Modeling Soil Erosion and Sediment Deposition at Furman University Using USLE

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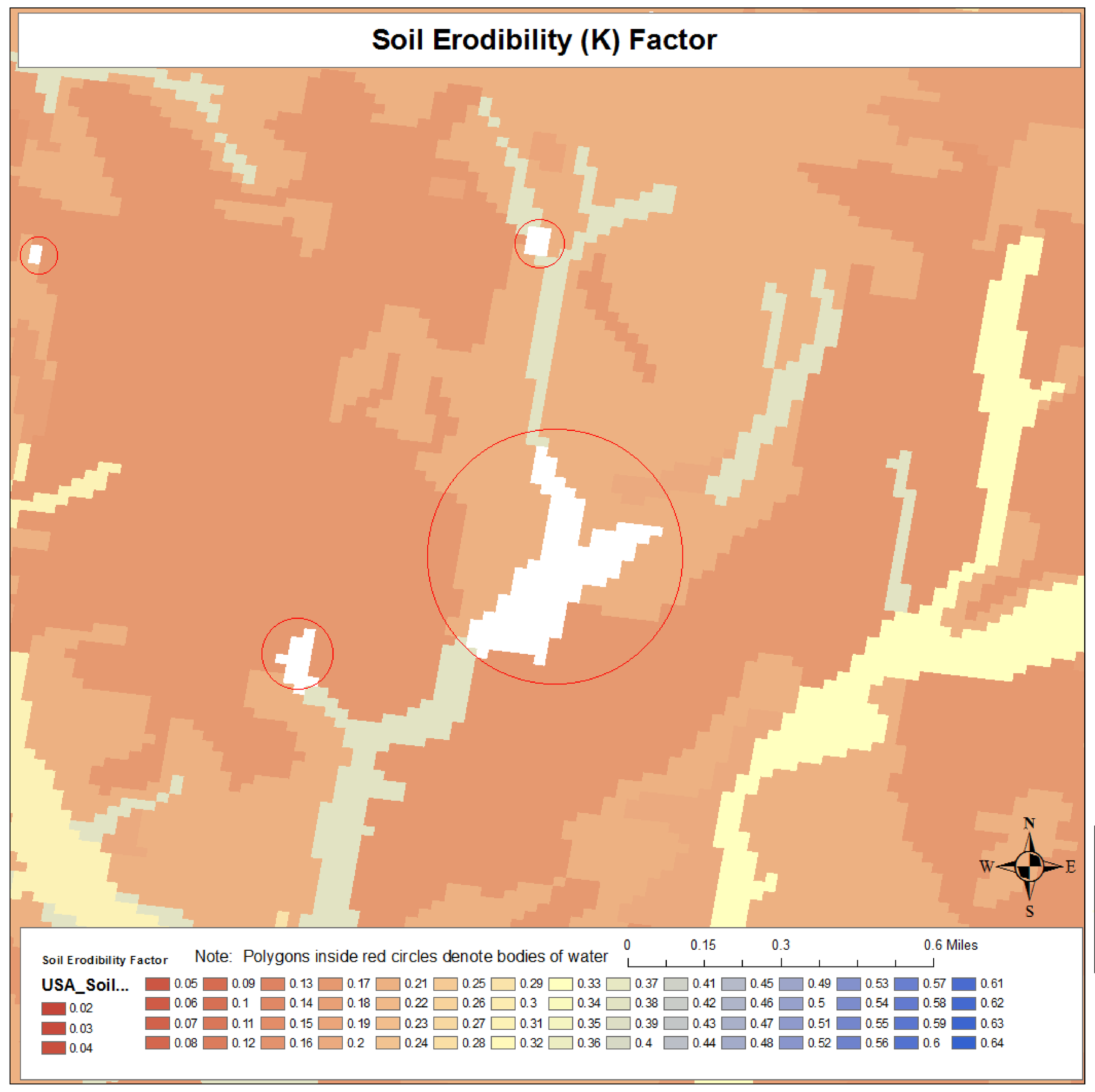
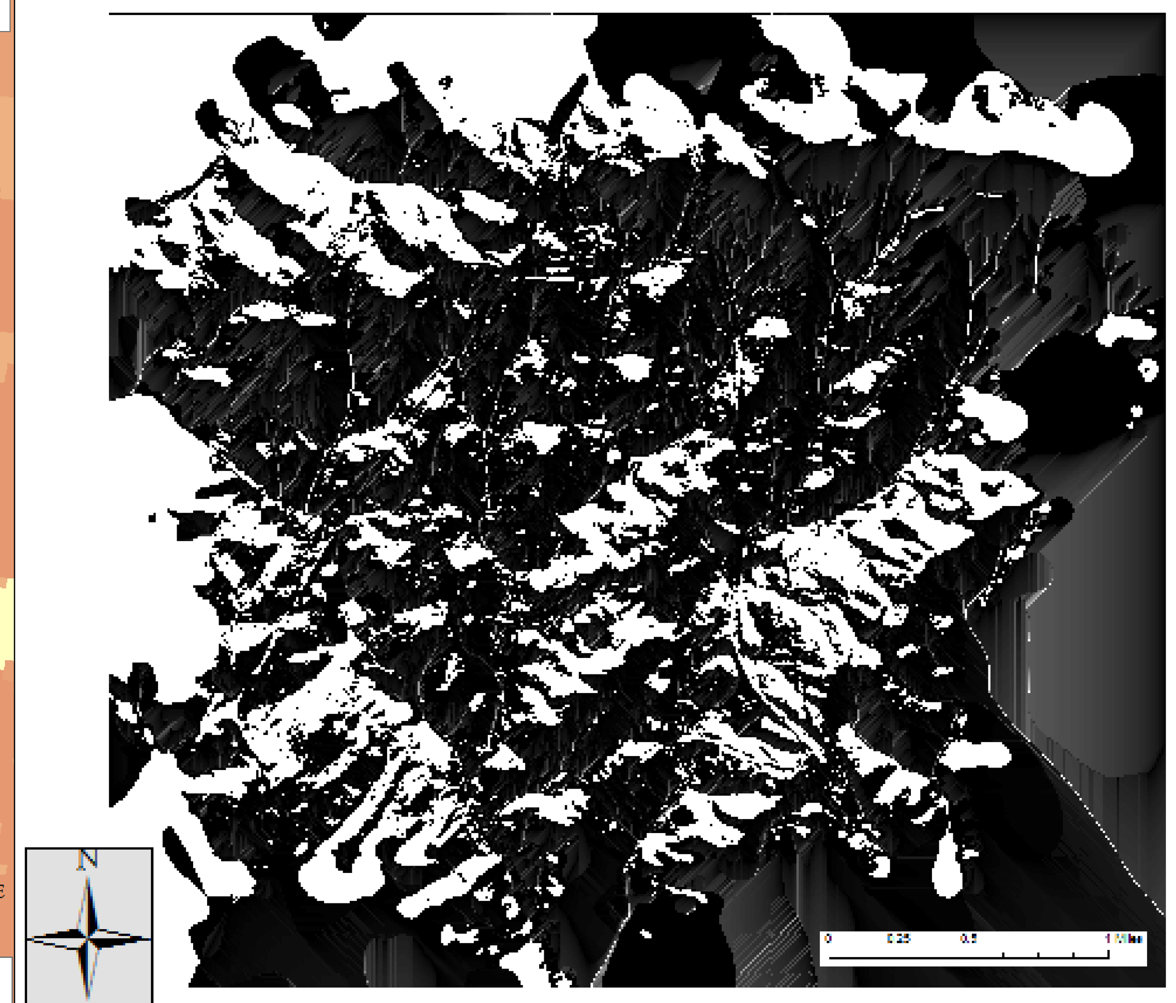
Abstract

In this study, the Universal Soil Loss Equation (URSE) was used to estimate erosion patterns on Furman University's campus. The factors of the Universal Soil Loss Equation are R, K, LS, C, and P. R refers to the average rainfall runoff factor which is determined by the average rainfall quantities and intensity over a given period of time. K refers to the soil erodibility factor, which is based on various soil properties including the presence of organic matter, clay content and sand content. LS refers to the direction, length and steepness of the terrain. C represents the land use factor. P refers to the conservation efforts put forth to prevent soil loss. Combined in the equation A=R*K*LS*C*P, these factors provide an estimate of the soil loss for the study area. The R value was determined by data in the USDA (US Department of Agriculture) Agricultural Handbook Number 537 which provides regional estimates for erosion rainfall losses. The K factor was determined by data from the Natural Resources Conservation Service which produced raster data showing the values of the soil erosion factors. The LS factor was determined by converting topographic lines into direction-slope-length values. The C value was determined by collecting Land Use Data from SC.gov and applying appropriate values C factor values to each attribute based on data originally found in Haan, Barfield, Hayes,1994. but accessed through Kim et. al 2014. In this study, there was not enough data for the P factor or conservation methods, so this factor was set to 1 as not to alter the final estimate.



The Soil Erodibility Factor is the susceptibility of soil particles to be detached by rainfall, snowmelt, or other forms of runoff. The soil erodibility factor is determined based on the size of the particulate, the percent organic matter present, the sand content, clay content and permeability of the soil. Soil erodibility factor is measured on a scale of 0,2 to 0.69, the higher the number, the more likely the particulate is to be displaced by rainfall or runoff.

LS Factor: Length of Slopes



Legend

LS Factor

Value

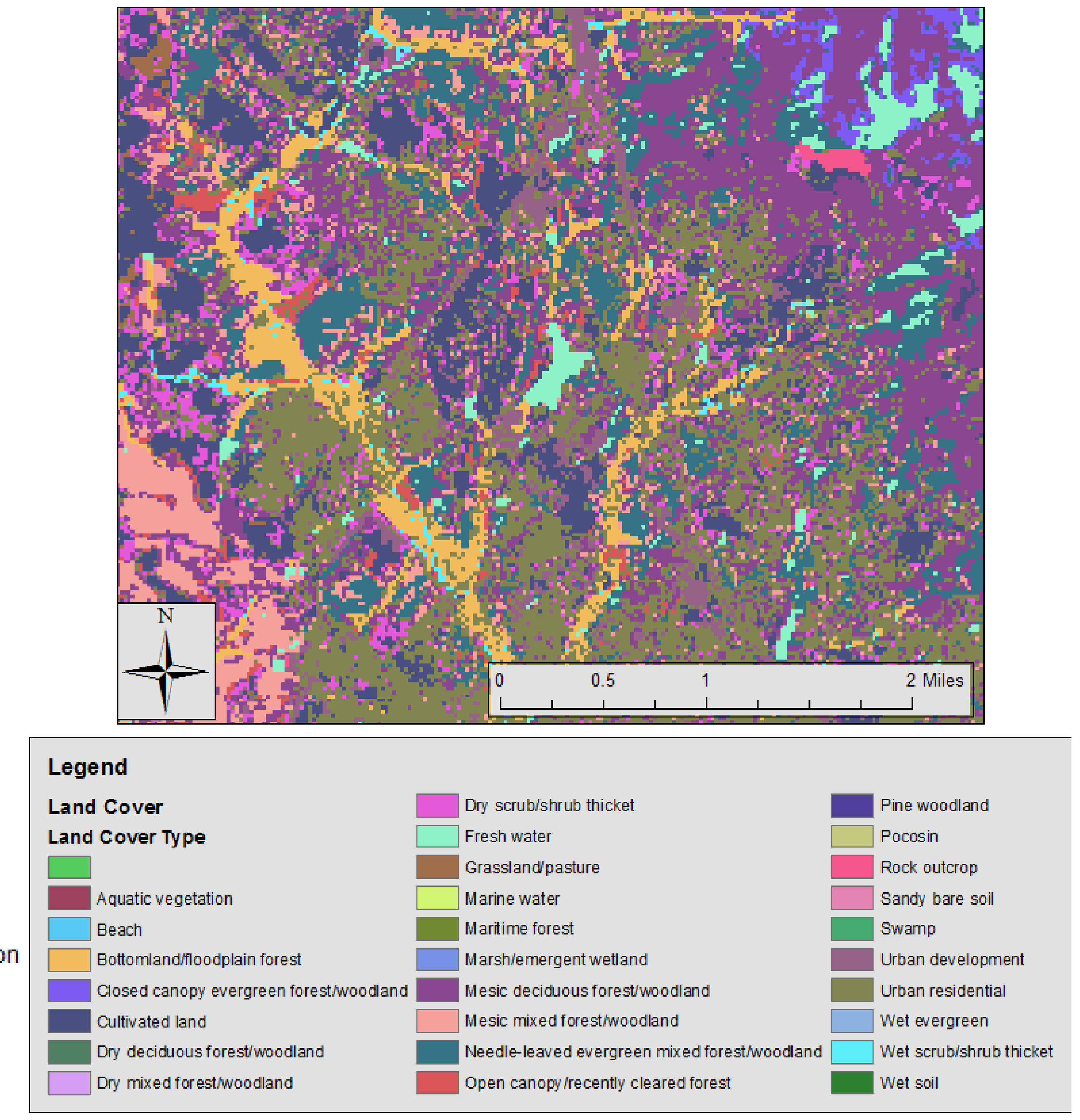
High : 100.168

Low : 0

The map above is the resulting data, showing the length-slope relation of the area. This map was created by converting Contour Line data into Raster elevation data, then calculating flow direction using the Flow Direction tool. Then the Flow Accumulation was calculated using the Flow Accumulation Tool. The data was then put into the Slope tool to determine slope in degrees over the area. Finally, these inputs were put into the Raster Calculator in the LS Formula

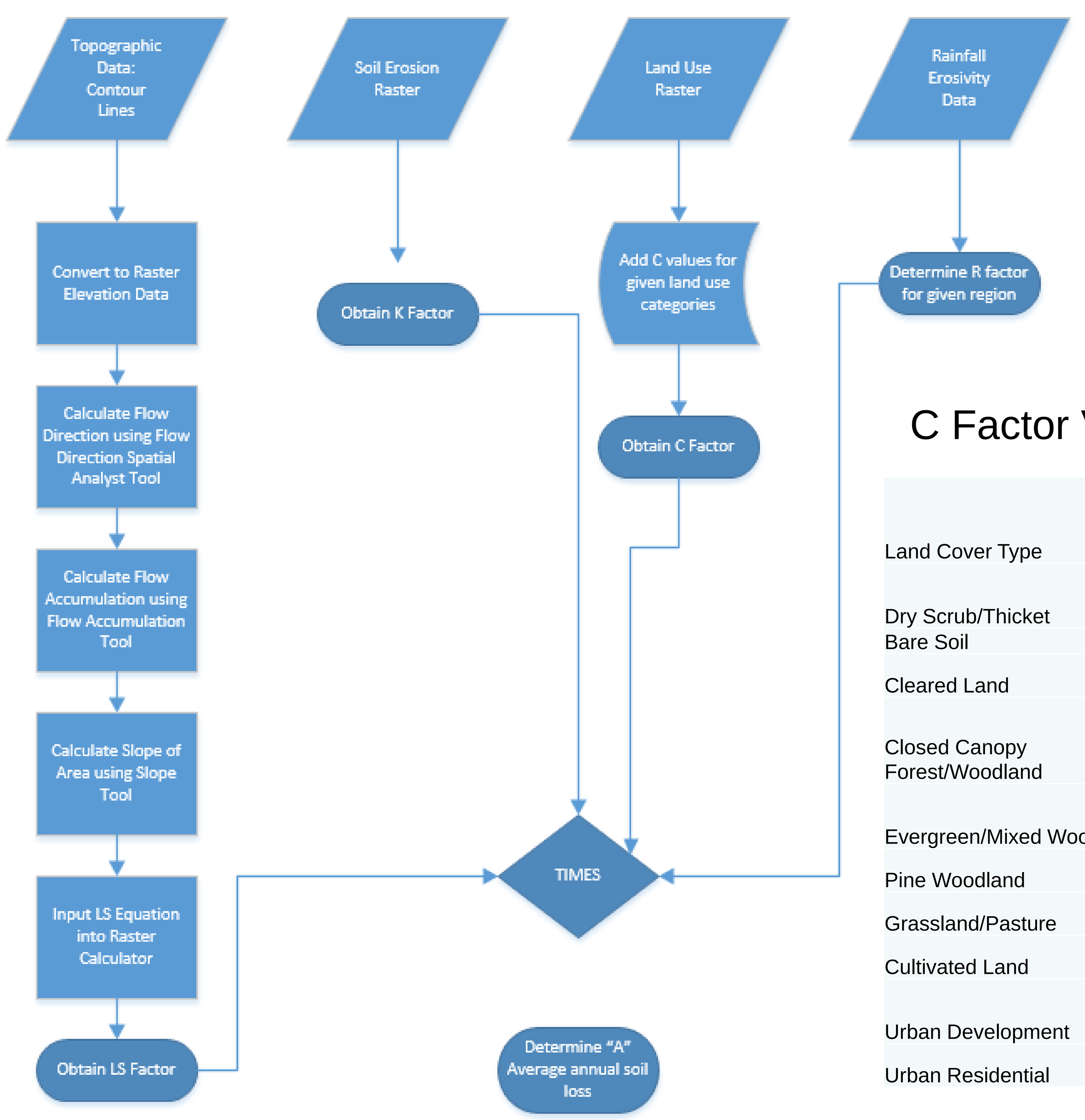
(Power("flow accumulation"*[cell resolution]/22.1,0.4) *Power(Sin("slope ofdegree"*0.01745))/0.09, 1.4)*1.4.). (Kim et. al 2014).

C Factor: Land Use



This map shows the land use raster data for the area of study. Currently, land use is categorized by type, but the data can also be categorized by the C value or the impact that the land use type has on the soil erosion in the area.

Methods

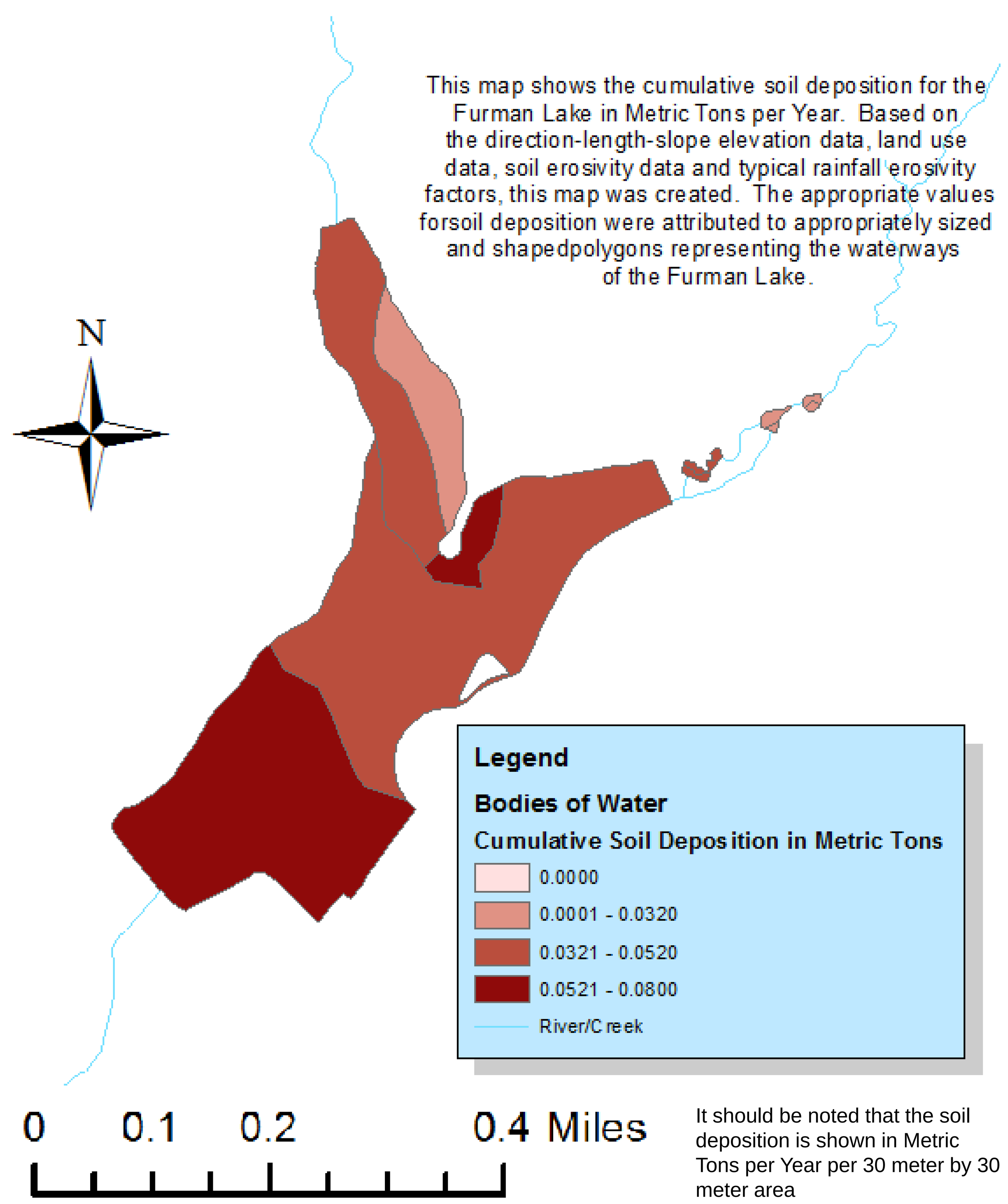


C Factor Values

Land Cover Type	C Factor
Dry Scrub/Thicket	0.02
Bare Soil	1
Cleared Land	1
Closed Canopy Forest/Woodland	0.001
Evergreen/Mixed Woodland	0.001
Pine Woodland	0.001
Grassland/Pasture	0.013
Cultivated Land	0.01
Urban Development	0.45
Urban Residential	0.3

Cumulative Soil Deposition per Year

This map shows the cumulative soil deposition for the Furman Lake in Metric Tons per Year. Based on the direction-length-slope elevation data, land use data, soil erosivity data and typical rainfall erosivity factors, this map was created. The appropriate values forsoil deposition were attributed to appropriately sized and shapedpolygons representing the waterways of the Furman Lake.



It should be noted that the soil deposition is shown in Metric Tons per Year per 30 meter by 30 meter area

Conclusion

Using GIS combined with the Universal Soil Loss Equation is an effective way to estimate soil loss due to erosion, however the results of this study were not as conclusive as hoped. The finalized map had to be manipulated significantly to show variation in soil deposition within the study area. The uniformity in soil loss within the study region is due to multiple factors. Firstly, the study area is small in comparison with the large tracts of farmland and massive watersheds this method often applied to. The Furman Lake is also an interconnected series of man-made ponds and creeks which makes determining the appropriate study area or watershed more difficult. The study area, as mentioned, is relatively small and therefore we see uniformity in soil erosivity (K factor). For this study, the P Factor and R factor were set as constants (1, and 250 respectively), which further reduced the accuracy of the results. For completely accurate results, a more comprehensive land use survey, a more defined watershed survey and a more comprehensive soil erosivity survey would need to be conducted. Overall, it was interesting examining the components of the Universal Soil Loss Equation and it is clear that this method could be useful when trying to determine the impact of land use change on a watershed.

References and Data Sources

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