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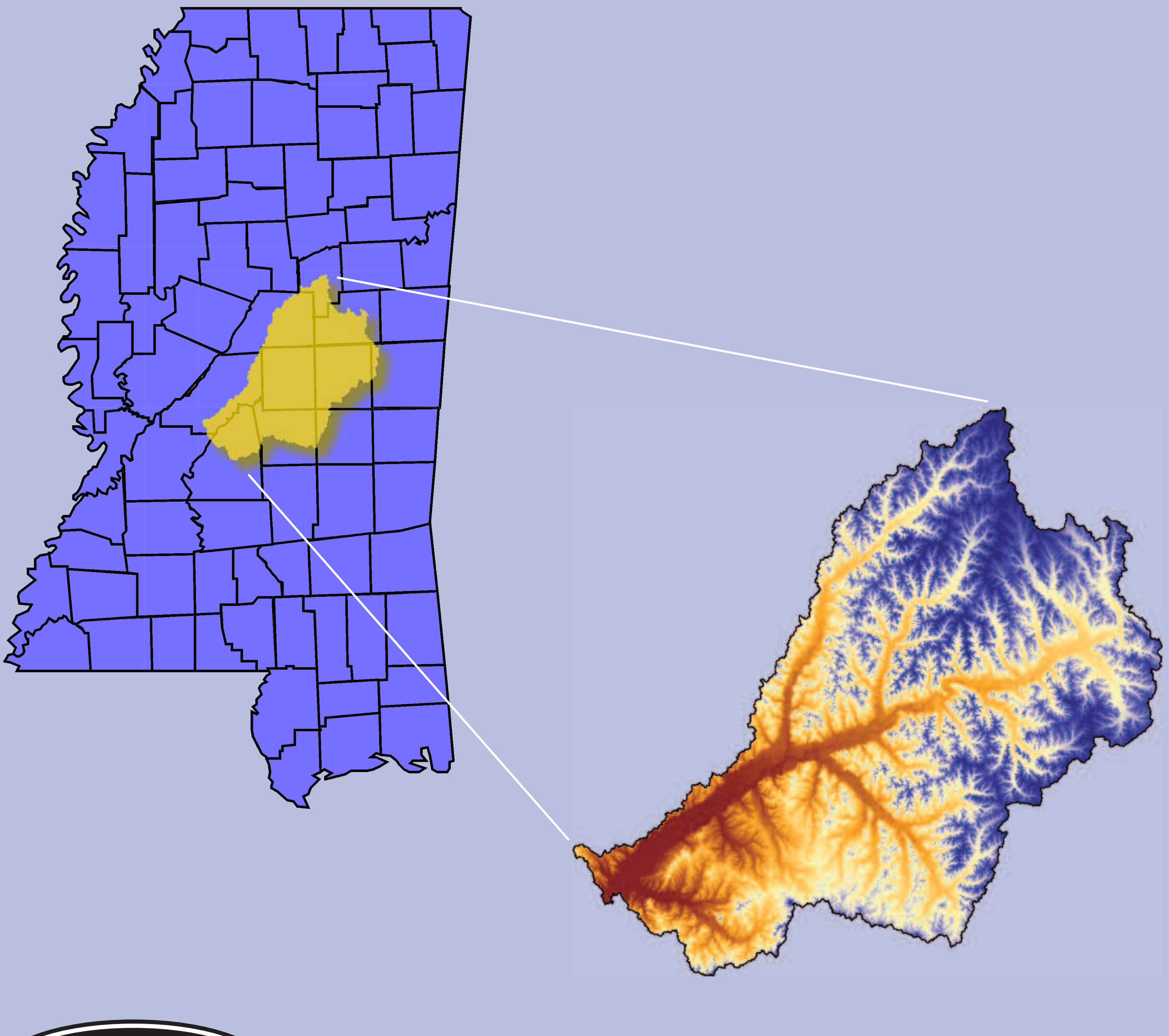
UPPER PEARL RIVER WATERSHED ASSESSMENT:
Preliminary Report



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Upper Pearl River Watershed Assessment: Preliminary Report

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Contents

Upper Pearl River Watershed Assessment: Preliminary Report

Description

The 7,588-square-kilometer Upper Pearl River Watershed (UPRW) flows into the Ross-Barnett Reservoir (RBR), which is one of the Mississippi's largest areas of surface drinking water storage and serves as the primary water source for about 200,000 people in Jackson and surrounding areas (Figure 1) (Parajuli et al., 2010). The headwaters of the Pearl River begin in the area of the Nanih Waiya Indian mounds in Winston County, Mississippi, and the Pearl River basin is the third largest drainage basin in Mississippi. The Pearl River transports more than 2 trillion gallons of water every year (PRBDD, 2010). The RBR and the UPRW are essential to the caliber of Mississippi's economy (Tagert, 2006). The UPRW's human population is 111,050 compared with 129,500 cattle (USCB, 2000; USDA/NASS, 2010). This fact may be linked to one of the most imminent threats to water quality; fecal coliforms and nutrients produced by the cattle can be major sources of contamination to the Pearl River if managed inadequately. Another major threat to the Pearl River's water quality can be diverse land-based urban development and agricultural activity. These actions can cause erosion that would result in sedimentation and nutrient loading to the RBR (Parajuli et al., 2010).

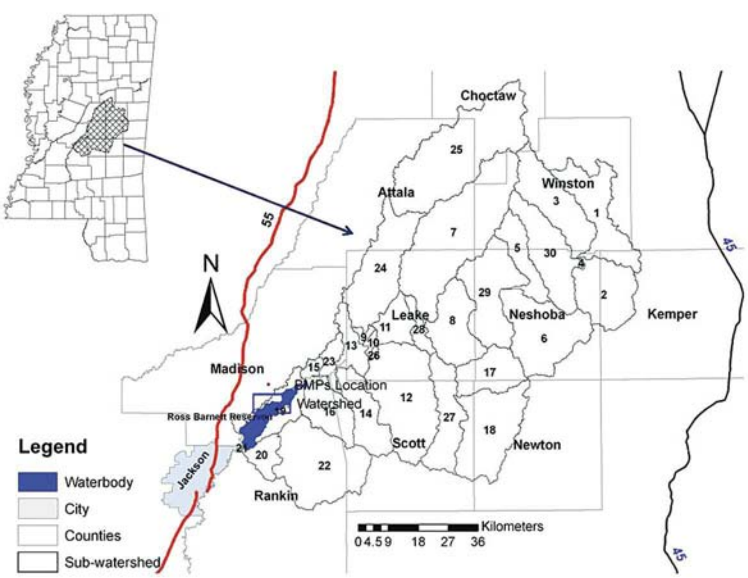

Figure 1. Location map of the Upper Pear River Watershed in Mississippi.

Overview of Water Quality Issues

When excess rainfall flows across land, it can carry pollutants into water bodies. The UPRW is threatened by several potential pollutant sources, primarily nonpoint-source pollution (MDEQ, 2009). The nonpoint-source pollutant sources are 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, failing septic systems, and wildlife. The top three sources of pollution for water bodies in Mississippi are sedimentation, biological impairments, and fecal coliform (Table 1). Nutrients are a major source of nonpoint-source pollution in water bodies, and phosphorus is a particularly harmful nutrient because it can cause eutrophication. Table 1 lists the water bodies, especially tributaries of the Pearl River within the UPRW, and the main water-quality concerns of each water body (MDEQ, 2009).

Table 1. Pollutants of concern in the various tributaries of the Pearl River within the watershed.[1]

Water body name	Pollutants of concern
Bogue Chitto Creek	Organic Enrichment/Low DO, Nutrients, and Pesticides
Coffee Bogue Creek	Organic Enrichment/Low DO, Nutrients, and Pathogens
Conehoma Creek and Yockanookany River	PCBs
Fannegusha Creek	Pathogens
Fannegusha Creek Watershed	Biological Impairment Due to Sediment
Hughes Creek	Organic Enrichment/Low DO, Nutrients, and Ammonia Toxicity
Nanih Waiyah Creek	Organic Enrichment/Low DO, Nutrients, and Pesticides
Noxapater Creek	Organic Enrichment/Low DO, Nutrients, and Pesticides
Shockaloo Creek	Pathogens
Tibby Creek	Pathogens
Tuscolameta, Tallabogue, and Shockaloo Creeks	Organic Enrichment/Low DO and Nutrients

[1]DO = dissolved oxygen; PCBs = Polychlorinated biphenyls.

Land Use

Because land-use practices can affect water quality, land cover classification is an important factor regarding overall water quality in the watershed. Different types of land usage can have varying effects on the water quality, such as sediment, nutrient, and pesticide retention. In 1965, the Water Quality Act was passed, which was the country's first law regarding water-quality standards. Since then, regulations have been more thoroughly enforced, and new regulations have also been implemented to improve water quality. In 1972, the Clean Water Act (CWA) was passed to further improve water-quality standards (USEPA, 2007). It is necessary to monitor land usage because the CWA requires that the state determine both point and nonpoint pollutant loads that may enter a water body and still allow that water body to comply with minimum water-quality standards. This pollution concentration is called the Total Maximum Daily Load (TMDL). Nonpoint-source pollutants are difficult to manage, but it is still very important to monitor the ways in which the land is being used (Tagert, 2006). Forest is the dominant land usage for the UPRW at 72%. Pasture/hay is the second largest at 20%. Urban areas (6%) and other uses (2%) constitute the remaining land cover (Parajuli et al., 2010).

Land Uses and Soil Types

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	30	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS144, MS154	Ora, Sweatman, Rosebloom
2	24	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS144, MS154	Ora, Sweatman, Rosebloom
3	28	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS154, MS069	Ora, Rosebloom, Tippah
4	12	PAST, WETF, UINS, FRSD, FRSE, FRST	MS144, MS154	Sweatman, Rosebloom
5	24	PAST, WETF, UINS, FRSD, FRSE, FRST	MS144, MS154, MS048, MS069	Sweatman, Rosebloom, Smithdale
6	41	PAST, WETF, UINS, FRSD, FRSE, FRST	MS138, MS144, MS154	Bibb, Sweatman, Rosebloom
7	40	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS154, MS155	Mantachie, Williamsville, Smithdale
8	20	PAST, WETF, UINS, FRSD, FRSE, FRST	MS132, MS154, MS155	Smithdale, Rosebloom, Williamsville
9	18	PAST, WETF, UINS, FRSD, FRSE, FRST	MS048, MS059, MS067	Smithdale, Ariel, Providence
10	19	PAST, WETF, UINS, FRSD, FRSE, FRST	MS048, MS059, MS067	Smithdale, Ariel, Providence
11	24	PAST, WETF, UINS, FRSD, FRSE, FRST	MS132, MS048, MS059	Smithdale, Ariel, Providence
12	44	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS132, MS150	Ora, Smithdale, Vaiden
13	29	PAST, WETF, UINS, FRSD, FRSE, FRST	MS048, MS059, MS067	Smithdale, Ariel, Providence
14	28	PAST, WETF, UINS, FRSD, FRSE, FRST	MS136, MS150, MS067	Catalpa, Providence, Kipling
15	27	PAST, WATR, WETF, UINS, FRSD, FRSE, FRST	MS067, MS079, MS080	Providence, Columbus, Cascilla
16	16	SOYB, PAST, WETF, CORN, UINS, FRSD, FRSE, FRST	MS089, MS087, MS080	Kipling, Urbo, Cascilla
17	18	PAST, WETF, UINS, FRSD, FRSE, FRST	MS132, MS138, MS048	Smithdale, Bibb
18	40	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS132, MS138	Ora, Smithdale, Rosebloom
19	33	PAST, WATR, WETF, UINS, FRSD, FRSE, FRST	MS082, MS089, MS080	Providence, Columbus, Byram
20	28	PAST, WATR, WETF, UINS, FRSD, FRSE, FRST, URLD, URML	MS042, MS089, MS079	Smithdale, Kipling, Columbus
21	1	WETF	MS080	Cascilla
22	35	PAST, WETF, UINS, FRSD, FRSE, FRST	MS042, MS087, MS089	Smithdale, Urbo, Kipling
23	24	PAST, WETF, UINS, FRSD, FRSE, FRST	MS067, MS079, MS080	Providence, Columbus, Cascilla
24	24	PAST, WETF, UINS, FRSD, FRSE, FRST	MS042, MS048, MS059	Smithdale, Ariel, Providence

[1]HRU: Hydrologic Response Unit.

Table 2 (continued). 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**
25	36	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS042, MS048	Smithdale, Kirkville, Ora
26	22	PAST, WETF, UINS, FRSD, FRSE, FRST	MS132, MS059, MS067	Smithdale, Ariel, Providence
27	30	PAST, WETF, UINS, FRSD, FRSE, FRST	MS131, MS132, MS150	Ora, Smithdale, Vaiden
28	18	PAST, WETF, UINS, FRSD, FRSE, FRST	MS132, MS048, MS059	Smithdale, Ariel
29	51	PAST, WETF, UINS, FRSD, FRSE, FRST	MS132, MS138, MS144	Kirkville, Smithdale, Bibb
30	31	PAST, WETF, UINS, FRSD, FRSE, FRST	MS144, MS141, MS048	Bibb, Sweatman, Rosebloom

[1]HRU: Hydrologic Response Unit.

Land Uses and Soil Types Key:

PAST = Pasture
WETF = Wetlands-Forested
UINS = Urban-Institutional
FRSD = Forest-Deciduous
FRSE = Forest-Evergreen
FRST = Forest-Mixed
URLD = Urban Low Density
URML = Urban Medium Density
WATR = Water
CORN = Corn
SOYB = Soybean
AGRR = Agricultural Land-Row Crops
WETL = Wetlands-Mixed
URHD = Urban High Density
SHRB = Forest Shrub
GRSG = Grain Sorghum
WWHT = Winter Wheat
OATS = Oats
RICE = Rice
PMIL = Pearl Millet
BROM = Meadow Brome Grass
SOYB = Soybean
PNUT = Peanut
COTS = Upland Cotton-Harvested With
POTA = Potato
SUNF = Sunflower
WMEL = Watermelon

Land Uses Map

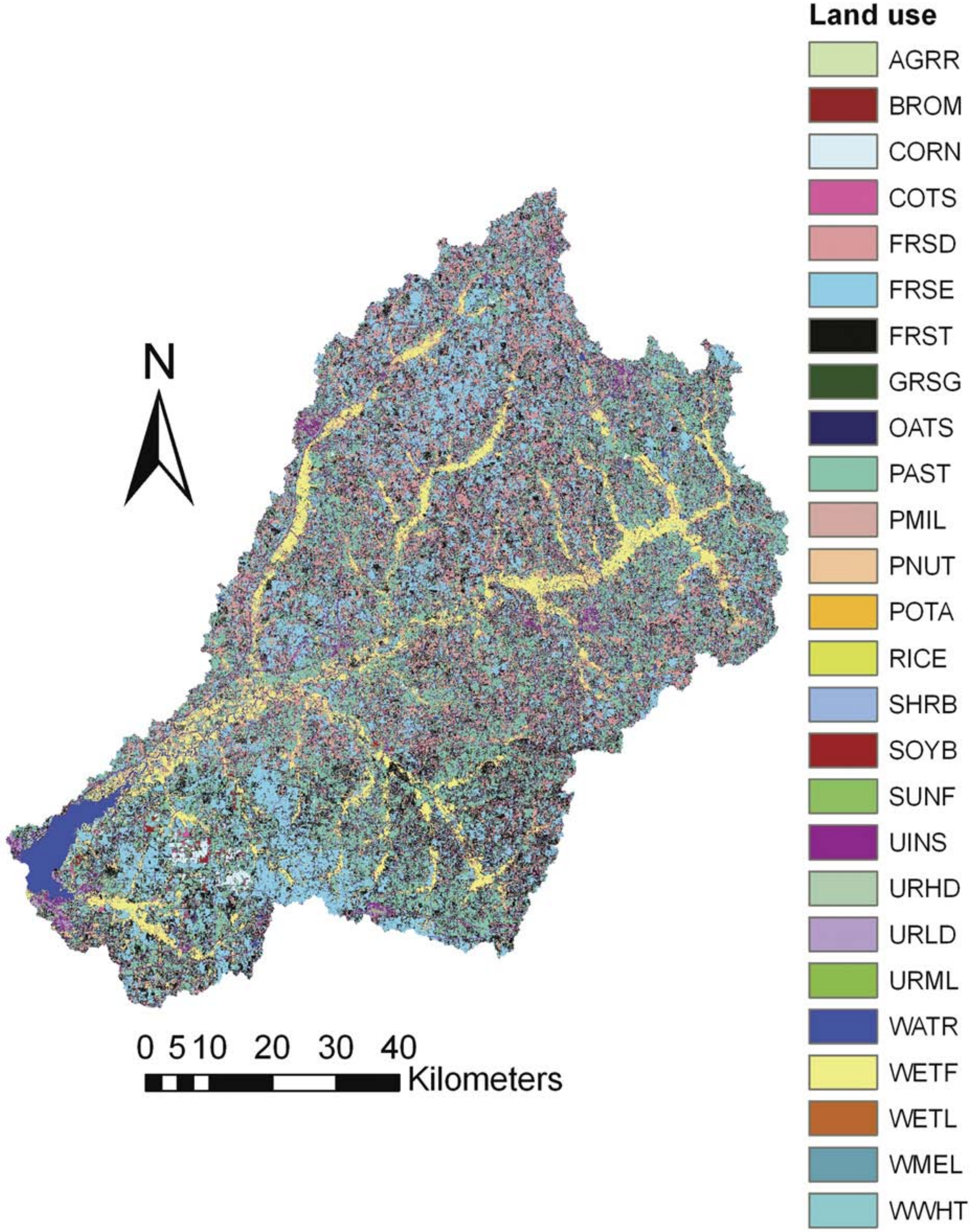

Figure 2. Distribution of land uses within the watershed.

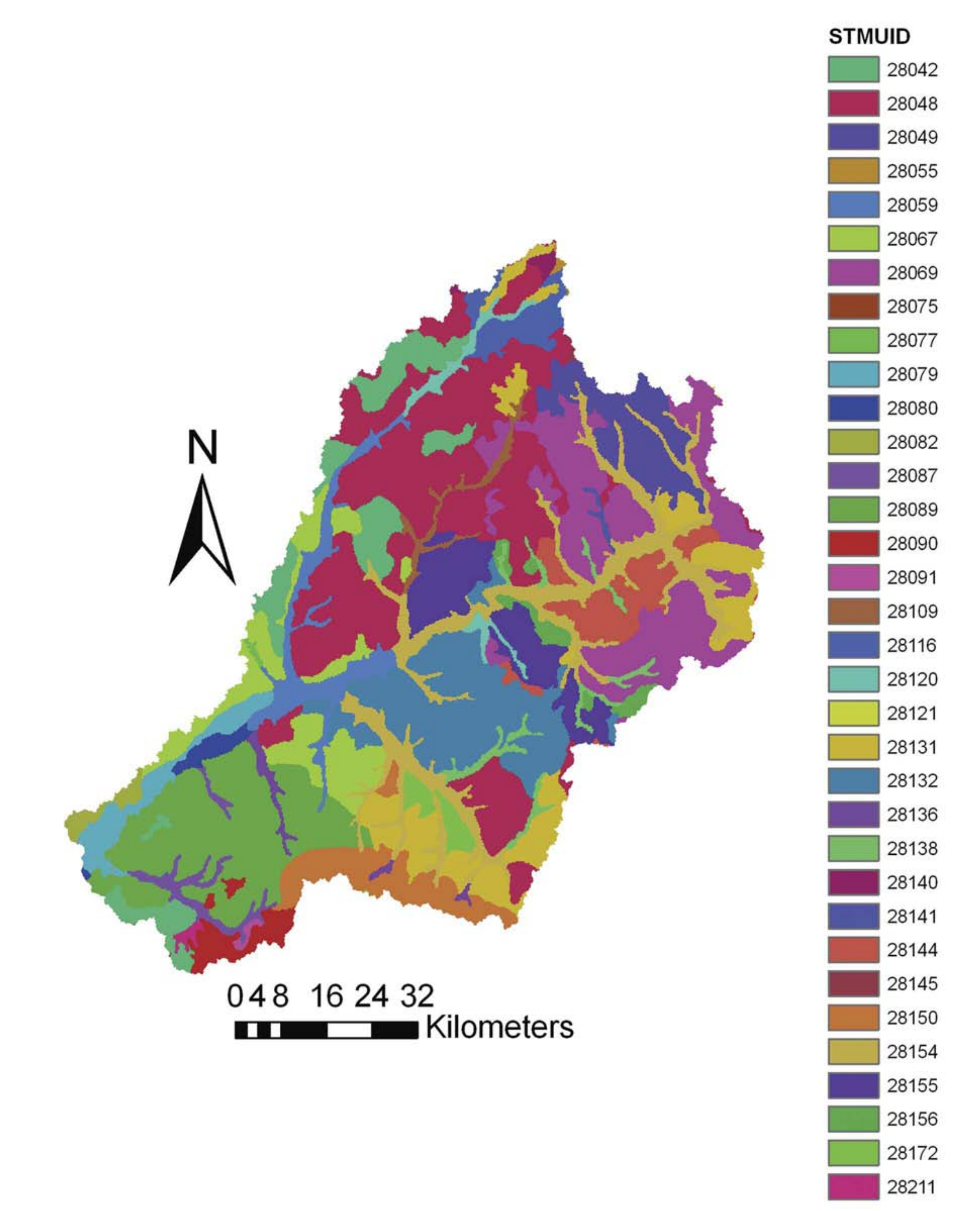

Figure 3. Distribution of state soil map unit ID (STMUID) within the watershed.

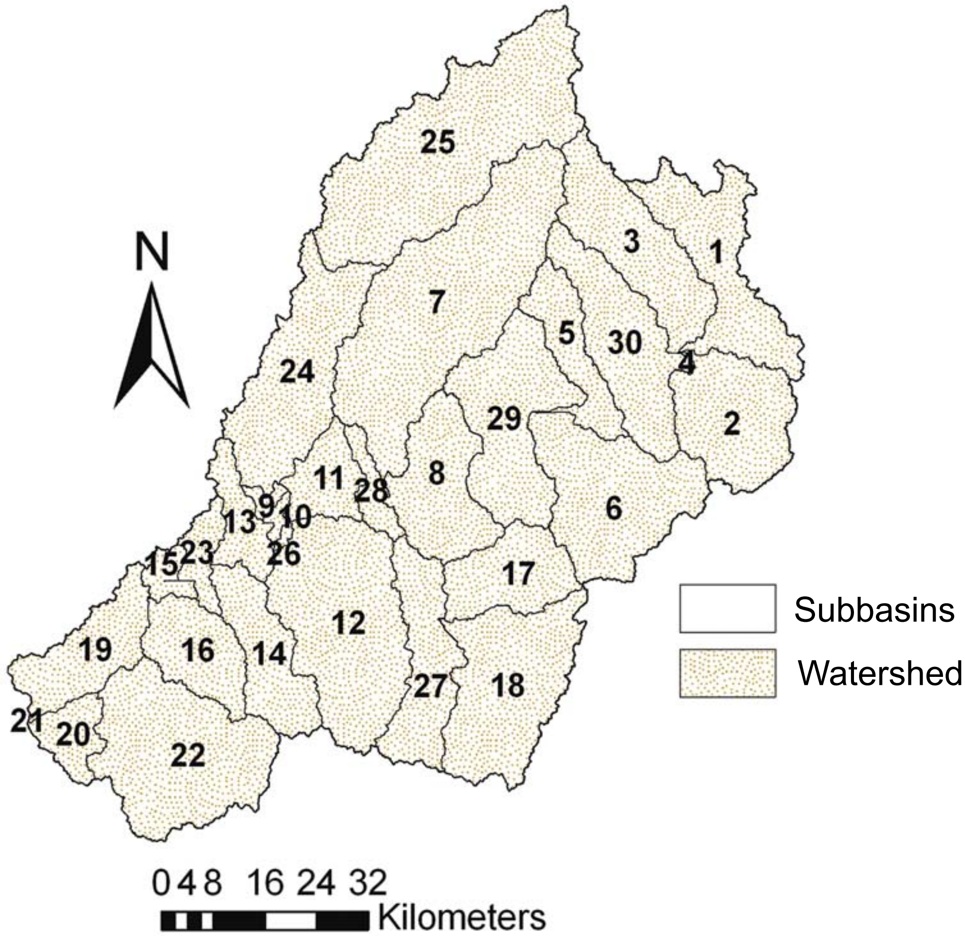

Figure 4. Map of the watershed subbasins (30) used during preliminary study.

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	34484	136	16	19800	94
2	31999	130	17	21656	127
3	33796	157	18	44048	138
4	434	125	19	22853	88
5	16944	128	20	9699	119
6	44000	130	21	1	80
7	82106	145	22	52713	113
8	28315	133	23	7180	93
9	1825	99	24	43250	110
10	1536	97	25	78427	140
11	12841	112	26	762	103
12	56718	118	27	26157	139
13	11605	101	28	6244	103
14	22372	108	29	38658	142
15	4596	91	30	33465	149

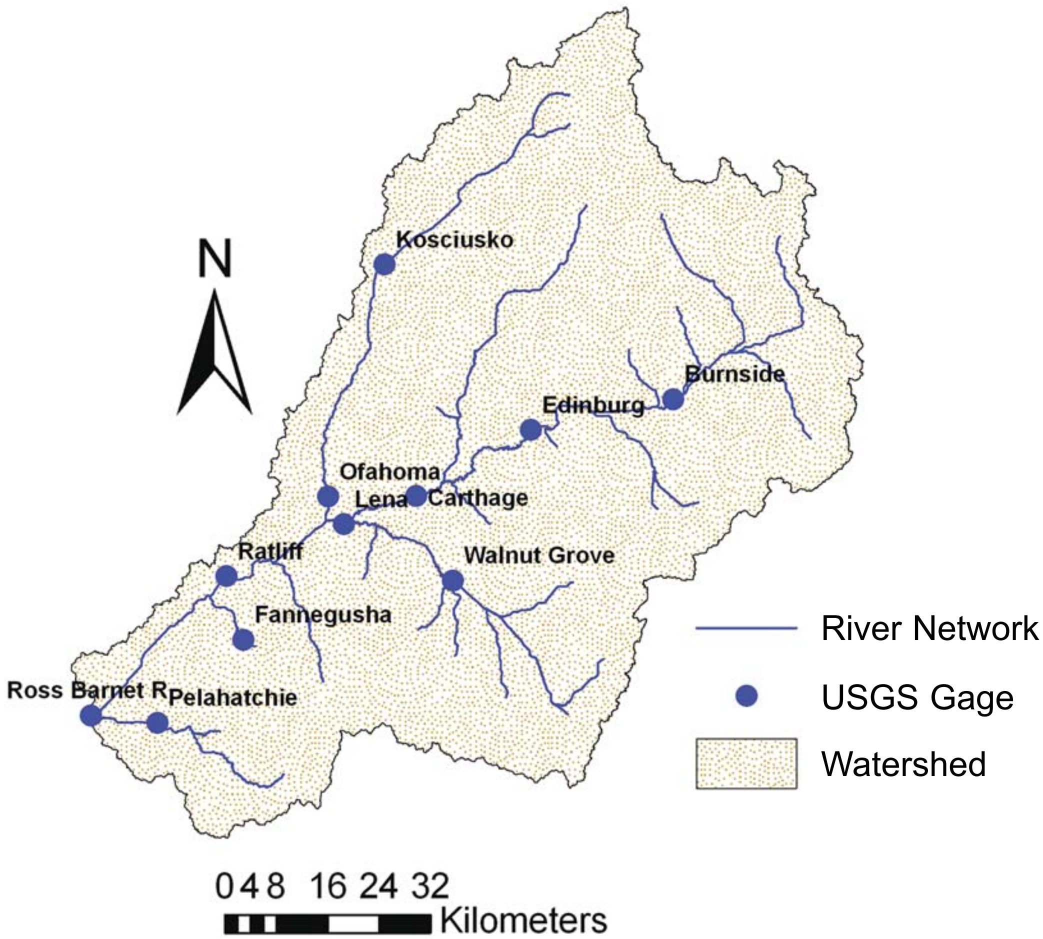

Figure 5. Distribution of the USGS gage stations within the watershed.

USGS Gage Station Locations

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

Name	Latitude	Longitude	Name	Latitude	Longitude
Burnside	32.841°	-89.098°	Walnut Grove	32.588°	-89.465°
Edinburg	32.799°	-89.335°	Ross Barnett Reservoir	32.398°	-90.065°
Carthage	32.707°	-89.526°	Fannegusha	32.505°	-89.813°
Lena	32.667°	-89.646°	Pelahatchie	32.388°	-89.955°
Ofahoma	32.706°	-89.672°	Ratliff	32.594°	-89.841°
Kosciusko	33.032°	-89.578°			

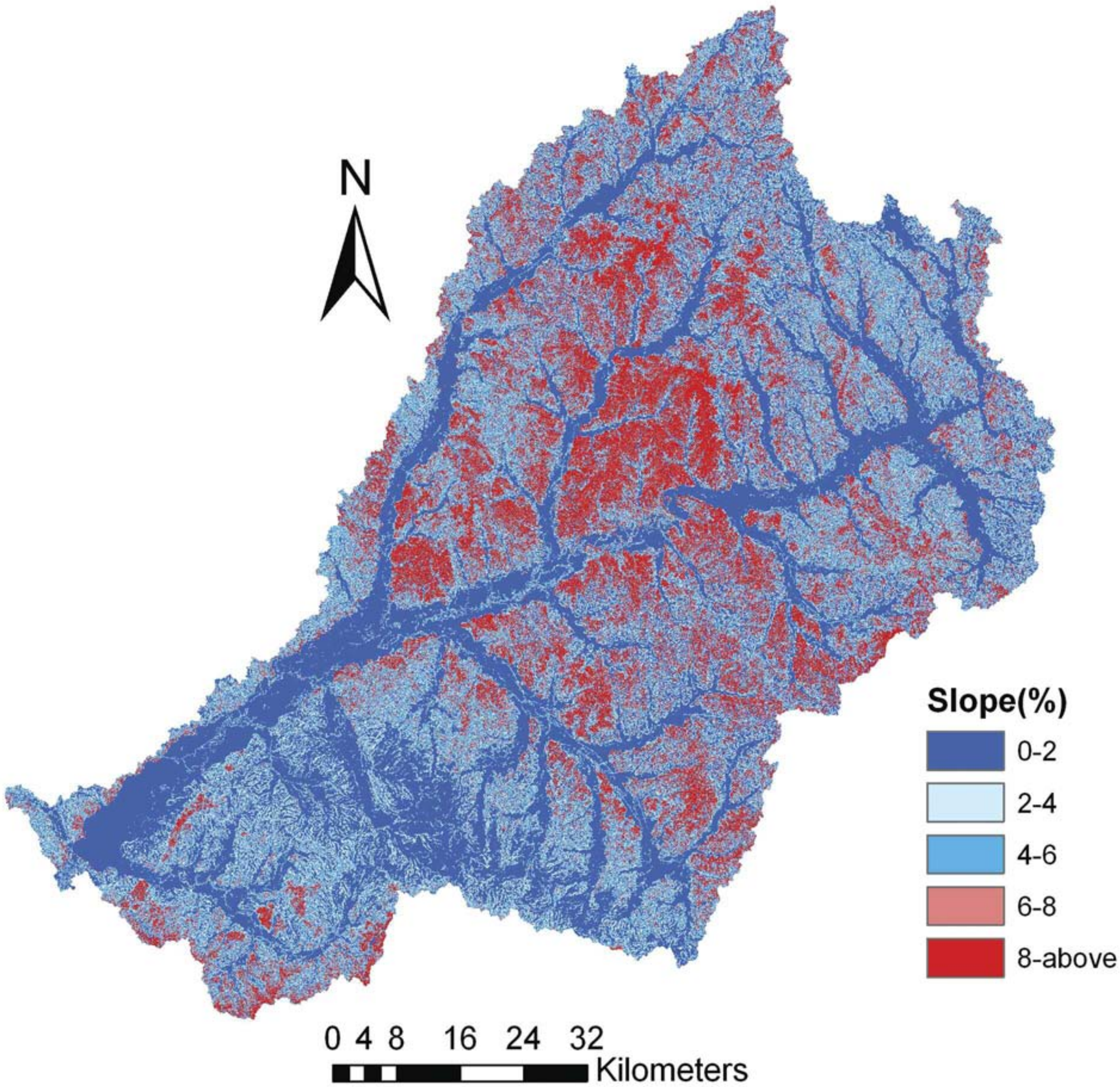

Figure 6. Distribution of landscape slopes in the watershed as classified using model.

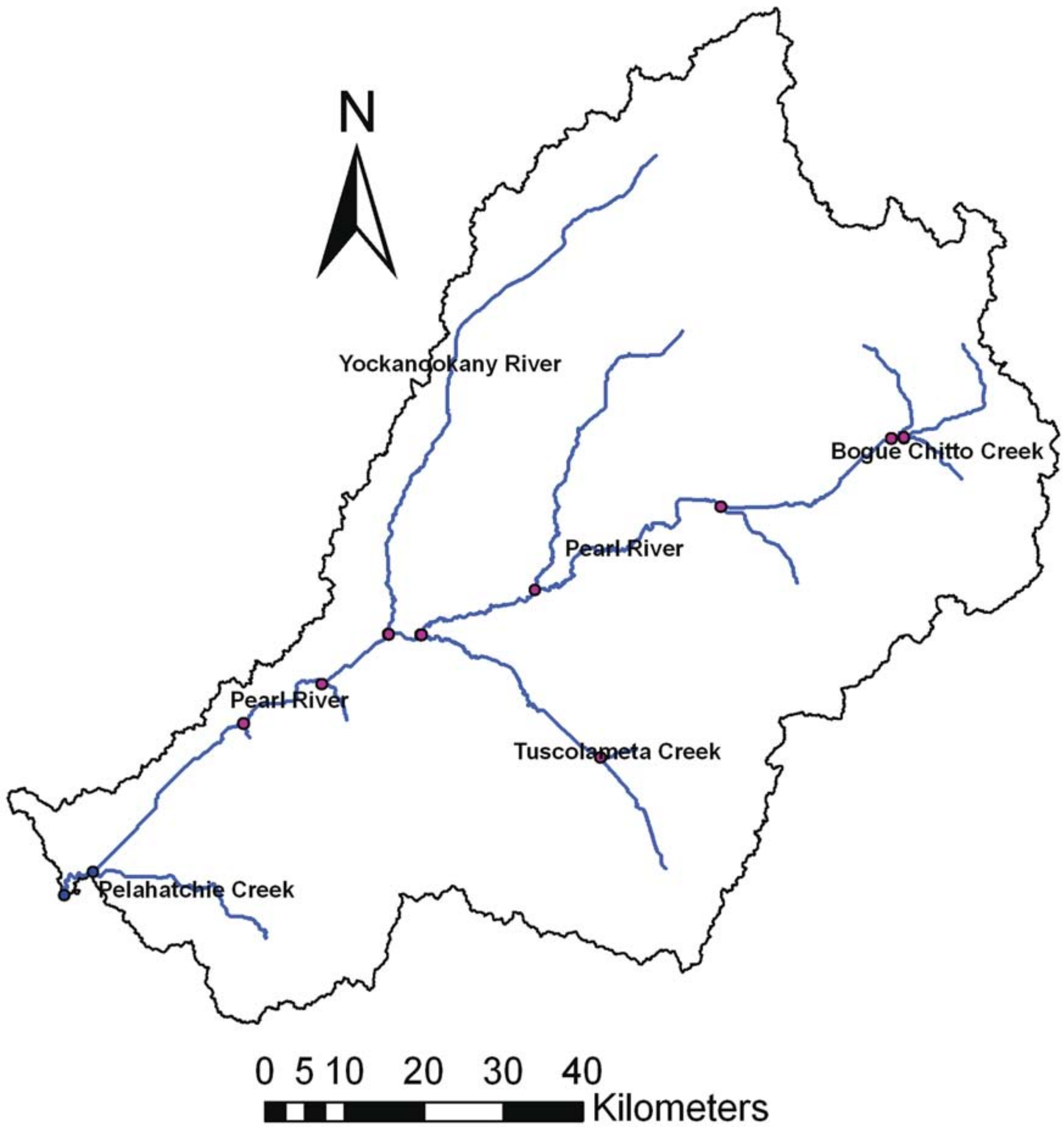

Figure 7. Major rivers network within the watershed as delineated by the model.

Rain Gage

Rain Gage Stations

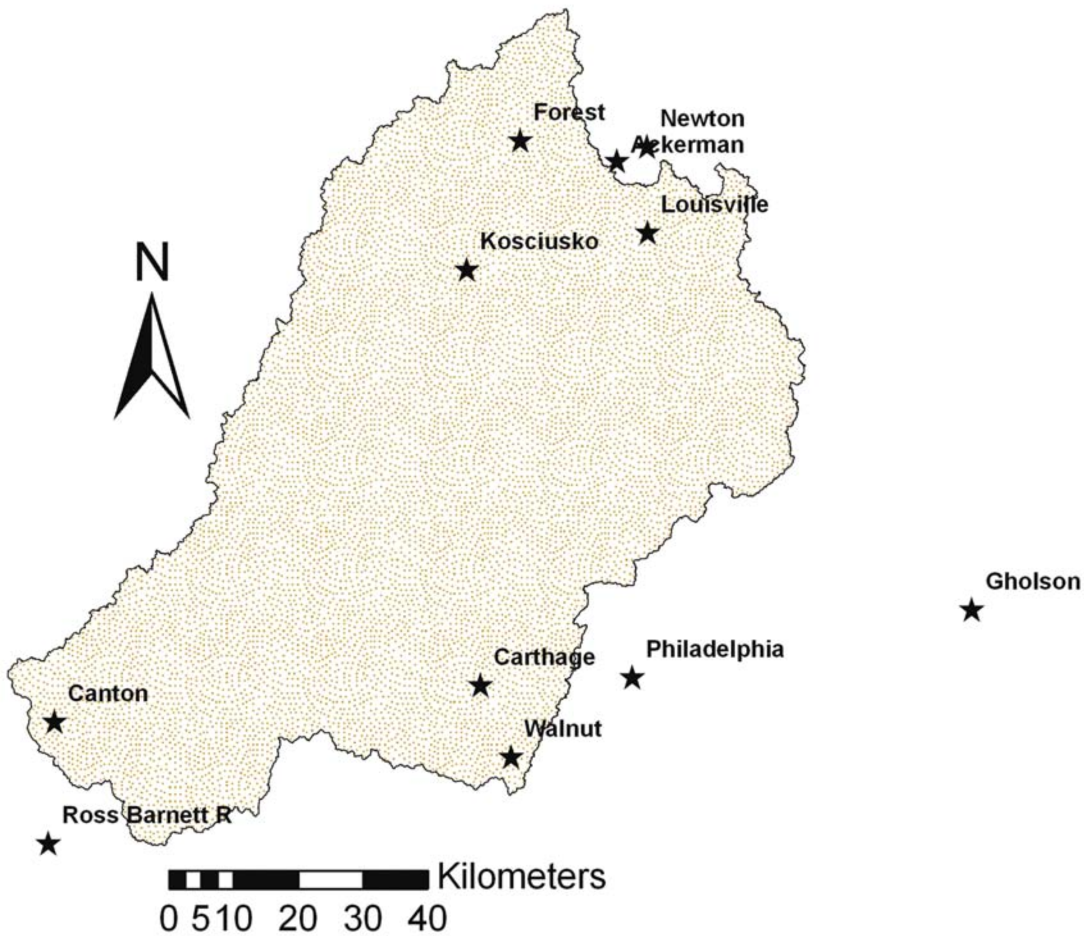

Figure 8. Distribution of the 11 rain gages used in the preliminary study of the watershed.

Rain Gages by Subbasins

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

Subbasin	Station	Subbasin	Station	Subbasin	Station
1	Louisville	11	Kosciusko	21	Canton
2	Louisville	12	Carthage	22	Canton
3	Louisville	13	Canton	23	Canton
4	Louisville	14	Carthage	24	Kosciusko
5	Kosciusko	15	Canton	25	Forest
6	Philadelphia	16	Canton	26	Carthage
7	Kosciusko	17	Carthage	27	Carthage
8	Carthage	18	Carthage	28	Carthage
9	Carthage	19	Canton	29	Kosciusko
10	Carthage	20	Canton	30	Louisville

Rain Gage Locations

Table 6. Coordinates and elevations of the rain gage locations used by the model.			
Name	**Elevation (m)**	**Latitude**	**Longitude**
Ackerman	560	33.18°	-89.09°
Canton	250	32.40°	-90.02°
Carthage	370	32.45°	-89.32°
Forest	450	33.21°	-89.25°
Gholson	500	32.55°	-88.51°
Kosciusko	410	33.03°	-89.34°
Louisville	581	33.08°	-89.04°
Newton	349	33.20°	-89.04°
Philadelphia	413	32.46°	-89.07°
Ross Barnett Reservoir	310	32.23°	-90.03°
Walnut	318	32.35°	-89.27°

HYDROLOGIC SOIL GROUP

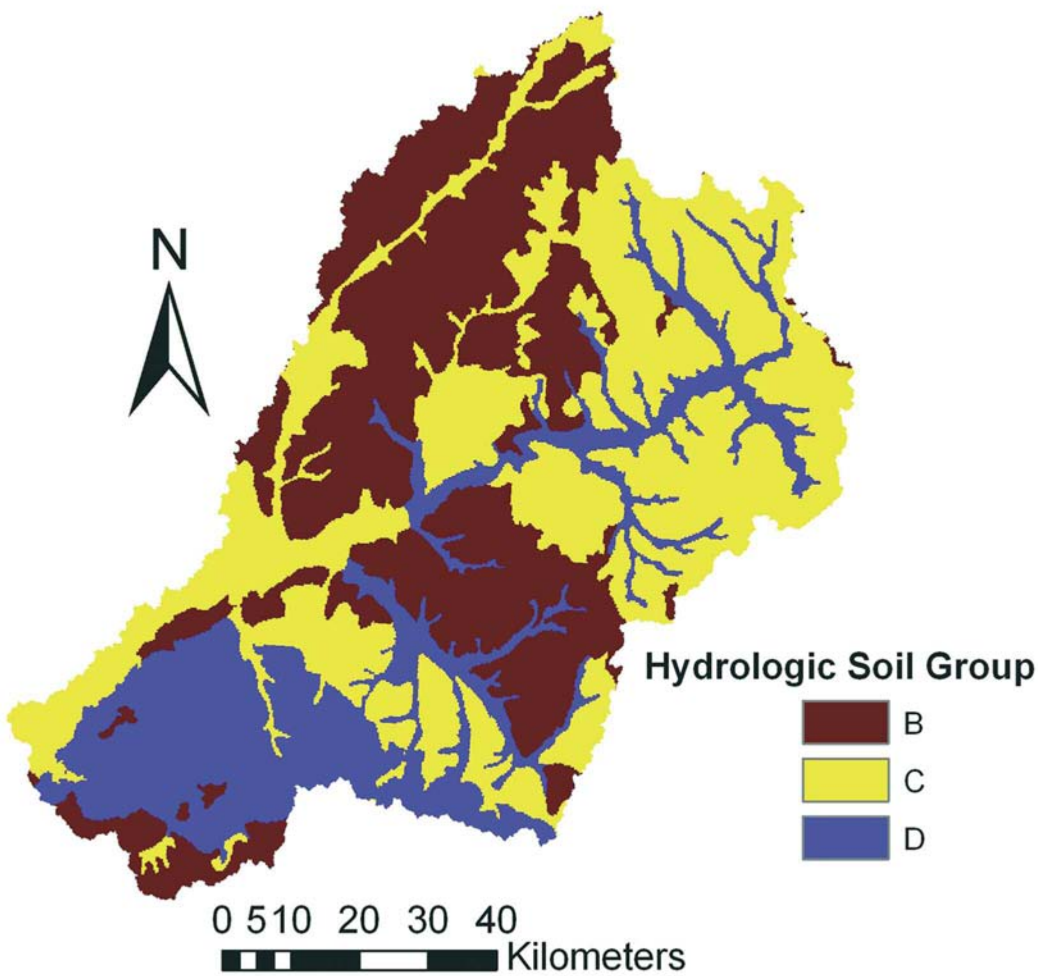

Figure 9. Distribution of hydrologic soil groups within the watershed used by the model. Note: Group B = moderately low runoff potential when very wet; Group C = moderately high runoff potential when very wet; and Group D = high runoff potential when very wet.

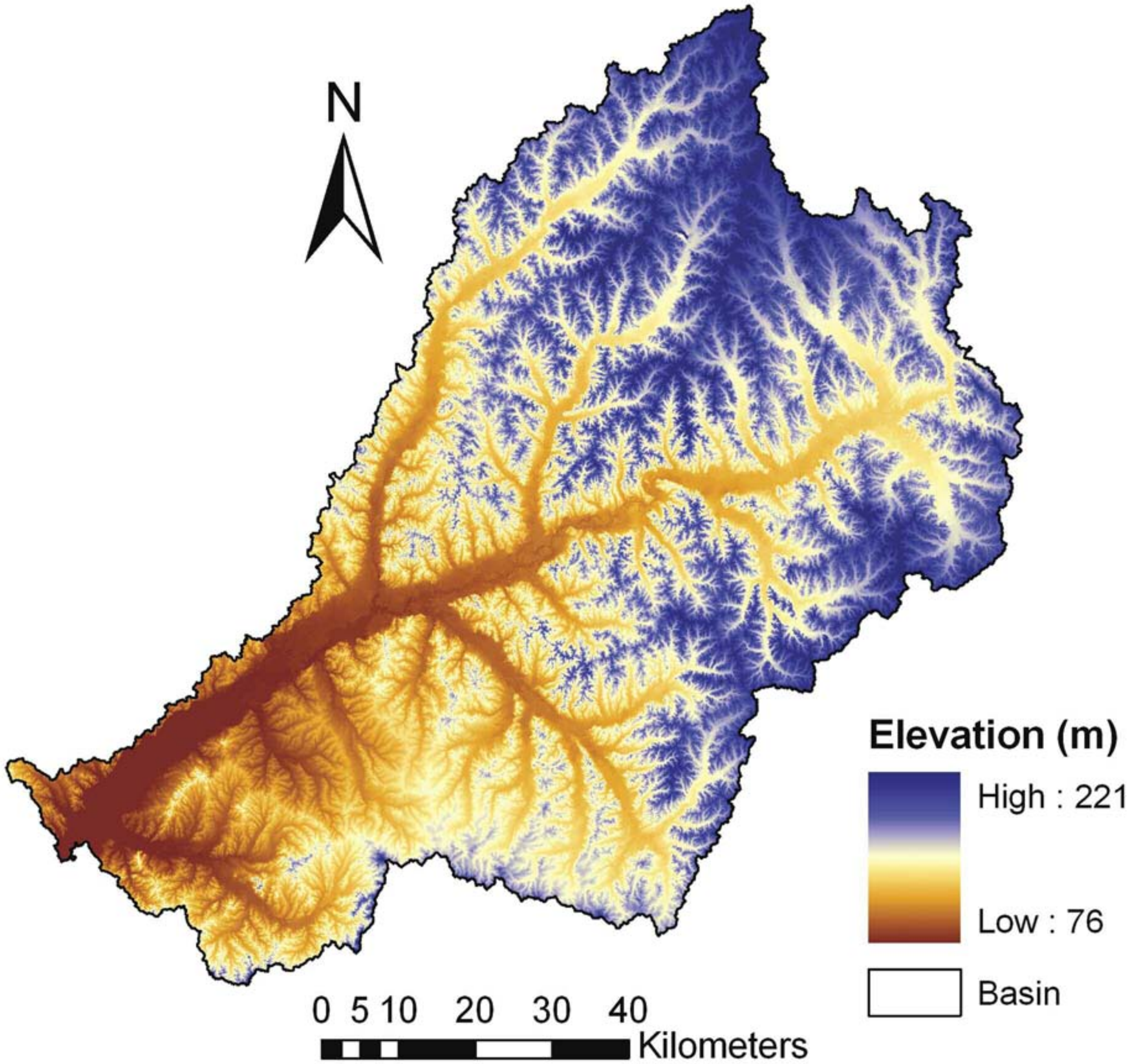

Figure 10. Distribution of elevation ranges within the watershed as determined by the model.

CITIES

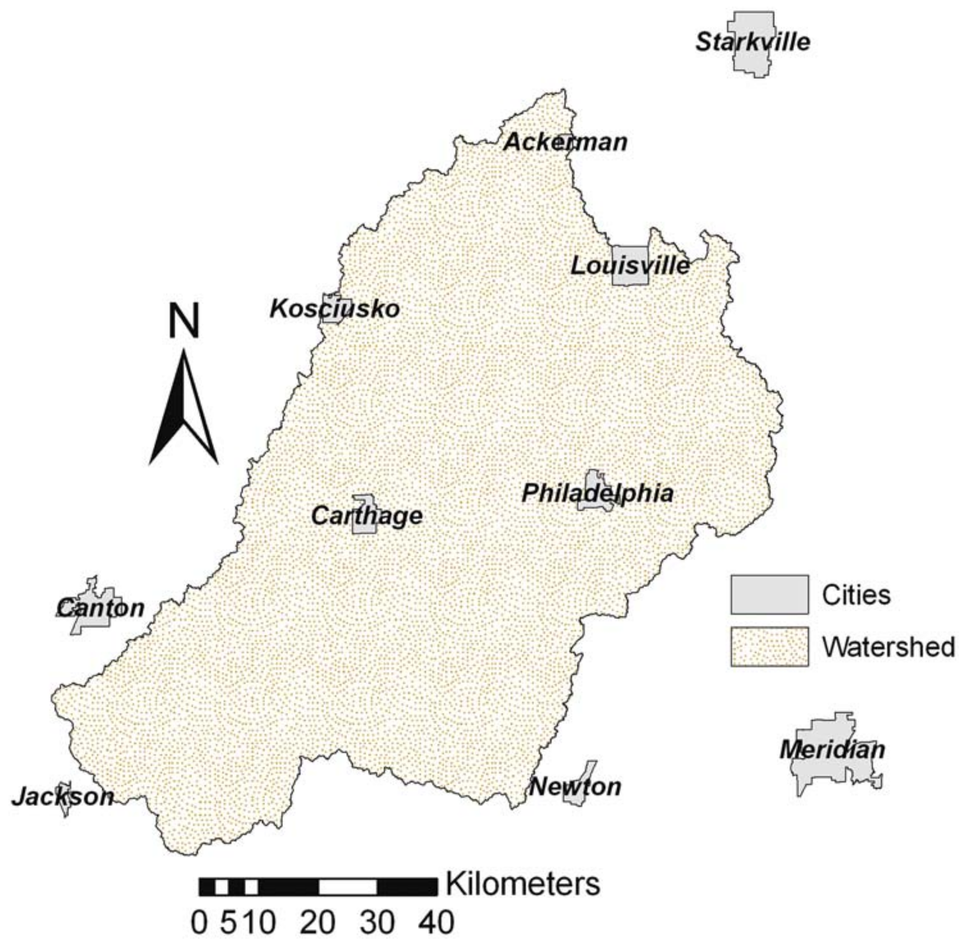

Figure 11. Distribution of local cities around the watershed.

BEEF COWS

There are 10 counties within the UPRW: Attala, Choctaw, Kemper, Leake, Madison, Neshoba, Newton, Rankin, Scott, and Winston. Each county has its own unique beef-cow population. Table 7 shows the beef-cow population of each county from 2000 to 2009 (USDA/NASS, 2010).

Table 7. Long-term annual average (2000-09) beef cow populations of the counties.

County	Beef cows	County	Beef cows
Attala	6,960	Scott	10,360
Choctaw	2,580	Kemper	7,870
Rankin	10,250	Newton	21,180
Winston	7,000	Leake	19,700
Madison	9,110	Neshoba	10,390

Population by County

Table 8. Estimated populations of the counties.[1]			
County	**Population**	**County**	**Population**
Attala	20,000	Leake	21,000
Choctaw	10,000	Madison	75,000
Kemper	10,000	Neshoba	29,000
Winston	20,000	Newton	22,000
Rankin	115,000	Scott	28,000

[1]Polidata, 2002.

Preliminary Results

This research evaluated spatially and temporally variable phosphorus loading to the Ross Barnet Reservoir in east-central Mississippi using a modeling approach. Modeling methods were developed to model livestock, poultry, and human sources of nutrients from the UPRW. The Soil and Water Assessment Tool (SWAT) model was applied to evaluate average monthly flow, sediment, total nitrogen (N), and total phosphorus (P) loading to the Ross Barnett Reservoir inlet. The SWAT model was calibrated from January 1981 to December 1994 and validated from January 1995 to September 2008 using five USGS gauge 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 (Table 9). No measured sediment and nutrient data were available to calibrate and validate the model. The use of field-measured data may improve model efficiency. Although calibration and validation of sediment and nutrient data may improve model efficiency, it does not limit the use of the model to assess relative impact of sediment and nutrient loading from the watershed subbasins (Hernandez et. al., 2000). The preliminary results of the SWAT model demonstrated spatial distribution of the pollutant loadings from each subbasin (Table 10), which helps to identify pollutant-specific critical subbasins in the watershed (Figure 3).

Table 9. Model efficiency during stream flow calibration and validation period.

Station	Calibration period			Validation period		
	R^2	E	Slope	R^2	E	Slope
Burnside	0.79	0.73	0.95	0.64	0.64	0.77
Ofahoma	0.72	0.68	0.77	0.60	0.17	0.86
Edinburg	0.76	0.75	0.81	0.68	0.65	0.70
Lena	0.69	0.69	0.82	0.80	0.86	0.82
Carthage	0.78	0.79	0.78	0.74	0.55	0.81

Table 10. Ranking of subbasins based on annual (2003-2010) water yield, sediment yield, total phosphorus (TP), and total nitrogen (TN) yields within the Upper Pearl River watershed.

Rank	Water yield		Sediment yield		Total nitrogen		Total phosphorus	
	Subbasin	WY	Subbasin	SY	Subbasin	TN	Subbasin	TP
		mm		*Mg/ha*		*kg/ha*		*kg/ha*
1	7	877	20	1.71	17	10.22	11	1.39
2	25	849	11	0.85	2	8.51	2	1.36
3	29	843	24	0.63	12	8.37	16	1.31
4	11	808	6	0.62	27	7.73	12	1.29
5	24	808	16	0.56	6	7.25	17	1.27
6	5	804	5	0.55	16	6.91	27	1.25
7	2	777	30	0.53	29	6.83	29	1.24
8	1	753	29	0.52	18	6.68	6	1.12
9	30	751	7	0.52	14	5.84	18	1.05
10	3	744	3	0.49	22	5.07	20	1.02
11	22	692	1	0.48	20	5.03	1	1.00
12	6	688	2	0.45	11	4.64	14	0.91
13	16	680	25	0.43	1	4.42	22	0.90
14	17	668	8	0.34	15	4.10	30	0.84
15	20	661	22	0.34	30	4.00	3	0.84
16	19	658	28	0.32	13	3.86	24	0.83
17	18	654	27	0.31	4	3.85	13	0.81
18	8	647	18	0.31	8	3.84	8	0.78
19	13	645	26	0.31	3	3.63	7	0.70
20	27	627	12	0.30	26	3.62	4	0.68
21	23	624	17	0.29	24	3.59	15	0.68
22	14	622	13	0.27	19	3.03	26	0.64
23	12	620	23	0.23	7	2.99	25	0.63
24	28	620	9	0.23	25	2.95	19	0.60
25	15	600	14	0.21	9	2.65	5	0.59
26	9	533	15	0.19	10	2.56	28	0.57
27	26	525	4	0.18	5	2.48	9	0.55
28	4	509	19	0.18	28	2.41	10	0.51
29	10	476	10	0.17	23	2.24	23	0.49
30	21	206	21	0.00	21	0.69	21	0.02

Discussion

Based on SWAT simulation results, the water yield, sediment yield, total nitrogen yield, and total phosphorus yield from the watershed subbasins were spatially and temporally variable. Pollutant load generation was dependent on the source, topography, land-use conditions, and weather condition of the watershed. This study helps watershed managers to prioritize their best management practice implementation efforts to focus on the most impaired watershed subbasins.

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