Estimation of USLE K-values with a Process-based Approach

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Introduction

Soil erodibility is considered as an important factor in soil erosion prediction. In the Universal Soil Loss Equation (USLE), the K – erodibility factor is defined as the rate of soil loss per unit of the erosion index (EI) from a continuously tilled fallow plot 72.6 ft long on a 9% slope (unit plot). A soil erodibility nomograph, which allows rapid estimation of K values for different soils, was developed from both long-term natural runoff plots, as well as from rainfall simulation studies. In this study, a combination of lab experiment with WEPP model simulation was used to back-calculate USLE K values.

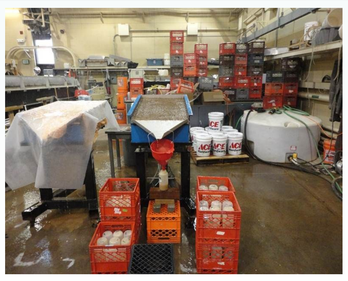
Materials and Methods

Indiana Soil (Miami clay loam)

South Dakota Soil (Opal clay)

Vermont Soil (Vergennes silty clay)

Interrill Experiment (Rainfall Simulation)

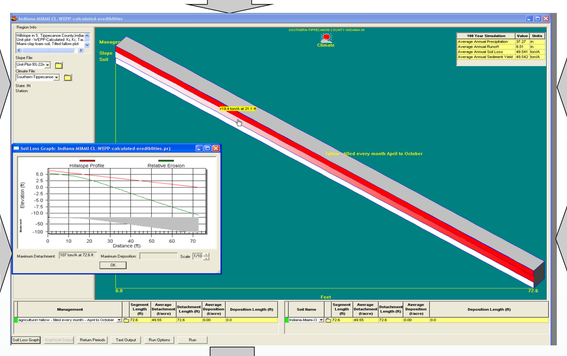


Dry - K_i
Saturated - K_i
Drainage - K_i

Rill Experiment (Mini-Flume)

Dry - K_r and τ_{cr}
Saturated - K_r and τ_{cr}
Drainage - K_r and τ_{cr}

Climate Input: 100 years of synthetic weather



Soil Input: Soil Texture; OM; CEC.

Slope Input: 72.6 ft. long, 6 ft. wide, 9% uniform slope

Management Input: Fallow, tillage every month from April to October.

WEPP Soil Loss

USLE Soil Erodibility

$$K = \frac{\text{WEPP Soil Loss}}{\text{USLE R}}$$

Conclusions

The nomograph K for Indiana soil was nearly same as WEPP K and RUSLE2 K, lower for South Dakota and Vermont soils. The WEPP K were nearly same as RUSLE2 K for Indiana and South Dakota soil, lower for Vermont soil. The dry and saturated K were slightly greater and drainage K was lower while compared with RUSLE2 K. It is a good method for estimating USLE K-values especially for the soils from Indiana and South Dakota.

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Results and Discussion

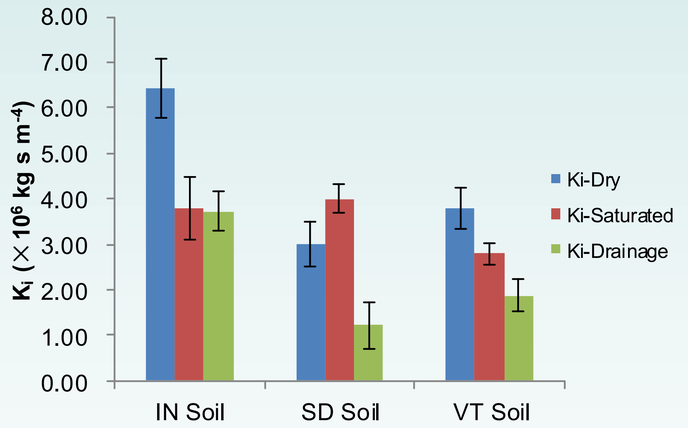

Figure 1. Measured Interrill Erodibilities (K_i)

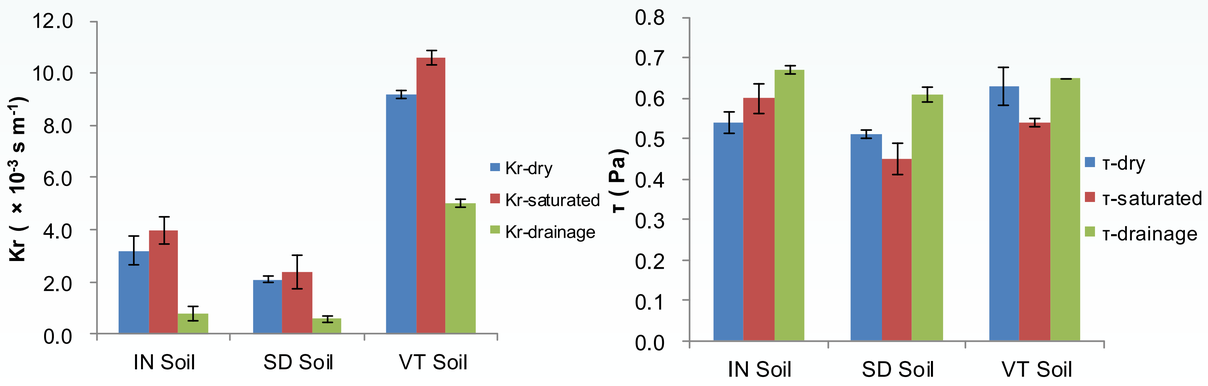

Figure 2 Measured Rill Erodibilities (K_r) and Critical shear Stresses (τ_{cr})

Figures 1&2 show the experiment results for the three soils. The data were input to WEPP model to compute long-term average annual soil loss. Then USLE K values were back-calculated (Figure 3).

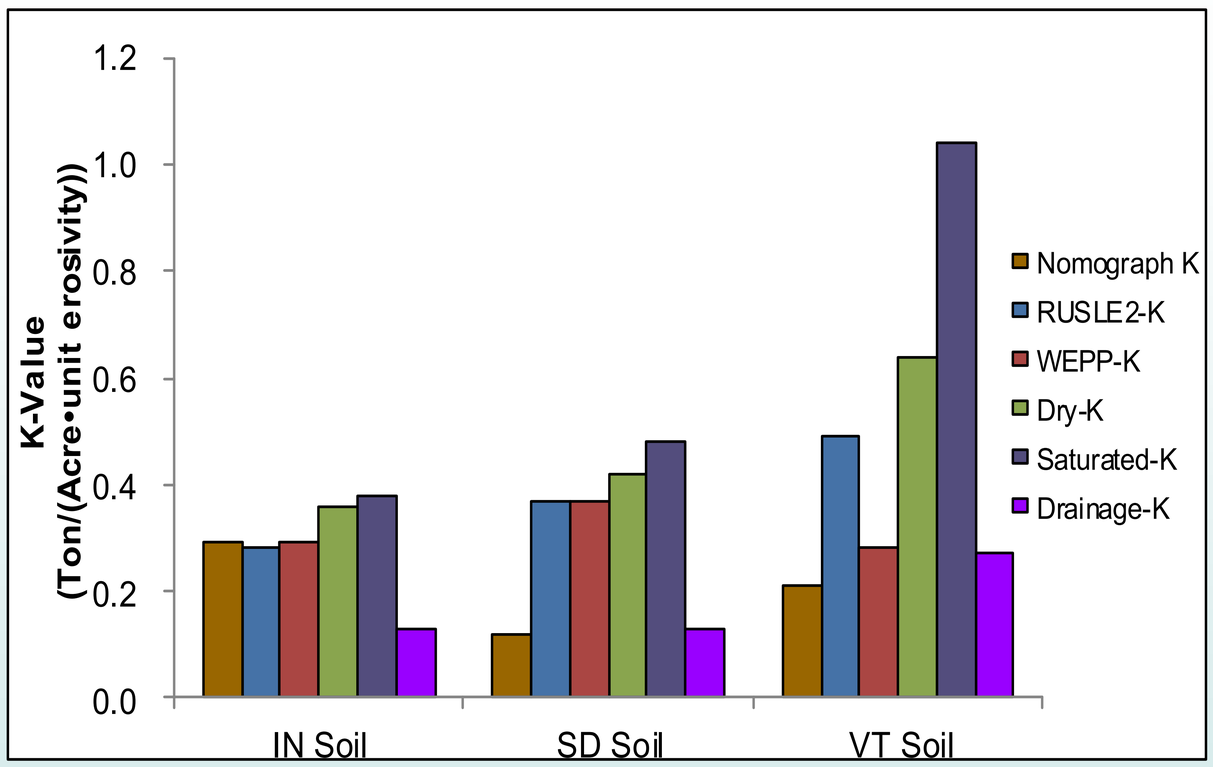

Figure 3. A comparison of the RUSLE2 K Value and Back-Calculated K-Value

- Nomograph K for IN soil was nearly same as WEPP K and RUSLE2 K, lower for SD and VT soils.
- WEPP-K was same as RUSLE2 K for IN and SD Soils, lower for VT soil.
- Dry and saturated K greater and drainage K lower compared with RUSLE2 K.
- Greatest K resulted from saturated condition and lowest K resulted from drainage condition.