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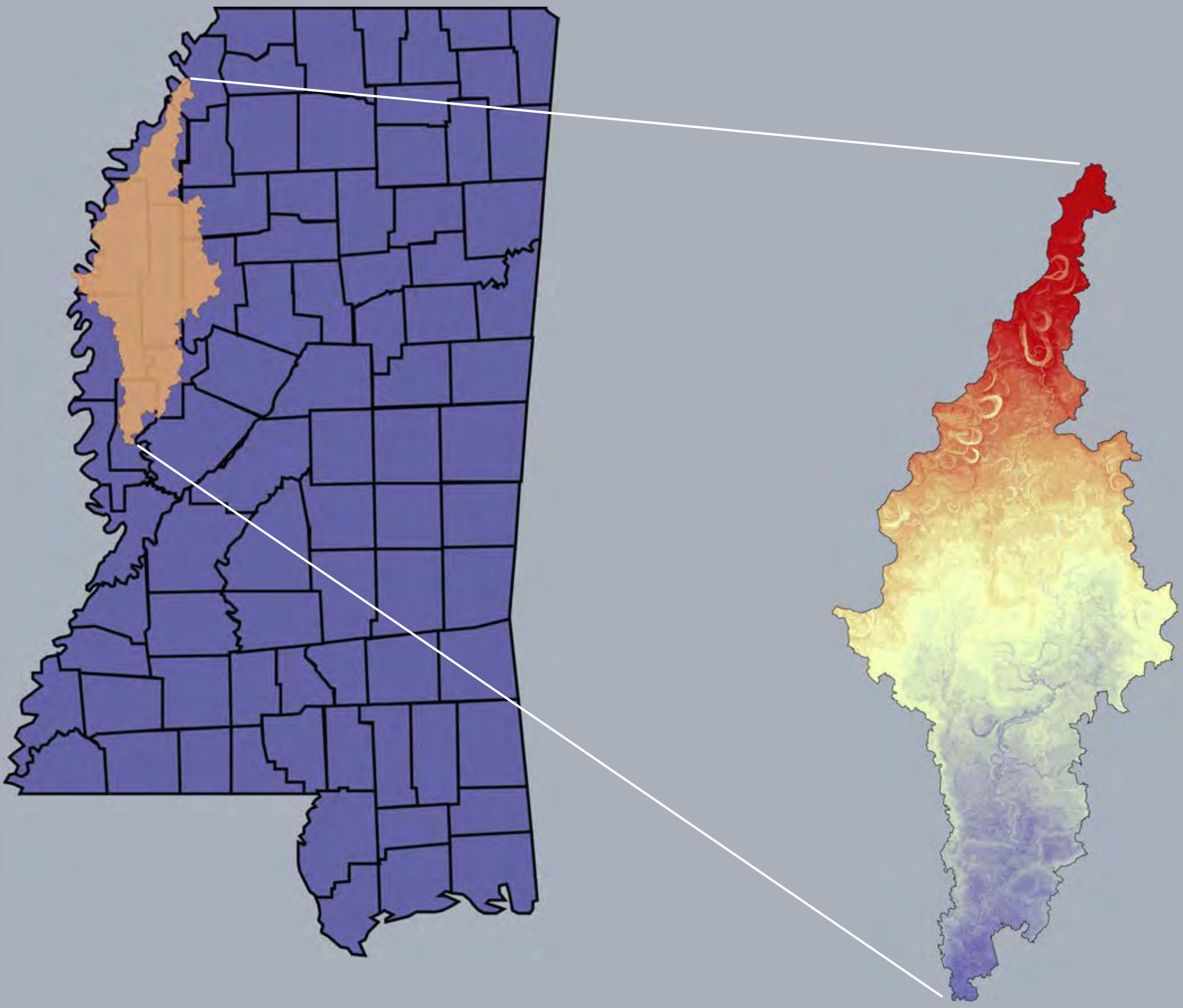
BIG SUNFLOWER RIVER WATERSHED ASSESSMENT:

Preliminary Report



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Big Sunflower River Watershed Assessment: Preliminary Report

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Big Sunflower River Watershed Assessment: Preliminary Report

DESCRIPTION

The Big Sunflower River Watershed (BSRW) covers approximately 7,660 square kilometers in northwest Mississippi. On the western side, the watershed is bounded by the Mississippi River. The Big Sunflower River (BSR) meanders over the flat flood plain as a slow-moving river and flows through an ecologically rich landscape (American Rivers 2004). According to the Mississippi Water Quality Criteria for Interstate and Intrastate, the BSR is also categorized as "ephemeral," which means its waters do not support a fisheries resource and are not usable for human consumption or aquatic life (MDEQ 2007). BSR is also listed on the EPA Section 303(d) list of impaired water bodies in Mississippi. The majority of the BSRW lies within Coahoma, Bolivar, Sunflower, Washington, Humphreys, and Sharkey counties with smaller portions in Leflore, Tallahatchie, Yazoo, and Tunica counties in Mississippi (Figure 1). This area is well known for agriculture and referred to as the Yazoo delta. The Sunflower is a major sub-watershed of the Yazoo watershed, and it is an area of intensive crop production, mainly soybean, corn, rice, and cotton. The BSR mainly consists of the Sunflower River and Bogue Phalia tributary. It joins the Yazoo River near Vicksburg and drains into the Mississippi River a few miles south of Vicksburg.

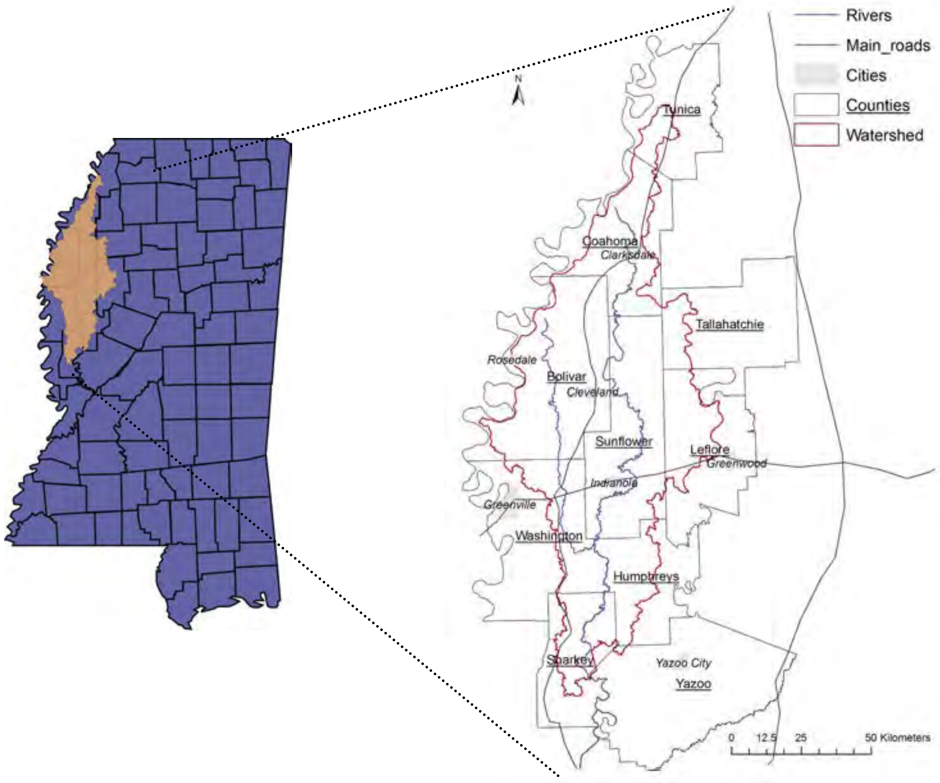

Figure 1. Location map of the Big Sunflower Watershed in Mississippi.

OVERVIEW OF WATER QUALITY ISSUES

Point and nonpoint sources are contributing to water-quality impairment in the BSRW. Agricultural water withdrawals from the Mississippi River Valley alluvial aquifer have contributed to a decrease in its base flow and a degradation in the condition of the river (Holms 2004, YMD 2005). Intensive groundwater abstraction for crop production depletes the groundwater table (Shane Powers 2007). Primary water-quality concerns of the BSRW are nutrients, organic enrichment, low dissolved oxygen, suspended solids, turbidity, and pathogens (MDEQ 2002, 2003). Irrigation runoff from surrounding cropland contributes 78% of the Sunflower River flow (MDEQ 2003). Ammonia (NH_3), nitrate (NO_3), phosphate (PO_4), algal biomass, carbonaceous biochemical oxygen demand, dissolved oxygen, and organic nitrogen are among the main concern of point-source pollution (MDEQ 2003). Agriculture and urbanization are the main nonpoint pollution sources in the basin. Sedimentation is one of the major concerns in the basin. Contributing sources include agriculture, silviculture, rangeland, construction sites, roads, urban areas, mass wasting areas, gullies, and surface mining (MDEQ 2003). Wildlife, livestock, and urban development are the main nonpoint sources of pathogen contamination in surface waters of the BSRW, which generally violates water-quality standards related to pathogens (MDEQ 2002).

LAND USE

Land cover classification is an important factor related to overall water quality within a watershed because land-use practices can affect water quality. Different types of land usage have varying effects on water quality, such as sediment, nutrient, and pesticide retention. In 1965, the Water Quality Act (WQA) became the nation's first law regarding water-quality standards. Since then, regulations have been strictly enforced, and new regulations have been implemented to improve water quality. Similarly, Congress passed the Clean Water Act (CWA) of 1972 to improve water-quality standards. It is necessary to monitor land usage because the CWA requires that the state determine both point- and nonpoint-source pollutant loads that may enter a water body and still allow that water body to comply with minimum water-quality standards, such as the total maximum daily load (TMDL). Nonpoint-source pollutants are difficult to manage, but it is still important to monitor the ways land is being used (Tagert 2006). The BSRW is dominated by the cropland — 81% of the area. Other land uses include wetlands (13%), water bodies (3%), urban areas (2%), and other uses (1%).

Land Uses and Soil Types

Table 1. Model-generated subbasins, HRUs, land uses, and dominant soils in the watershed.[1]

Subbasin	No. of HRUs	Major land uses	Dominant soil types	Dominant soil textures
1	85	CORN, COTP, SOYB, URMD, WETF, WWHT	MS137, MS139	Fine-silty, Coarse-silty, Coarse-loamy, Fine-loamy
2	73	CORN, SOYB, URMD, WETF, WWHT	MS139	Fine-silty, Coarse-silty, Coarse-loamy
3	97	CORN, RICE, SOYB, URMD, WETF, WWHT	MS013, MS107, MS139	Fine-silty, Coarse-silty, Coarse-loamy, Fine-loamy, Clayey
4	71	CORN, PAST, RICE, SOYB, WETF, WWHT	MS013, MS139	Fine-silty, Coarse-silty, Coarse-loamy, Clayey
5	79	PAST, RICE, SOYB, URMD, WETF, WWHT	MS013, MS107	Fine-silty, Coarse-silty, Coarse-loamy, Very fine
6	59	CORN, RICE, SOYB, WETF	MS013, MS017	Fine-silty, Coarse-silty, Coarse-loamy

[1] HRU: Hydrologic Response Unit.

Table 1 (continued). Model-generated subbasins, HRUs, land uses, and dominant soils in the watershed.[1]

Subbasin	No. of HRUs	Major land uses	Dominant soil types	Dominant soil textures
7	49	CORN, RICE, SOYB, WETF	MS013	Fine-silty, Coarse-silty
8	60	CORN, RICE, SOYB, WETF	MS013, MS107	Fine-silty, Coarse-silty, Coarse-loamy, Very fine
9	99	CORN, PAST, RICE, SOYB, URMD, WETF	MS107, MS119	Fine-silty, Coarse-silty, Very fine
10	22	RICE, SOYB, WETF	MS033, MS107	Fine-silty, Coarse-silty
11	53	CORN, RICE, SOYB, URMD, WETF	MS107, MS125	Fine-silty, Coarse-silty, Very fine
12	36	RICE, SOYB, WATR, WETF	MS033, MS107, MS119	Fine-silty, Coarse-silty, Very fine
13	45	CORN, COTP, SOYB, WETF	MS033	Fine-silty
14	45	CORN, RICE, SOYB, WETF	MS013	Fine-silty, Coarse-silty
15	43	CORN, RICE, SOYB	MS013, MS017	Fine-silty, Coarse-silty, Very fine
16	71	CORN, RICE, SOYB, URMD, WETF	MS017, MS119	Fine-silty, Coarse-silty, Very fine, Coarse-loamy
17	32	RICE, SOYB, WATR, WETF	MS033, MS107, MS119	Fine-silty, Coarse-silty, Very fine
18	28	CORN, COTP, RICE, SOYB, WATR, WETF	MS033	Fine-silty
19	54	RICE, SOYB, URMD, WETF, WWHT	MS013, MS151, MS163	Fine-silty, Coarse-silty, Very fine
20	47	CORN, SOYB, WETF	MS107, MS119	Fine-silty, Coarse-silty, Very fine
21	44	CORN, RICE, SOYB, WETF	MS013, MS107	Fine-silty, Coarse-silty
22	41	CORN, RICE, SOYB, WETF	MS013, MS151	Fine-silty, Coarse-silty, Very fine
23	65	CORN, SOYB, URMD, WATR, WETF	MS107, MS119	Fine-silty, Coarse-silty, Very fine
24	58	CORN, RICE, SOYB, WATR, WETF	MS033, MS107, MS119	Fine-silty, Coarse-silty
25	40	CORN, SOYB, WETF	MS013, MS017, MS163	Fine-silty, Coarse-silty
26	53	CORN, COTP, SOYB, URMD, WETF	MS017, MS151, MS163	Fine-silty, Coarse-silty
27	47	CORN, COTP, SOYB, WETF	MS107, MS119, MS163	Fine-silty, Coarse-silty, Very fine
28	47	CORN, SOYB, WATR, WETF	MS027, MS107, MS119	Fine-silty, Coarse-silty, Very fine
29	36	CORN, SOYB, WATR	MS027, MS107, MS119, MS151, MS163	Fine-silty, Coarse-silty, Very fine
30	44	CORN, RICE, SOYB, WETF	MS151, MS163	Fine-silty, Coarse-silty
31	49	CORN, RICE, SOYB, WATR, WETF	MS027, MS151, MS163	Fine-silty, Coarse-silty, Very fine
32	49	CORN, COTP, SOYB, WATR, WETF	MS027, MS107	Fine-silty, Coarse-silty
33	46	CORN, RICE, SOYB, WETF	MS027, MS093, MS151, MS163	Fine-silty, Coarse-silty, Sandy
34	40	CORN, COTP, PAST, SOYB, WETF	MS027, MS107	Fine-silty, Coarse-silty
35	33	CORN, SOYB, WATR, WETF	MS093, MS107	Fine-silty, Coarse-silty
36	45	CORN, SOYB, URMD, WETF	MS093, MS107, MS151, MS163	Fine-silty, Coarse-silty, Very fine
37	15	PAST, SOYB, WETF	MS033, MS107, MS135	Fine-silty, Coarse-silty

[1] HRU: Hydrologic Response Unit.

Land Use Key — AGRL = Agricultural Land - Generic, AGRR = Agricultural Land - Row Crops, COTP = Upland Cotton, GRSG = Grain Sorghum, HAY = Hay, OATS = Oats, PMIL = Pearl Millet, PNUT = Peanut, RICE = Rice, SCRN = Sweet Corn, SPOT = Sweet Potato, SUNF = Sunflower, UCOM = Commercial, PAST = Pasture, WETF = Wetlands - Forested, FRSD = Forest - Deciduous, FRSE = Forest - Evergreen, FRST = Forest - Mixed, URLD = Urban Low Density, URMD = Residential - Medium Density, URML = Urban Medium Density, WATR = Water, CORN = Corn, SOYB = Soybean, WETF = Wetlands - Forested, WETN = Wetlands - Nonforested, WETL = Wetlands - Mixed, URHD = Urban High Density, and WWHT = Winter Wheat.

Land Use Map

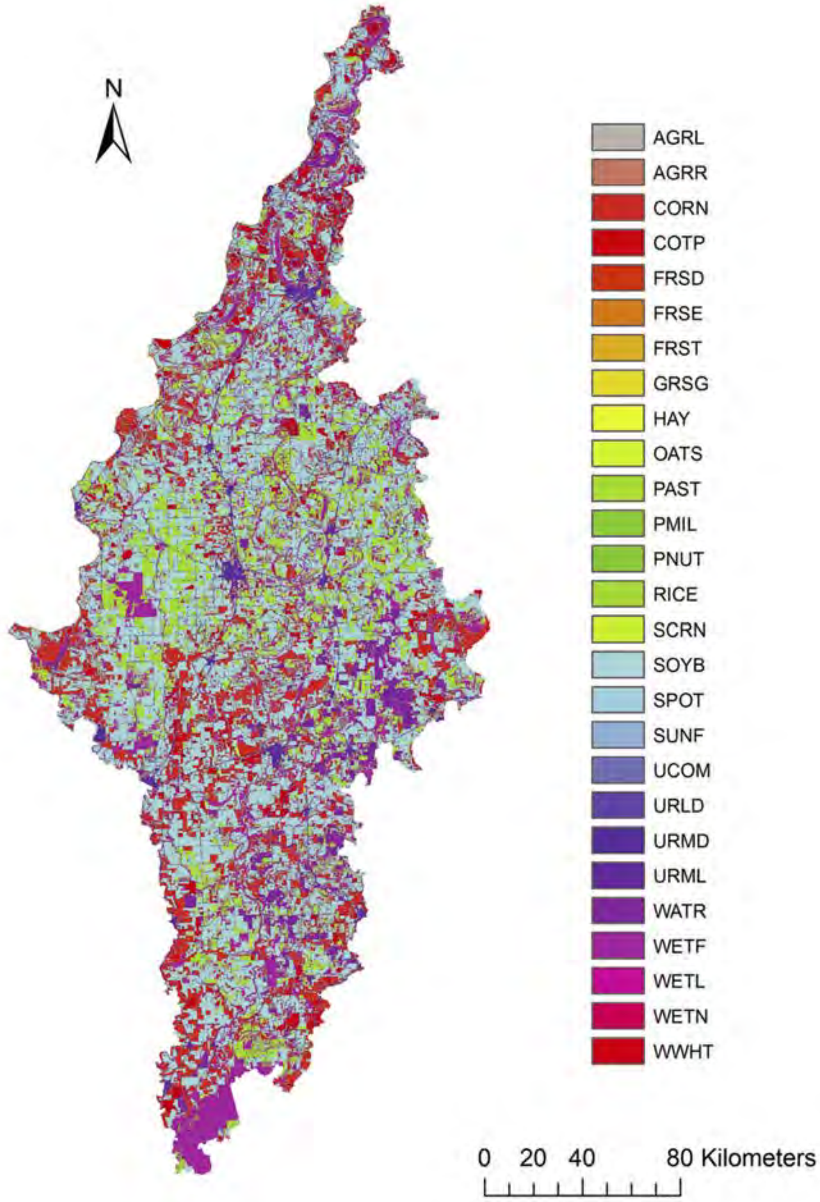

Figure 2. Distribution of land uses within the watershed.

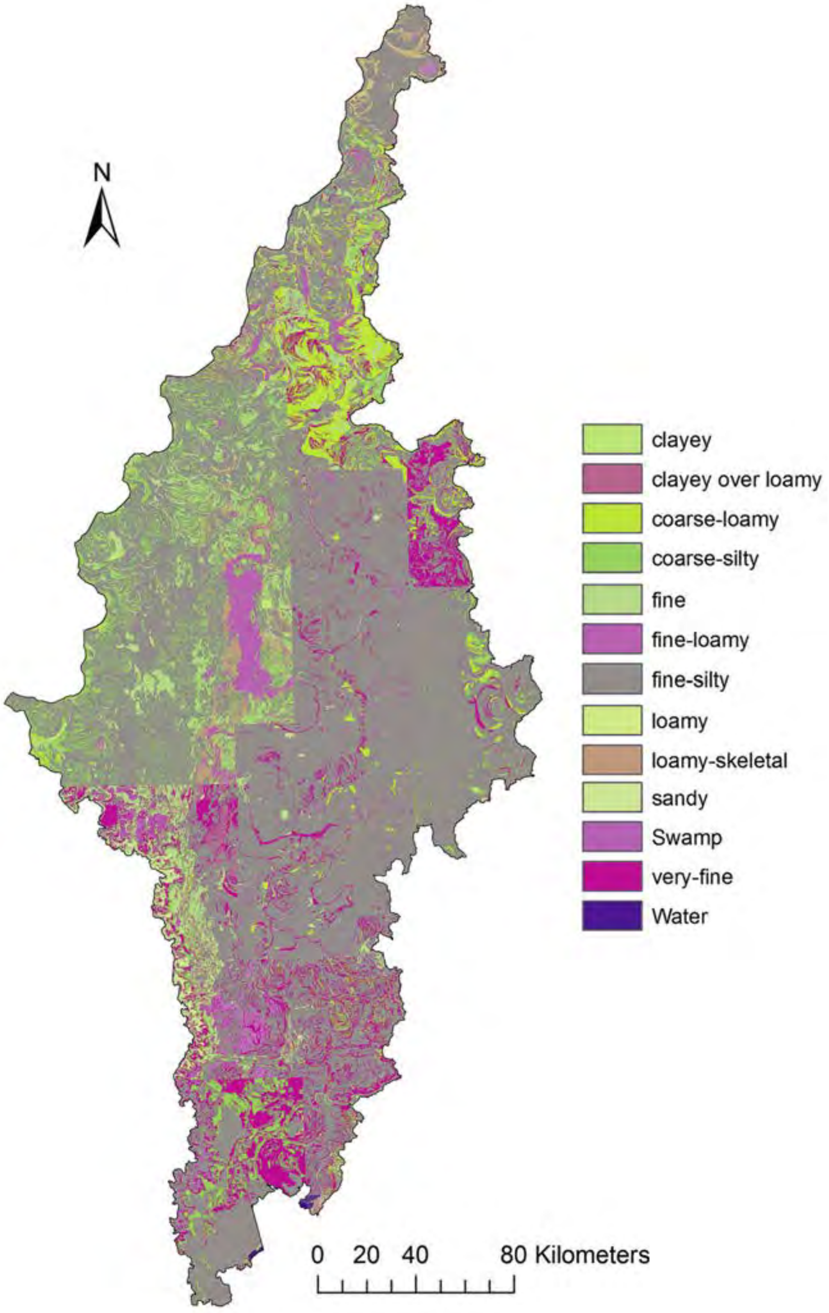

Figure 3. Distribution of state soil textural classes within the watershed.

SUBBASINS

Subbasins Map

Figure 4. Map of the delineated watershed showing 37 subbasins.

Subbasin Area and Elevation

Table 2. Watershed subbasin area and average elevation.

Subbasin	Area (ha)	Avg. elevation (m)	Subbasin	Area (ha)	Avg. elevation (m)
1	66,161	48	20	4,282	36
2	23,902	46	21	21,031	38
3	16,587	44	22	29,526	39
4	38,045	47	23	9,462	36
5	25,127	42	24	29,930	35
6	35,318	43	25	22,013	40
7	13,311	41	26	13,736	36
8	15,430	41	27	30,617	31
9	14,672	39	28	22,751	31
10	20,316	38	29	13,192	33
11	46,451	33	30	20,150	32
12	3,021	33	31	27,158	31
13	11,743	37	32	26,616	30
14	8,969	41	33	24,353	30
15	31,422	39	34	21,540	30
16	28,381	37	35	8,874	31
17	7,746	33	36	17,264	27
18	13,719	39	37	2,358	26
19	873	35			

U.S. GEOLOGICAL SURVEY (USGS) GAGES

USGS Gage Station Locations

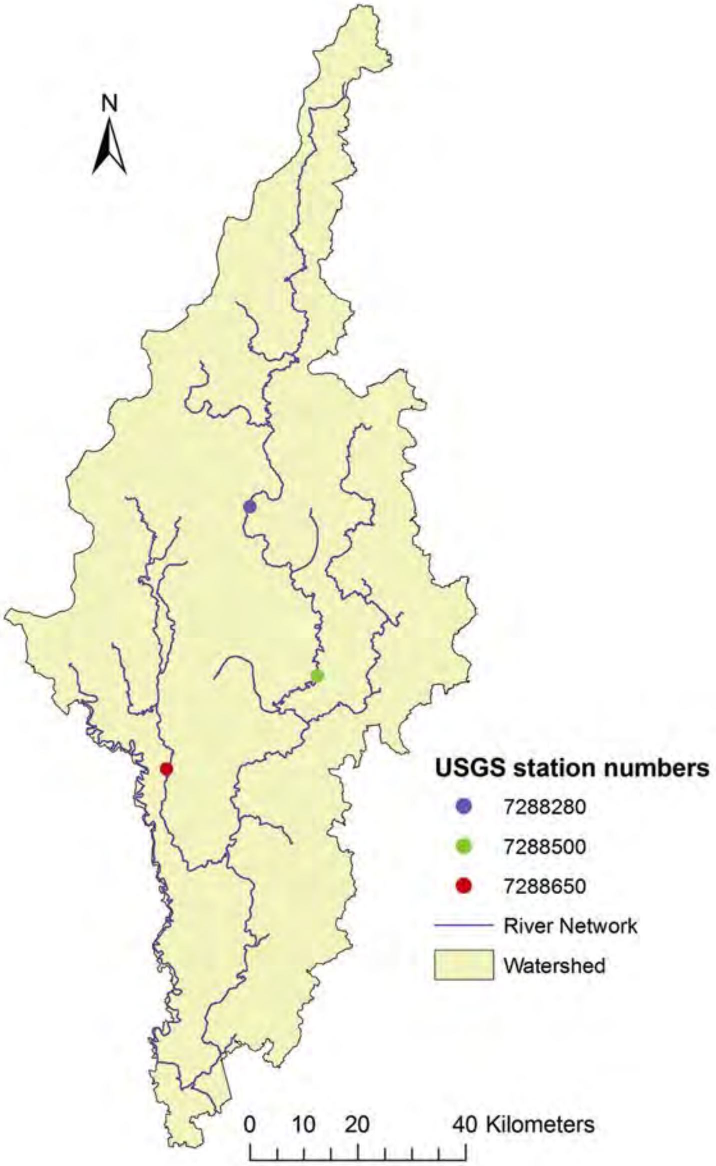

Figure 5. USGS gage stations within the watershed.

Table 3. Name and coordinates of the USGS gage stations in the watershed.

Name	Latitude	Longitude
Big Sunflower River near Merigold (USGS 07288280)	33°49’57”	90°40’12”
Big Sunflower River at Sunflower (USGS 07288500)	33°32’50”	90°32’35”
Bogue Phalia near Leland (USGS 07288650)	33°23’48”	90°50’52”

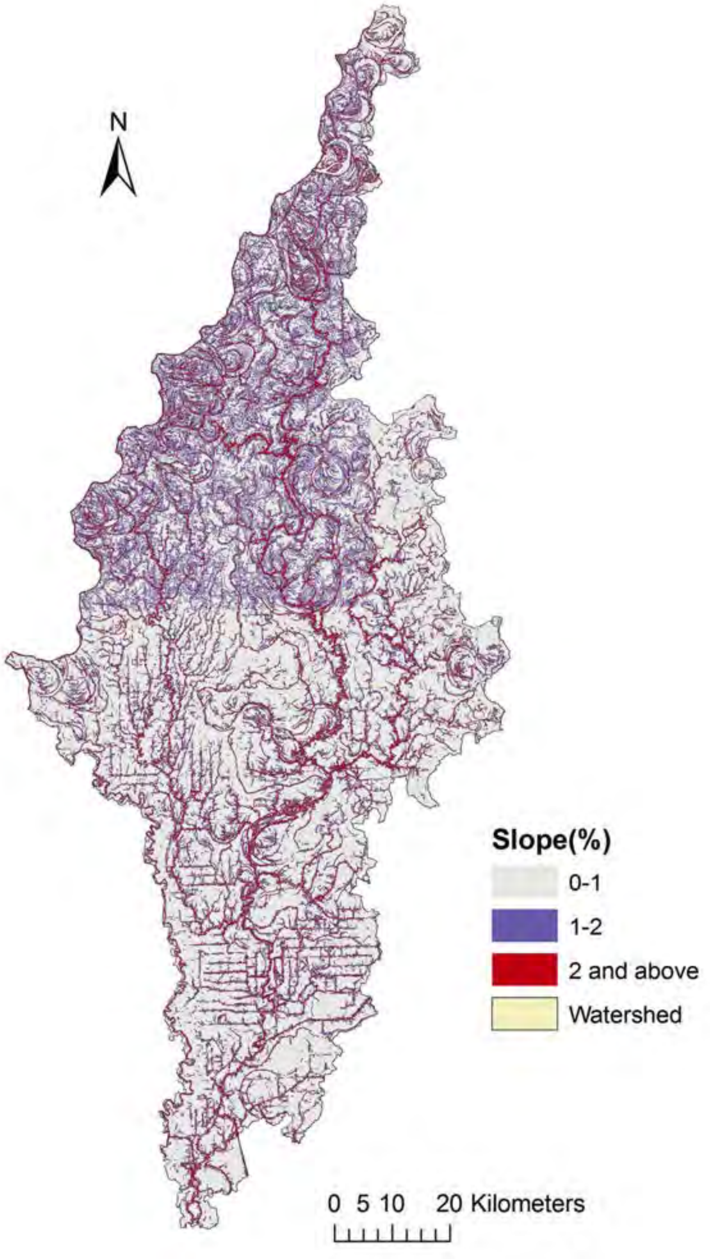

Figure 6. Distribution of landscape slopes in the watershed as classified using the model.

MAJOR RIVER NETWORK

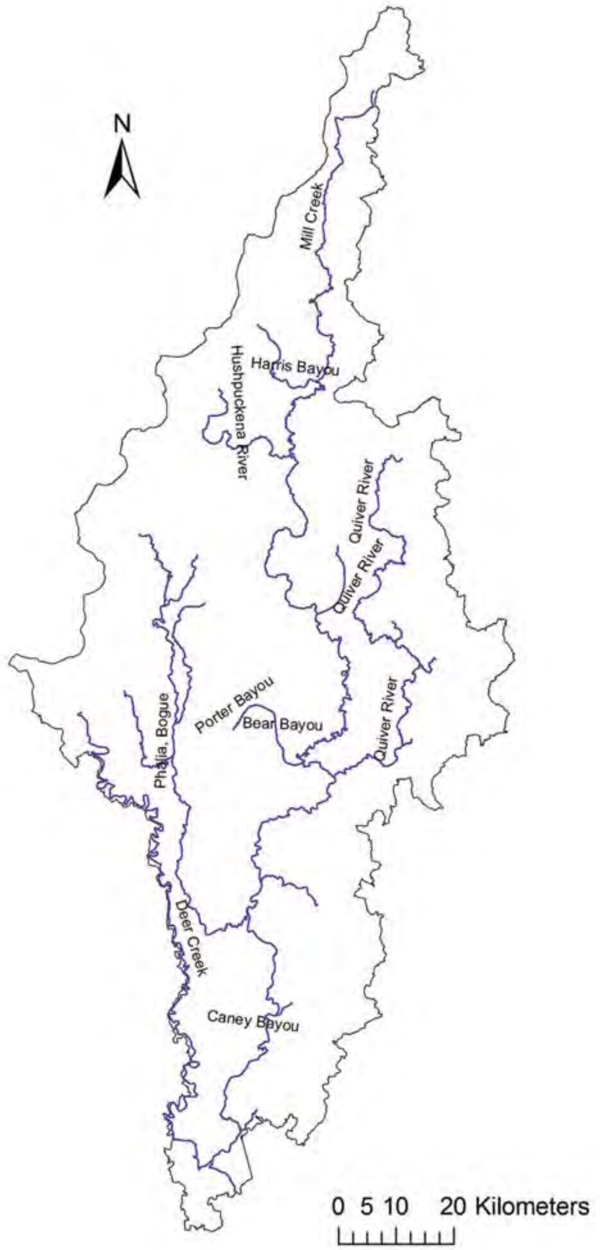

Figure 7. Major rivers network within the watershed as delineated by the model.

RAIN GAGE

Rain Gage Stations

Figure 8. Distribution of the rain gages in the watershed.

Rain Gage Data

Table 4. Location of rain gage stations for each subbasin assigned by the model.

Subbasin	Station	Subbasin	Station
1	Clarksdale	20	Moorhead
2	Clarksdale	21	Stoneville Research Field
3	Clarksdale	22	Stoneville Research Field
4	Clarksdale	23	Moorhead
5	Clarksdale	24	Moorhead
6	Stoneville Research Field	25	Stoneville Research Field
7	Clarksdale	26	Stoneville Research Field
8	Moorhead	27	Stoneville Research Field
9	Clarksdale	28	Moorhead
10	Minter City	29	Stoneville Experiment Station
11	Minter City	30	Stoneville Experiment Station
12	Minter City	31	Belzoni
13	Minter City	32	Belzoni
14	Stoneville Research Field	33	Rolling Fork
15	Stoneville Research Field	34	Rolling Fork
16	Moorhead	35	Rolling Fork
17	Moorhead	36	Rolling Fork
18	Moorhead	37	Rolling Fork
19	Stoneville Research Field		

Table 5. Coordinates and elevations of the rain gage locations used by the model.

Name	Latitude (degrees)	Longitude (degrees)	Elevation (m)
Clarksdale	34.18	-90.55	52.8
Stoneville Research Field	33.45	-90.87	36.0
Moorhead	33.45	-90.50	35.7
Minter City	33.75	-90.20	44.2
Stoneville Experiment Station	33.42	-90.90	38.7
Belzoni	33.17	-90.48	35.1
Rolling Fork	32.88	-90.88	32.0

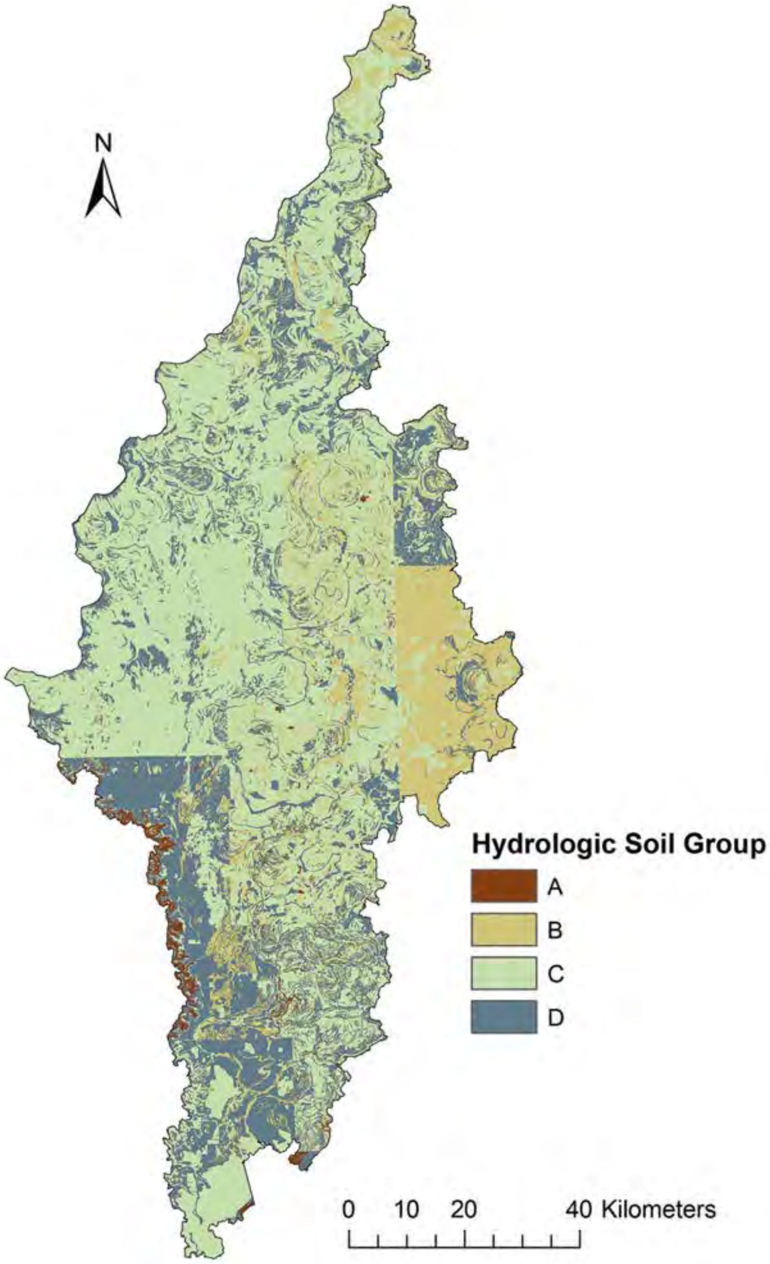

Figure 9. Distribution of hydrologic soil groups within the watershed used by the model. Note: Group A = low runoff potential when very wet; Group B = moderately low runoff potential when very wet; Group C = moderately high runoff potential when very wet; and Group D = high runoff potential when very wet.

ELEVATION

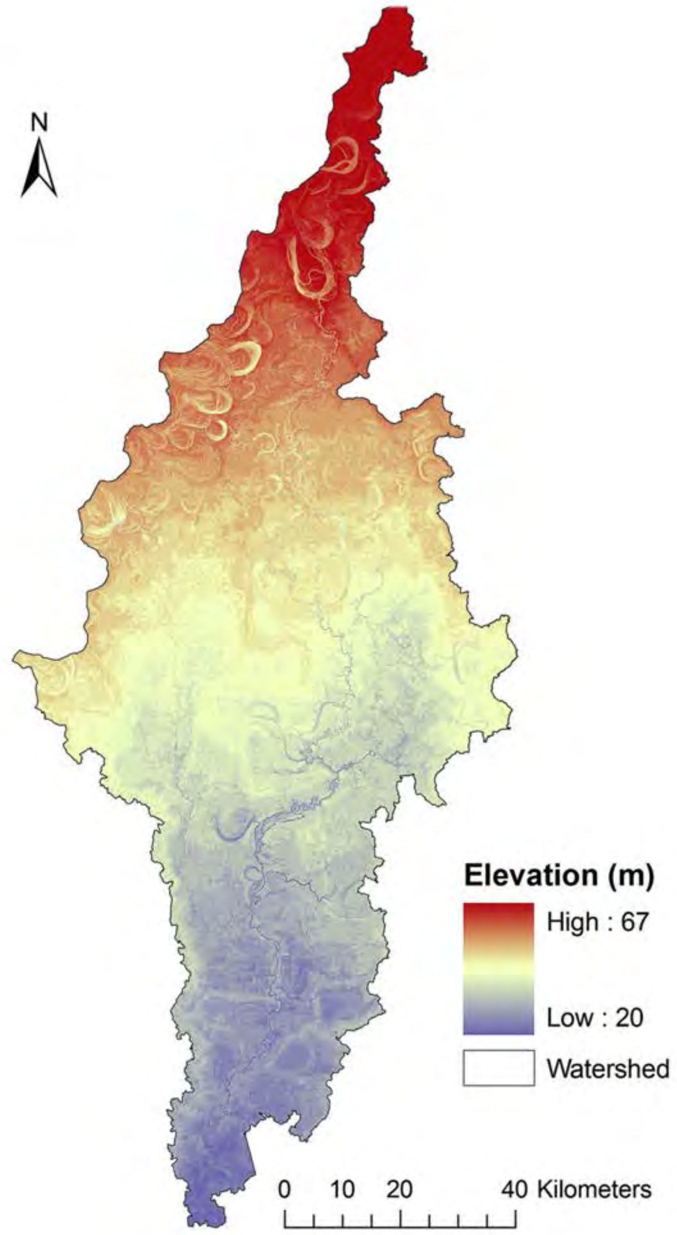

Figure 10. Distribution of elevation ranges within the watershed based on digital elevation model (DEM) grids.

Figure 11. Distribution of local cities and towns around the watershed.

BEEF COWS

Coahoma, Bolivar, Sunflower, Washington, Humphreys, and Sharkey counties comprise the majority of the BSRW. Figure 12 shows the long-term average number of beef cows (by head) for each county from 2000 to 2010 (USDA/NASS 2011).

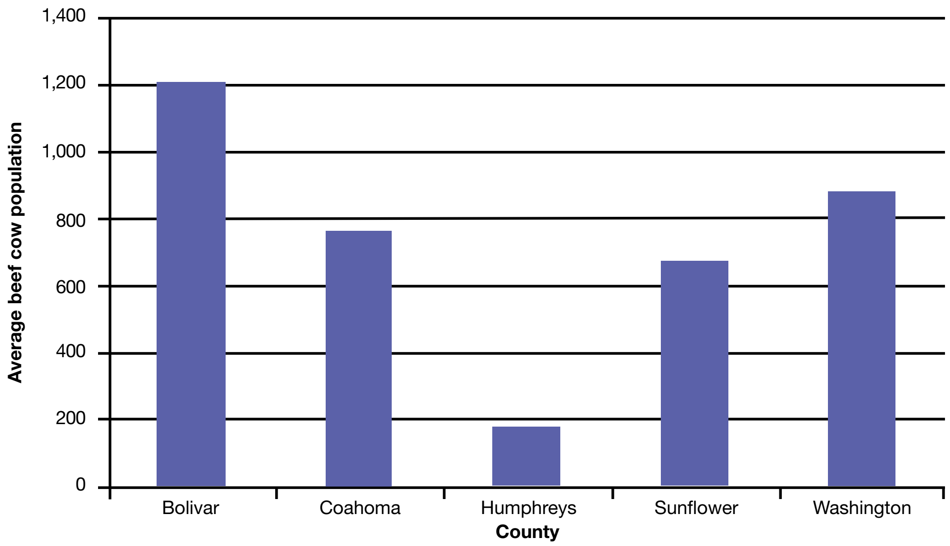

Figure 12. Long-term (2000-2010) average estimated number of beef cows by county.

POPULATION BY COUNTY

Table 6. Estimated populations of each county.[1]

County	Population	County	Population
Bolivar	41,000	Sunflower	34,000
Coahoma	31,000	Washington	63,000
Humphreys	11,000	Sharkey	7,000

[1] Polidata, 2002.

PRELIMINARY RESULTS

This research evaluated spatially and temporally variable crop production within the watershed. Modeling methods were developed to model crop yield in the BSRW. The Soil and Water Assessment Tool (SWAT) model was applied to evaluate average monthly flow and annual crop production. The SWAT model was calibrated from 2001 to 2005 and validated from 2006 to 2010 using three USGS gage stations and monthly measured stream flow data. Preliminary results of the calibrated and validated SWAT model determined reasonable performance for mean monthly stream flow prediction with average R^2 values of 0.73 during model calibration and average R^2 value of 0.80 during model validation. SWAT/crop model results showed reasonable performance for corn and soybean yield from the Delta Branch Experiment Station in Stoneville during model calibration, as well as reasonable performance with Clarksdale experiment data during model validation. The preliminary results of the SWAT model demonstrated spatial distribution of the crop yields from each subbasin, which helps to identify important subbasins in the watershed for crop production.

DISCUSSION

Based on SWAT simulation results, the water yield and crop yield from the watershed subbasins were found to be spatially variable. Crop yield was dependent on the management practices, topography, land-use conditions, and weather conditions in the watershed. This study helps watershed managers to prioritize areas in the watershed.

ACKNOWLEDGMENTS

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