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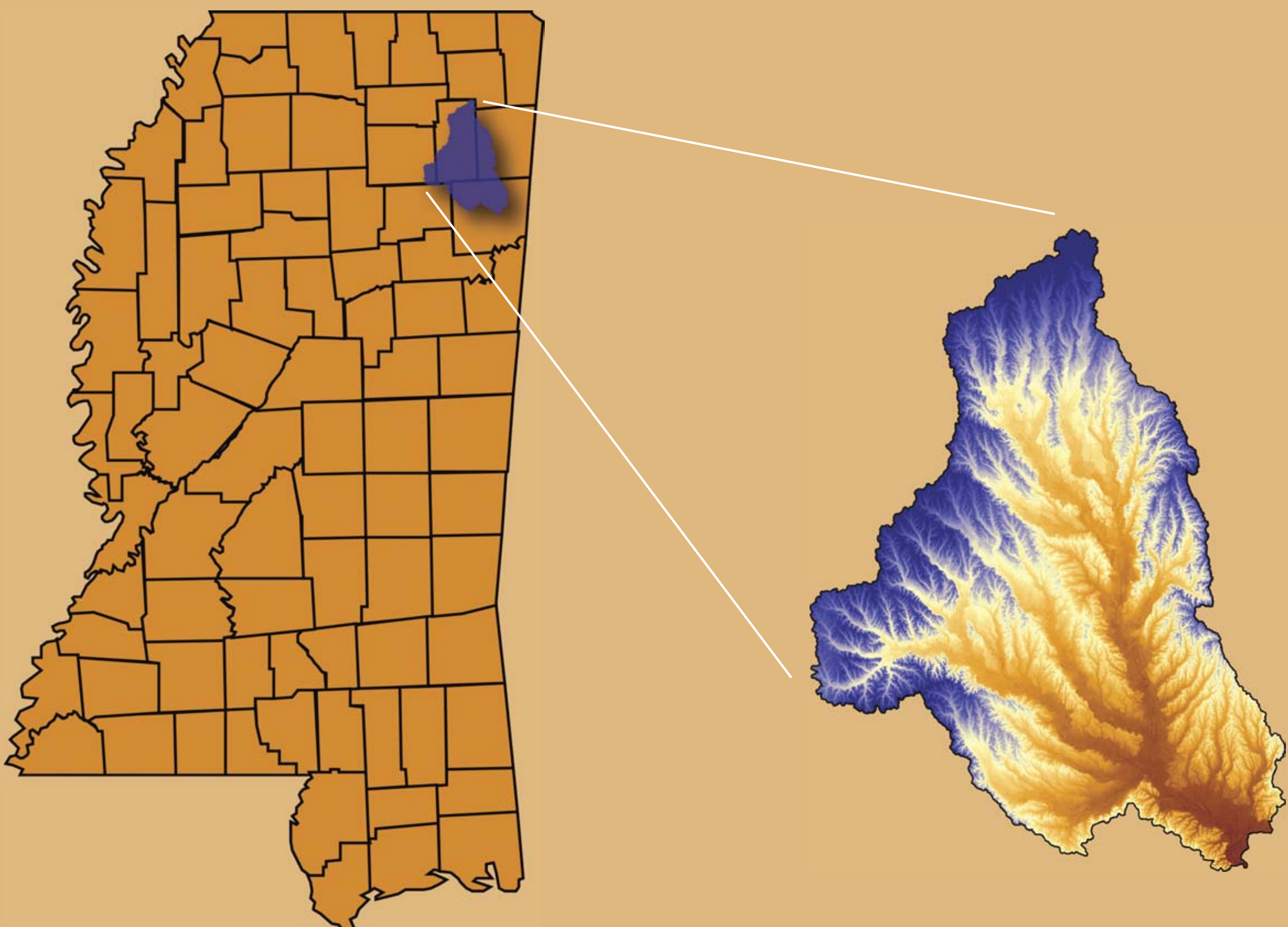
TOWN CREEK WATERSHED ASSESSMENT: *Preliminary Report*



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Town Creek Watershed Assessment: Preliminary Report

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Town Creek Watershed Assessment: Preliminary Report

Description

The Town Creek Watershed (TCW) is approximately 1,775 square kilometers and is located in northeast Mississippi. Its total area represents approximately 50% of the upper Tombigbee River Basin area contributing to the Aberdeen Pool on the Tennessee-Tombigbee Waterway (Ramirez-Avila, 2010). The majority of TCW lies within Lee, Union, and Pontotoc counties with smaller portions in Chickasaw, Monroe and Itawamba counties (Figure 1). There are 999 farms in the watershed with an average size of 187 acres (Natural Resources Conservation Service, 2011). The major water system within TCW is Town Creek, which begins near Sherman and culminates south of Nettleton (U.S. Environmental Protection Agency, 2006). Major threats to Town Creek's water quality are the consequences of agricultural activity and urban development. These activities, in addition to severe bank erosion, result in sedimentation and nutrient loading that affect the Tombigbee River Basin (Ramirez-Avila, 2010).

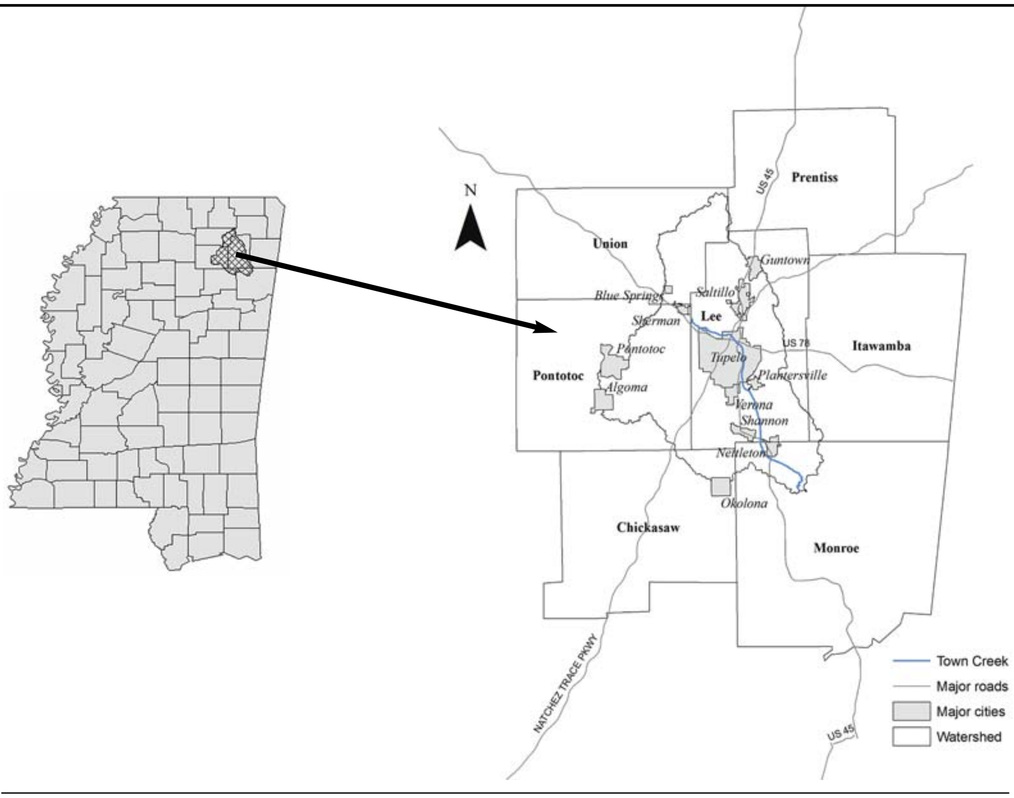

Figure 1. Location map of the Town Creek Watershed in Mississippi.

Overview of Water Quality Issues

When excess rainfall flows across land, pollutants are deposited into water bodies. The TCW is threatened by several potential pollutant sources, primarily nonpoint-source pollution (Mississippi Department of Environmental Quality, 2009). Nonpoint-source pollutant sources stem from agricultural activities and urban development. Surface runoff from agricultural activities carries sediment, organic matter, and nutrients that can harm water quality in the watershed. Agricultural nonpoint-source pollution can originate from livestock grazing, chicken litter application, fertilizer runoff, and other agricultural activities. The chief source of pollution for TCW is sediment (Table 1) (Environmental Protection Agency, 2006). As with all water bodies, nutrients are a major source of nonpoint-source pollution in the TCW. Phosphorus is a particularly harmful nutrient because it can cause eutrophication. Table 1 lists the water bodies and tributaries of Town Creek and the water quality concerns of each (Mississippi Department of Environmental Quality, 2009).

Table 1. Pollutants of concern in the various tributaries of Town Creek within the watershed.

Water body name	Pollutant of concern
Kings Creek	Biological Impairment due to Sediment
Roberts Branch	Biological Impairment due to Sediment
Town Creek	Biological Impairment due to Sediment
Tubbalubba Creek	Biological Impairment due to Sediment

Land Use

Land-use practices can affect water quality within a watershed, thus land cover classification is an important factor to analyze. Different types of land usage can have varying effects on water quality, such as sediment, nutrient, and pesticide retention. The 1965 Water Quality Act was the country's first law regarding water quality standards. Since that time, these regulations have been strictly enforced, and new regulations have been implemented to improve water quality. Similarly, the 1972 Clean Water Act (CWA) was passed in order to further improve water-quality standards (Environmental Protection Agency, 2007). The CWA requires each state to determine the amounts of point and nonpoint pollutants that can enter water bodies without compromising minimum water-quality standards. This pollution concentration is called the "Total Maximum Daily Load." CWA mandates make it necessary for the state to monitor land usage in watersheds. Nonpoint-source pollutants are difficult to manage, but it is still important to monitor the ways in which land is being used (Tagert, 2006). Forestland dominates the TCW at 44% while pasture/hay fields come in second at 27%. Agricultural fields (15%), urban areas (12%), and other uses (2%) constitute the remaining land cover (Table 2, Figure 2). The soil data used in the model showed 14 commonly known soil groups (Figure 3) in the watershed.

Table 2. Model-generated subbasins, HRUs, land uses, and dominant soils in the watershed.[1]

Subbasin	No. of HRUs	Land uses	Dominant soil types	Dominant soil names
1	75	FRSD, FRST, PAST	MS048, MS129, MS217	BIBB, BELDEN, JENA
2	57	FRSD, FRST, FRSE	MS048, MS129, MS217	BIBB, BELDEN, JENA
3	7	SOYB, WWHT	MS217	JENA
4	93	FRSD, FRST, PAST	MS129, MS048, MS217	BELDEN, BIBB, JENA
5	143	PAST, SOYB, FRST	MS130, MS129, MS117	ATWOOD, BELDEN, CATALPA
6	99	HAY, PAST, FRST	MS129, MS130, MS117	BELDEN, ATWOOD, CATALPA
7	37	URMD, FRSD, FRST	MS131, MS117	BELDEN, CATALPA
8	84	FRSD, FRST, FRSE	MS111, MS129, MS217	BIBB, BELDEN, JENA
9	101	SOYB, PAST, HAY	MS131, MS117, MS129	BELDEN, CATALPA, BELDEN
10	111	FRST, PAST, SOYB	MS129, MS131, MS117	BELDEN, BELDEN, CATALPA
11	60	URMD, SOYB, URLD	MS117, MS130, MS131	CATALPA, ATWOOD, BELDEN
12	104	FRSD, URMD, SOYB	MS111, MS217, MS117	BIBB, JENA, CATALPA
13	42	URMD, URLD, UCOM	MS130, MS117, MS131	ATWOOD, CATALPA, BELDEN
14	82	URMD, URLD, SOYB	MS117, MS111, MS217	CATALPA, BIBB, JENA
15	45	FRSD, FRST, PAST	MS130, MS117	ATWOOD, CATALPA
16	42	FRSD, FRST, PAST	MS130, MS117	ATWOOD, CATALPA
17	47	URMD, SOYB, URLD	MS117, MS130, MS111	CATALPA, BELDEN, BIBB
18	138	FRSD, FRST, FRSE	MS111, MS131, MS129, MS217	BIBB, BELDEN, BELDEN, JENA
19	90	FRSD, FRST, PAST	MS130, MS153, MS117	ATWOOD, ARKABUTLA, CATALPA
20	26	SOYB, PAST, HAY	MS130, MS117	ATWOOD, CATALPA
21	92	PAST, SOYB, HAY	MS131, MS117, MS130	BELDEN, CATALPA, ATWOOD
22	152	SOYB, FRSD, FRST, PAST	MS129, MS117, MS111	BELDEN, CATALPA, BIBB
23	102	SOYB, PAST, HAY	MS117, MS131, MS130	CATALPA, BELDEN, ATWOOD
24	3	CORN, HAY, PAST	MS117	CATALPA
25	81	PAST, SOYB, HAY	MS131, MS117, MS130	BELDEN, CATALPA, ATWOOD
26	22	PAST, WETF, SOYB	MS117	CATALPA
27	76	SOYB, PAST, WETF	MS117, MS131, MS130	CATALPA, BELDEN, ATWOOD
28	107	HAY, PAST, FRST	MS131, MS117, MS133	BELDEN, CATALPA, BROOKSVILLE

[1]HRU: Hydrologic Response Unit.

Subbasin	No. of HRUs	Land uses	Dominant soil types	Dominant soil names
29	144	PAST, FRST, SOYB	MS129, MS131, MS117	BELDEN, BELDEN, CATALPA
30	98	FRST, PAST, FRSD	MS131, MS129, MS117	BELDEN, BELDEN, CATALPA
31	86	PAST, WETF, FRST	MS117, MS133, MS048	CATALPA, BROOKSVILLE, BIBB

Table 2 (continued). Model-generated subbasins, HRUs, land uses, and dominant soils in the watershed.[1]

[1]HRU: Hydrologic Response Unit.

Land Use Key:

PAST = Pasture
WETF = Wetlands-Forested
FRSD = Forest-Deciduous
FRSE = Forest-Evergreen
FRST = Forest-Mixed

URLD = Urban Low Density
URML = Urban Medium Density
WATR = Water
CORN = Corn

SOYB = Soybean
WETL = Wetlands-Mixed
URHD = Urban High Density
WWHT = Winter Wheat

Land Uses Map

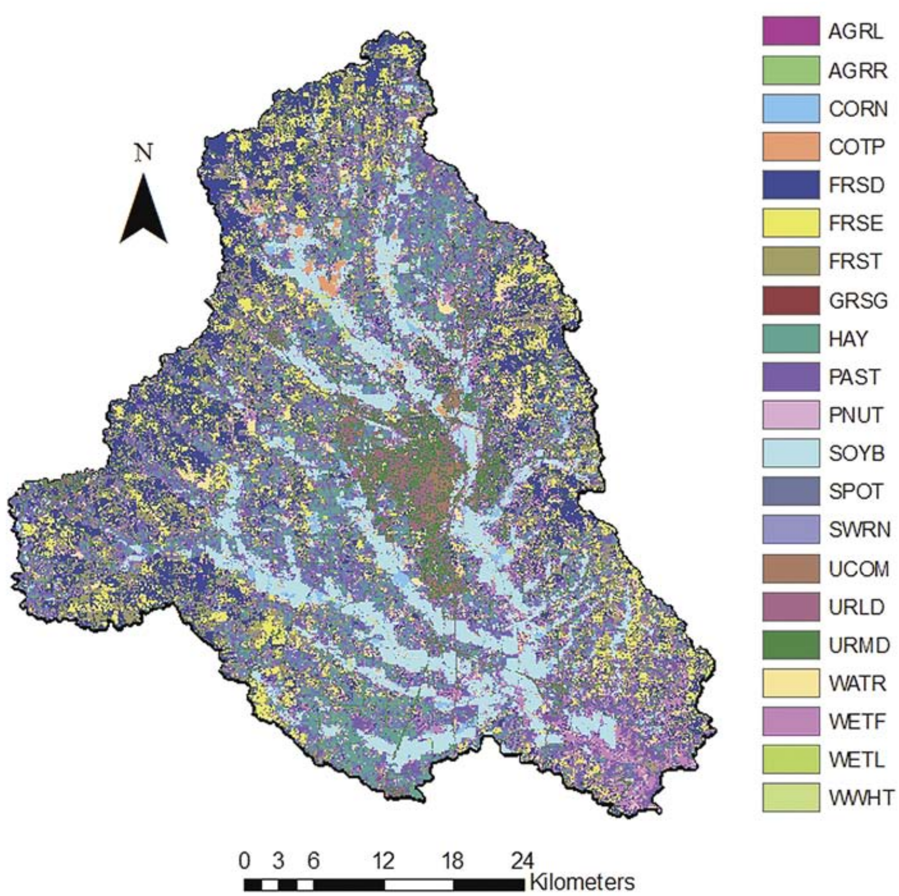

Figure 2. Distribution of land uses within the watershed.

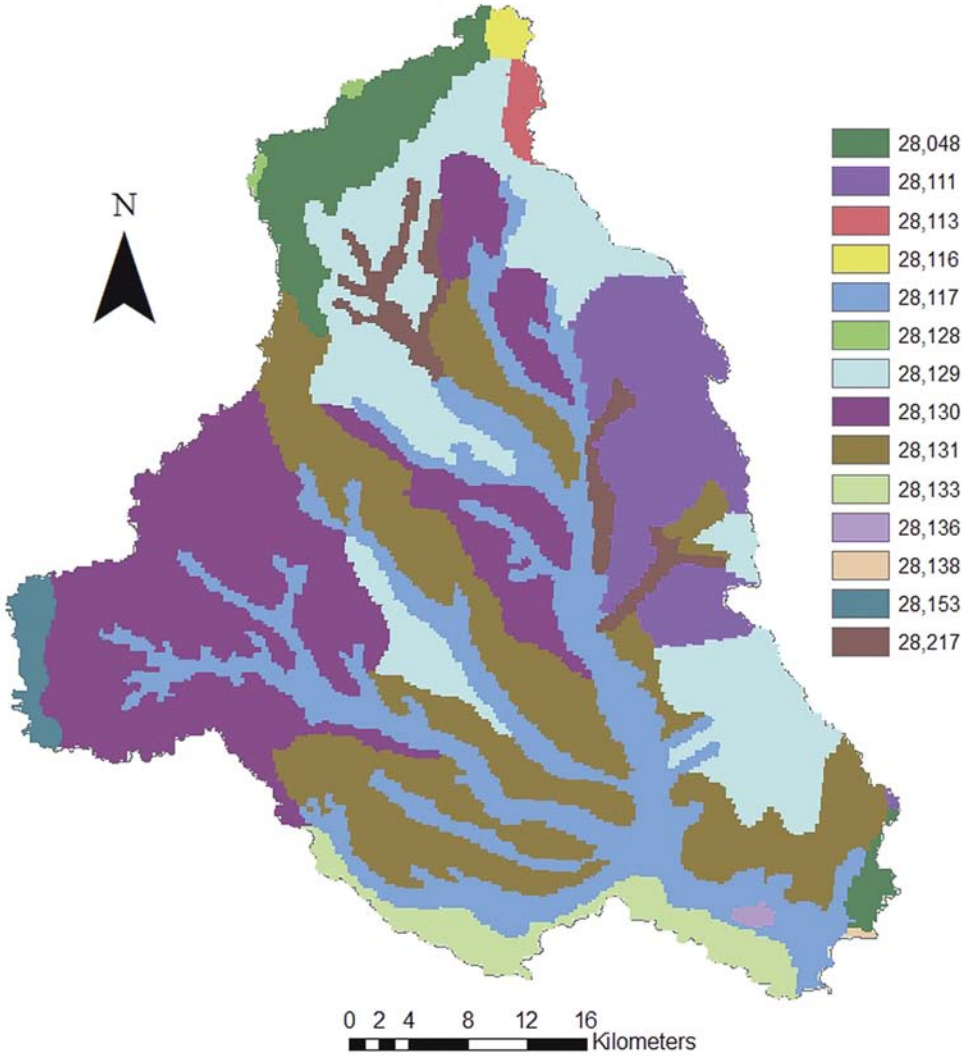

Figure 3. Distribution of state soil map unit ID (STMUID) within the watershed.

SUBBASINS

The SWAT model used in this study delineated 31 subbasins in the watershed (Figure 4) with varying sizes (Table 3).

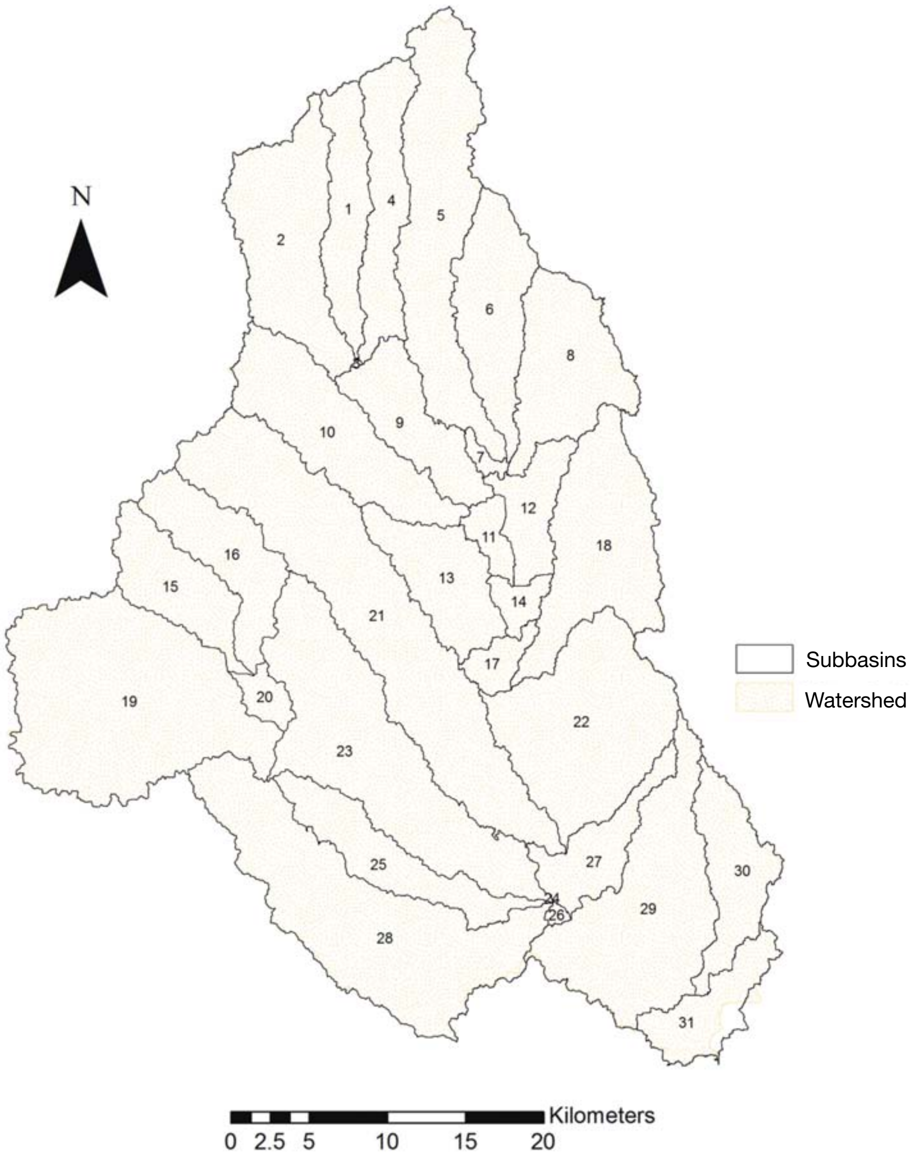

Figure 4. Map of the watershed subbasins (31) used during preliminary study.

Subbasins Area and Elevation

Table 3. Watershed subbasins, areas, and average elevations.

Subbasin	Area (ha)	Avg. elevation (m)	Subbasin	Area (ha)	Avg. elevation (m)
1	3970.35	115	17	1144.71	72
2	7992.45	118	18	8471.25	117
3	22.86	93	19	16270.29	96
4	4663.26	113	20	950.04	88
5	10575.99	96	21	16973.1	98
6	5557.68	98	22	10767.42	94
7	384.3	92	23	12883.77	76
8	6370.83	115	24	0.36	67
9	4281.03	89	25	4503.24	83
10	7476.3	104	26	158.85	69
11	1074.96	81	27	3102.39	74
12	2713.14	82	28	14531.76	84
13	4524.03	92	29	10833.3	65
14	948.69	76	30	4215.24	77
15	4160.52	128	31	3168.99	61
16	4831.74	129			

U.S. GEOLOGICAL SURVEY (USGS)

This study used monthly observed stream flow data from the Nettleton USGS gage station (Figure 5, Table 4).

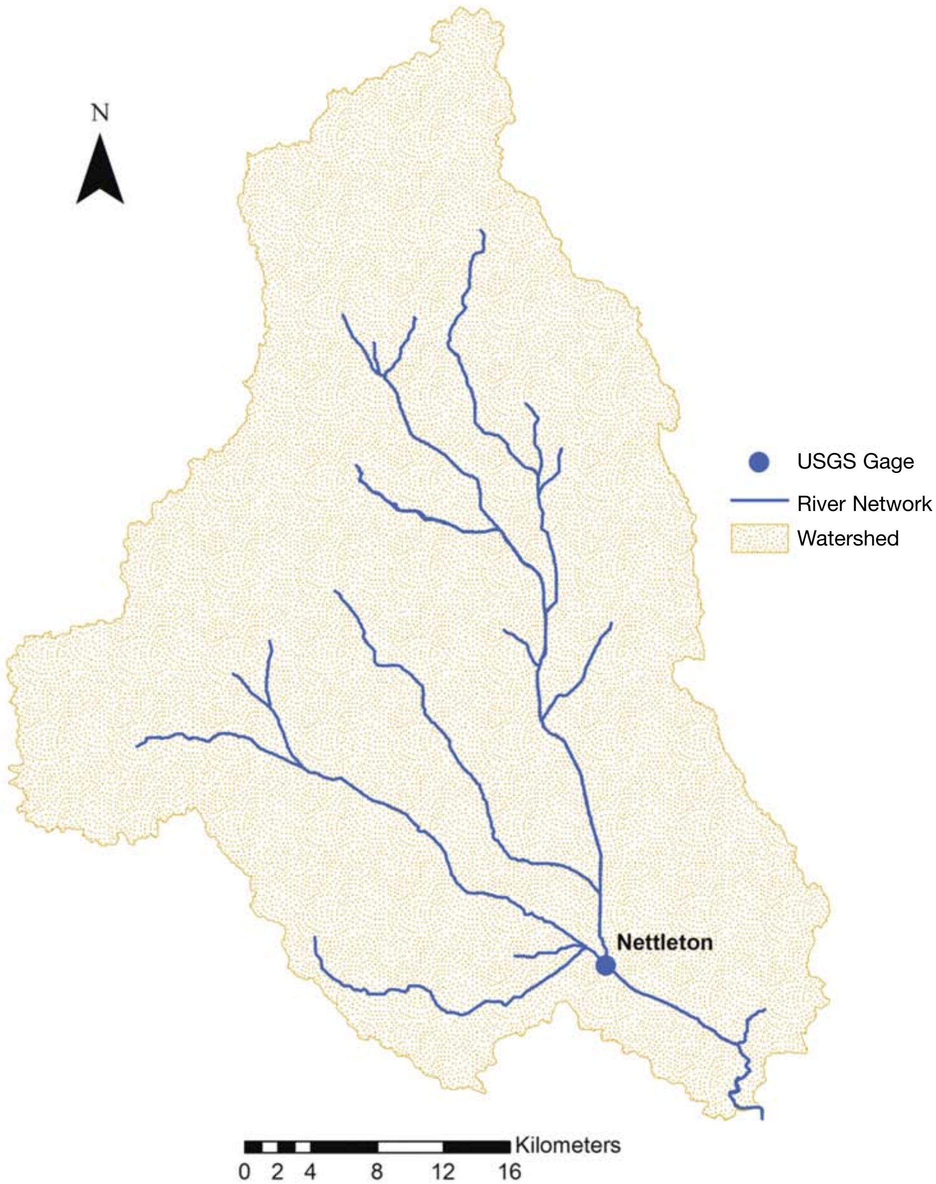

Figure 5. Distribution of the USGS gage stations within the watershed.

USGS Gage Station Location

Table 4. Name and coordinates of the USGS gage station in the watershed.

Name	Latitude	Longitude
Nettleton (USGS 02436500)	34°03’33”	88°37’41”

SLOPE

The SWAT model classified slopes within the watershed (Figure 6) and delineated the stream network (Figure 7).

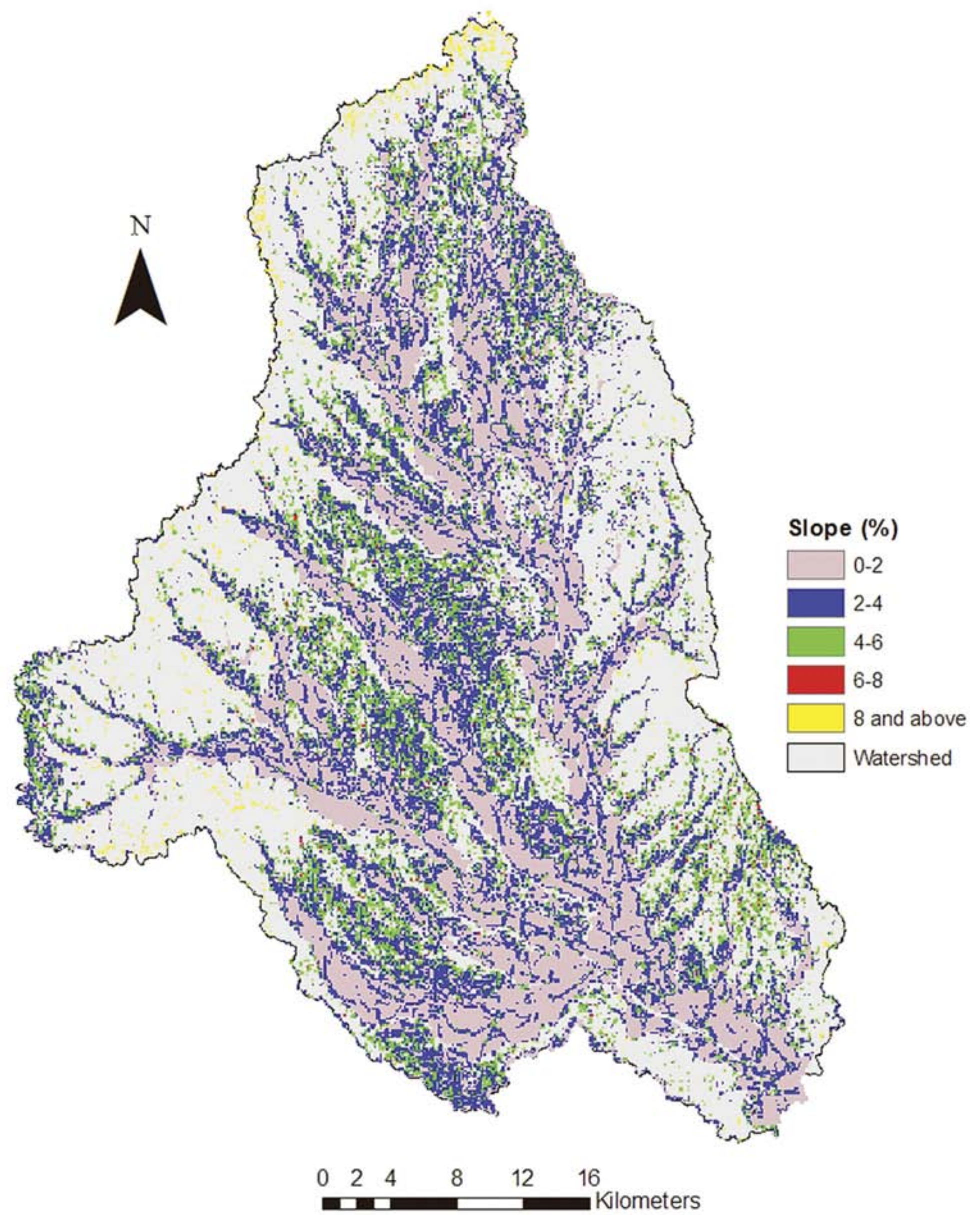

Figure 6. Distribution of landscape slopes in the watershed as classified using model.

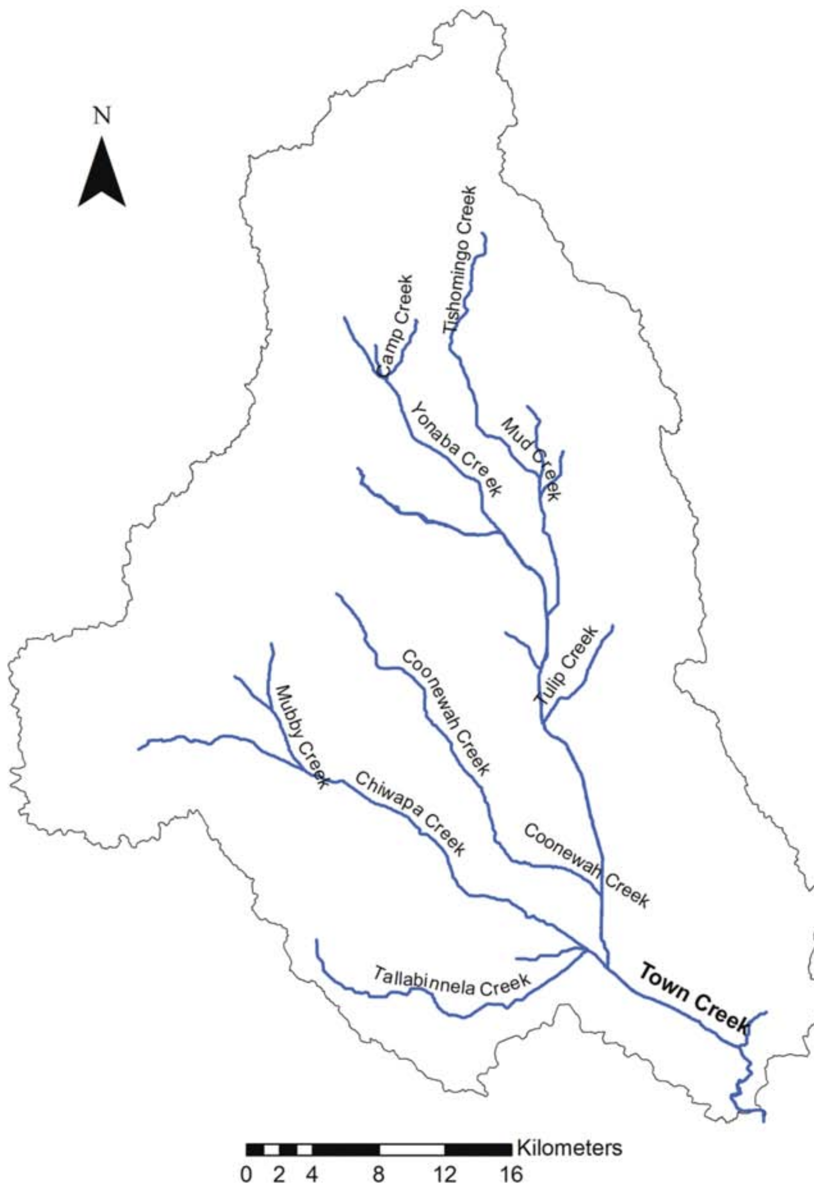

Figure 7. Major rivers network within the watershed as delineated by the model.

Rain Gage

Rain Gage Stations

This study used weather data from three rain gage stations (Figure 8, Table 6), and watershed subbasins utilized weather data based on the closest available station (Table 5).

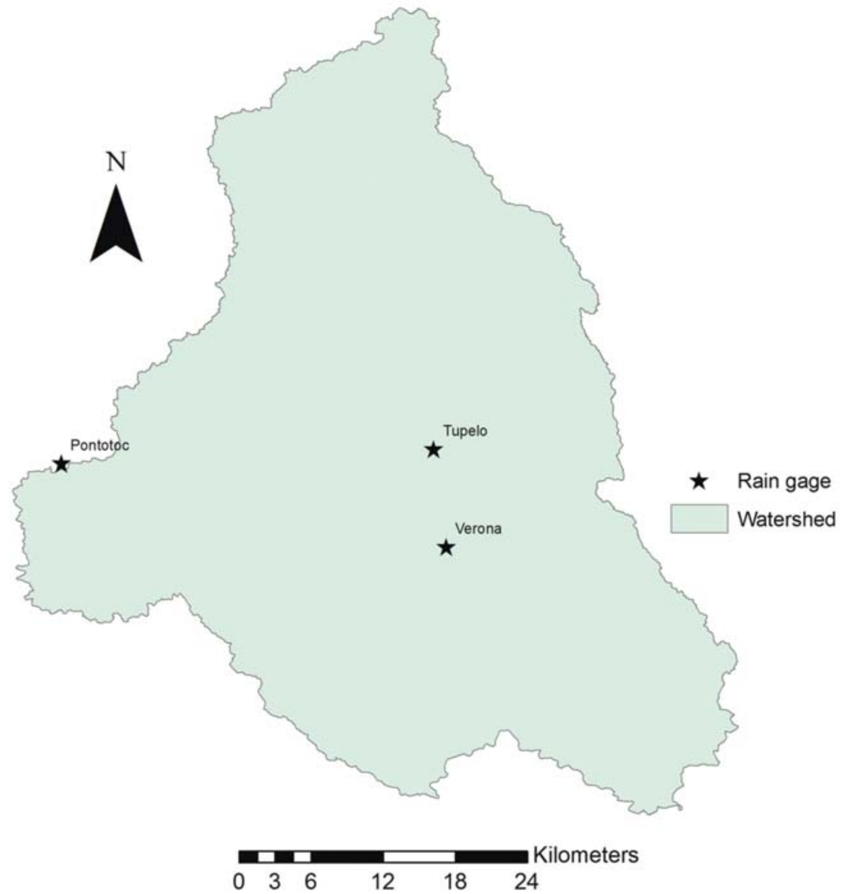

Figure 8. Distribution of the three rain gages used in the preliminary study of the watershed.

Rain Gages by Subbasin

Table 5. Location of rain gage stations for each subbasin assigned by the model.

Subbasin	Station	Subbasin	Station	Subbasin	Station
1	Tupelo	12	Tupelo	23	Verona
2	Tupelo	13	Tupelo	24	Verona
3	Tupelo	14	Tupelo	25	Verona
4	Tupelo	15	Pontotoc	26	Verona
5	Tupelo	16	Verona	27	Verona
6	Tupelo	17	Tupelo	28	Verona
7	Tupelo	18	Tupelo	29	Verona
8	Tupelo	19	Pontotoc	30	Verona
9	Tupelo	20	Verona	31	Verona
10	Tupelo	21	Verona		
11	Tupelo	22	Tupelo		

Rain Gage Locations

Table 6. Coordinates and elevations of the rain gage locations used by the model.			
Name	**Elevation (m)**	**Latitude**	**Longitude**
Pontotoc	123.4	34.13°	-89.00°
Tupelo	79.2	34.23°	-88.70°
Verona	99.1	34.20°	-88.72°

HYDROLOGIC SOIL GROUP

The SWAT-model-generated hydrologic soil groups showed that the TCW is dominated by Group C soils (Figure 9).

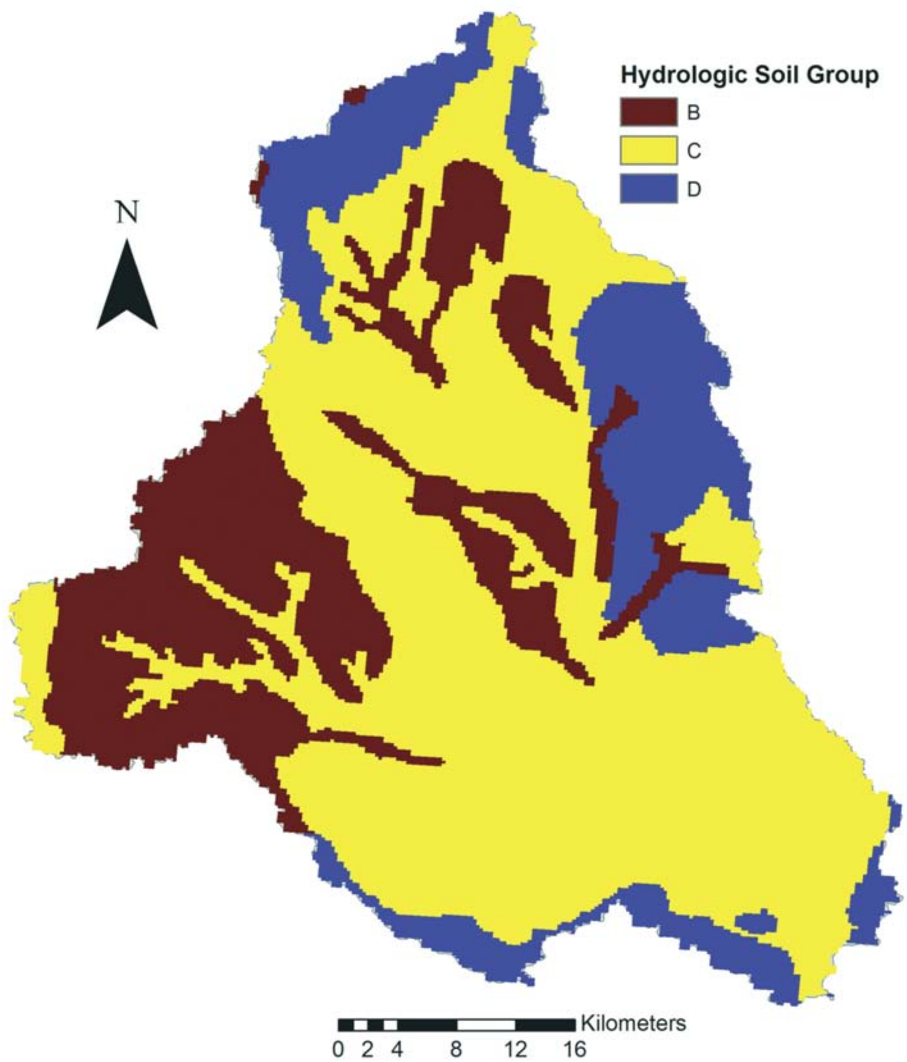

Figure 9. Distribution of hydrologic soil groups within the watershed used by the model. Note: Group B = moderately low runoff potential when very wet; Group C = moderately high runoff potential when very wet; and Group D = high runoff potential when very wet.

Elevation

The SWAT model delineated the watershed boundary using digital elevation model data and determined that the TCW elevation ranges from 56–241 meters (Figure 10).

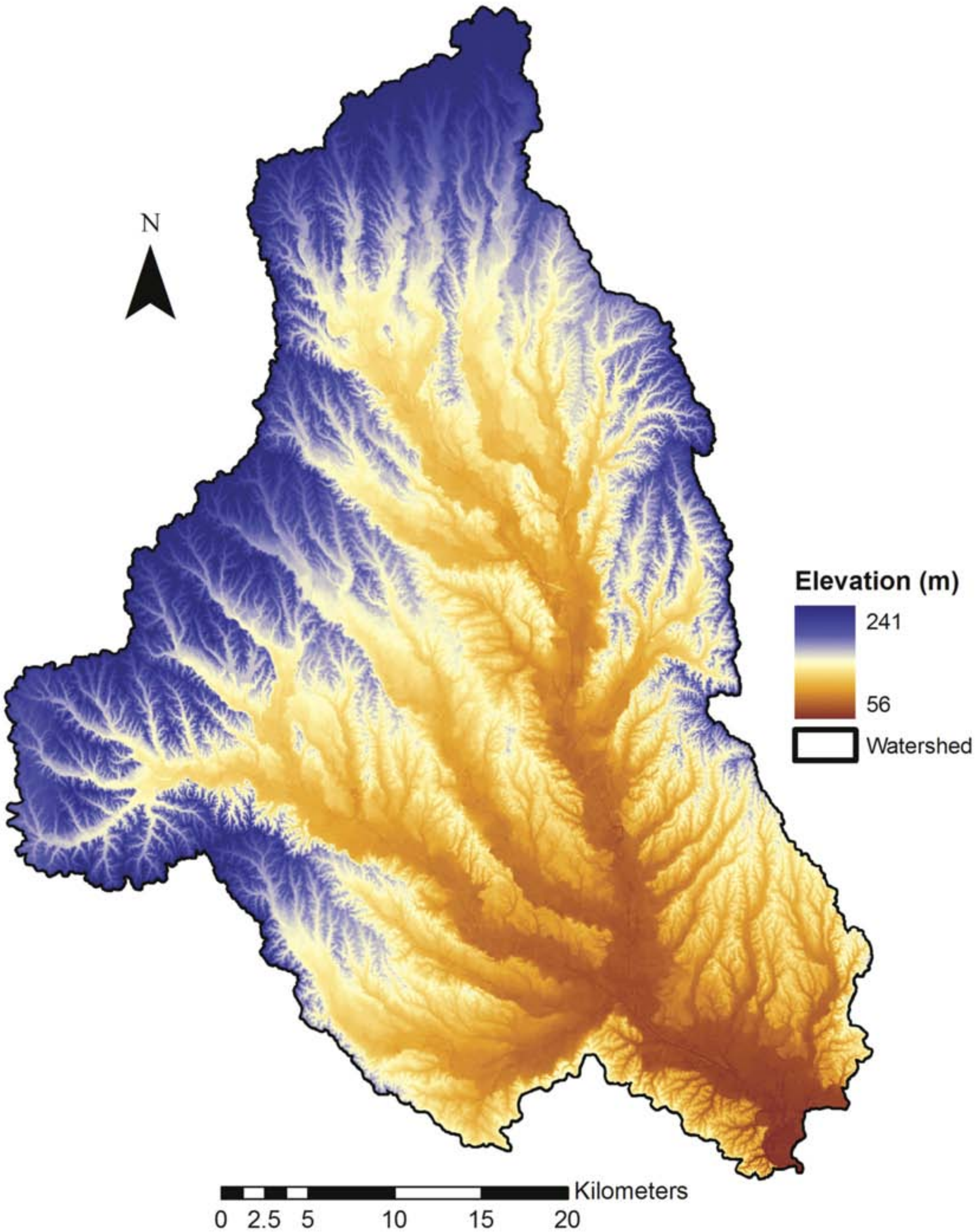

Figure 10. Distribution of elevation ranges within the watershed based on digital elevation model (DEM) grids.

CITIES

There are 12 cities located within the TCW boundary (Figure 11) based on TIGER data.

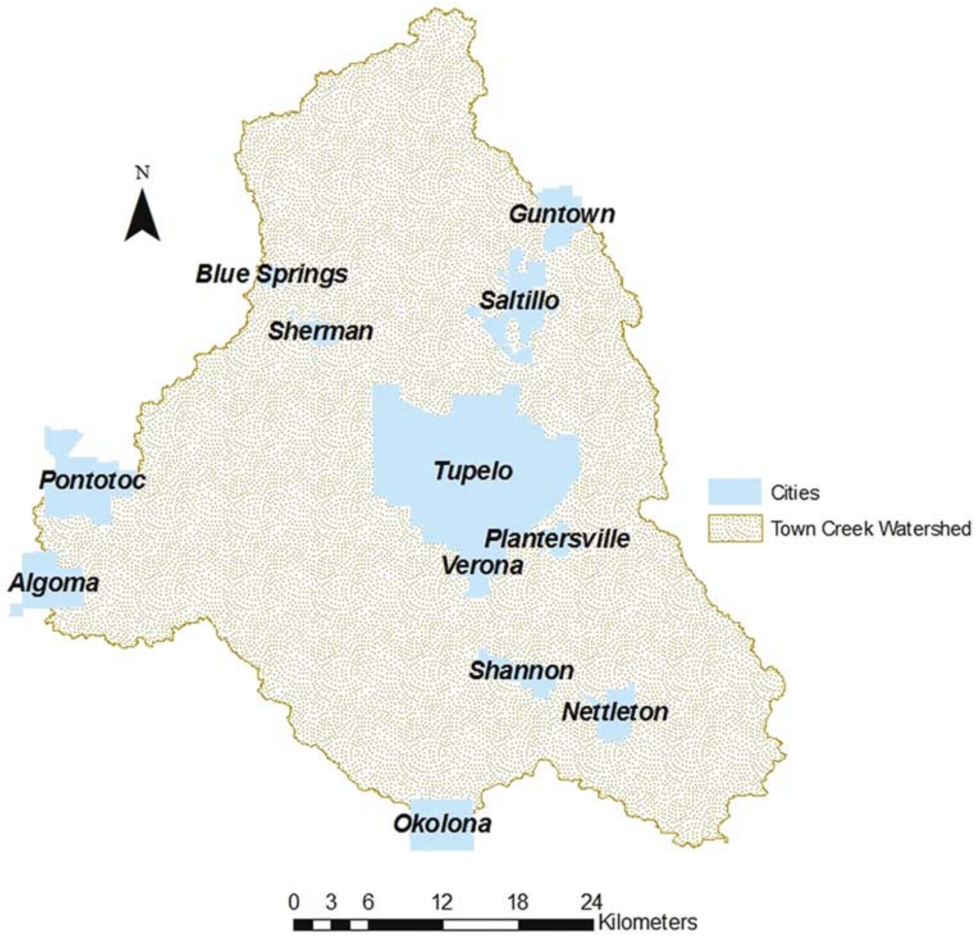

Figure 11. Distribution of local cities around the watershed.

BEEF COWS

The four major counties comprising the TCW are Lee, Monroe, Pontotoc, and Union. Figure 12 shows the long-term average number of beef cows (by head) for each county from 2000 to 2010 (USDA/NASS, 2011).

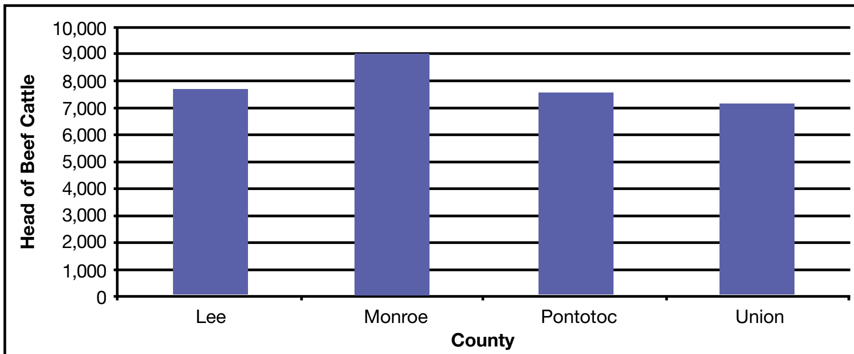

Figure 12. Long-term average (2000–2010) of estimated beef cows by county.

Population by County

Table 7. Estimated populations of the counties.[1]			
County	Population	County	Population
Lee	76,000	Pontotoc	27,000
Monroe	38,000	Union	25,000

[1]Polidata, 2002.

Preliminary Results

This research evaluated spatially and temporally variable hydrologic responses of the TCW using the Soil and Water Assessment Tool (SWAT) model. The SWAT model was calibrated from January 1990 to December 1999 and validated from January 2000 to September 2009 using one USGS gage station's monthly measured stream flow data. The preliminary results of the calibrated and validated SWAT model determined reasonable performance for mean monthly stream flow prediction (Table 8 and Figure 13). The use of field-measured data may improve model efficiency. Crop yield data in addition to soil samples can be used for comparison and accuracy. The preliminary results of the SWAT model demonstrated spatial distribution of the highest crop yields from each subbasin, which helps to identify important subbasins in the watershed.

Table 8. Model efficiency during stream flow calibration and validation period.

Station	Calibration period			Validation period		
	R^2	E	Slope	R^2	E	Slope
Nettleton	0.84	0.78	0.85	0.83	0.38	0.94

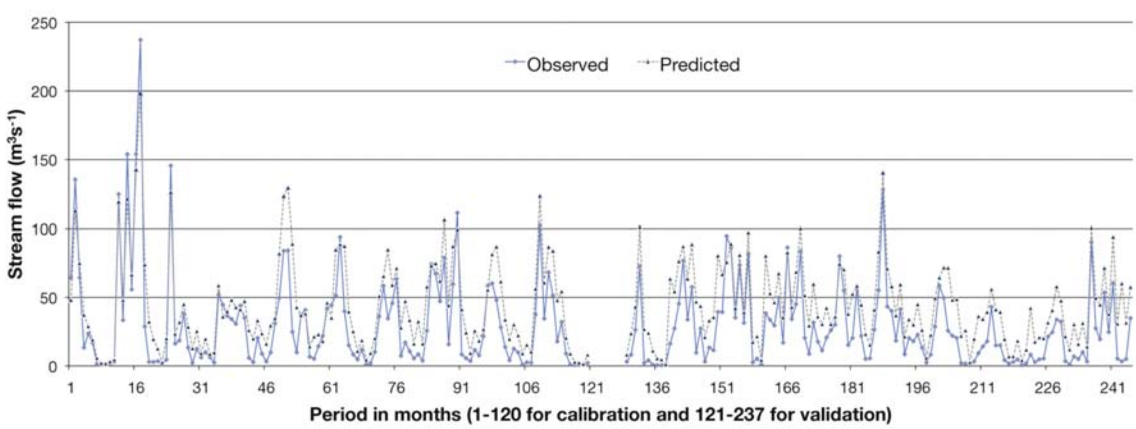

Figure 13. Measured versus model-predicted average monthly stream flow during model calibration and validation periods for the Nettleton gage station in the watershed.

Discussion

Based on SWAT simulation results, the water yields from the watershed subbasins were spatially and temporally variable, which was dependent on the topography, land-use conditions, and weather conditions of the watershed. This study helps watershed managers to prioritize areas in the watershed and also identify areas where possible nonpoint-source pollution due to agricultural practices could be the highest.

Acknowledgments

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