Spatial Relationships between Conservation Practices and Sediment or Nutrient Loss Potential in an Agricultural Watershed

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Introduction

Cheney reservoir is a major water supply for the city of Wichita, Kansas. Elevated phosphorus and sediment inputs to the reservoir have caused algal blooms and resultant foul taste and odor problems in the drinking water. Possible sources of this phosphorus could be runoff and erosion from agricultural fields. In the mid 1990s a citizen's task force was organized to assist producers through cost sharing the implementation of best management practices (BMPs). Implementation of BMPs is voluntary, which can potently lead to those fields at higher risk for loss not being targeted for BMPs.

Figure 1. Location of Cheney Lake watershed

Sampling of an alga bloom in Cheney Lake

Objectives

The objective of this study is to evaluate changes in field-scale erosion resulting from BMP implementation between the years 1997 to 2006.

Methods

Potential for sediment and associated nutrient loss was determined by computing erosion with the revised universal soils loss equation (RUSLE) equation A=(R*K*LS*C*P) in a geographical information system (GIS) for the entire 2430 km^2 watershed. Figures 2-7 represent the RUSLE factors.

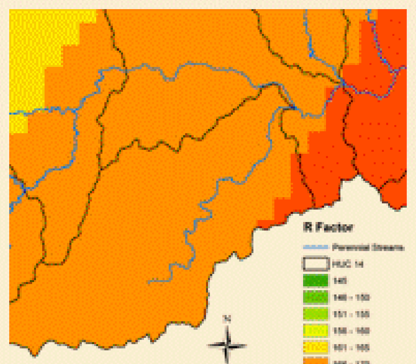

Figure 2. Rainfall Factor

R factor is based on an isoline map of county R factor. The R factor increases from west to east in the watershed.

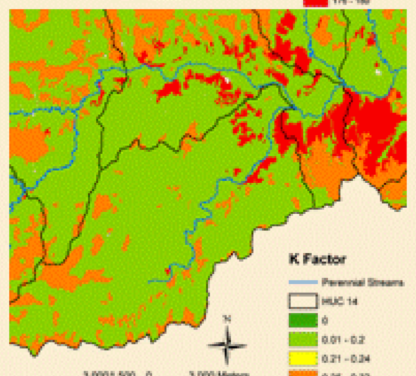

Figure 3. Soil Erodibilty Factor

K factors acquired from the SURGO Soils database. The eastern portion of the watershed has the greatest K factors.

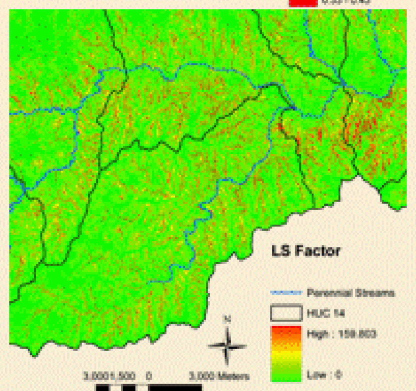

Figure 4. Length Slope Factor

LS factors were calculated from 30m National Elevation Data. The western portion of the watershed is relatively flat, with greater topographical relief in the east.

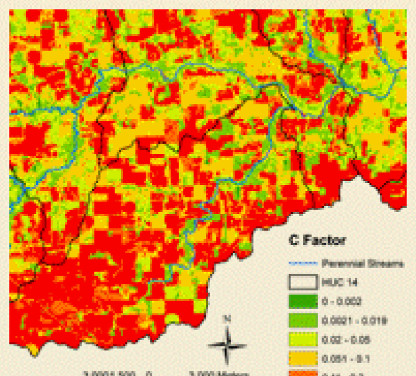

Figure 5. Cover Factor

C factors are based on 1997 landuse data provided by USDA-NRCS. The various cover types were given a rating of low, medium, and high.

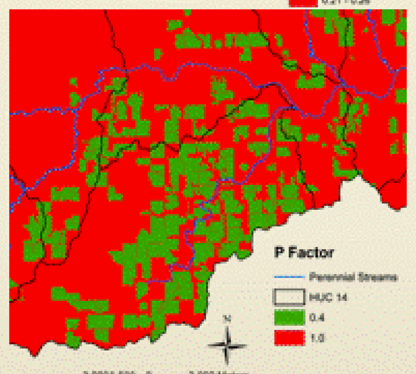

Figure 6. Conservation Practice Factor

P factors from 1997 data on terraces and associated contour tillage were used.

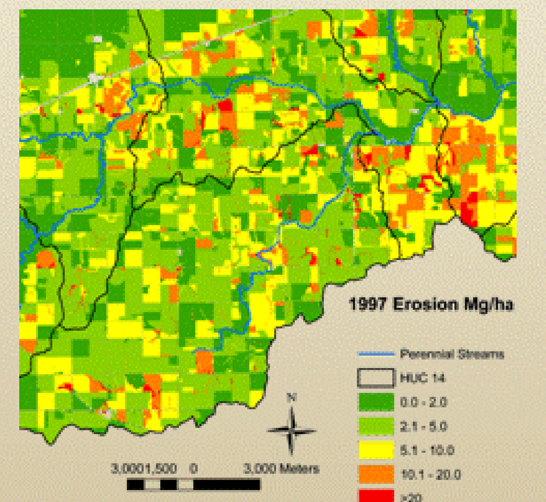

Figure 7. 1997 Soil Erosion

The end result of multiplying the above factors is erosion at a30m pixel scale. Which is then scaled up to the field scale using the USDA's common land unit layer.

Results

Table 1 shows landuse changes from 1997-2006. All three of the landuse categories increased in the 9-year time span, with BMPs being implemented on over 20,000 ha.

Table 1. Landuse changes in the Cheney Lake watershed

	1997		2006		%
	ha	%	ha	%	Change
Terraces	18400	7	22100	9	20
CRP	48500	19	62300	24	29
Fields with BMPs	N/A	N/A	20600	8	N/A

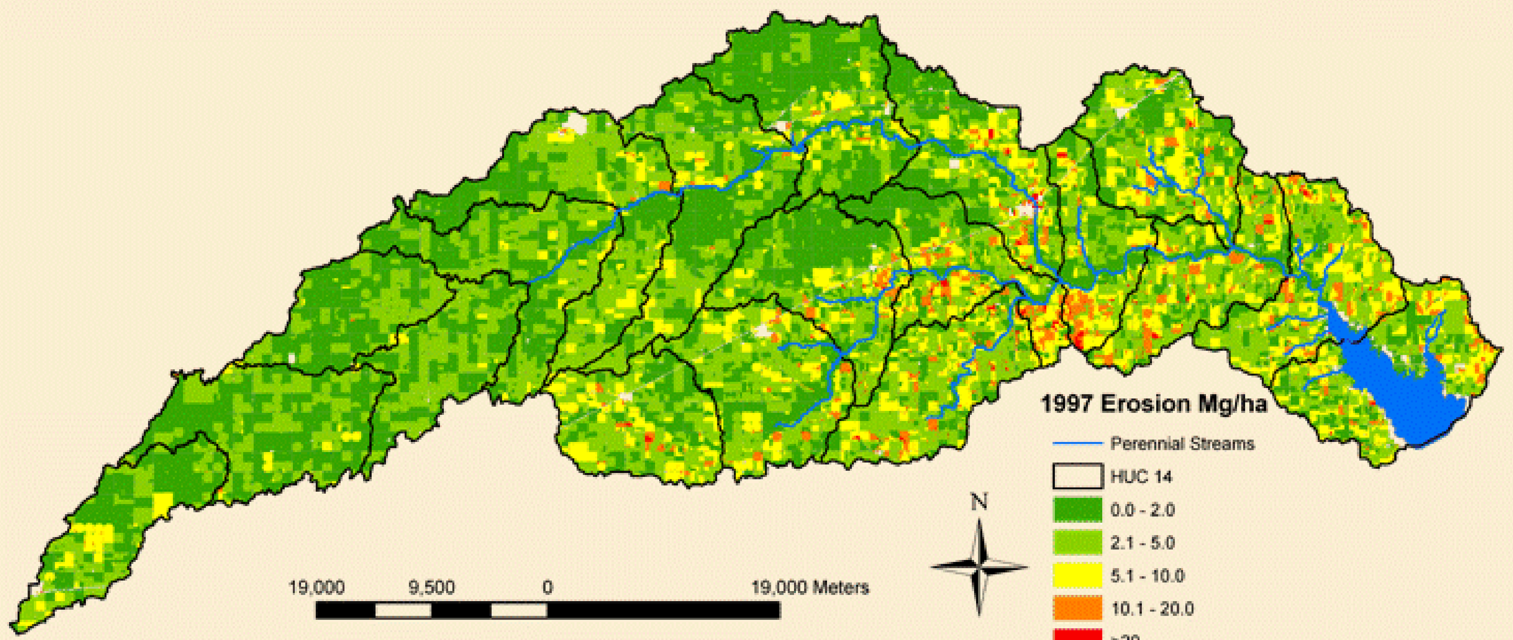

Figure 8. 1997 Annual Soil Erosion

Figure 8 provides a base line for soil erosion in the watershed. The fields located in the eastern portion of the watershed tend to have the greatest erosion. The total watershed had predicted erosion of 800,100 Mg.

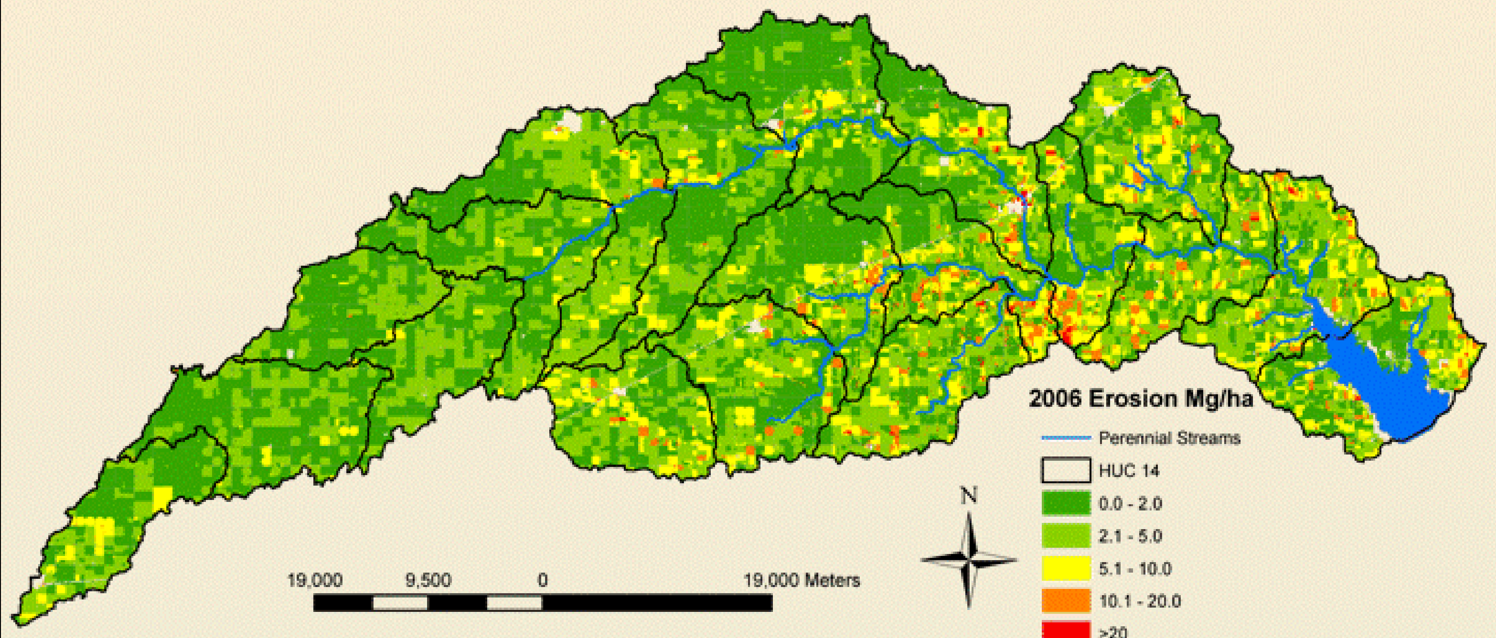

Figure 9. 2006 Annual soil erosion

Figure 9 provides a comparison of the last 9 years of landuse changes and implementation of BMPs effects in the watershed. It also provides the spatial relationships of were changes have occurred and were future efforts can be targeted. It also predicts a 12% reduction of total erosion to 708,000 Mg of soil erosion.

Grass buffer along Red Rock Creek in Cheney Lake watershed

Discussion

Table 2 provides a summary of field erosion rates in 1997 and 2006. It is seen that 17.5% of the watershed produces 46% of the total erosion. A similar result is seen in 2006 but with a reduction to 13.3 % of the watershed contributing 42% of the erosion.

Table 2. Watershed area and associated erosion contribution within five soil-loss classifications.

Field-scale Erosion Rate	1997 Watershed Area	1997 Soil Erosion	2006 Watershed Area	2006 Soil Erosion	Change in Area
	% of Total				%
0-2 Mg/ha	45	14	51	17	12
2.1-5 Mg/ha	38	39	38	41	-6
5.1-10 Mg/ha	14	30	11	28	-17
10.1-20 Mg/ha	3	12	2	11	-23
>20 Mg/ha	0.5	4	0.3	3	-30

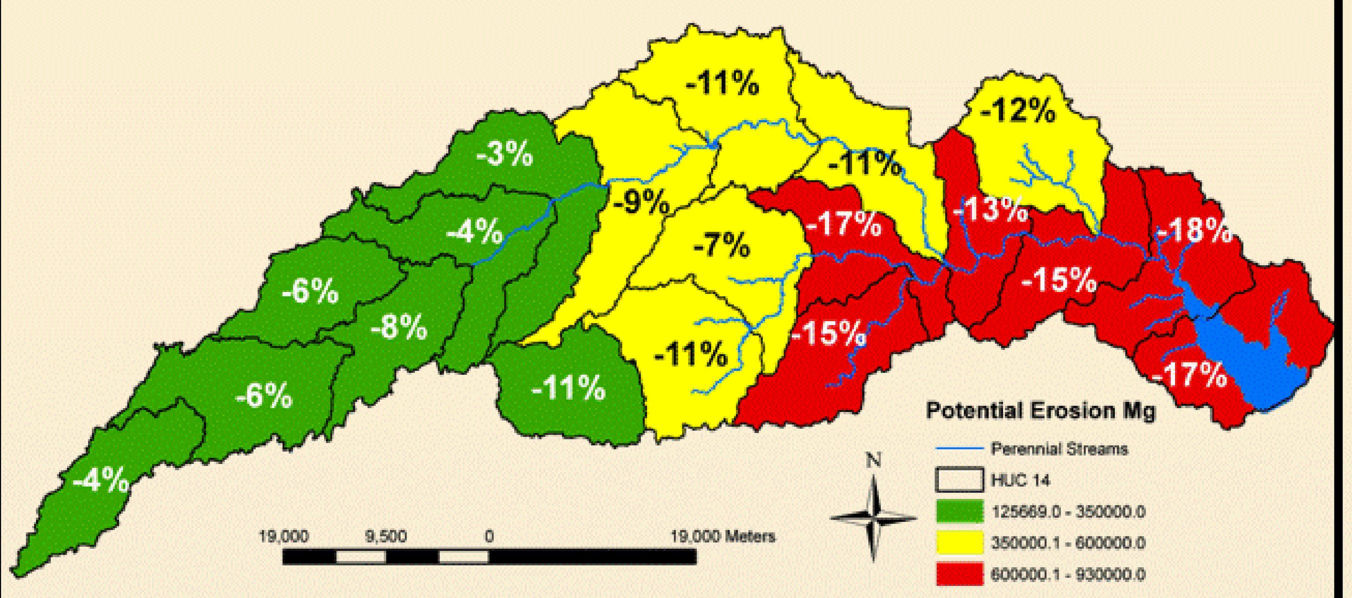

Figure 10. Erosion potential based on the R,K,& LS factors of RUSLE, including percent change in predicted erosion within the HUC 14 sub-basins from 1997 to 2006.

Figure 10 illustrates the spatial relationship of where the change in erosion is occurring relative to the potential for erosion to occur in that area. The figure shows that reduction in erosion ranges from 3% to18%, with the greater changes in areas with greater potential for erosion.

Conclusions

Over the past 9 years the watershed has seen increases in BMPs and changes in landuse, with a watershed wide erosion reduction of 12% and up to an 18% reduction in some sub-basins. Also, the areas of greater change are in those areas with the greatest potential erosion. The tool allows for managers to evaluate historical and future landuse changes, and their potential impact on erosion.

This tool also allows for the identification of fields with greater potential for sediment and associated nutrient loss, as seen in Figure 11, and thus can lead to better targeting of BMPs.

Figure 11. 2006 field erosion