Downstream Runoff and Sediment Response to Conservation Practice Implementation

by

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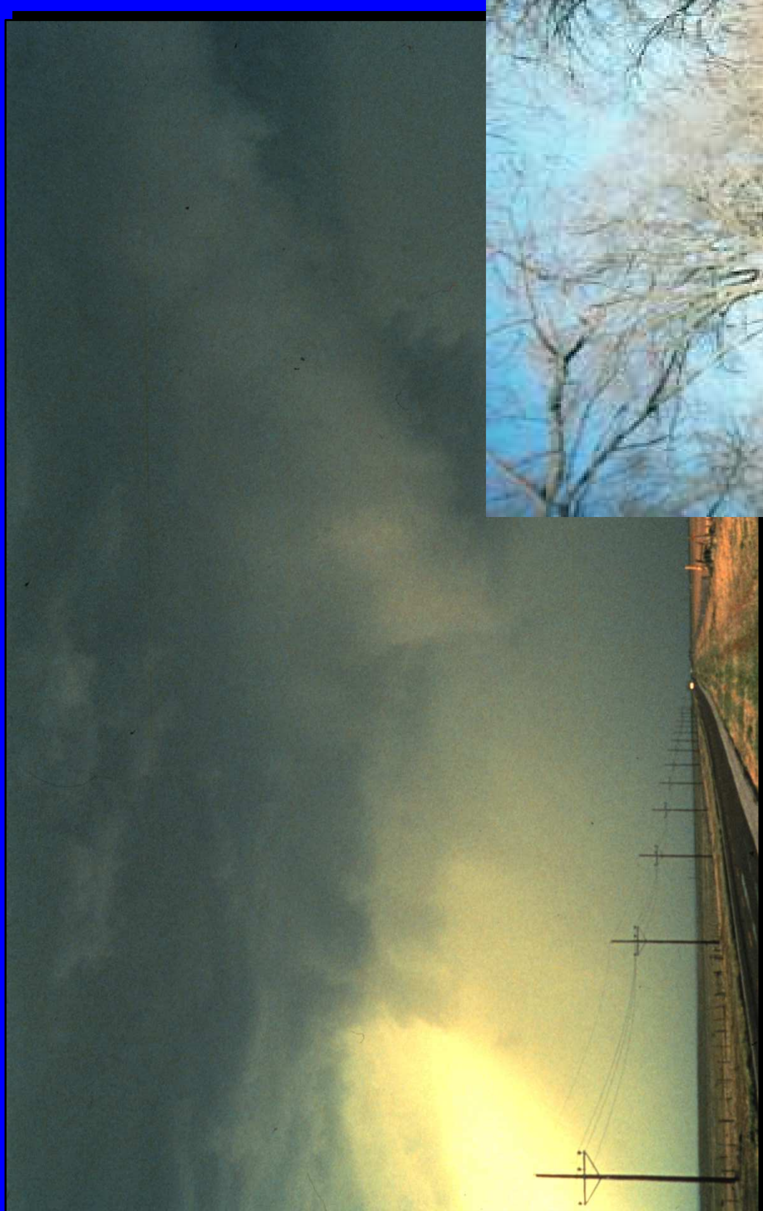
Conservation Effects Assessment Program (CEAP)

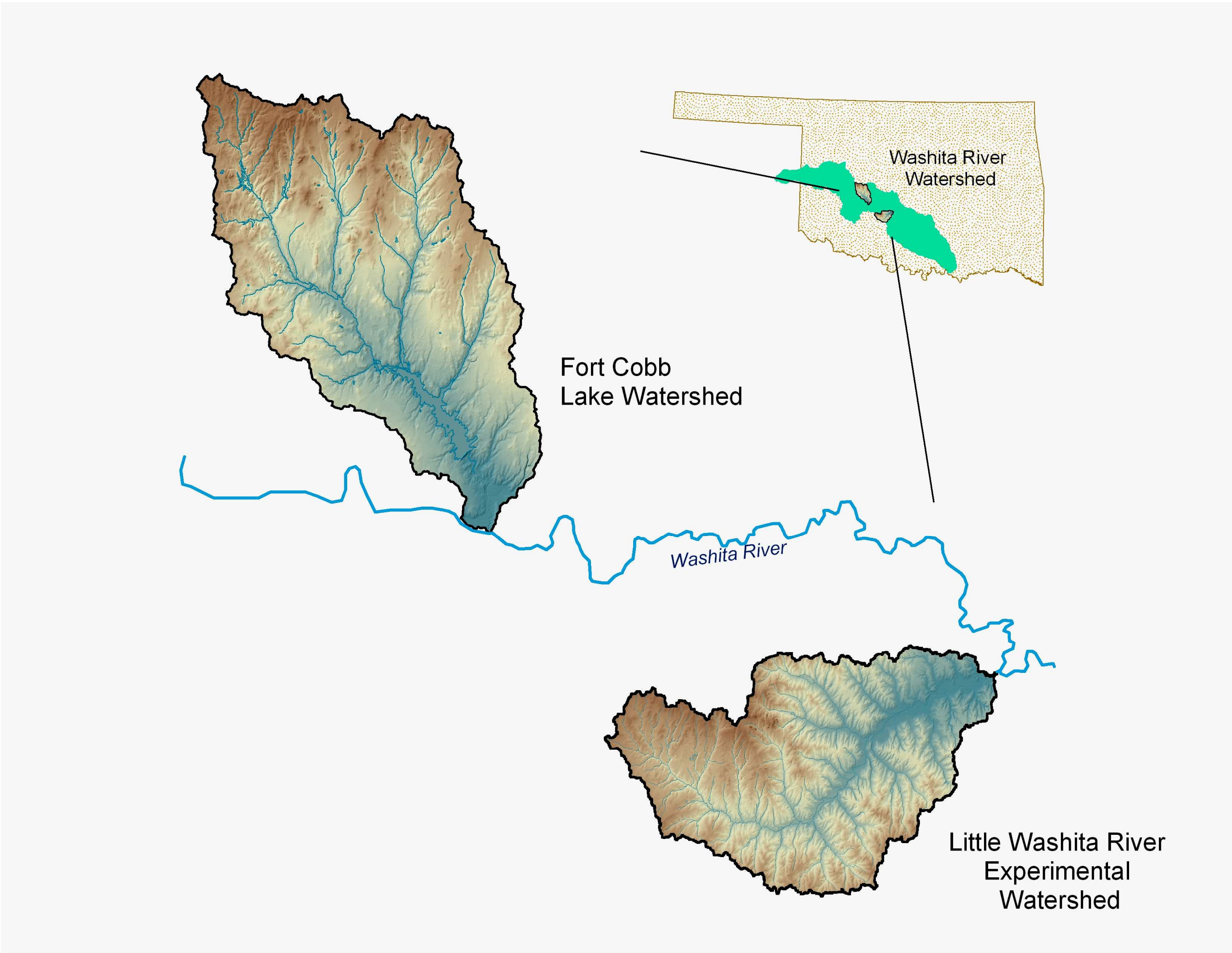
In response to the 2002 Farm Bill, the Conservation Effects Assessment Program (CEAP) was created to assess and quantify the effects and benefits of USDA conservation programs.

Conservation Effects Assessment Program (CEAP)

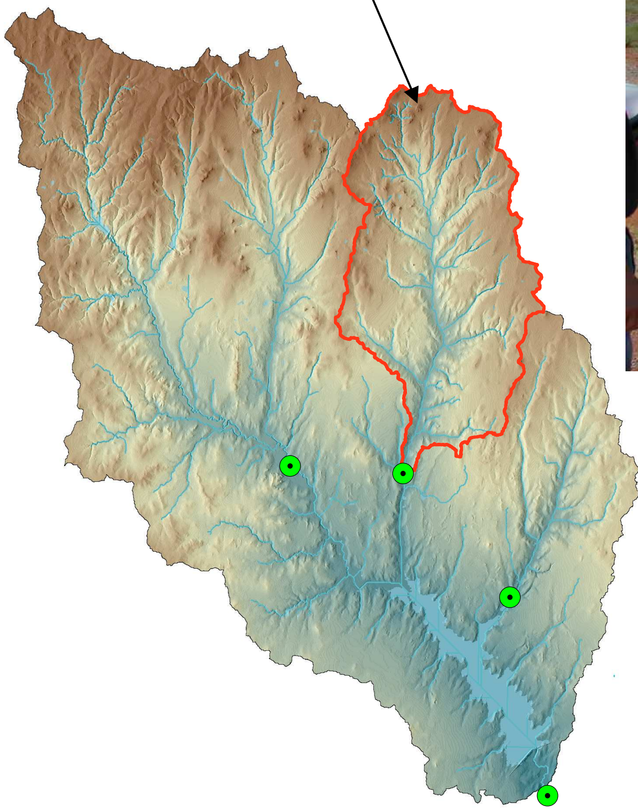
Principle focus of CEAP: a national assessment of environmental benefits resulting from conservation programs to support policy decisions and effective program implementation



Upper Washita River Subwatersheds



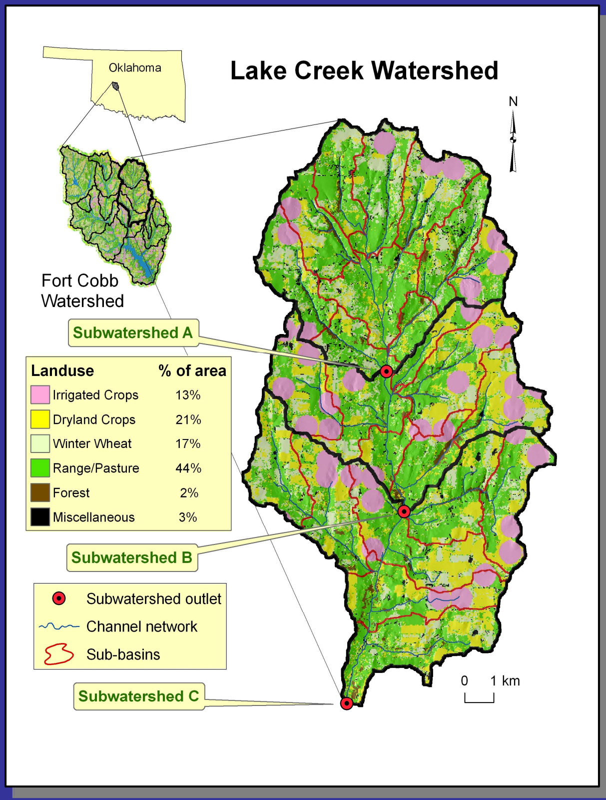
Lake Creek Subwatershed



Study Objectives:

to determine the spatial distribution of runoff and sediment yield from the Lake Creek Watershed

to quantify the relative reductions in runoff and sediment yield that might be expected to occur if conservation practices were implemented in the upper most portion of the watershed under dry, average, and wet climatic conditions

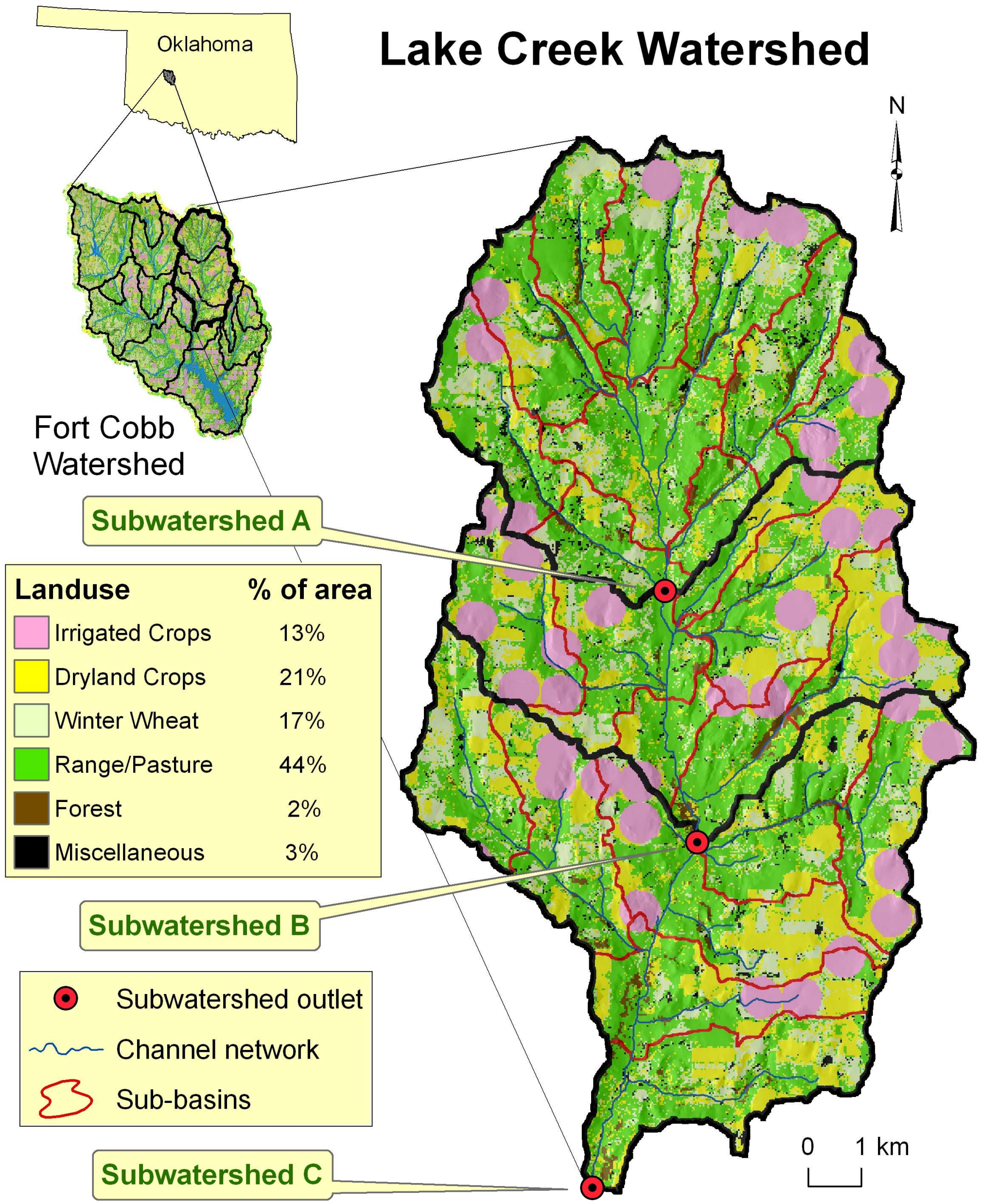


Conservation Practice Implementation Strategy:

Convert winter wheat, sorghum-wheat, and peanut-wheat to Bermuda grass

Perform conversions in the upper most portion of the watershed

Implement conversions at three BMP levels, representing 2.5%, 5.0%, and 7.5% of the total watershed area


Lake Creek Watershed
Oklahoma
Fort Cobb Watershed
N
Subwatershed A
Subwatershed B
Subwatershed C
Landuse % of area
Irrigated Crops 13%
Dryland Crops 21%
Winter Wheat 17%
Range/Pasture 44%
Forest 2%
Miscellaneous 3%
Subwatershed outlet
Channel network
Sub-basins
0 1 km

Methodology

Soil and Water Assessment Tool (SWAT) employed to simulate runoff and sediment losses from the Lake Creek Watershed

Watershed delineated as 24 subbasins and 175 hydrologic response units (HRUs) in SWAT; the most erosive HRUs identified and ranked in the upper 50 sq km subwatershed within Lake Creek

Runoff response calibrated in SWAT using the newly developed autocalibration tool in the model; default values in model selected for parameters used to simulate sediment losses

Model simulations performed to determine the base line conditions for long term average annual runoff and sediment loss under dry (1963 to 1972), near average (1973 to 1982) and wet (1983 to 1992) climatic conditions

SWAT rerun with conservation practice implemented at a given level for a particular cropping system

Percent reductions in runoff and sediment yield as a result of BMP implementation computed from base line conditions

Management Operations Schedule in SWAT

Winter Wheat for Grain

Harvest Wheat	June 1
Fertilize 135 kg/ha N	Sept 20
Fertilize 34 kg/ha P2O5	Sept 20
Disk	Sept 22
Springtooth harrow	Sept 24
Plant Wheat	Sept 25
Grazing 0.81 au/ha for 90 days	Dec 1

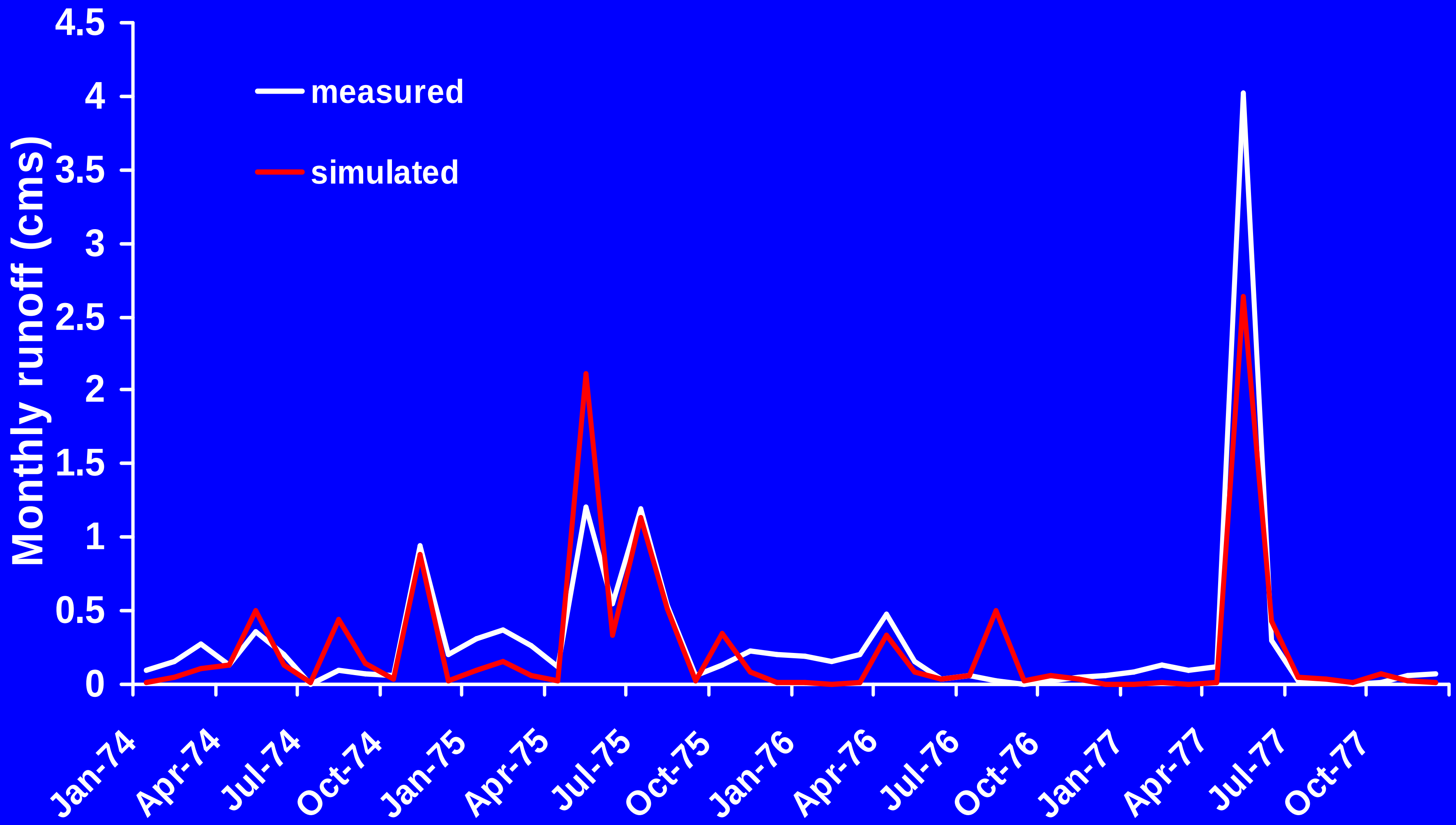
Sorghum-Wheat

Harvest Wheat	May 25
Fertilize 45 kg/ha N	May 27
Fertilize 17 kg/ha P2O5	May 27
Disk	May 28
Insecticide Aldicarb 1.1 kg/ha	May 28
Herbicide Alachlor 2.8 kg/ha	May 28
Springtooth harrow	May 29
Plant Sorghum	June 1
Auto-irrigate	June 20
Harvest sorghum	Oct 15
Fertilize 92 kg/ha N	Oct 17
Disk	Oct 18
Springtooth harrow	Oct 19
Plant Wheat	Oct 20

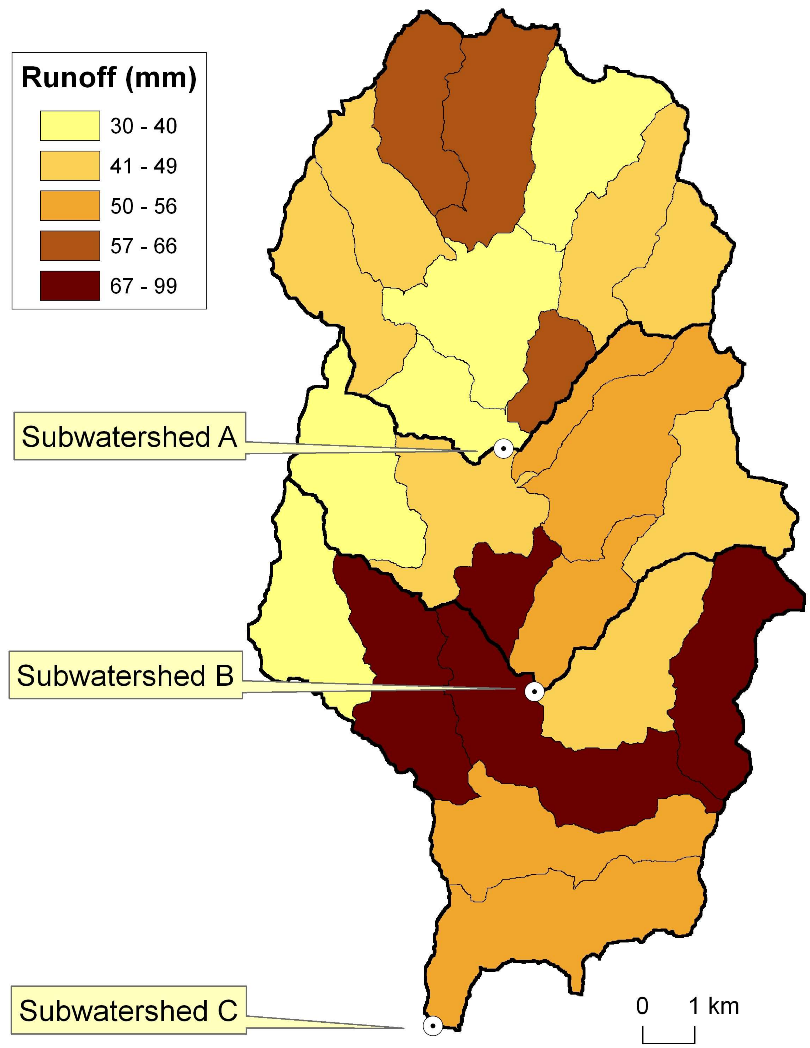
Peanut-Wheat

Kill Wheat	April 15
Fertilize 30 kg/ha N	April 16
Fertilize 79 kg/ha P205	April 16
Disk	April 17
Insecticide Aldicarb 1.1 kg/ha	April 17
Herbicide Alachlor 3.4 kg/ha	April 17
Springtooth harrow	April 18
Plant Peanuts	April 19
Auto-irrigation	April 20
Harvest Peanuts	Oct 15
Fertilize 45 kg/ha N	Oct 17
Fertilize 17 kg/ha P2O5	Oct 17
Disk	Oct 18
Springtooth harrow	Oct 19
Plant Wheat	Oct 20
Grazing 0.81 au/ha for 130 days	Dec 1

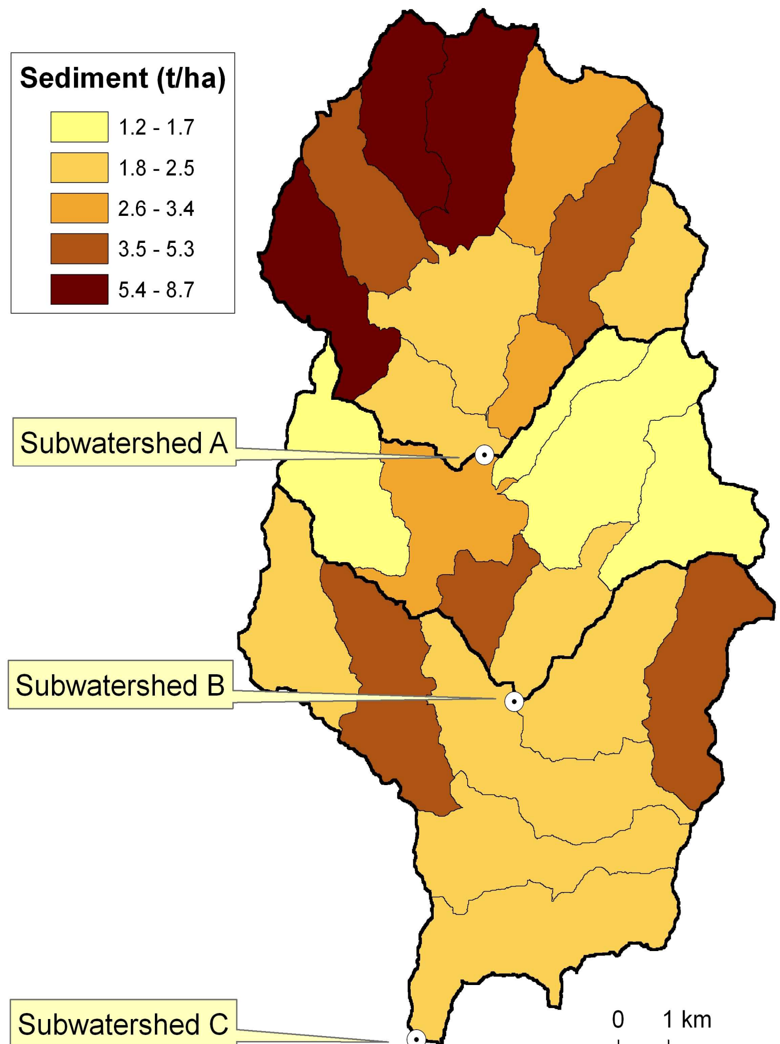
Monthly runoff comparison for the Lake Creek Watershed from 1974 to 1977



Average annual runoff by subbasin as simulated by SWAT for a 30 year period from 1963 to 1992



Average annual sediment yield by subbasin as simulated by SWAT for a 30 year period from 1963 to 1992



Measured average annual precipitation and simulated average annual runoff and sediment yield for existing land use conditions on Lake Creek subwatersheds A, B, and C under dry, average, and wet climatic conditions.

Subwatershed	Contributing Drainage Area (sq km)	Climatic Period	Average Annual Precipitation (mm)	Average Annual Runoff (mm)	Average Annual Sediment Yield (tonnes/ha)
A	49.6	1963-1972	646	22.6	2.1
		1973-1982	803	46.1	4.6
		1983-1992	898	75.5	5.5
B	85.2	1963-1972	631	22.7	1.6
		1973-1982	780	47.4	3.7
		1983-1992	897	77.1	4.3
C	136	1963-1972	628	27.4	1.6
		1973-1982	771	54.2	3.5
		1983-1992	896	84.9	4.0

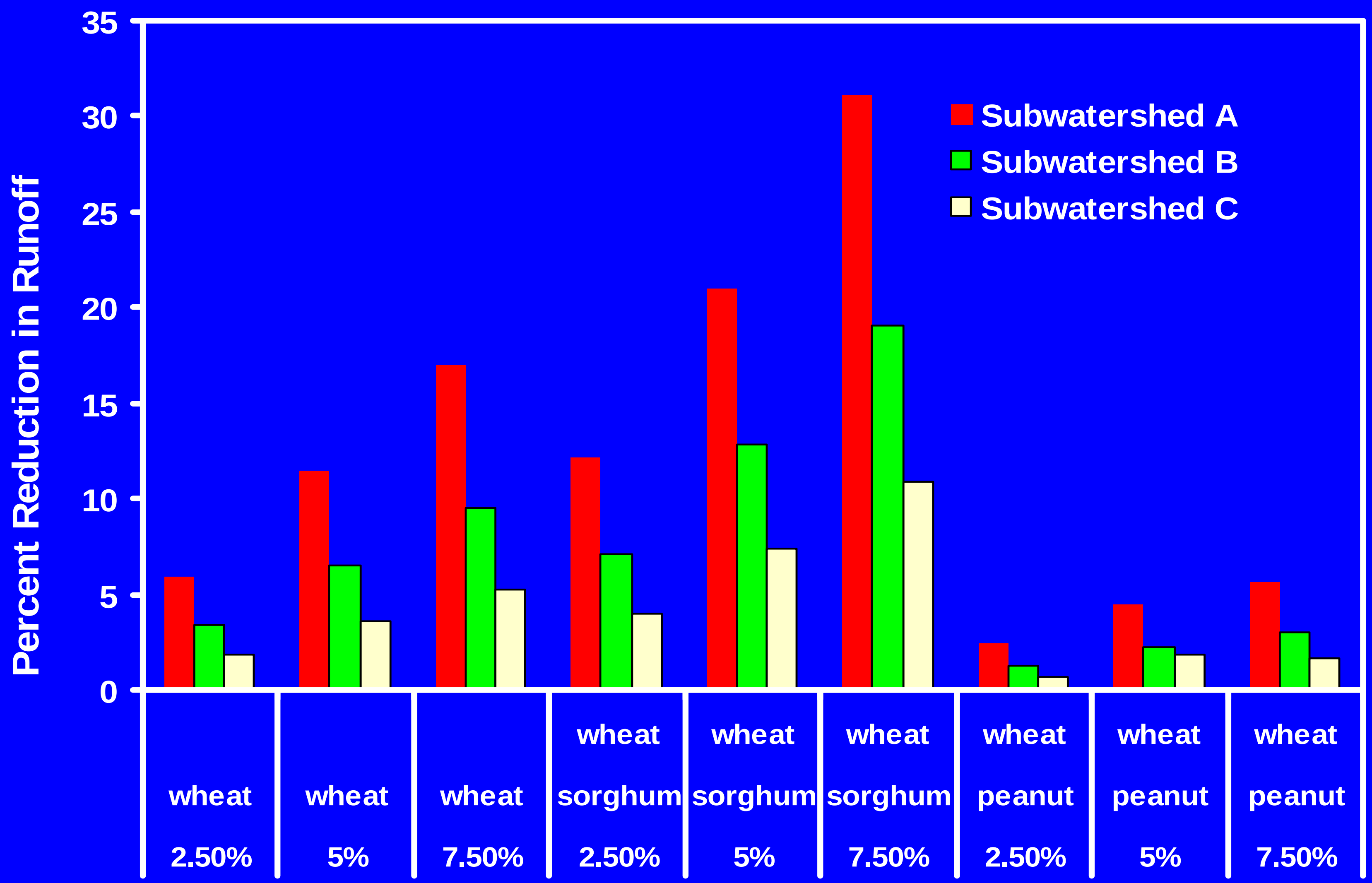
Percent reductions in runoff on subwatersheds A, B, and C as a result of BMP implementation at 2.5%, 5.0%, and 7.5% levels for each of the three cropping systems under dry, average, and wet climatic conditions.

Sub-watershed	Climatic Period	Wheat to Bermuda			Sorghum-Wheat to Bermuda			Peanut-Wheat to Bermuda		
		2.50%	5.00%	7.50%	2.50%	5.00%	7.50%	2.50%	5.00%	7.50%
A	1963-1972	-7.9	-15.0	-22.2	-16.2	-26.5	-39.3	-3.1	-5.5	-7.5
	1973-1982	-6.0	-11.4	-17.0	-12.2	-21.0	-31.1	-2.4	-4.5	-5.7
	1983-1992	-5.6	-10.2	-15.1	-9.7	-16.5	-24.6	-0.6	-3.1	-5.3
B	1963-1972	-4.5	-8.7	-12.9	-9.7	-16.9	-25.1	-1.6	-2.9	-4.0
	1973-1982	-3.4	-6.5	-9.5	-7.1	-12.8	-19.0	-1.3	-2.3	-3.0
	1983-1992	-3.2	-5.8	-8.6	-5.6	-9.9	-14.7	-1.9	-3.3	-4.4
C	1963-1972	-2.4	-4.5	-6.7	-5.2	-9.5	-14.0	-0.8	-1.5	-2.0
	1973-1982	-1.9	-3.6	-5.3	-4.0	-7.4	-10.9	-0.7	-1.8	-1.6
	1983-1992	-1.8	-3.3	-4.9	-3.2	-5.8	-8.6	-1.1	-1.8	-2.5

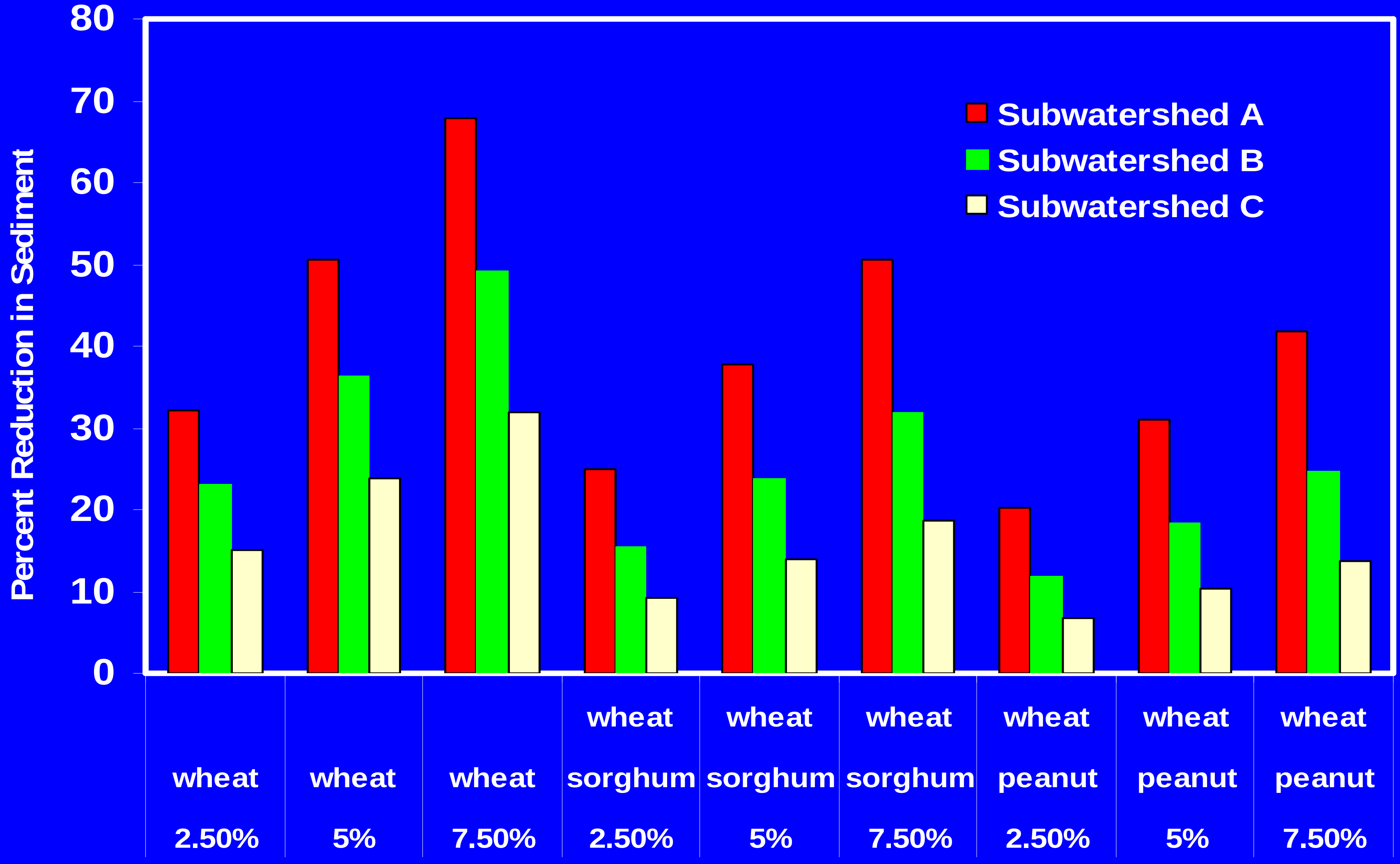
Percent reductions in sediment yield on subwatersheds A, B, and C as a result of BMP implementation at 2.5%, 5.0%, and 7.5% levels for each of the three cropping systems under dry, average, and wet climatic conditions.

Sub-watershed	Climatic Period	Wheat to Bermuda			Sorghum-Wheat to Bermuda			Peanut-Wheat to Bermuda		
		2.5%	5.0%	7.5%	2.5%	5.0%	7.5%	2.5%	5.0%	7.5%
A	1963-1972	-33.0	-51.7	-70.3	-27.6	-42.9	-58.2	-18.7	-28.4	-38.1
	1973-1982	-32.0	-50.5	-67.9	-24.9	-37.7	-50.6	-20.2	-31.1	-41.7
	1983-1992	-30.3	-46.8	-63.1	-23.3	-36.2	-49.0	-21.2	-32.3	-43.0
B	1963-1972	-25.0	-39.2	-53.3	-19.2	-29.7	-40.3	-11.3	-17.1	-23.0
	1973-1982	-23.2	-36.5	-49.3	-15.6	-23.7	-31.9	-12.0	-18.4	-24.7
	1983-1992	-22.7	-35.2	-47.5	-16.0	-24.9	-33.8	-14.2	-21.6	-28.7
C	1963-1972	-16.3	-25.6	-34.9	-11.4	-17.7	-24.0	-5.8	- 8.8	-12.2
	1973-1982	-15.1	-23.7	-32.0	- 9.2	-13.9	-18.6	-6.7	-10.3	-13.7
	1983-1992	-15.4	-23.8	-32.2	-10.0	-15.5	-21.0	-8.5	-13.0	-17.2

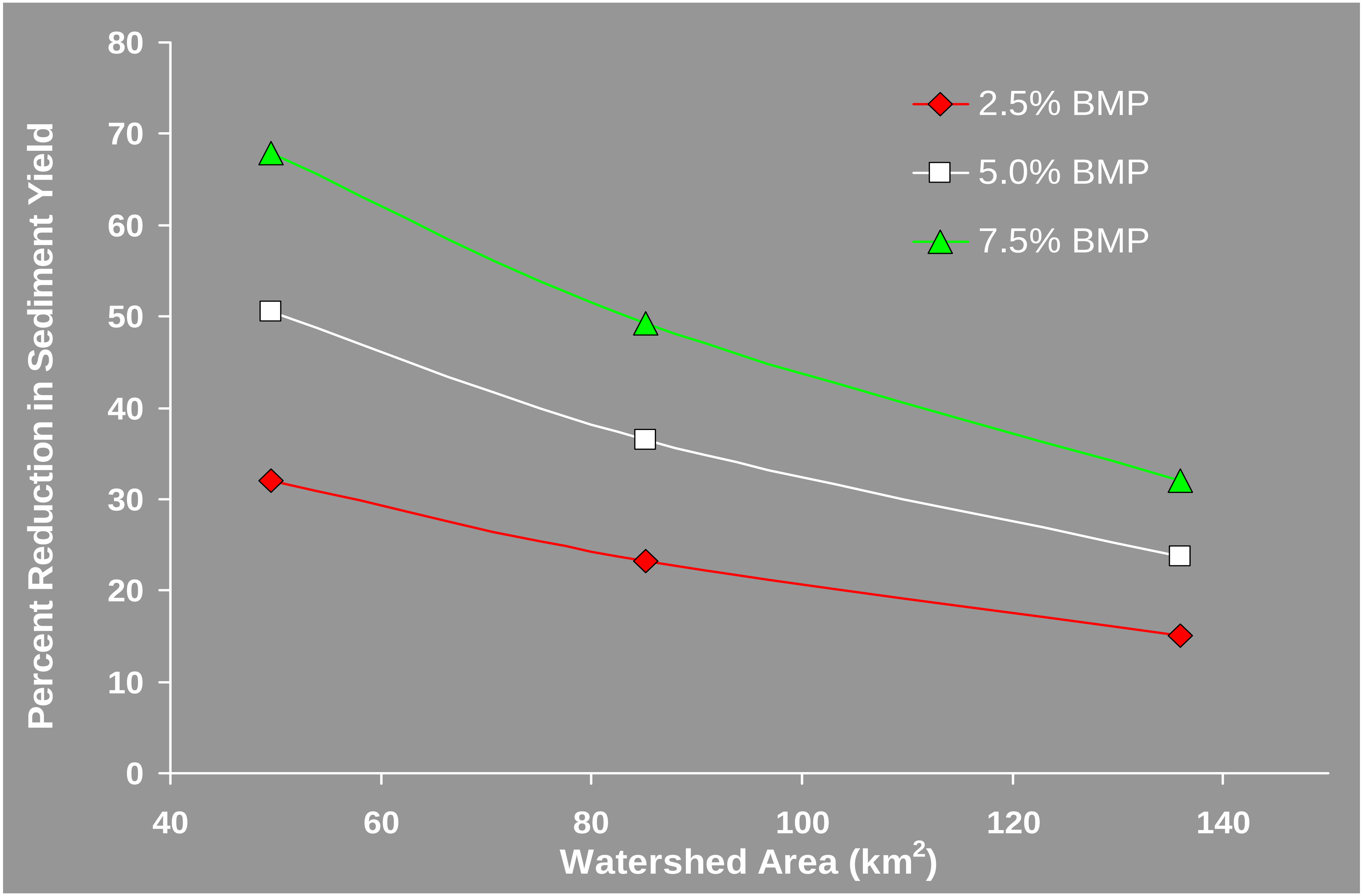
Percent Reductions in Runoff for Subwatersheds A, B, and C under the Average Climatic Condition



Percent Reductions in Sediment Yield for the Upper, Middle, and Lower Subwatersheds under the Average Climatic Condition



Impact of wheat to bermuda grass conversion on the 3 subwatersheds under average climate



Conclusions

- The impact of decadal scale variations in precipitation is minimal on percent reductions in runoff and sediment among the three cropping systems.
- For the most part, runoff amounts at the outlet of Lake Creek would be minimally impacted by conversion of one of the cropping systems to Bermuda grass.
- Differences in reductions in sediment among the three cropping systems as a result of BMP implementation mainly reflect changes in runoff amounts and USLE C factors that vary seasonally due to differences in land management practices for each system.
- Sediment reductions are strongest in the upper reaches of the watershed and became increasingly less pronounced further downstream, due to the dampening effect of averaging sediment yields from larger, contributing watershed areas.

Future Work

- Recalibrate SWAT with runoff, sediment, and nutrient data currently being collected on the Fort Cobb Watershed
- Incorporate newly developed landscape feature in SWAT to account for the buffer effect on riparian zones
- Evaluate the impact of a suite of conservation practices such as land conversion, no-till, and riparian buffers on sediment and nutrients at downstream locations on the watershed
- Determine what combination of conservation practices could be implemented on the watershed to achieve a two-thirds reduction in phosphorous loading to Fort Cobb Reservoir