SUPPLEMENTARY MATERIALS

The complete methodology for GIS RUSLE model

The Slope Length and Steepness (LS) Factor accounts for the effect of topography on soil loss through sheet and rill erosion, and it combines slope length (L) and slope steepness (S). It is the ratio of soil loss from the study area to the soil loss from a standard unit plot under the same conditions (Wischmeier and Smith 1978, Foster 1977). The first equations were proposed by Wischmeier and Smith 1978, and subsequent equations improved the accuracy of the equations to account for erosion on higher relief topography (Van Remortel et al 2001; Desmet and Govers 1996; Mitasova et al 1996).

Different equations for slope steepness are recommended depending on whether slope is greater or less than 9% in order for RUSLE to be more accurate for different terrains. The Unit Stream Power Erosion and Deposition method is adequate for regions with low relief (Renard, USLE revised; Pelton 2014, Moore and Wilson 1992, Oliveira et al 2013). In this method, the area of upland contributing flow replaces linear distance for slope length calculations to incorporate the impact of flow convergence (Efe et al, Pelton et al 2014, Gertner et al. 2002). Area calculations are achieved by using a digital elevation model (DEM) (Parveen and Kumar, Van der Kniff, Uddin 2016). Elevation data is typically best at as fine scale a resolution as possible and LiDAR data at a resolution of 8.5 meters was available from TopoLens (Hu et al. 2016). Slope, flow direction and flow accumulation were calculated from the DEM, from which the LS factor could be derived using the equations outlined in Oliveira et al. 2013 (Equations 2 and 3).

$$L = (m+1)\left(\frac{\lambda_A}{22.13}\right)^m \qquad \text{Equation 2}$$

Where L is the slope length factor at some point on the landscape, λ_A is the area of upland flow, 22.13 is the standard unit plot length, and m is an adjustable value depending on the average slope gradient of the study region (Uddin et al. 2016).

$$S = \left(\frac{\sin(0.01745 \times \theta_{deg})}{0.09}\right)^n \qquad \text{Equation 3}$$

Where θ is the slope in degrees, 0.09 is the standard unit plot slope, and n is an adjustable value depending on the soil's susceptibility to erosion.

The Rainfall Erosivity (R) factor reflects the erosivity of rainfall events over a location based on mean annual rainfall (Wischmeier and Smith 1978). Correlation between the R factor and mean annual precipitation is given in Equation 4 and was determined by using U.S. monthly precipitation data from 1951-1980 (Renard and Freimund 1994).

$$R = 578.8 - 1.219P + 0.004105\,P^2 \qquad \text{Equation 4}$$

Where P is mean annual precipitation (mm) and R is in (MJ mm/ ha $^{-1}$ h $^{-1}$ year $^{-1}$) for locations with mean annual precipitation > 850 mm.

Data was sourced from the Daymet Version 3 annual summary climatologies at a 1 kilometer spatial resolution for annual total precipitation (Thornton et al. 2016). Precipitation was averaged over the time period of 2001 to 2015, for which the average rainfall for the USRW was 1047 mm/year (Thornton et al. 2016).

The Soil Erodibility (K) factor quantifies the susceptibility of soil particles to detachment and transport by rainfall and runoff (gSSURGO). K factor values are determined from direct measurements on runoff plots where soil and topography are uniform within the plot, and adhere to the standard unit plot size. The variability of soil erosion rates are due to physical soil characteristics: soil texture, organic matter, soil structure, and soil depth (Agriculture Handbook 703, Renard et al. 1997). Erosion factor K values were provided in the gSSURGO soil database, available from the USDA NRCS SSURGO. The database provides spatial soil data with associated soil characteristics compiled in several tables linked together by keys to maintain unique identifiers. When joining and relating tables, information was sorted according to top soil horizon or major soil component. To convert the gSSURGO K factor to SI it was multiplied by 0.1317 (Foster et al 1989).

The Crop Management (C) factor represents the erosion on different cropping systems and tillage practices relative to a freshly tilled, bare fallow condition (Wishmeier and Smith 1978). The RUSLE was originally used for farm fields, where specific practices such as crop rotations, cover crops, residue management were detailed at the field scale, and C factor values were computed using the software program for RUSLE1. In this study, estimation of average C factor values at the county scale used land management practice data from the 2015 Illinois Soil Conservation Transect Survey. The transect survey is a biannual survey in which county Soil and Water Conservation District staff visually estimate from the roadside at fixed locations crops planted, residue cover, tillage system, and P values. From these data and previously determined estimates of slope, slope length, and soil type, annual soil loss was calculated for each location using both USLE and RUSLE1. The RUSLE1 software was used to calculate C factors for crop and tillage systems that correspond to the residue levels after planting observed in the transect survey (Table 3). Recent crop yields and residue production have been greater than the maximum values in the RUSLE1 software, and additional residue applications were input to 1 to account for increased yields over time. Weighted average C factor values for corn following corn, soybean following soybean, corn soybean rotation, and small grains were determined in each county by frequency of tillage system reported in the transect survey and mapped by joining data with the 2015 CDL (Table 3).

The Conservation Practice (P) factor reflects the reduction in soil erosion due to conservation support practices that actively redirect and reduce the rate of water runoff, and it is the ratio of soil loss from an area with a support factor to that of one with strait-row farming up and down the slope (Wischmeier Smith 1978). In the region of interest there is low relief topography, with the average slope 0 to 4%, and conservation support practices such as contour farming, strip cropping, and terracing are not frequently practiced. The most common erosion reducing practice implemented at a large scale is subsurface drainage, using tile drainage lines (Skaggs et al. 1994). Documentation of land area with tile drainage is limited, thus efforts have been made to estimate the areas of land with a high probability of having subsurface drainage (Fraterrigo and Downing 2008, WRI). To predict drainage areas in the study region slope, drainage class, and clay content of the soils were mapped and reclassified to account for soils with less than 3% slope, poor drainage, and more than 40% clay content, respectively (Fraterrigo and Downing 2008, 703, USLE Handbook). Land under corn soy production were identified from the CDL to ensure only cropland was considered. Identified areas with a high probability of having subsurface tile drainage was assigned P factor value of 0.6 (Handbook 703 Soil Erosion, pg 215, Bengston and Sabbagh 1990).

Table 1 RUSLE results for the soil erodibility map layers with 8.5 meter cell resolution.

Factor	Units	Value Range	Mean	SD
Annual soil loss (A), Scenario 1	ton/(ha*yr)	0 - 135.94	0.342	1.753
Rainfall erosivity (R)	MJ*mm/(ha*hr*yr)	3258 - 4445	3817.070	184.957
Soil erodibility (K)	t*ha*h/(ha*MJ*mm)	0.0026 - 0.0645	0.039	0.007
Slope length, slope steepness (LS)	ratio	0 - 10.71	0.03	0.152
Crop management (C)	ratio	0.003 - 0.218	0.143	0.040
Conservation practice (P)	ratio	0.6 - 1	0.646	0.127

Table 2 Details of the suitability analysis variables.

Name	W*i*	R*ij*	Cell Value	Units	Class	Variable Statistics		Marginal Condition
Crop Productivity Index	6	1	127-130	-	yield	min	69	<116
		2	117-126			max	130	
		3	69-116			mean	120.8	
						SD	8.7	
A- Annual Soil loss	5	1	0-0.5	ton/(ha*year)	RUSLE	min	0	
		2	0.6-4.9			max	135.9	
		3	5.0-136			mean	0.3	
						SD	1.8	
Flood frequency	4	1	none	text (%)	physical	%	94.4	Occasional, Frequent
		1	rare				0.4	
		2	occasional				0.3	
		3	frequent				5.0	
Riparian Areas	4	3		50 m buffer	edge			
Natural Areas		2		50 m buffer	edge			
Roadsides		1		50 m buffer	edge			
Sand content	3	1	0-22	%	physical	min	0	>55%
		2	23-55			max	91	
		3	56-91			mean	7.0	
						SD	6.2	
Cation Exchange Capacity	3	1	24-133	meq/100g	geochemical	min	1.6	<14
		2	15-23			max	132.5	
		3	1.6-14			mean	23.2	
						SD	5.1	
Pond frequency	2	1	0-5	%	physical	min	0	>15%
		2	6 to 14			max	100	
		3	15-100			mean	41.6	
						SD	43.9	
Water Table	2	1	90-190	cm	physical	min	7	<50 cm
		2	50-90			max	190	
		3	7.0-51			mean	41.1	
						SD	32.5	
Soil pH	1	1	6.2-6.5	pH	geochemical	min	5.5	<6.2, >6.5 pH
		2	5.5-6.2, 6.5-8.2			max	8.2	
						mean	6.4	
						SD	0.4	