# Using SWAT Model to Quantify the Impact of Converting Cropland to Grassland on Soil Loss and Water Quality in Cobb Creek Sub-watershed

**D.N. Moriasi, P.J. Starks, and J.L. Steiner**
**USDA-ARS Grazinglands Laboratory, El Reno OK**

## Introduction

The Conservation Effects Assessment Project (CEAP), led by USDA NRCS and ARS, is designed to quantify the effects of conservation practices in national benchmark watersheds, one of which is the Fort Cobb Reservoir Watershed (FCRW) (830 km²) in Caddo County, OK. Fort Cobb Reservoir and contributing stream segments are listed on the Oklahoma 303(d) list as not meeting water quality standards based on high sedimentation, phosphorus, and nitrogen levels in some stream segments in some seasons. The FCRW consists of three main sub-watersheds (Cobb Creek, Lake Creek, and Willow Creek). The Cobb Creek sub-watershed was chosen to study the impact of conversion of cropland to grassland on soil loss to surface streams. Conversion of cropland to grass is a popular conservation practice in the FCRW. Landuse in Cobb Creek consists of winter wheat (47.6%), grass (38.3%), peanuts/cotton (4.8%), other summer crops (1.7%), forest (3.2%), water (0.4%), and urban/roads (3.8%) (Fig. 2).

A rapid geomorphic assessment revealed stream bank instability for some streams (Fig. 1), which together with soil erosion from crop agriculture and roads (Figs. 3-5) lead to the stated water quality problems.

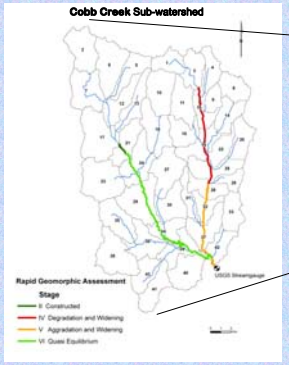


Fig 1. Cobb Creek Sub-watershed.

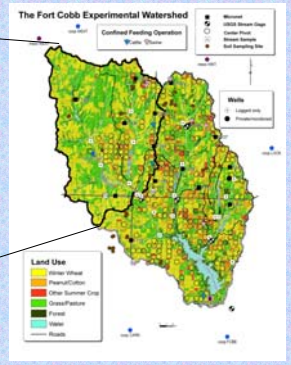


Fig 2. Fort Cobb Reservoir Watershed.

Fig 3. Rapid geomorphic assessment.

Fig 4. Erosion from crop land.

Fig 5. Erosion from roadside ditch.

## Objectives

➢Identify "hot" spots (cropland in targeted sub-basins) and quantify reduction of field-scale erosion resulting from the conversion of cropland to grassland in targeted or all sub-basins. In this study targeted sub-basins are defined as sub-basins with cropland erosion rates that exceed 4.2 mt/ha/yr (cropland water erosion rate for the sub-watershed under 2005 landuse).

➢Quantify anticipated impacts of converting cropland (in targeted or all sub-basins) to grassland on average sub-basin sediment yield and suspended sediment concentration at the sub-watershed outlet (sub-basin 42).

## Approach

- Used the Soil and Water Assessment Tool (SWAT), an ARS watershed scale hydrologic model.
- Calibrated SWAT for streamflow and sediment: Geomorphic assessment was used to estimate the channel cover and channel erodibility parameters, which are used to control channel contributions of sediment.
- Identified "hot" spots/cropland in targeted sub-basins
- Performed scenarios: conversion of cropland in targeted or all sub-basins to grassland.

## SWAT Calibration Results

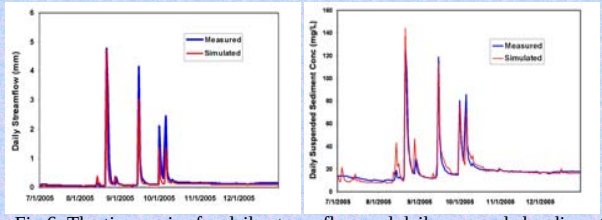


Fig 6. The time series for daily streamflow and daily suspended sediment concentration calibration

Table 1. Daily model performance statistics at the outlet

| | Component | | | | | |
|---|---|---|---|---|---|---|
| | Streamflow (mm) | | | Suspended Sediments (mg/L) | | |
| Statistic | Target | Attained | Rating | Target | Attained | Rating |
| NSE | > 0.65 | 0.8 | Very Good | > 0.65 | 0.74 | Good |
| PBIAS (%) | < ±10 | 4.5 | Very Good | < ±15 | -2.6 | Very Good |
| RSR | ≤ 0.60 | 0.45 | Very Good | ≤ 0.60 | 0.51 | Good |
| RMSE | Low | 0.45 | Very Low | Low | 10.9 | Low |

Table 2. Calibration parameter values for Cobb Creek sub-watershed

| Component | Parameter | Description | Parameter value range | Calibrated values |
|---|---|---|---|---|
| | CN2 | Curve number | 30 - 100 | 44 - 64 |
| | ESCO | Soil evaporation compensation coefficient | 0.01 - 1 | 0.9 |
| | RCH_DP | Aquifer percolation coefficient | 0.01 - 1 | 0.05 |
| | EPCO | Plant uptake compensation factor | 0.01 - 1 | 0.01 |
| | CH_K1 ($mmhr^{-1}$) | Effective hydraulic conductivity in tributary channel alluvium | 0 - 300 | 0.5 |
| Streamflow | SURLAG | Surface runoff lag coefficient | 1 - 24 | 1 |
| | *Overland* | | | |
| | USLE_P | USLE equation support practice factor | 0-1.0 | 0.5 |
| | USLE_K | USLE equation soil erodibility factor | 0-0.65 | 0.2-0.37 |
| | USLE_C | Minimum USLE land cover/plant factor | .001-0.5 | .001-0.3 |
| | *Channel* | | | |
| | SPCON | | .0001-1.0 | 0.0003 |
| | SPEXP | | 1.0-1.5 | 1.2 |
| | CH_COV | Channel cover factor | .001-1.0 | 0.2-0.7 |
| Sediments | CH_EROD | Channel erodibility factor | .05-0.6 | 0.2-0.5 |

**Please contact Daniel Moriasi with any questions/comments.** daniel.moriasi@ars.usda.gov

## Model Scenario Results

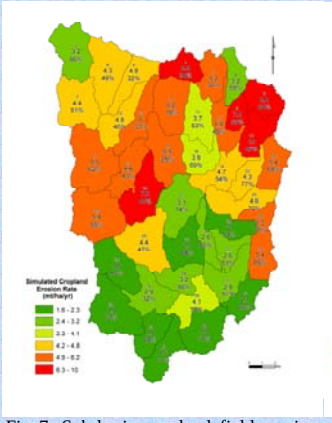


Fig 7. Sub-basin cropland field erosion rates under 2005 landuse (mt/ha/yr)

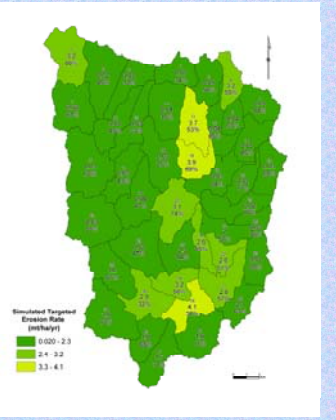


Fig 8. Sub-basin field erosion rates after targeted conversion of cropland to grassland (mt/ha/yr)

Table 3. Field erosion, average sub-basin sediment yield (average field erosion delivered to stream from sub-basin), and suspended sediment concentration (at sub-watershed outlet) reduction: [CURRENT = All sub-watershed cropland under 2005 landuse; TARGET = Conversion of cropland to grassland in sub-basins with erosion rates > 4.2 mt/ha/yr + rest of sub-watershed cropland under 2005 landuse; GRASS = Conversion of all sub-watershed cropland under 2005 landuse to grass]

| SUB-WATERSHED CROPLAND (%) | FIELD EROSION (mt/ha/yr) | | | AVERAGE SUB-BASIN SEDIMENT YIELD (mt/ha/yr) | | | SUB-WATERSHED OUTLET SUSPENDED SEDIMENT (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|
| | CURRENT | TARGET | GRASS | CURRENT | TARGET | GRASS | CURRENT | TARGET | GRASS |
| 54 | 4.2 | 1.2 | 0.02 | 2.0 | 0.6 | 0.02 | 20.7 | 17.7 | 15.2 |
| Reduction (%) | -- | 72 | 99 | -- | 70 | 99 | -- | 15 | 27 |

## Conclusions

➢24 sub-basins (yellow to red color in Fig.7 ) were selected for targeting.

➢ Conversion of cropland in targeted sub-basins to grassland resulted in a 72% reduction in field erosion from the converted cropland and the rest of the sub-watershed cropland area, a 70% reduction in average sub-basin sediment yield, and a 15% reduction in suspended sediment concentration at the sub-watershed outlet.

➢Conversion of all sub-watershed cropland to grassland resulted in a 99% reduction in field erosion from the converted cropland area, a 99% reduction in average sub-basin sediment yield , and a 27% reduction in suspended sediment concentration at the sub-watershed outlet .

➢Further research is underway to determine the impact of converting cropland to grassland (in targeted or all sub-basins) on total phosphorus and nitrogen.

**Acknowledgments:** The authors are grateful to Alan Verser for his invaluable assistance with building the project, calibrating the model, and running the scenarios. Funding for this study was provided by USDA-ARS.