

Final Report: 2006 Arkansas Land Use and Land Cover (LULC)

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Executive Summary

The Arkansas LULC 2006 project developed statewide land-use/land-cover (LULC) maps representing the landscape of Arkansas in the year 2006 and provides follow-up monitoring from 1999 and 2004. A modified Anderson Level II-III classification schema was used for the 30 × 30 m spatial scale of analysis. The bulk of the LULC information was derived from Landsat 5 Thematic Mapper (TM) image scenes acquired in spring and summer of 2006. Additional ancillary datasets used to extract LULC information were derived from the USGS National Elevation Dataset (NED), U.S. Bureau of the Census maps, and Arkansas Highway and Transportation Department road locations. Training data was collected through fieldwork and inspection of National Aerial Photography Program (NAPP) 1m × 1m aerial photographs. The project enabled specific from-to change information about agricultural crops, pasture types, forestland conversion, urban change, and seasonal flooding patterns.

1. Satellite Image Processing

Twenty-six Landsat 5 TM images were acquired and orthorectified to the Universal Transverse Mercator (UTM) projection, according to the World Geodetic Survey datum of 1984 (WGS84). Corrections for topographic distortion were applied using Toutin's satellite orbital modeling algorithm. The Satellite Orbital Model (SOM) is a rigorous transformation developed by Dr. Thierry Toutin at the Canadian Center for Remote Sensing. It was designed to compensate for distortions such as sensor geometry, satellite orbit and attitude variations, and earth shape, rotation, and relief. The model utilizes Landsat 5's orbital data, a series of ground-control points, and a digital elevation model (DEM) to make these adjustments.

2. Field Observations

Field Observations: Project personnel spent approximately two weeks touring the state: taking field notes, collecting complimentary GPS coordinates representing final output categories. The field data was useful for our image analysts to have a better understanding of the relationships between the satellite images and actual ground conditions. The GPS positions were also used to train supervised classification algorithms (see below), make additional measurements of positional accuracy, and measure the accuracy of the final product.

3. Image Classification and Post Processing

An initial unsupervised "Isodata" clustering algorithm was performed on all of the spectral data (pixel by pixel) for each year: both spring and summer seasons together. Using basic image interpretation methods with both the Landsat data and Arkansas 2006 statewide ADOP photos, analysts aggregated clusters into 7 Level-One categories: Forest, Pasture, Cropland, Barren Land, Woody/ Herbaceous, Water, and Urban.

Next, certain level-one categories: pasture, cropland, and urban, were further broken into additional land-use categories. Pasture was broken into cool and warm season categories. Cropland was broken into 7 categories: soybean, rice, cotton, winter wheat (for spring only), corn/sorghum, other cropland, and bare soil/seedbed. Level-one urban was broken into high-

intensity, and low intensity categories. High urban intensity indicates a high intensity of man-made surfaces such as concrete and asphalt. Low intensity urban indicates a mix of man-made and natural settings. High intensity roughly correlates with commercial and industrial areas, while low intensity urban correlates with residential areas. It is important to note that some areas, such as parks and cemeteries within urban complexes may be categorized as woodlands or grasslands. The level-two classification was carried out using a “maximum likelihood” supervised image classification algorithm. Training sites for the classification were selected from a subset of the field observation data mentioned above. Other urban features were selected from high resolution aerial photography.

Data from the resulting classifications were used only if the pixel fit into a category with a 90% certainty. This second-pass supervised classification normally accounted for approximately 80% - 85% of the study area. All “problem areas” we identified and a third pass classification was done using a K-means clustering algorithm, and assigning all clusters to their respective categories manually by comparing clusters with their location on the ADOP high resolution photographs.

Once the individual Landsat scene areas were classified, all scenes were combined into one mosaic. Then the final 2006 statewide scene was co-registered with products from the 2004 and 1999 LULC projects. These co-registered scenes are new to the project this year, and will be useful for conducting accurate pixel-to-pixel change detection studies between project years.

4. Accuracy Assessment

A standard error confusion matrix analysis was employed for the accuracy assessment. All field observation points not used in the classification training procedure mentioned above were used in the accuracy assessment. Additional points for urban categories were selected from the 2006 high resolution ADOP photos. These points were overlain on the image and the categorical value of the point was compared to the categorical value of the corresponding pixel. Water category had the highest average accuracy: 96.8%. The forest category came in second with an average accuracy of 91.9%. The Barren land category had an average accuracy of 85%. The level-one cropland category accuracy has an accuracy of 84.92%. Warm and cool season pasture categories had a relatively low accuracy: 72.3% and 81.3% respectively. Eighty percent of the associated confusion of the pasture categories was cross-categorical with the other pasture category (i.e. cool pasture confused with warm pasture, and warm pasture confused with cool pasture. When cool and warm season grasses were combined, for the sake of accuracy analysis, the accuracy for that combined category was a respectable 84.4%. Level-two summer cropland category accuracies are as follows: Soybean 89.2%, Rice 92.1%, Cotton 83.6%, Corn/Sorghum 68.1%, and Bare Soil 90.9%. When cross categorical error between level-two categories is excluded the level-one accuracy for cropland is 89.2% There was also confusion between the high and low intensity urban categories. The average accuracy of the low intensity urban category was 77.6% and 91.1% for high density. The accuracy for a combined urban category was 92.2%. (Note: more work needs to be done to identify rural urban features. The accuracy of the low intensity category is somewhat questionable because bright areas near major highways, such as bare soil, culverts, etc., are very likely to be mistaken for urban features.) The woody/herbaceous category had the lowest accuracy at 71.5%, but that category typically

comprised a relatively small portion of the study area. The average accuracy for the final level-two map was 84%. With combined pasture, cropland, and urban categories, the average map accuracy was 87.6%.

5. Output Products

Two output products were generated. The first is an Arkansas 2006 statewide LULC map using the following 15 category classification schema.

Level-One Category Name	Level-Two Category Name	Category Number
Urban		
	Low Intensity Urban	11
	High Intensity Urban	13
Barren Land		
	No Level-Two Component	31
Water		
	No Level-Two Component	41
Woody/Herbaceous		
	No Level-Two component	51
Forest/Woodland		
	No Level-Two Component	101
Cropland		
	Soybeans	201
	Rice	202
	Cotton	203
	Winter Wheat: spring only	204
	Corn/Sorghum	205
	General Agriculture	206
	Bare Soil	208
Pasture/Grassland		
	Warm Season Grasses	209
	Cool Season Grasses	210

The second was a from-to (post-classification) change map showing change information between 2004-2006. The from-to change information about agricultural crops, pasture types, forestland conversion, and seasonal flooding patterns is vital for many groups throughout Arkansas. The change data will appear in the coming months on the on-line Arkansas Automated Reporting and Mapping System (AARMS).

The products are being made available to the public through both the University of Arkansas Spatial Library (UASL) and GeoStor. UASL can be found at <http://www.cast.uark.edu/UASL/> and GeoStor can be found at <http://www.geostor.arkansas.gov/Portal/index.jsp>. Metadata, including a brief summary, is included with the LULC 2006 map.