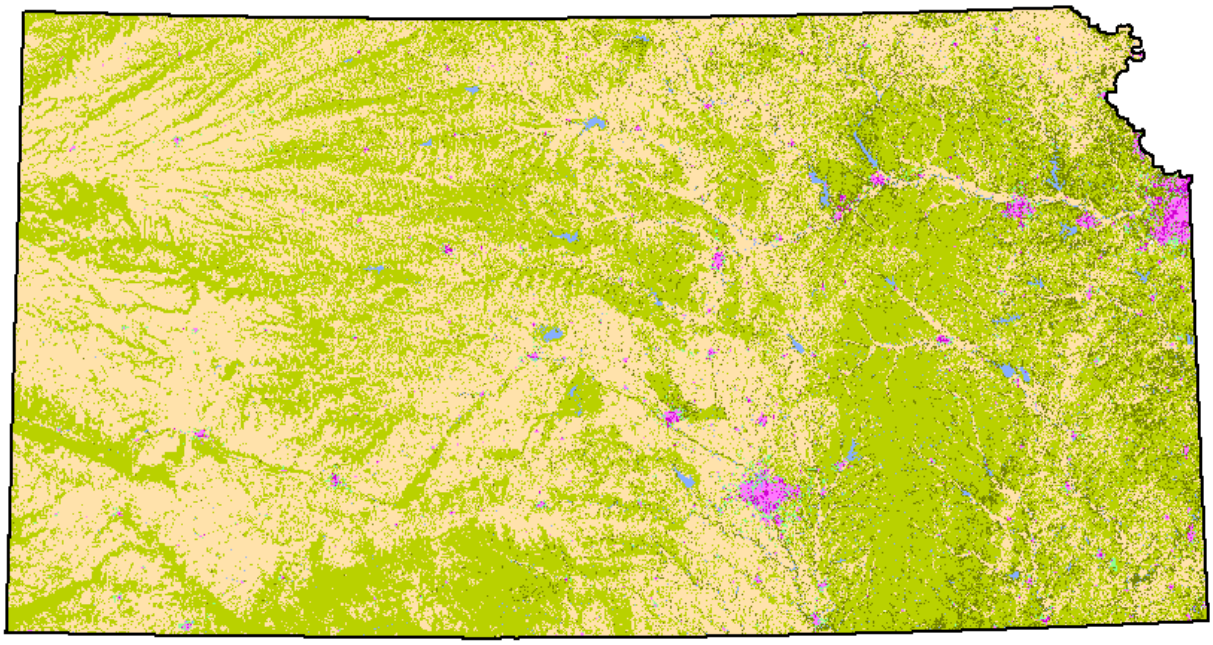
2015 KANSAS LAND COVER PATTERNS
PHASE I - FINAL REPORT



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Credits

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Executive Summary

The 2005 Kansas Land Cover Patterns map represents an update of the 1990 Kansas Land Cover Patterns map. The update, designed to be explicitly comparable to the 1990 Kansas Land Cover Patterns map, uses the same source data (Landsat Thematic Mapper (TM)), classification scheme (Modified Level I), classification approach (unsupervised classification), and spatial resolution (minimum mapping unit (MMU)). Using a similar methodology to produce the 2005 Kansas Land Cover Patterns map allows end-users to identify and examine changes in the Kansas landscape over the last 15 years.

The Modified Level I map was produced from multi-seasonal Landsat TM imagery acquired during the 2004 and 2005 growing seasons. The map contains eleven land use/land cover classes and has a positional accuracy and spatial resolution appropriate for producing 1:50,000 scale maps. The MMU varies by land cover class and ranges between 0.22 to 5.12 acres.

The 2005 Kansas Land Cover Patterns map has an overall accuracy of 90.72%, the highest overall accuracy level for a Level I map produced by the Kansas Applied Remote Sensing Program to date. While the overall accuracy level is high, User and Producer accuracies vary by land cover class.

The 2005 Kansas Land Cover Patterns map represents Phase 1 of a two-phase mapping initiative occurring over a three-year period. During Phase 2, subclasses will be mapped to produce a Modified Level II map of Kansas using 250-meter resolution time-series MODIS NDVI imagery.

Digital versions of the map, metadata, and accuracy assessment can be accessed from the Data Access and Support Center (DASC) website of the Kansas Geological Survey (http://www.kansasgis.org/).

Introduction

The Next-Generation Statewide Land Cover Mapping Initiative was co-funded by the Kansas State GIS Policy Board and Kansas Department of Wildlife, Parks and Tourism. Work on the mapping initiative was split into two phases. The work and products described in this report correspond to Phase I of the land cover mapping initiative.

The modified Anderson Level I (Anderson *et al.*, 1976) land cover map developed in Phase I was generated to make land cover data comparable to previous land cover maps created by the Kansas Applied Remote Sensing Program of the Kansas Biological Survey. The three other statewide land cover maps were (1) Kansas Land-Use Patterns: Summer 1973 (non-digital, hard copy only) (KARS, 1973), (2) the 1990 Kansas Land Cover Patterns map (KARS, 1997; Whistler *et al.*, 1996), and (3) the 1992 Kansas Vegetation Map created for the Gap Analysis Program (Egbert *et al.*, 2001; KARS, 2002).

Methods

The land cover map contains ten land use/land cover (LULC) classes and was designed to be explicitly comparable to the 1990 and 2005 Kansas Land Cover Patterns database. A three-stage generalization technique was used to refine the map classes to their specified minimum mapping units. A formal accuracy assessment was conducted using both existing databases and high-resolution digital aerial photography (using manual photo interpretation techniques) as ground reference data.

Mapping Standards and Data Sources

Table 1 summarizes the mapping standards used and data products developed for this land cover mapping initiative. The primary data source for map development was the 2015 Cropland Data Layer. The land cover map has thematic detail based on an Anderson Modified Level I classification scheme and a minimum mapping unit that varies by class type. The goal for overall map accuracy was 85% or greater. The map is distributed as a statewide digital database as Erdas Imagine file format (.img).

Table 1. Mapping standards, data sources and products for the 2005 Kansas Land Cover Patterns map.

Item	**Standard or Product**
Primary Data Source	Landsat Thematic Mapper (30m resolution)
Thematic Detail	Anderson Modified Level I; eleven classes total
Minimum Mapping Unit (MMU)	Varies by LULC class (0.2224 to 5.115 acres)
Spatial Reference	Albers Conic Equal-Area (A Kansas Projection Standard) Spheroid GRS 1980 Datum NAD83 Latitude of 1st standard parallel: 29:50:00 N Latitude of 2nd standard parallel: 45:50:00 N Longitude of central meridian: 96:00:00 W * Latitude of origin of projection: 23:00:00 N * * National projection parameters
Spatial Accuracy	15 meters (0.5 pixels)
Thematic Accuracy	As determined through accuracy assessment; goal 85% or greater
Tiling Scheme	Statewide database with 300m buffer
Format	Geotiff and ArcInfo Grid
Product	Digital land cover database

Data Sources:

The data sources in Table 2 were used to generate the 2015 KLCP.

Table 2. Ancillary data sets used to create the 2005 statewide land cover map.

Data Set	Source	Purpose
2015 Cropland Data Layer	USDA NASS	General Classification Scheme
2005 KLCP	KBS/KARS	Classification QAQC and modifications.
2015 FSA National Agriculture Imagery Program (NAIP)	USDA	Create Urban Mask, Classification QAQC, and Accuracy Assessment
2015 Common Land Unit (CLU) Database	USDA/NRCS	Accuracy Assessment
Field-Level Boundaries	KARS/NASS	Generalization
Kansas State Highway System	KDOT	Generalization
Kansas Public Land Survey System (PLSS)	KGS	Accuracy Assessment
Kansas GAP Vegetation Database	KBS/KARS	Accuracy Assessment

Thematic Detail:

The classification scheme was designed to be explicitly comparable to the 1990 and 2005 Kansas Land Cover Patterns database (Table 3).

Table 3. The Modified Anderson Level I Land use/land cover classes mapped.

Level I Class Code and Name	Level II
10, Urban	11, Urban Commercial/Industrial
	12, Urban Residential
	13, Urban Openland (typically grassland - includes golf courses, cemeteries, and parks)
	14, Urban Woodland
	15, Urban Water
20, Cropland	
30, Grassland (includes rangeland and pasture)	
40, Woodland	
50, Water	
60, Other (including sandbars, quarries, segments of major highways)	

The ten mapped classes are defined as:

(11) Commercial/Industrial - commercial/industrial land consists of areas of intensive use with much of the land covered by structures or other hard surfaces. These areas are used predominantly for the manufacture and sale of products and/or services. This category includes the central business districts of cities, towns, and villages; suburban shopping centers and strip developments; educational, governmental, religious, health, correctional and institutional facilities; industrial and commercial complexes; and communications, power, and transportation facilities. The main buildings, secondary structures, and areas supporting the basic use are all included - office buildings, warehouses, driveways, parking lots, landscaped areas, streets, etc. Highways or interstate systems running through the core of urban areas, are also included in this class.

(12) Residential - residential land consists of areas of medium density housing characterized by a more or less even distribution of vegetative cover and houses/garages, to high density housing characterized by multi-unit structures such as apartment complexes. Linear residential developments along transportation routes extending outward from urban areas are included. Rural subdivisions not directly connected to the core of an urbanized area are also included. The main buildings, secondary structures, and immediate surrounding landscape are all included (i.e., houses, apartment complexes, streets, garages, driveways, parking areas, lawns, trees, etc.).

(13) Urban-Openland - urban-openland consists of areas primarily of open grassland, sometimes mixed with trees, with uses such as golf courses, zoos, urban parks, cemeteries, and undeveloped land within an urban setting. Low density rural residential areas may also be included in this category. This category also includes tracts of land that have been zoned residential or commercial, but have yet to be developed.

(14) Urban-Woodland - urban-woodland consists of wooded tracts within a town or city. These wooded tracts maybe associated with golf courses, zoos, urban parks, and other undeveloped land.

(15) Urban-Water - urban-water consists of any open surface water within a town or city. This includes ponds, lakes, sewage settling ponds, etc.

(20) Cropland - cropland includes all areas with actively growing row crops and small grains, as well as harvested land, fallow land, and large, uniform areas of bare, plowed ground.

(30) Grassland - this category includes all pasture (hayed land), rangeland, and other grasslands having insufficient trees and/or shrubs to be classified as "woodland". It does NOT include conservation reserve program (CRP) land.

(40) Woodland - this class includes any wooded areas having a canopy closure of 50% and greater.

(50) Water - all open water bodies, including reservoirs, lakes, ponds, rivers and streams. Ephemeral streams may not be represented.

(60) Other - the "other" class is used to identify land cover / land use classes not previously defined. In general, this class is used for exposed, bare ground other than cropland. Examples include rock quarries, sand and gravel pits, sandbars, and built-up areas less than 40 acres.

Positional accuracy and spatial resolution (minimum mapping unit - MMU) are appropriate for producing 1:50,000 scale maps (approximately 2 acres). MMU's varied by LULC class and match the MMU's used in the 1990 and 2005 Kansas Land Cover Patterns databases (Table 4).

Table 4. Minimum mapping units by LULC class.

LULC Class	Landsat Pixels	Acres
Urban Commercial/Industrial	15	3.11
Urban Residential	15	3.11
Urban Openland	15	3.11
Urban Woodland	3	0.67
Urban Water	1	0.22
Cropland	23	5.12
Grassland	23	5.12
Rural Woodland	3	0.67
Rural Water	1	0.22
Other	15	3.11

Generalization Procedures

Introduction

Thematic generalization of the land cover was performed to align thematic classes to match the 1990 and 2005 classification schemes. Cartographic generalization of the land use/land cover data was performed to eliminate "noise" in the classification and simplify the map. Noise is comprised of either extraneous misclassified pixels or small clumps of pixels that are insignificant at the suggested mapping scale of the map (1:50,000) (Figure 1a). Noise tends to create visual confusion and obscure overall patterns. Before designing and running the generalization procedures, the minimum mapping unit (MMU) was chosen for each land

use/land cover class. The MMU size, or smallest number of contiguous pixels, chosen for a particular class was based on the following factors:

1) Is the class reliably detected by the classification?
2) Is the class accurately represented?
3) What level of thematic detail (i.e., how small an area) should be preserved at the suggested mapping scale?
4) MMUs that would be comparable to the 1990 and 2005 Kansas Land Cover Patterns databases.

Taking these factors into account, the MMU for each land use/land cover class was established. MMUs are listed in Table 4 (above).

Overview of the Generalization Procedure

Generalization was accomplished in three stages. The first stage consisted of recoding the CDL classes to match the ten classes in the KLCP classification system. Next, the recoded map was visually examined, scanning for misclassified areas, and manually correcting them. In the second stage, conventional automated generalization procedures were used to simplify the manually cleaned classification by removing misclassified or spatially insignificant clumps of pixels (Figure 1b). During this stage, the objective was to achieve the MMU standard for the individual classes. In the third stage, the field-level database was used to fit the Cropland and Grassland classes from the mosaic into fields delineated in the field-level database (Figure 1c). The objective was to utilize the spatial precision of field boundaries provided by combining multi-years of CLU data and manual splits of fields to better depict the spatial extent of Cropland and Grassland.

(a) **(b)** **(c)**

Figure 1. An example of a map (a) prior to generalization, (b) following generalization using traditional techniques and (c) following generalization using CLU data.

Stage I Generalization – Manual Cleanup of Woods and Water

Manual cleanup was performed using ArcGIS. The procedure was initiated by displaying the map and corresponding 2015 NAIP imagery and the 2005 KLCP map. The 2015 map was then examined by an analyst who looked for classification errors. For the woodland and water map components, the analyst focused on eliminating errors of commission and delineating areas of omission that were correctly mapped in the 2005 map. When errors were

found, the analyst would digitize the misclassified pixels and assign an attribute to indicate if it was an error of omission or commission. Upon investigation, the CDL had a high omission error. Digitizing all existing omission of water would be extremely time-consuming, therefore omitted water that was classified in the 2005 KLCP was added to the 2015 water class. The digitized locations of omission and commission were used in model builder to reassign pixels accordingly.

Stage II Generalization – Eliminating Small Clusters of Pixels

Generalization – Water

There was no generalization of the water class.

Generalization – Woodland

The generalization of the woodland class was accomplished using two functions in ERDAS Imagine 2015. The first step utilized the CLUMP function to identify all contiguous pixels (i.e., clumps) of woodlands using the eight connected neighbors rule. The second step used the ELIMINATE function to remove clumps with less than three pixels.

Generalization – Urban Classes

The generalization of the Urban classes Industrial/Commercial, Residential, and Openland was accomplished using two functions in ERDAS Imagine 2015. The first step utilized the CLUMP function to identify all contiguous pixels (i.e., clumps) of each class using the four connected neighbors rule. The second step used the ELIMINATE function to remove clumps with less than 15 pixels. Woods and water were added back and the EXPAND function in ArcGIS 10.4 was used to fill remaining Zero areas. This function fills the Zero area with surrounding class value(s) excluding Woodland and Water. This step is run iteratively until Zero areas are filled.

Recode any remaining Zero areas (e.g., areas embedded in Woodland, a class that was not allowed to expand in the previous step), as Woodland.

Generalization – Cropland, Grassland, and Other Classes

The generalization of the classes Cropland, Grassland, and Other was accomplished using a S functions and running under ArcGIS 10.4 and ERDAS Imagine.2015. The following outlines the generalization procedure for these classes.

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1. Recode the Cropland around 4-lane highways to Grassland. Use a 45m buffer around the highway's centerline (90m total; 3 TM pixels wide) to delineate the recode area.
2. Use the CLUMP function to identify all contiguous areas of Grassland and Cropland.
3. Use the ELIMINATE function to remove clumps less than the MMU for Grassland, Cropland, and Other.
4. Add Water and Woodland to the Cropland/Grassland map.

Mosaic of Stage II Generalizations

Stage III Generalization – Fitting to CLU Boundaries

To conduct the Stage III generalization, multi-year field-boundary dataset consisting of multiple years of CLU data and manual splits of fields were converted to a raster grid and used to create a field-level representation of rural land cover. Output raster cells were assigned the feature identifier (FID) of the shapefile during the conversion to a grid because the value was unique and thus could be used to identify unique zones. The following outlines the procedures for the Stage III generalization.

1. Create a Cropland/Grassland grid by recoding all values other than Cropland (20) and Grassland (30) on the Stage I generalization to NODATA.
2. For each Zone in the CLU grid, calculate the ZONALMAJORITY for the Cropland/Grassland grid.
3. Using the Stage I generalization grid, write all values other than Cropland and Grassland to a new output grid, recoding Cropland and Grassland areas to Zero (0)
4. Write the ZonalMajority values from Step 2 to the new grid, filling only Zero areas.

Results

The end product for Phase I of the 2015 Kansas Land Cover mapping project is an updated digital Level 1 land cover map of Kansas (Figure 2). A summary of the land cover types, their area mapped in square kilometers, and the percent of the total area in Kansas represented by each type is presented in Table 5.

Table 5. Modified Anderson Level I land cover classes, their area mapped (acres and sq. km.), and the percent of the State's total area represented by each land cover class.

LULC Class	LULC Code	Pixel Count	Percent Mapped	Area (km^2) Mapped	Area (m^2) Mapped
Commercial/Industrial	11	682,595	0.34	614.34	237.20
Residential	12	1,928,812	0.69	1,735.93	670.25
Urban Openland	13	1,456,502	0.59	1,310.85	506.12
Urban Woodland	14	287,123	0.09	258.41	99.77
Urban Water	15	68,852	0.02	61.97	23.93
Cropland	20	110,947,791	45.98	99,853.01	38,553.47
Grassland	30	106,661,794	41.97	95,995.61	37,064.12
Woodland	40	12,253,521	4.07	11,028.17	4,258.00
Water	50	2,425,008	0.79	2,182.51	842.67
Other	60	64,845	0.09	58.36	22.53
Total		***236,776,843***	***100.00***	***213,099.16***	***82,278.05***

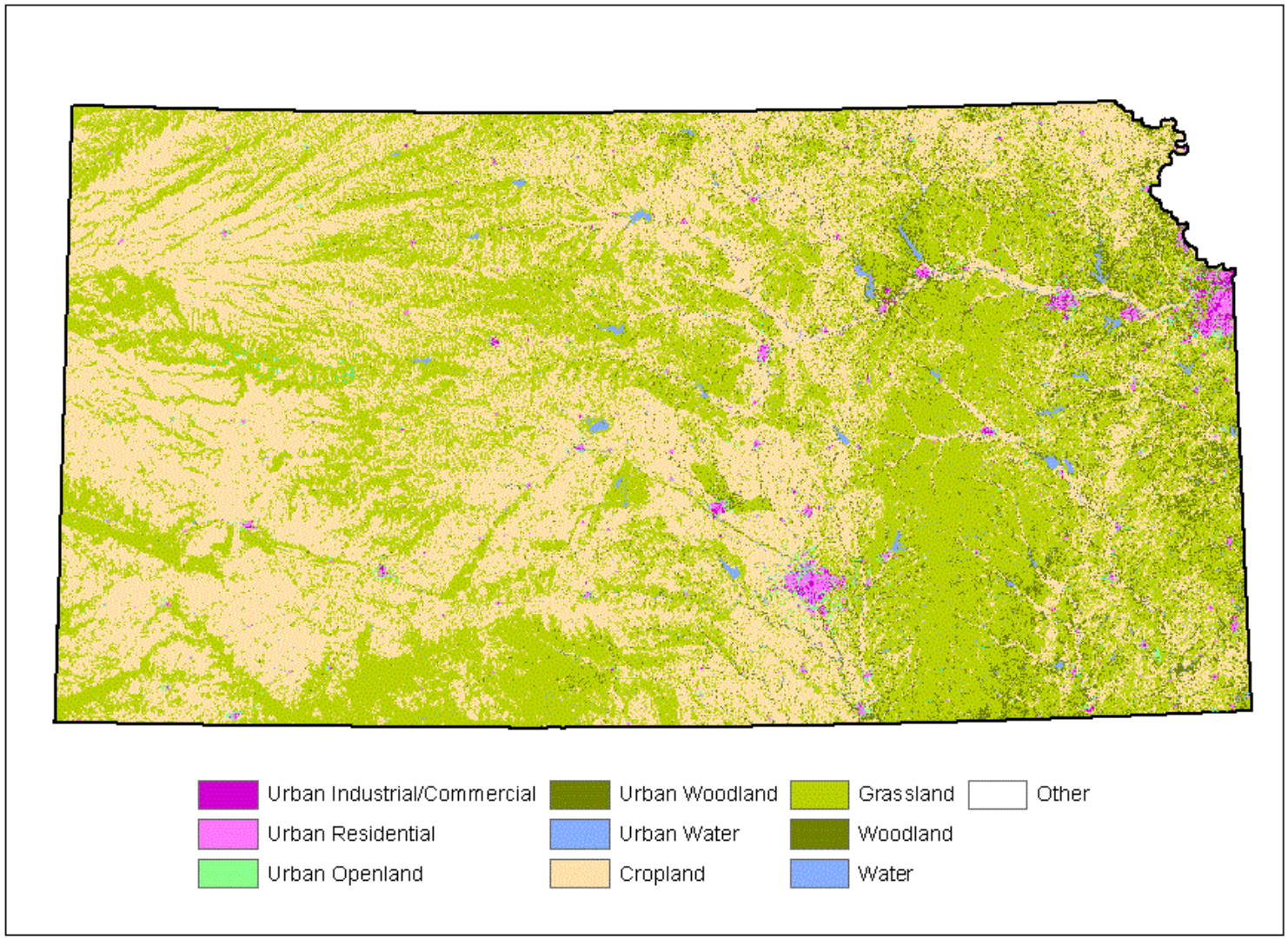

Figure 2. The 2015 Kansas Land Cover Patterns map developed using the Cropland Data Layer and ancillary data sources.

Accuracy Assessment

Field campaigns for accuracy assessments can be costly and time-consuming endeavors. Rather than conducting an independent field campaign for the accuracy assessment, two existing databases were used to assess the accuracy of the 2015 land cover map. The 2015 Common Land Unit (CLU) dataset was used to assess the accuracy of mapped grassland and cropland and the Kansas GAP vegetation database was used to assess the accuracy of mapped woodlands. The Kansas GAP vegetation database is a digital database of sample sites used for training and validation of the Kansas Vegetation Map (Egbert *et al.*, 2001). Urban and water databases were unavailable, and therefore, manual photo interpretation of high-resolution digital aerial photography was used to assess the accuracy of these land cover classes.

More than thirty thousand sample sites were used to generate the formal accuracy assessment. The formal accuracy assessment consists of an error matrix, an overall accuracy figure, Cohen's Kappa statistic (1960), and for each class, omission accuracy (often referred to as producer accuracy) and commission accuracy (user accuracy).

Sampling Unit:

According to Congalton and Green (1991), the sampling unit dictates the level of detail in the accuracy assessment and the same MMU used for map development should also be used for reference data development. The MMU and the spatial detail of the map were the two factors considered for selecting the appropriate sampling unit.

With the exception of the urban and rural water classes, all land use/land cover classes had MMU's greater than a single pixel. Therefore, single pixels were deemed inappropriate sampling units for the accuracy assessment. Since the land cover map depicts landscape features (i.e., fields of cropland or grassland, stands of trees, etc.), polygon features were selected as the most appropriate sampling unit for the accuracy assessment. The MMU for each land cover class was used as an area threshold for site selection (i.e. polygon features less than the MMU were excluded from the accuracy assessment).

Site Selection and Sample Size:

A stratified random sample by land use/land cover class was used to select sites for the accuracy assessment. Sample size was roughly proportionate to the percent area mapped for each land use/land cover class. According to Congalton and Green (1991), a minimum of 75-100 samples should be used per land use/land cover class when mapping large areas. Seventy-seven sites were selected from the smallest class mapped (Commercial/Industrial, representing 0.28% of the total study area). The numbers of samples selected for the additional map classes were determined using roughly the same sample-size-to-area-mapped ratio, with the exception the woodland class, which lacked the available data to maintain a similar proportion (Table 6). A total of 18,445 sites were used to assess the accuracy of the land cover map.

Table 6. Number of samples for the accuracy assessment by LULC class, roughly proportioned by mapped area.

LULC Class	Sample Size
Urban Commercial/Industrial	77
Urban Residential	84
Urban Openland	172
Cropland	8,232
Grassland	7,187
CRP	0
Urban and Rural Woodland	609
Urban and Rural Water	2,084
Other	0
Total	*18,445*

The approach and methods used to generate ground reference data for land cover class are described below.

Urban:

Polygons within urban areas were randomly selected from the land cover map. Randomly selected polygons were visually interpreted using the 2015 NAIP as ground reference and assigned an urban class. For the accuracy assessment, urban water and urban woodland were grouped with rural water and woodland classes.

Water:

Two hundred two-square mile areas were randomly selected from the statewide public land survey system (PLSS) data layer. For each selected area, water bodies larger than 30 m x 30 m (one TM pixel) were identified on the 2015 NAIP and digitized. Because many streams in the study area are ephemeral, only standing water bodies were represented in the accuracy assessment.

Grasslands:

Dominant grass types (e.g. Fescue, Brome, Native, Big Blue, etc.) specified by the attribute "TYPE_ABBR" in the CLU database were subset from the CLU database. Several grassland features and types were excluded from the accuracy assessment. The description and rationale for the exclusions follow.

- Uncommon grass types, defined as representing less than 100 acres in the state (as determined by the CLU database), and grasses grown in a crop type fashion for sod (e.g. Crabgrass, Turf, Zoysia), were excluded from the site selection process.
- The 30m spatial resolution of Landsat Thematic Mapper is too coarse to map many grass waterway features (grass planted in drainage routes in crop fields to reduce soil

erosion). Because of this limitation, grass waterway features were excluded from the accuracy assessment. These features were identified as having a relatively high perimeter-to-area ratio. Specifically, grassland features with a perimeter-to-area threshold greater than 45.2 were eliminated from the accuracy assessment site selection process.

Woodlands:

Accuracy levels for the rural and urban woodland classes were assessed using the Kansas GAP vegetation database. The woodland polygons from the GAP database were overlaid on 2015 NAIP and sample sites with positional accuracy problems or sample sites that fell on non-woodland, were modified or deleted from the database. To ensure adequate class representation, additional urban woodland sites were collected using manual photo interpretation techniques.

Other:

The "other" class was not included in the accuracy assessment since the class represents such a small percentage (0.07%) of the study area and is a rare, catch-all class, (e.g. the class represents bare earth (other than tilled cropland), rock outcrops, sandbars, and man-made features). Therefore, a random, non-clustered dataset for use in the accuracy assessment could not be developed.

Accuracy Assessment Results:

The overall accuracy of the map was 93.3%, easily surpassing the goal of achieving an accuracy level greater than 85%. The Cohen KAPPA statistic was 89.4%. User and Producer accuracies are reported in Table 7. User and Producer accuracies vary by land cover class and rural classes have higher accuracy levels (92-98%) than urban classes (35-67%) (Table 7). Of 8,232 cropland reference sites used in the accuracy assessment, 103 were misclassified as grassland (Table 8). Of the 7,187 grassland sites, only 57 were misclassified as cropland and 297 were misclassified as woodland. The error matrix for the formal accuracy assessment is in Table 8.

Table 7. User and Producer accuracy levels by land use/land cover type.

LULC Class	LULC Code	User Accuracy (%)	Producer Accuracy (%)
Urban Commercial Industrial	11	61.8	61.0
Urban Residential	12	35.6	67.9
Urban Openland	13	65.2	62.2
Cropland	20	98.7	98.6
Grassland	30	92.1	94.98
Woodland (rural and urban)	14 & 40	63.2	97.7
Water (rural and urban)	15 & 50	99.5	74.5
Other	60	NA	NA

Table 8. Error matrix for the 2005 Kansas Land Cover Patterns map. The error matrix is a cross-tabulation between the map and ground reference data and is used to calculate accuracy levels.

Ground Reference Data

Classified Map											
Land Cover Class		**Commercial/ Industrial**	**Residential**	**Urban Openland**	**Cropland**	**Grassland**	**CRP**	**Woodland**	**Water**	**Other**	
	Code	**11**	**12**	**13**	**20**	**30**	**31**	**40**	**50**	**60**	***Row Total***
Commercial/Industrial	**11**	**47**	23	4					2		76
Residential	**12**	21	**57**	61		1		1			160
Urban Openland	**13**	9	4	**107**	6	8		2	28		164
Cropland	**20**				**8,117**	57			48		8,222
Grassland	**30**				103	**6,819**		11	473		7,406
CRP	**31**										0
Woodland	**40**				5	297		**595**	44		941
Water	**50**				1	5			**1,469**		1,475
Other	**60**										1
Column Total		77	84	172	8,232	7,187		609	2,084		18,445

Summary

The 2015 Kansas Land Cover Patterns map represents Phase 1 of a two-phase mapping initiative. The map is designed to be explicitly comparable to the 1990 and 2005 Kansas Land Cover Patterns maps to provide opportunities to identify and examine how the Kansas landscape has changed over time.

The map contains ten land use/land cover classes. The positional accuracy and spatial resolution of the map are appropriate for producing 1:50,000 scale maps. The map is not intended to define precise boundaries between landscape features and while the source satellite images have a spatial resolution of 30 m x 30 m, the minimum map unit varies by land cover class and ranges between 0.22 to 5.12 acres.

The formal accuracy assessment reports an overall accuracy level of 93.3%. User and Producer accuracies vary by land cover class and rural classes have higher accuracy levels (92-98%) than urban classes (35-67%). Users are encouraged to reference the reported accuracy levels in this report and/or metadata when using the 2015 Kansas Land Cover Patterns map. Digital versions of the map, metadata, and accuracy assessment can be accessed from the Data Access and Support Center (DASC) website of the Kansas Geological Survey (http://www.kansasgis.org/).

During Phase 2, subclasses will be mapped to produce a Modified Level II map of Kansas using Landsat TM data and 250-meter resolution time-series MODIS NDVI imagery. To produce the Modified Level II map, cropland and grassland will be broken into subclasses. Cropland from the Level I map will be used as a mask to identify and isolate cropland areas in the MODIS imagery. A supervised classification will be used to map dominant cropy types in Kansas.. The cropland pixels in the Level I map will be reassigned to the cropland subclasses. Likewise grassland from the Level I map will be used to identify and isolate grassland pixels in Landsat and MODIS imagery. A supervised classification will be used to map cool-season and warm-season grasslands. Next, grassland pixels in the Level I map will be reassigned to the grassland subclass. A formal accuracy assessment of the Level II map will be performed and delivered along with the digital map and final report.

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List of Acronyms and Abbreviations

CDL	Cropland Data Layer
CLU	Common Land Unit
DASC	Data Access and Support Center
DTC	Decision Tree Classifier
FID	Feature ID
FSA	Farm Service Agency
KARS	Kansas Applied Remote Sensing Program
KBS	Kansas Biological Survey
KGS	Kansas Geological Survey
KDOT	Kansas Department of Transportation
KDWPT	Kansas Department of Wildlife, Parks and Tourism
LULC	Land Use / Land Cover
MMU	Minimum Mapping Unit
MODIS	Moderate Resolution Imaging Spectroradiometer
NAIP	National Agriculture Imagery Program
NDVI	Normalized Difference Vegetation Index
NRCS	Natural Resources Conservation Service
PLSS	Public Land Survey System
TM	Thematic Mapper
USDA	US Department of Agriculture