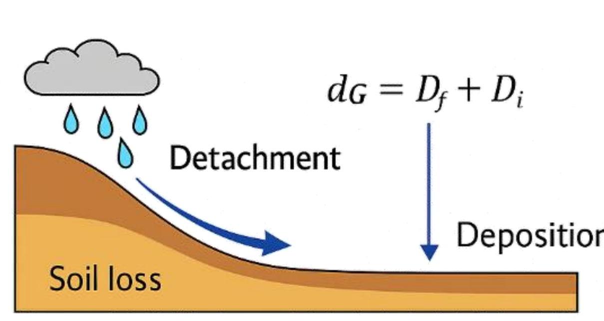


Figure 1: WEPP Erosion Calculation

STUDY AREA

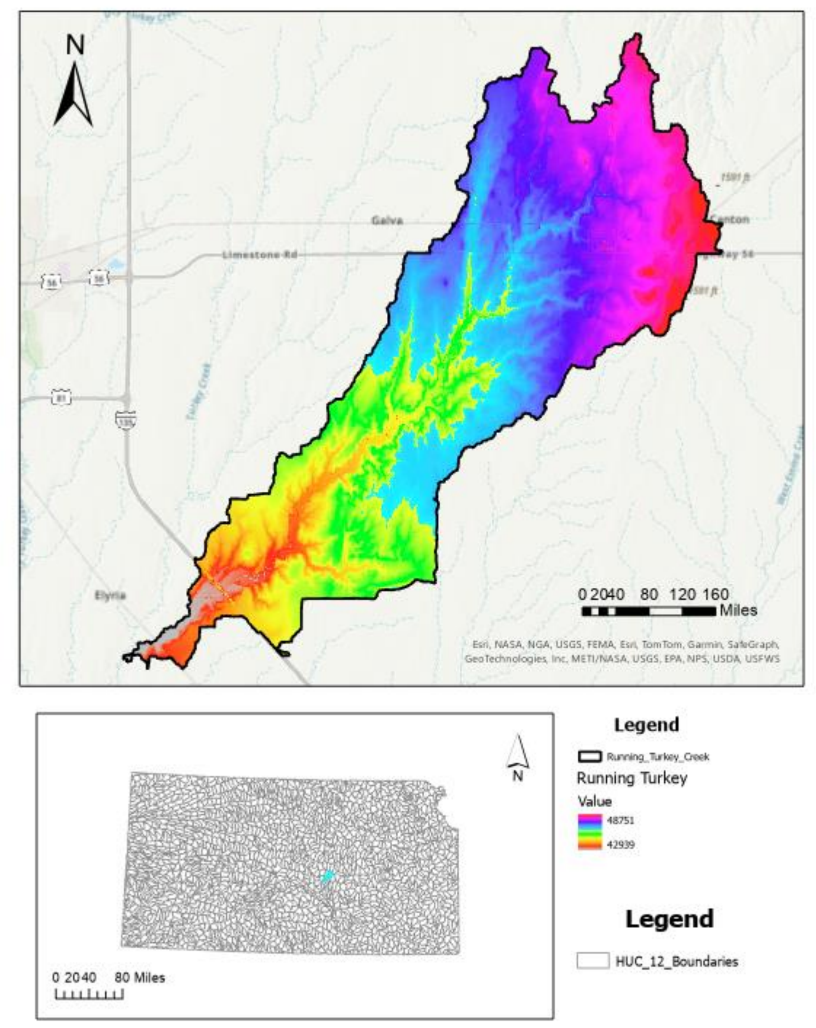


Figure 2: Running Turkey Creek in southcentral Kansas

METHODOLOGY

WEPP Runs

Filtered flowpath

Topography | Soil | Climate | Management

Crops/Rotations

Corn/rot1 | Soybean/rot2 | Sorghum/rot3 | WW/rot4

Tillage Operations

No-Till | Medium mulch | Low mulch | Conventional Tillage

100 year simulation

Soil loss values

Evaluate BMP Effectiveness

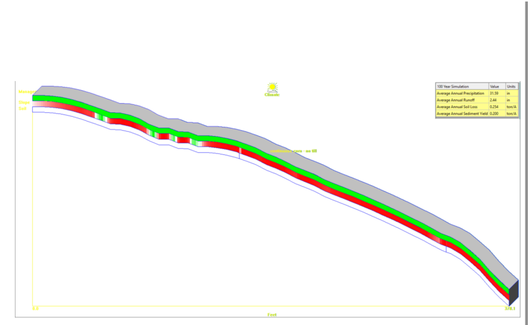


Figure 5: WEPP result for one selected hillslope

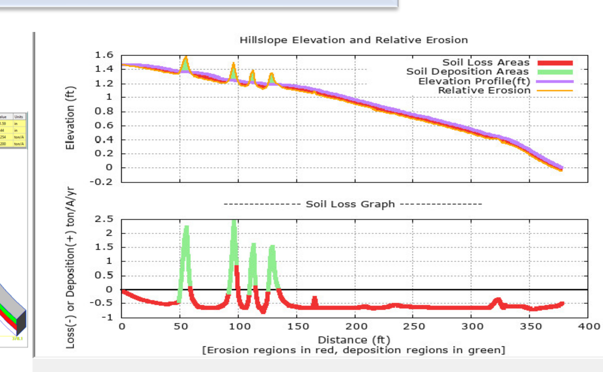


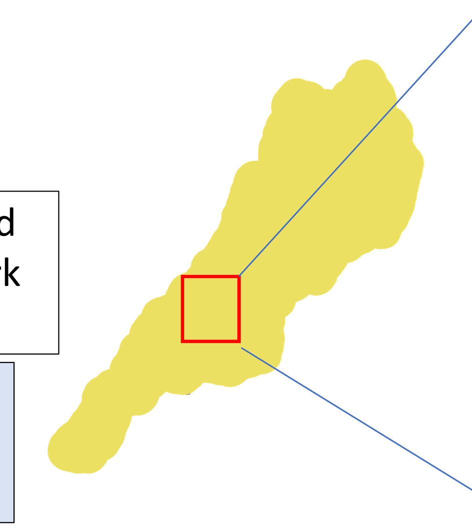
Figure 6: Soil Loss Graph, Erosion and Deposition Areas

SELECTION OF FLOWPATHS

LiDAR 2m DEM

Delineation and Stream Network Creation

Minimum Drainage Area= 4m2



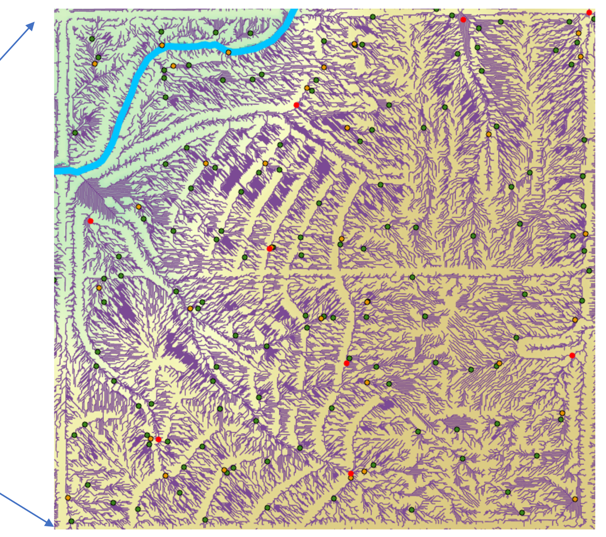
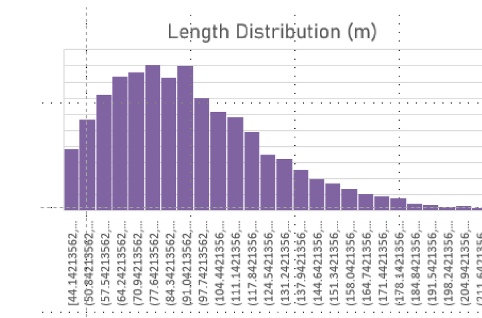
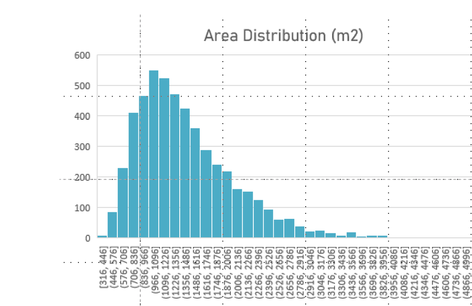
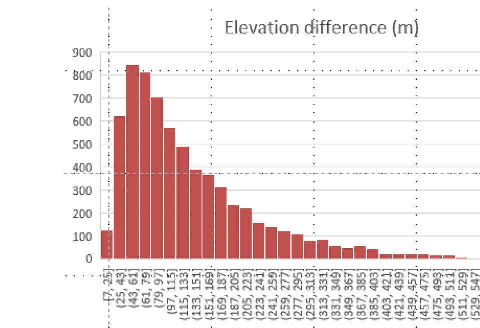


Figure 3: Stream Network

Figure 4: Final Selected Flowpaths







Filters

44m< Length< 220m	>0.1 % Avg slope	85 % or more croplands	Intersecting roads	Topographic wetness Index ~ 10-12

Legends

- Catchments and flowpaths of GORD 4
- Catchments and flowpaths of GORD 5
- Catchments and flowpaths of GORD 6

RESULTS AND DISCUSSION

Crop Rotation	From Tillage	To Tillage	% Change	Interpretation
C	CT	LM	-43.77	Moderate Decrease
C	CT	NT	-87.17	Strong Decrease
C	MM	NT	-87.87	Strong Decrease
CW	CT	LM	-63.45	Moderate Decrease
CW	CT	NT	-84.06	Strong Decrease
CW	MM	NT	-79.03	Strong Decrease
CWS	CT	LM	-60.59	Moderate Decrease
CWS	CT	NT	-86.01	Strong Decrease
CWS	MM	NT	-82.54	Strong Decrease

Table 1: WEPP Simulated Soil Loss under Different Rotations and Tillage Systems

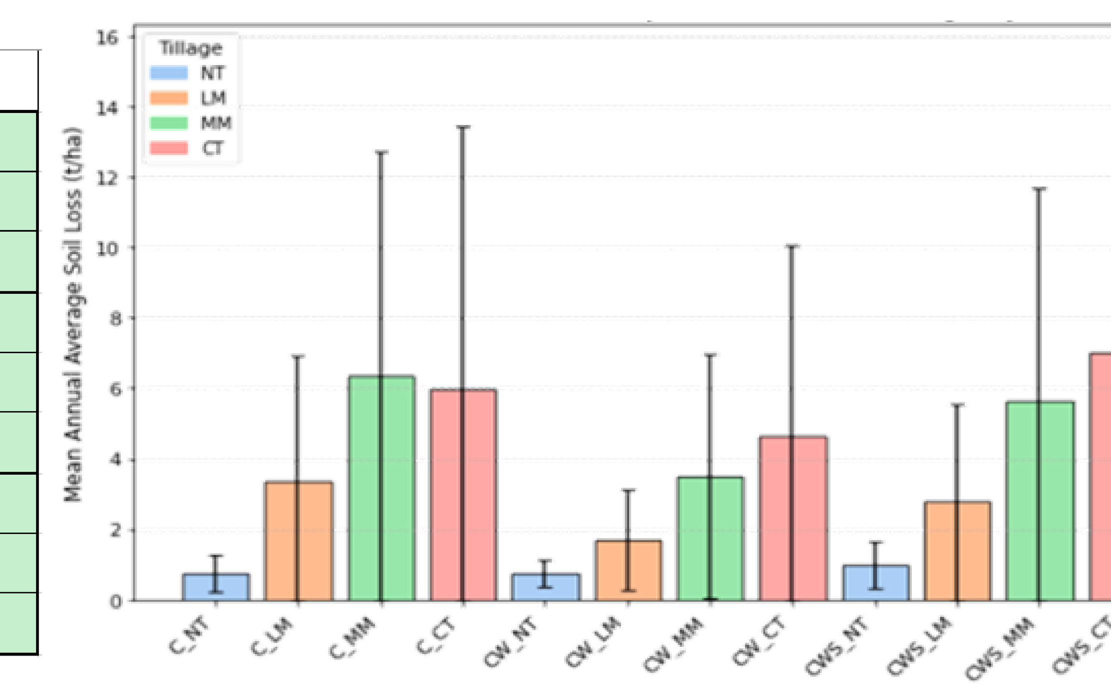


Figure 7: WEPP Simulated Soil Loss under Different Rotations and Tillage Systems

C= Corn, CW= Corn-Winter Wheat, CWS-=Corn-Wheat-Soybeans. NT= No Till, LM= Low Mulch, MM= Medium Mulch, CT= Conventional Tillage.

CONCLUSION AND FUTURE WORK

WEPP simulations confirmed that tillage intensity strongly controls soil erosion under continuous corn in Kansas conditions. No-till systems significantly reduce soil loss, demonstrating their effectiveness as a best management practice (BMP). Future expansion with machine learning will enable the potential to design conservation planning specific to a region and ensure sustainable agricultural practices along with improved water quality and stream protection due to sedimentation..

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