

GENERAL REPORT FOR THE 2004 LULC PROJECT

SUMMARY:

New digital land use / land cover (LULC) maps have been created for the entire state of Arkansas. The new map series was created from satellite imagery and represents a detailed mapping of Arkansas' landscape in the spring, summer, and fall of 2004. The maps provide a way for a wide variety of users, such as natural resource managers, urban planners, educators, as well as academic and private researchers in the natural and social sciences, to assess important economic, agricultural, and environmental changes across the state of Arkansas. The maps were created by researchers at the University of Arkansas' Center for Advanced Spatial Technologies (CAST), with funding from the Arkansas Natural Resource Commission (ANRC).

Most of the social and natural resource challenges facing Arkansans are related, either directly or indirectly, to landscape characteristics. "Land cover" refers to what actually covers the land surface and includes categories such as forest, water, etc. The term "land use" refers to how the land is being used or modified by human activity and includes categories such as urban, soybean field, etc. Because landscape changes and their effects take place in both space and time, regularly updated LULC maps present the public with a doubly useful source of information. With the aid of spatial analysis tools this dataset can be used to identify spatial and temporal patterns. The 2004 LULC dataset is the latest in an ongoing effort to map the landscape of Arkansas. This new digital map is an update to the initial statewide LULC created for the year 1999. In 1996 a pilot LULC project was completed for 27 counties in eastern Arkansas which depicted the landscape of the Delta in 1992. Maps from these different times can be used to see how land use has changed. For example, between 1992 and 2004 the amount of land used for aquaculture (fish farms) in Chicot county in southeast Arkansas jumped from 8,453 acres to 20,862 acres. In that same time period on the Grand Prairie of Arkansas, an important rice growing region, rice production went from 228,974 acres in 1992 to 209,138 acres in 2004. The data also show considerable growth in Pulaski county in central Arkansas. Land use in the high density urban category (industrial and commercial lands) went from 18 mi² in 1992 to just under 29 mi² in 2004. Similar urban growth has taken place in northwest Arkansas.

The three projects have been funded by the Arkansas state legislature with the support of a number of state senators and representatives, most recently state senator Sue Madison,. In that time ANRCC and CAST also collaborated on the production of other important natural resources digital data sets including new, extensive soil maps for the 75 counties of Arkansas. ANRCC and other state agencies recognize the value of spatial data, and use it in their various programs.

The LULC data was derived from moderate resolution satellite imagery from the Thematic Mapper (TM) sensor onboard the Landsat 5 satellite. The TM sensor measures reflected and emitted energy from the Earth's surface, views the landscape from an

altitude of 438 miles, and travels in a polar orbit around the Earth at a speed of 4 miles per second. The satellite images the same area on the Earth's surface every 16 days. Three separate images from the spring, summer, and fall of 2004 were used in the creation of the 2004 LULC dataset. For more information on the Landsat program please visit the following web page: landsat.usgs.gov. CAST, through its participation in the ArkansasView consortium, received a substantial discount on the price of the satellite imagery. For more information on ArkansasView and its parent organization AmericaView please visit: www.cast.uark.edu/cast/arkansas_view/.

The accuracy of the dataset was measured by comparing map results to a set of ground reference points collected by CAST researchers at various sites around the state. The overall accuracy of the map, based on the ground reference data, is 87%.

The data products generated for the project were designed primarily for planning and research activities at the county, regional, or statewide level, and are not intended for high resolution, site specific investigations. The 2004 LULC datasets should be of particular interest to those studying land use or land cover changes. If plans to map the landscape of Arkansas on a regular basis are made a reality, it will provide means for end users of the data to spot trends, identify potential future challenges, and to make more informed decisions.

The data can be accessed on GeoStor, Arkansas' online spatial data source on the world wide web at www.geostor.arkansas.gov. For more information about LULC mapping in Arkansas please contact Jason A. Tullis (jatullis@cast.uark.edu) or Bruce Gorham (bruce@cast.uark.edu).

PROCESSING STEPS:

For more detailed methodology information please see the overall project methodology section at: http://www.cast.uark.edu/local/arlulc99/final_report.htm.

Phase One - Field Work and Satellite Data Acquisition

A. GPS and Computer equipment/software configuration

- Mission planning: project personnel determined the best dates and times to collect for ground-truth (GT) data for image classification and accuracy assessment based on modeled GPS accuracies.
- Trained graduate assistant to use GPS hardware and mapping/data dictionary software.
- Data dictionary creation: Developed procedures and protocols for streamlining the collection of GT data.
- System testing and refinement: Assured that the GPS equipment and software would work in the field as expected for peak efficiency.

B. Collect ground-truth data for image classification and accuracy assessment.

- Trimble mapping-grade GPS equipment was used to collect sub-meter accuracy GT samples for winter wheat, warm season pasture, and cool season pastures, soybeans (both late and early), cotton, rice, sorghum, corn, bare soil. The GT data collection was performed on the following schedule.

Mid April: collected GT for winter wheat, cool season pasture, and warm season pasture. (7 days)

Week 1: Northern Mississippi Alluvial Valley of Arkansas & Arkansas River Valley (3 days)

Week 2: Southern Mississippi Alluvial Valley of Arkansas and Red River Valley of Arkansas. (3 days)

Mid-late August: collected GT for summer crop categories.

Week 1. Northern Mississippi Alluvial Valley (4 days)

Week 2. Southern Mississippi Alluvial Valley (4 days)

Week 3. Arkansas River Valley and Red River Valley. (3 days)

- Visits and interviews with field scientists. For both the 1992 and 1999 LULC projects we found that a little time spent talking to field scientists (agriculture extension agents, etc.) helped greatly in producing a better, and more accurate map product. Year specific information, such as temporal planting patterns, of tremendous benefit. We conducted in-field interviews with three field scientists around the state for the purpose of better understanding the year specific land-use characteristics in 2004. (3 days)

C. Download and Process GPS and Other Field Data. When all GT data had been collected in the field and downloaded from the GPS units to in-house computers, the resulting GPS data was processed for use in a GIS/image processing environment. Processing steps included:

- Differential correction. GPS data was improved through differential correction processes. This insured that the field data had a suitable positional accuracy.
- Data quality check. Visual inspection of all GPS data points was conducted to remove bad, incorrectly labeled, and/or redundant data points.
- Exported all GPS data (points, lines, and polygons) to Arc Shapefile format.
- Incorporated field notes, field photos, and interview notes into vector database, where applicable.

D. Satellite image selection, acquisition, import, inspection & exploration, backups.

When all GT and interview data had been compiled and examined we had a much clearer picture of the dates for which imagery should be purchased. The image purchase task was comprised of the following steps:

- Identified satellite images to cover the entire state for the three seasons of the growing season: spring summer and fall based on minimal cloud cover and best fit for differentiating land-use/land-cover types.
- Acquired the satellite imagery, via FTP Push from the U.S. Geological Survey's EROS Data Center (Sioux Falls, SD).
- Imported satellite imagery into PCI Geomatica for inspection and further manipulation.
- Inspected data for errors, and returning for exchange where applicable.
- This step also included some time for the analyst to become familiar with the particulars of each scene, such as clouded areas or other special situations that need to be addressed.
- Created 2 CD backups for each individual data/scene: one for CAST archives, one for delivery to ASWCC.

Phase Two:

A. Image Processing: Level 1 Feature Extraction. This step assigned categories to all land in Arkansas to one of 7 basic categories: water, forest, woody-herbaceous, agricultural land, urban, and barren land.

- Extracted 3-season water coverage by scene using TM band 4/5 gray-level thresholding by scene.
- Extracted forest through classification and change detection by scene.
- Extracted woody-herbaceous through classification and change detection by scene.
- Extracted agricultural land determination by scene.
- Urban classification by scene with additional ancillary road and urban boundary vector layers.
- Barren land classification by scene with additional ancillary data about mining operations.
- Mosaic of Level One map for entire state.

B. Image Processing: Level 2 Feature Extraction. This step broke down Level One features into more refined categories. For example, agricultural land was broken into various types of pasture and crop land, and urban was broken into high and low density categories. Additionally, for Level Two, satellite images were subdivided by physiographic region for classification purposes. This improved overall map accuracy.

- Subdivided Level-One mosaic into physiographic region.
- Generated category signatures based on collected ground-truth (GPS) data.
- Prepared three season cropland classification based on crop category signatures and temporal (phenology) information
- Seasonal pasture land classification was based on seasonal grass condition in three seasons of data (cool and warm season grasses).

- Differentiated Level one from Level two urban based on spectral and urban boundary information.

C. Accuracy Assessment, Data Formatting, and Reports

- Assessed accuracy based on reserved ground-truth points using matrix analysis.
- Created tabular land cover reports for state and individual counties
- Exported Level 2 raster data to ARC GRID and GeoTiff formats
- Delivered datasets to ANRC and to AGIO for inclusion on GeoStor.