Modeling sediment accumulation in North American playa wetlands in response to climate change, 1940-2100

Climatic Change

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Details of RUSLE Computations

A. Playa Identification

We combined several existing spatial layers of potential playa wetland locations and geometries (Kansas Data Access and Support Center [http://www.kansas.org]; M. McLachlan, D. Pavlacky unpublished data) to create a single dataset containing roughly 84,000 playa wetlands on the west-central Great Plains. We assumed the playa data to be the current best estimate of playa location and extent. Due to file size processing limitations and because few playas occurred east of 98.4°W, we truncated the playa dataset here. Not including this playa-sparse portion of the study area in our analyses resulted in a loss of about 0.33% (788 ha) of total playa wetland area and ca 1% (1049) of all playas.

We applied a circularity threshold of ≥ 0.75 to identify circular and ellipsoidal playas. We estimated playa circularity (approximation to a circle) by

$$c = \frac{\sqrt{A_{playa} / \pi}}{P_{playa} / 2\pi} \qquad \text{(ESM-1)}$$

where A_{playa} was playa area and P_{playa} was playa perimeter. We removed non-circular playas and interior stock ponds and pits. To define drainage loci or "watersheds", we combined the playa layer with other surface water features (flow paths, rivers, canals, reservoirs, and lakes) obtained from the high-resolution National Hydrography dataset (http://nhd.usgs.gov/index.html). In the absence of high resolution DEMs, we created watersheds using nearest neighbor to assign landscape pixels to the nearest water and retained only those watersheds containing playas. We compared our watershed areas to those determined by Ekanayake et al. (2009) for the minimum distance method.

B. Soil K-Factor

Soil K-factor (erodibility, multiplied by 0.1317 for SI units [Foster et al. 1981]), texture (% sand, % silt, and % clay), and bulk density were obtained from SSURGO2.0 (USDA Natural Resources Conversation Service Soil Survey Spatial and Tabular Data, http://datagateway.nrcs.usda.gov). Data were limited to the uppermost-recorded major soil horizon in each soil mapping unit.

C. Slope and Playa Depth

We extracted playa elevations and upland slopes using a 10-m digital elevation model (DEM, National Elevation Data set, http://datagateway.nrcs.usda.gov), the highest resolution available with coverage of the complete study area. For this DEM, vertical resolutions of 0.01 m, 0.1 m, and 1 m were reported for 50, 25, and 25% of the area, respectively (http://ned.usgs.gov/downloads.asp). We used XTools Pro (version 6.2, Data East 2003-2010) to create points at 10-m intervals around each playa perimeter and determined the elevation at each point. The difference between the lowest point on the playa perimeter and the lowest point within the playa established the playa depth. Although we were able to discern playa watersheds using the 10-DEM, vertical resolution was not sufficient to consistently differentiate within-playa elevations. Based on average playa depth from field measurements (Luo 1994; Tsai et al 2010), we assigned a depth of 0.3 m to playas with calculated depths of < 0.3 m. Because playas are extremely shallow, we likely overestimated the depth and increased the potential sediment capacity of some playas. We computed the topographic factor (LS) after Renard et al. (1997:Eqns. 4-1, 4-4, adjusted for SI units per Foster et al. [1981])

$$LS = \left(\frac{l}{22.13}\right)^{\mu}(10.8 \sin slope + 0.03) \qquad \text{(ESM-2)}$$

where 22.13 was the length of a RUSLE reference plot (m), l was the length (m) of the field under test, and slope was the slope angle (degrees) of the field under test. The length exponent, μ, (McCool et al. 1989:Table 2) and slope term (McCool et al. 1987:Eqn. 10) were both based on shallow slopes and low to moderate rill/interrill ratios. Using a GIS approach, the field length under test was equal to the cell length (grid dimension, m).

ESM References

Data East (2003-2010) XTools Pro for ArcGIS version 6.2. Novosibirsk, Russia

Foster GH, McCool DK, Renard, KG, Moldenhauer WS (1981) Conversion of the universal soil loss equation to SI metric units. J Soil Water Conserv 36:355-359

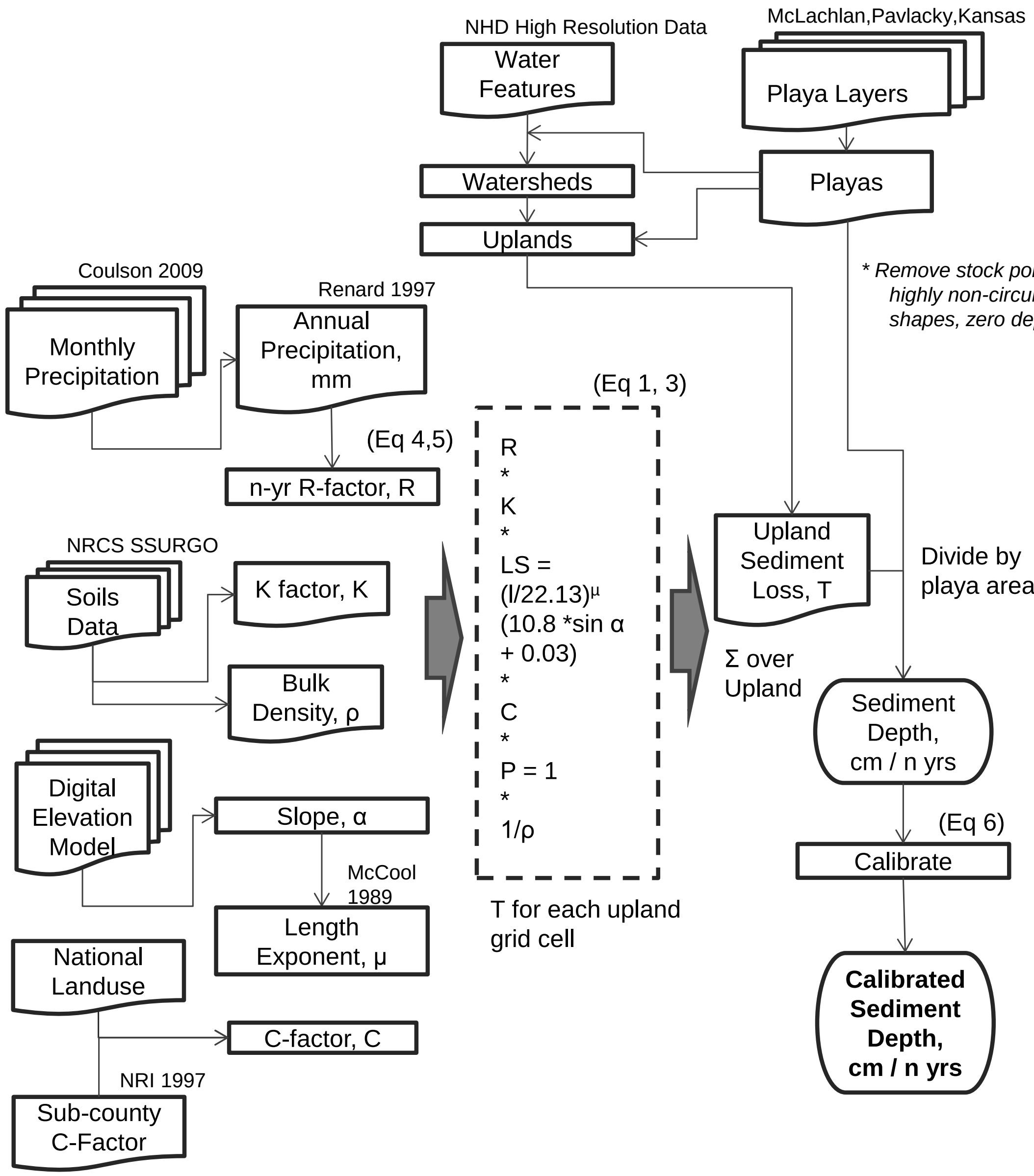
McCool DK, Brown JC, Foster GR, Mutchler CK, Meyer LD (1987) Revised slope steepness factor for the Universal Soil Loss Equation. Trans Amer Soc Agricul Eng 30:1387-1396

McCool DK, Foster GR, Mutchler CK, Meyer LD (1989) Revised slope length factor for the Universal Soil Loss Equation. Trans Amer Soc Agricul Eng 32:1571-1576

Captions

Fig 1 Data processing flow chart for implementation of RUSLE (revised Universal Soil Loss Equation) using GIS (geographical information system)

Table 1 Correspondence of National Resources Inventory (NRI) Land Use categories, crop types, and C-factor values by state to National Land Cover (NLC) categories and determination of average C-factor by generalized land use (cropland, pasture, or grassland) for the west-central Great Plains



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NRI Land Use										
		C-Factor by State						NLC Category	Average	% Land
Code	Use[a]	CO	KS	NE	OK	NM	TX		C-factor	Area
11	Corn		0.16-0.24	0.15-0.16			0.35	82	0.22	26
12	Sorghum		0.18-0.28				0.35	82		
13	Soybeans			0.13-0.18				82		
14	Cotton						0.35-0.7	82		
111	Wheat	0.32	0.23	0.1-0.16	0.12-0.21	0.13-0.18	0.15-0.25	82		
142	Hay/legume	0.02	0.02	0.02		0.02		81	0.02	9
170	Other/summer fallow	0.17-0.37	0.17-0.21	0.11-0.13				81		
211	Pasture grass			0.01	0.01-0.04		0.01	81		
410	Other farm land / CRP	0-0.01	0.01	0-0.01	0-0.04	0.03	0.01	81		
250	Grassland	0	0	0	0	0	0	71	0.01	55
	Other							Other	0	8

[a] C-factors for major land uses only. Average C-factor based on weighted average of land use by acreage in the category. Although grassland had an average C-factor of 0, it was assigned a small value (0.01) to distinguish it from non-eroding surfaces that also have a C-factor of 0 and to reflect the field evidence of some erosion.