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Little River Experimental Watershed, Tifton, Georgia, United States: A geographic database

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[1] The Little River Experimental Watershed is located in the headwaters of the Upper Suwannee River basin and is one of twelve national benchmark watersheds participating in the U.S. Department of Agriculture Conservation Effects Assessment Project–Watershed Assessment Studies. A geographic database has been established to include topography, land use, hydrology, soil distribution, watershed boundaries, and site locations for all weirs, rain gauges, soil moisture sites, and climate stations. These data provide the foundation for integrating point-based measurements with landscape attributes. Each spatial layer can be accessed individually for use within a geographic information system. The watershed boundary layer will serve as the base map, projected into universal transverse Mercator coordinates (zone 17), using NAD83 as the datum and GRS80 as the ellipsoid. Data may be accessed via ftp://www.tiftonars.org/.

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1. Introduction

[2] The U.S. Department of Agriculture (USDA) Agricultural Research Service Southeast Watershed Research Laboratory (SEWRL) has collected hydrologic and climatic data on the 334 km^2 Little River Experimental Watershed (LREW) near Tifton, GA (approximately centered at N31.61°, W83.66°). The watershed is typical of the heavily vegetated, slow-moving stream systems in the Coastal Plain region of the United States.

[3] Several geographic information system (GIS) coverages of the watershed have been assembled and provide a framework for evaluating watershed-scale processes using long-term water quality/quantity, climate, and landscape attributes. Raster data (continuous data) include: topography and land use. Vector data include: watershed boundaries, precipitation stations, climate stations, stream gauges, topographic contours, soils and hydrology. This manuscript provides details on the GIS database, components of a more comprehensive LREW database.

2. Watershed Boundaries and Data Collection Sites

[4] The LREW is located in the headwaters of the Suwannee River Basin, Georgia. The watershed is approximately 334 km^2. Data are also collected from seven nested subwatersheds that range from approximately 3–115 km^2 [*Bosch et al.*, 2007]. The watershed boundary was delineated using a composite of nine U.S. Geological Survey (USGS) 7.5 minute topographic quadrangle sheets (contour interval of 3 m) published between 1973 and 1977 [*U.S. Geological Survey* (*USGS*), 1972, 1973a, 1973b, 1973c, 1973d, 1973e, 1973f, 1977a, 1977b]. Minor adjustments were made (on the basis of field observations) to the watershed boundary because of the effects of roadways and railways on the natural drainage system. Boundary data are available in ESRI ArcView shapefile format and will serve as the base layer for all other GIS data.

[5] Shapefiles were created designating the current position of (1) eight horizontal broad-crested weirs with V notch center sections, (2) 47 tipping bucket precipitation gauges, (3) 29 soil moisture stations, (4) three SEWRL climate stations, (5) five University of Georgia climate stations and (6) one NRCS SCANS climate station. The locations of all sites were determined using a Trimble submeter GPS with differential correction. At each location an average of 100 readings were used to delineate a location. It should be noted that these data reflect the current positions of rain gauges, over the lifetime of the watershed some of the gauges have been relocated or removed because of construction, land ownership, and suitability of the site.

3. Landscape Attributes

3.1. Topography

[6] Digital elevation models (DEMs) for seven counties were acquired from the Georgia GIS Data Clearinghouse (http://www.gis.state.ga.us/), having a spatial resolution of 30 m. The files were merged and converted to grid file format. Contour coverages (shapefile format) were created by hand, digitizing contour lines (3 m contour interval) from the corresponding USGS 7.5 minute topographic quadrangle sheets [*USGS*, 1972, 1973a, 1973b, 1973c, 1973d, 1973e, 1973f, 1977a, 1977b]. Digital elevation models were clipped using a 1 km buffer around the watershed boundary. This was done to maintain topographic integrity of the data set, sufficient for integration with the soil and water assessment tool (SWAT) [*Arnold et al.*, 1998].

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Table 1. Satellite Acquisition Date, Time, and Spatial and Spectral Resolution for Images Used in Land Use Classification

Satellite	Date	Collection Time	View Angle, deg	Spatial Resolution, m	Spectral Resolutions, μm
Landsat 2	4 Jun 1975	15:27:19	−0.21	80	0.5–0.6, 0.6–0.7, 0.7–0.8, 0.8–1.1
Landsat 2	11 Jul 1980	10:46:59	0.02	80	0.5–0.6, 0.6–0.7, 0.7–0.8, 0.8–1.1
Landsat 5	2 Jul 1985	15:36:59	0.06	30	0.45–0.52, 0.52–0.60, 0.63–0.69, 0.76–0.90, 1.55–1.75, 2.08–2.35
Landsat 5	14 Jun 1990	12:52:12	0.05	30	0.45–0.52, 0.52–0.60, 0.63–0.69, 0.76–0.90, 1.55–1.75, 2.08–2.35
Landsat 5	15 Aug 1995	15:10:23	NA[a]	30	0.45–0.52, 0.52–0.60, 0.63–0.69, 0.76–0.90, 1.55–1.75, 2.08–2.35
Landsat 7	20 Jul 2003	15:43:28	−0.02	30	0.45–0.52, 0.52–0.60, 0.63–0.69, 0.76–0.90, 1.55–1.75, 2.09–2.35

[a]NA means not available.

3.2. Hydrography

[7] Streams and water body data were hand digitized from the USGS 7.5 minute topographic quadrangle sheets [*USGS*, 1972, 1973a, 1973b, 1973c, 1973d, 1973e, 1973f, 1977a, 1977b]. These data are provided in shapefile format. Also, a separate coverage is provided for water bodies as delineated by NRCS. This coverage was hand digitized using the NRCS soil survey sheets for Tift, Turner and Worth counties [*Calhoun*, 1981, 1983, 1990]. A separate stream coverage was created for use with computer modeling programs. In this coverage, streams (as delineated by USGS) were revised to eliminate any breaks in those lines due to streams passing through lakes or swamps. This revision was necessary so that the modeling programs would correctly use the selected basin outlet points in their computations.

3.3. Land Use

[8] The watershed land use is a mixture of row crop agriculture, pasture and forage production, upland forest, and riparian forest. Land use within the watershed is approximately 50% woodland, 31% row crops (primarily peanuts and cotton), 10% pasture, and 2% water. Subwatersheds range from about 25% to about 60% agricultural land [*Sheridan*, 1997]. *Bosch et al.* [2006] showed that the overall forested acreage has remained consistent over the last 25 years. However, small increases in tilled field acreages (general agriculture and fallow combined) were observed in subwatersheds J, K and O. Several land use coverages are available spanning the period from 1975 to 2004. Data are provided as ERDAS Imagine files and are described below.

[9] Four Landsat images were acquired during summer months for the years 1985, 1990, 1995 and 2003. Summer months were chosen to provide maximum distinction between vegetation types, particularly row crop, riparian, and upland forested areas. Data were acquired from the Landsat 2 (1975 and 1980), Landsat 5 (1985, 1990, and 1995) and Landsat 7 [2003]. A complete description of the specifications for each acquisition is provided (Table 1).

[10] Each satellite image was georeferenced to 1999 digital orthoquadrangles using ERDAS Imagine (Leica Geosystems, Heerbrugg, Switzerland). A 1 km buffer was established around the watershed boundary base map and used to extract the area of interest (LREW) from each satellite scene. The extracted image was then entered into an unsupervised classification. The classification utilized 8-bit digital values calibrated for sensor gains and offsets only. The unsupervised classification assigns pixels to a specified number of classes based on an iterative self-organizing data analysis technique (ISODATA) [*Tou and Gonzalez*, 1974]. The ISODATA algorithm used for classification specified 45 classes, a maximum of 90 iterations, and a convergence of 0.98.

[11] Unsupervised classification data were assigned class names corresponding to the following land cover categories: riparian forest, upland forest, lakes/open water, urban, general agriculture, fallow, and pasture. General agriculture included row crops, vegetables, and in some cases fallow fields with heavy weed cover. Urban areas included any recognized residential and industrial structures, which for this watershed typically consisted of single rural homesteads less than 15 ha in size and small (<50 ha) residential areas.

[12] To determine the validity of the classified images, an accuracy assessment was conducted in ERDAS Imagine using historic land cover data from field surveys collected between 1980 and 2003. For each classified image, the assessment randomly chooses 75 points for comparison with surveyed data. Overall, classification resulted in an accuracy of 81–91%. Results from the accuracy assessment are provided in Table 2. Classified images are provided in ERDAS Imagine (.img) file format along with the corresponding look-up tables for use with the SWAT model

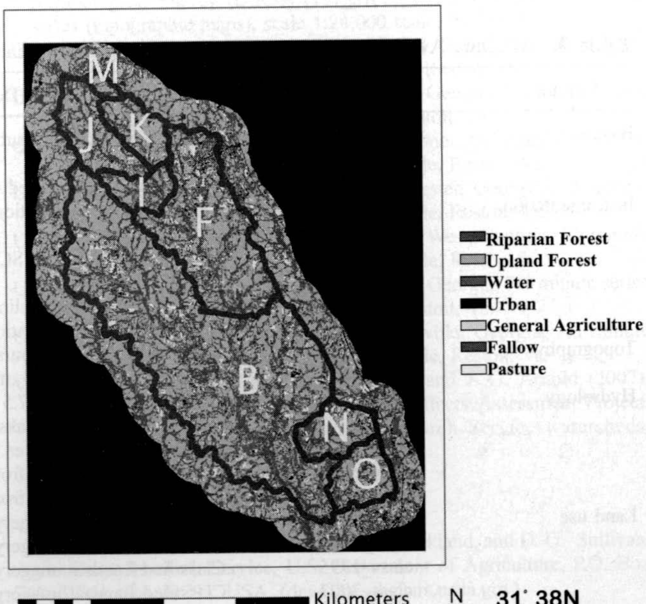

Figure 1. Classified 2003 Landsat TM image for the Little River Experimental Watershed. Watershed and subwatershed boundaries are shown. Color appears in back of the print issue.

Table 2. Results of the Accuracy Assessment for Each Unsupervised Landsat Image

Classification	1975 % Correct	1980 % Correct	1985 % Correct	1990 % Correct	1995 % Correct	2003 % Correct
Water	50	100	100	100	100	100
Urban	100	100	17	100	50	40
Fallow	100	100	100	92	67	80
Upland forest	82	76	100	89	86	93
Riparian forest	90	100	94	83	75	100
General agriculture	77	75	92	94	100	100
Pasture	NFC[a]	100	NFC	100	100	100
Total	82	86	86	91	81	91

[a]NFC means no fields classified.

[*Arnold et al.*, 1998]. An example of the unsupervised classification using the 2003 Landsat TM data is provided in Figure 1.

3.4. Soil

[13] Two soil coverages are available in ESRI shapefile format. These include the USDA NRCS State Soil Geographic Database (STATSGO) and the Soil Survey Geographic Database (SSURGO). Soil data are provided for portions of Tift, Turner and Worth counties within the LREW. The Georgia STATSGO database is a broad assessment of state soil and nonsoil areas that occur in repeatable patterns across the state [*U.S. Department of Agriculture*, 1991]. The SSURGO data represent digitized soil survey data, and provide a higher level of detail than the STATSGO data set (U.S. Department of Agriculture Soil Survey Geographic (SSURGO) database for survey area, state, 2006, available at http://soildatamart.nrcs.usda.gov). According to the SSURGO database, a majority of the soil classifies as a Tifton loamy sand (36%) followed by Alapaha loamy sand (12%) and Kinston and Osier fine sandy loam (8%).

4. Geology

[14] A geologic survey of the LREW was conducted by the USDA Agricultural Research Service and the University of Georgia in 1968. Although no digital data are available, a summary of the survey is presented below and a complete copy of the 1968 Survey Progress Report is available on the GIS database website.

[15] The LREW lies in the Tifton Upland of the Southeastern Coastal Plain physiographic region. The LREW is underlain by the Coastal Plain artesian aquifer [*Carver*, 1968], which is bounded by limestone capped by more impervious sediments of the late Miocene. The watershed consists primarily of low-gradient streams surrounded by higher-pressure gradients of 1.9 m km^{-1}or more.

Table 3. All Data Available in the Geographic Database by Feature and File Name[a]

Feature	File Name	Description	File Type	File Format
Basins	basins	LREW boundary with subbasin delineations	polygon	shape
	b_basin	LREW boundary	polygon	shape
	b_buffer	LREW boundary clipped with a 1 km buffer	polygon	shape
Instrumentation	curr_sew_rg	LREW rain gauge locations	point	shape
	s_gages2006	LREW stream gauges	point	shape
	scans	NRCS climate station (SCANS)	point	shape
	sew_climate	LREW climate stations	point	shape
	uga_climate	University of Georgia climate stations	point	shape
	sew_soilm	LREW soil moisture stations	point	shape
Topography	topo_ge	Topography (3 m contours) of the LREW	line	shape
	Lriver_huc	Digital elevation model of the LREW	grid	Grid
Hydrology	gis_streams	Digitized steams from 7.5 minute USGS quadrangle/ edited to remove breaks in coverage to due swamps, marshes or other water bodies	line	shape
	lakes	Digitized water bodies from 7.5 minute USGS quadrangle	polygon	shape
	nrcswater	Digitized water bodies from USDA NRCS soil surveys	polygon	shape
Land use	class_1985	Classified Landsat imagery for 1985	raster	imagine
	class_1990	Classified Landsat imagery for 1990	Raster	imagine
	class_1995	Classified Landsat imagery for 1995	raster	imagine
	class_2003	Classified Landsat imagery for 2003	raster	imagine
	Readme	Imagery converted to SWAT shapefiles	text	Word document
	swat_table	Look-up table for SWAT land use categories and S_values	database	DBF
Soils	lr_soils	USDA NRCS SSURGO data for the LREW	polygon	shape
	lr_statsgo	USDA NRCS STATSGO data for the LREW	polygon	shape
Geology	1968 Survey	1968 survey progress report	text	Word document

[a]A brief file description along with file type and format are also provided.

[16] The primary surface formation of the LREW is the Hawthorne Formation, which is underlain by limestone, dolomite, and calcareous sands that form the Floridan aquifer. In the northern portion of the watershed, the Hawthorne Formation (Hawthorne-Ashburn) consists primarily of nonmarine, poorly sorted, cross-bedded gravelly sands interbedded with partly indurated sandy clays. The Hawthorne-Ashburn Formation is approximately 21 m thick, with the lower 6.5 m consisting primarily of indurated, sandy, claystone with an apparent porosity of 10% [*Carver*, 1968]. The sand fraction is primarily common quartz, with a small percentage of metamorphic sand grains as well. Analysis of heavy mineral suites suggests the parent material is derived from igneous and metamorphic sources, very likely from the Piedmont of western Georgia.

[17] A second major rock type was also noted in the Hawthorne-Ashburn Formation, consisting primarily of sandy plastic, gray to green clay. This rock layer is approximately 3 m thick and presumed to form a nearly perfect aquiclude. Finally, in the southeastern portion of the watershed, the Hawthorne-Ashburn Formation consists primarily of gravelly sands interbedded with poorly sorted, fine to medium sand and sandy clay. Sand content and grain size typically increase toward the southern end of the watershed. Although this region is expected to hold water, the underlying clay formations effectively form an aquiclude and limit surface to groundwater contributions [*Carver*, 1968].

[18] On the eastern edge of the LREW, four sections of deep sands (>3 m) were identified. These surfaces are typically unconsolidated and permeable, thus a major consideration in the hydrology of the LREW. Data suggest that precipitation held in these sands contributes significantly to stream base flow and to a certain extent groundwater recharge [*Carver*, 1968].

5. Data Availability

[19] The geographical database for the LREW includes 23 data layers, along with corresponding metadata files (Table 3). Metadata include the projection system, dates of creation, originating source of the file, and pertinent information regarding how the file was created (ftp://www.tiftonars.org/).

6. Examples

[20] The GIS data have been used for several modeling studies that have been conducted using the LREW data [*Bosch et al.*, 2006; *Van Liew et al.*, 2007; *Feyereisen et al.*, 2007]. *Bosch et al.* [2006] found that higher-resolution GIS coverages can yield more accurate hydrologic simulations using the SWAT model. Their results illustrate the importance of accurate land use, soils, and topographic data. *Feyereisen et al.* [2007] and *Van Liew et al.* [2007] both found that for hydrologic simulation, the Curve Number is the single most important input parameter for SWAT simulations of the LREW. The Curve Number is determined by a combination of the land use, soil type, and existing water content. Thus accurate land use and soil coverages are critical for accurate hydrologic simulations.

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