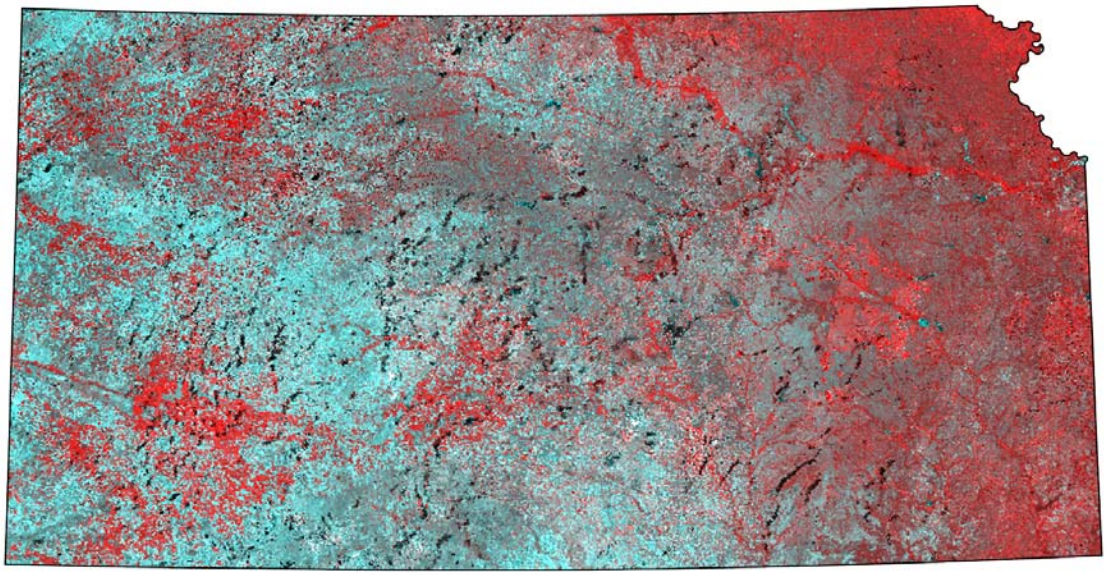
The Kansas Satellite Image Database:
2002-2003 Thematic Mapper Imagery
2001 ASTER Imagery
2001-2003 MODIS Imagery

Final Report



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Credits

The Kansas Satellite Image Database (KSID) 2002-2003 was created at the Kansas Applied Remote Sensing (KARS) Program of the Kansas Biological Survey. The database was funded by the Kansas GIS Policy Board with funds from the Kansas Water Plan that are administered by the Kansas Water Office (Contract 2004-2099).

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Introduction

This report summarizes the research methods and results for construction of the Kansas Satellite Image Database (KSID) 2002-2003. The KSID consists of three image databases derived from three satellite sensors: 1) 2002-2003 terrain-corrected, precision rectified spring, summer, and fall Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper (ETM+) imagery tiled by county; 2) precision rectified 2001 Advanced Spaceborne Thermal Emission and Reflectance (ASTER); and, 3) rectified 2001-2003 Moderate Resolution Imaging Spectroradiometer (MODIS) NDVI composites. All databases are in GeoTiff format.

The addition of the MODIS and ASTER databases to the existing TM/ETM+ satellite image database provides users with a wide variety of data containing high to coarse spatial resolution (15m to 250m) with varying temporal resolutions. The seamless MODIS NDVI database provides a quick, statewide assessment of vegetation condition throughout the year while the ASTER database augments the baseline Landsat TM/ETM+ database by providing up-to-date high-spatial resolution imagery over portions of Kansas.

The KSID is comprised of raw data and visual products. The raw data set includes the seven (TM) or eight (ETM+) geometrically corrected Landsat bands, the three ASTER bands, and the MODIS sixteen-day Normalized Difference Vegetation Index (NDVI) composites; all values are in their original units. The visual data set consists of: TM/ETM+ and scaled MODIS NDVI images, TM/ETM+ and ASTER false-color infrared composites, and TM/ETM+ resolution-enhanced natural color composites.

KSID was developed to provide federal, state, and local government and non-government entities and individuals a source for deriving recent land cover for application in natural resource management. In addition, the database is an essential component that will enable a future update to the Kansas land cover map, a core spatial database of Kansas. This satellite imagery database is also designed to provide educational and research opportunities using recent satellite imagery in K-12 classrooms and state universities.

Methods

TM and ETM+

Data Acquisition

Forty-eight Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) scenes were obtained to compile a multitemporal (spring, summer, and fall), nearly cloud-free satellite image database for the state of Kansas. The primary criteria for scene selection, therefore, were the date of acquisition for the image and little or no cloud contamination (Table 1).

The Landsat satellite imagery (20 ETM+ scenes and 28 TM scenes) was ordered through the USGS Earth Resources Observation Systems (EROS) Data Center (EDC) and were

processed using National Land Archive Production System (NLAPS). The scenes were level 1G products.

Table 1. Dates for Landsat ETM+ and TM scenes in the Kansas Satellite Image Database: 2002-2003.

Path/Row	Image Date		
	Spring	**Summer**	**Fall**
26/34	04/28/2002	*07/09/2002*	10/05/2002
27/32	04/22/2003	07/24/2002	*10/0/72003*
27/33	04/22/2003	*07/03/2003*	*10/23/2003*
27/34	04/22/2003	*07/03/2003*	*10/23/2003*
28/32	*04/21/2003*	*07/10/2003*	*10/14/2003*
28/33	*04/21/2003*	*07/10/2003*	*10/14/2003*
28/34	*04/21/2003*	*07/10/2003*	*10/14/2003*
29/32	*04/12/2003*	*07/17/2003*	*10/05/2003*
29/33	*04/12/2003*	*07/17/2003*	*09/19/2003*
29/34	*04/12/2003*	*07/17/2003*	*09/19/2003*
30/32	04/24/2002	07/29/2002	09/15/2002
30/33	04/24/2002	07/29/2002	09/15/2002
30/34	04/24/2002	*07/21/2002*	09/15/2002
31/32	04/15/2002	07/20/2002	*09/30/2002*
31/33	04/15/2002	06/18/2002	*09/30/2002*
31/34	04/15/2002	06/18/2002	*09/30/2002*

Italicized text indicates Landsat 5 data

The Landsat 7 ETM+ sensor collects data from eight bands of the electromagnetic (EM) spectrum: 1) blue (0.45-0.52 µm); 2) green (0.53-0.61 µm); 3) red (0.63-0.69 µm); 4) near-infrared (0.75-0.90 µm); 5) mid-infrared (1.55-1.75 µm); 6) thermal (10.4-12.5 µm); 7) mid-infrared (2.09-2.35 µm); and 8) panchromatic (0.52-0.90 µm). All bands have a spatial resolution of 30 m except for the thermal band (60 m) and the panchromatic band (15 m). Data for the thermal band is collected in both a high and low gain state (for more information regarding gain states, refer to *Landsat Data Users Handbook*, Chapter 6: Data Properties (http://ltpwww.gsfc.nasa.gov/IAS/handbook/handbook_toc.html).

The Landsat 5 TM sensor collects data in seven bands of the EM spectrum. The primary differences between TM and ETM+ are 1) the absence of the panchromatic band, 2) the thermal band has a spatial resolution of 90 m, and 3) data for the thermal band is only collected for one gain state.

The Landsat 7 ETM+ sensor experienced an uncorrectable data anomaly (gaps in the imagery) due to failure of its Line Scan Corrector and ceased data collection in May 2003. Although the USGS EROS Data Center was able to fill the gaps with data from older scenes and began offering this product in the fall 2003, this product was deemed unsuitable for use in the KSID. The Landsat ETM+ problem reduced the amount of cloud-free imagery that could be purchased for the 2002-2003 TM/ETM+ database and forced us to rely more heavily on Landsat 5 imagery.

While best available imagery were acquired for the 2002-2003 TM/ETM+ image database, not all best available imagery were cloud-free. As a result, ten counties contained some type and extent of cloud cover (Table 2). County images contaminated with haze were left as-is. Those counties included Comanche, Jewell, Smith, Ellis, Osborne, and Sherman counties. Similarly, county images with 1-3 scattered popcorn clouds were also left as-is. Those counties included Nemaha, Pottawatomie, Riley, Mitchell, and Cheyenne counties. For four county images contaminated by clouds, a cloud-free product was created by substituting imagery from a cloud-free overlapping scene. These counties include Atchison, Cloud, Clark, and Thomas. For these counties, two summer multispectral and multispectral derived products (one containing clouds and the other cloud-free) are available in the 2003-2004 TM/ETM+ satellite image database.

Data Pre-processing

The Landsat satellite imagery (20 ETM+ scenes and 28 TM scenes) were purchased from the USGS Earth Resources Observation Systems (EROS) Data Center (EDC). The imagery were ordered with the following specifications: terrain corrected, 30-m pixel size, cubic convolution resampling, National Land Archive Production System (NLAPS) data format in the Universal Transverse Mercator Projection, WGS84.

Each ETM+ and TM scene was imported from its native format on CD-ROM to the local hard drive using ERDAS Imagine software. Each scene was inspected for cloud cover, line dropout, and system noise. As an additional check of a scene's spatial accuracy, each

scene was compared to a corresponding scene from the KSID 2000-2001 TM/ETM+ archive . The scenes were then reprojected to UTM, NAD83.

Table 2. Images and counties affected by cloud cover. Cloud location identifies the general location of the cloud cover within each county. Some counties were affected by haze, which was left as is. The counties highlighted in bold are those where cloud cover was eliminated by using an overlapping satellite image. The overlapping image date is listed in the column of the table.

Path/Row	Date	County	Cloud Location	Cloud Free Date
27/33	07/03/2003	**Atchison**	Northeast	07/24/2003
28/32	07/10/2003	Nemaha	East Central, popcorn clouds	NA
28/33	07/10/2003	Pottawatomie	Northwest & West Central , popcorn clouds	NA
		Riley	Central, popcorn clouds	NA
29/32	07/17/2003	Jewell	South & Central, haze	NA
		Smith	Southwest, haze	NA
29/33	07/17/2003	Osborne	West, haze	NA
		Cloud	East	07/10/2003
		Mitchell	East Central, popcorn cloud	NA
29/34	07/17/2003	Comanche	Southwest, haze	NA
		Clark	Central and south	07/21/2003
31/32	07/17/2003	Cheyenne	Southwest, popcorn clouds	NA
31/33	06/18/2002	**Thomas**	North	07/20/2002
		Sherman	Northeast, haze	NA

Product Generation

Product 1, Raw Imagery.

After pre-processing the data, the ETM+ and TM scenes were clipped to county boundaries to create the raw imagery data set. Appendix 1 contains a listing of scenes used to cover each county. Twenty-three counties required two images to be spliced together to obtain the full county extent before clipping. The county boundaries used for clipping were from the Kansas Cartographic Database. Models were written in ERDAS Imagine to automate the clip and splice/clip process.

After creating the county-tiled raw data set, three image products were created: a Normalized Difference Vegetation Index (NDVI) image, a false-color composite image, and a resolution enhanced natural color composite image.

Product 2, NDVI Image.

NDVI was calculated using the standard equation (TM4 - TM3)/(TM4 + TM3) where Landsat TM band 4 is the near-infrared band and Landsat TM band 3 is the red band. The data values were then rescaled from an original range of -1.0 to +1.0 to an 8-bit range of 0 to 255. NDVI is a measure of vegetation greenness and provides an indication of vegetation condition or health. The higher the NDVI values, the more photosynthetically active vegetation is present. Conversely, low NDVI values indicate little or no vegetation.

Product 3, False-color Composite Image.

False-color-infrared composites were created by assigning the red, green, and blue colors to TM bands 4, 3, and 2, respectively. The false-color composite (FCC) visually resembles a color-infrared photograph. The FCC is useful because it is easy to differentiate between vegetated and non-vegetated features. Vegetation is highly reflectively of near-IR energy and appears red. Various shades of red indicate vegetated features, while blue and gray areas indicate non-vegetated features. Because water absorbs near-IR energy, water bodies are also more easily identified in a FCC image. This is especially true for water bodies with low suspended sediment loads, which often appear black.

Product 4, Resolution-enhanced Image.

The resolution-enhanced natural color composites were created by merging the panchromatic band with multispectral bands 7, 5, and 3. Because Landsat 5 images (which do not contain a panchromatic band) were used for 58% of the archive, it was necessary to use the panchromatic band from an off-date ETM+ image to create the resolution enhanced product (Table 3). For some Landsat 5 scenes, a KSID 2002-2003 ETM+ image was used. For other Landsat 5 scenes, a KSID 2000-2001 ETM+ image was use.

This product is actually a simulation of a natural color image because the resolution-enhanced image utilizes two infrared bands (7 and 5). The advantage to using the IR

bands is a haze-free image with superior image contrast. The trade-off is that the color of some features is exaggerated (e.g., dry or senescent vegetation will appear as shades of purple and orange rather than taupe and tan) and in some cases may be inaccurate (e.g., wet bare fields appear blue-gray).

GeoTIFF Export

All county-tiled data products were exported from ERDAS Imagine files to GeoTIFF files. To minimize the need for users to adjust image contrast and brightness when displaying the images, data values were rescaled (stretched) for the panchromatic, false-color infrared composite, and the resolution-enhanced natural color composite images. The contrast stretch uses the following steps:

1. Calculate the mean and standard deviation for the entire image .

2. Calculate two gray-level values (Z1 and Z2), which are X standard deviation units below (Z1) and above (Z2) the mean. Where X = 3.0 for panchromatic imagery, X = 2.0 for FCC imagery, and X = 2.2 for resolution-enhanced imagery.

3. The range Z1 to Z2 represents the range of gray-levels that will be mapped to the new range of 0 to 255. The input range of 1 to Z1 is mapped as 1 and the input range of Z2 to 255 is mapped as 255 (saturation).

The general equation for stretching image data values between Z1 and Z2 is:

stretch value = (original image value - Z1) * (255 / (Z2 - Z1))

File Name Convention: File names consist of the 2-letter county code, an underline ('_'), a six-digit date (month,day,year), and a 3-5 letter mnemonic for the image type.

Table 3. Multispectral and panchromatic dates used to create the fused image products. Fused image products for an ETM+ scene were created using the multispectral and panchromatic bands from the same date. When the fused product was created using TM multispectral data, a panchromatic band from an ETM+ scene with the closest date was used to create the fused product. Because all imagery from paths 28 and 29 were TM data, panchromatic bands from ETM+ images from the KSID 2000-2001archive were used to create the fused products.

Path/Row	Image Date	
	Multispectral	Panchromatic
26/34	04/28/2002	04/28/2002
	07/09/2002	04/28/2002
	10/05/2002	10/05/2002
27/32	04/22/2003	04/22/2003
	07/24/2002	07/24/2002
	10/07/2003	07/24/2002
27/33	04/22/2003	04/22/2003
	07/03/2003	04/22/2003
	10/23/2003	04/22/2003
27/34	04/22/2003	04/22/2003
	07/03/2003	04/22/2003
	10/23/2003	04/22/2003
28/32	04/21/2003	05/09/2001
	07/10/2003	08/13/2001
	10/14/2003	10/16/2001
28/33	04/21/2003	05/09/2001
	07/10/2003	07/09/2000
	10/14/2003	10/16/2001
28/34	04/21/2003	05/09/2001
	07/10/2003	07/09/2000
	10/14/2003	10/16/2001
29/32	04/12/2003	05/13/2001
	07/17/2003	07/03/2001
	10/05/2003	09/21/2001

29/33	04/12/2003	05/16/2001
	07/17/2003	08/04/2001
	09/19/2003	09/21/2001
29/34	04/12/2003	05/16/2001
	07/17/2003	08/04/2001
	09/19/2003	10/23/2001
30/32	04/24/2002	04/24/2002
	07/29/2002	07/29/2002
	09/15/2002	09/15/2002
30/33	04/24/2002	04/24/2002
	07/29/2002	07/29/2002
	09/15/2002	09/15/2002
30/34	04/24/2002	04/24/2002
	07/29/2002	09/15/2002
	09/15/2002	09/15/2002
31/32	04/15/2002	04/15/2002
	07/20/2002	07/20/2002
	09/30/2002	07/20/2002
31/33	04/15/2002	04/15/2002
	06/18/2002	06/18/2002
	09/30/2002	06/18/2002
31/34	04/15/2002	04/15/2002
	06/18/2002	06/18/2002
	09/30/2002	06/18/2002

ASTER

Data Acquisition

The ASTER data were ordered free of charge from EROS Data Center. All available data covering all or part of Kansas were acquired. ASTER is an experimental research sensor and, unlike TM, ETM+ and MODIS sensors, data are not continuously collected but are only collected when an order has been placed. Therefore, the ASTER database does not provide complete coverage of the state.

ASTER collects data from 14 spectral bands and has a swath width of 60 kilometers. Three bands have a spatial resolution of 15 meters. Six bands have a spatial resolution of

30 meters and the remaining five bands have a spatial resolution of 90 meters. We acquired the 15-meter data which includes three bands: 1) green (0.52-0.60 μm); 2) red (0.63 - 0.69 μm); 3) near-infrared (0.76-0.86 μm). For more information regarding ASTER data go to http://asterweb.jpl.nasa.gov/instrument/characterl.htm.

Data Pre-processing

Each ASTER scene was electronically transferred and imported from its native format to the local hard drive using ERDAS Imagine software. Each scene was inspected for cloud cover, line dropout, and system noise. Of the 183 scenes acquired, 61 scenes met our data quality standards and are included in the database. After data were inspected, the images were precision rectified (RMSE < 5m) and reprojected from their native Universal Transverse Mercator (UTM) projection (no datum or spheroid specified) to UTM datum NAD83, and spheroid GRS1980 using the cubic convolution resampling technique.

Product Generation

Product 1, False-color Composite Image.

False-color-infrared composites were created by assigning red, green, and blue to ASTER bands 3, 2,and 1, respectively. The false-color composite (FCC) visually resembles a color-infrared photograph. The FCC is useful because it easily differentiates between vegetated and non-vegetated features. Vegetation is highly reflectively of near-IR energy and appears red. Various shades of red indicate vegetated features, while blue and gray areas indicate non-vegetated features. Because water absorbs near-IR energy, water bodies are also more easily identified in a FCC image. This is especially true for water bodies with low suspended sediment loads, which often appear black.

GeoTIFF Export

The false color composite data products were exported from ERDAS Imagine files to GeoTIFF files.

File Name Convention:

The file names consist of a two character county abbreviation that corresponds to the county most covered by the ASTER scene. Additional two character county abbreviations are used for counties partially covered by the ASTER scene. The next six characters correspond to the image date (month, day, year) followed by three characters describing the product type (fcc = false color-composite).

MODIS

Data Acquisition

The MODIS 16-day composite NDVI data were acquired free of charge from the USGS Earth Resources Observation Systems (EROS) Data Center Land Processes Distributed Active Archive Center (LPDAAC). The original data were in Hierarchical Data Format (HDF) and had a native projection of Sinusoidal, WGS 84.

The MODIS sensor collects data from 36 bands of the electromagnetic (EM) spectrum in three spatial resolutions (250 m, 500 m, and 1 km). Only the 250 m NDVI data are currently included in the KSID. Bands 1 and 2 (0.62-0.67 µm, and 0.84-0.87 µm) bands were used by LPDAAC to generate the NDVI composites using the standard formula (NIR + Red/ NIR - Red) where MODIS band 2 is the near-infrared band and band 1 is the red band. An atmospheric correction was applied and then the data was converted to surface reflectance using other bands. For more information on this process visit http://edcdaac.usgs.gov/modis/mod13q1v4.asp.

Data Pre-processing

Data were obtained to compile a three-year (2001-2003) multitemporal NDVI image database. MODIS NDVI scenes from three 10° x 10° lat/long tiles (tiles H09V05, H10V05, and H10V09) are required to provide complete coverage of Kansas. A statewide image was generated by mosaicking the three MODIS NDVI tiles. Each NDVI image depicts a 16-day composite period. See Table 5 for a list of calendar days corresponding to each 16-day composite.

Each 10° x 10° lat/long tile of MODIS NDVI data was imported from its native format on DVD to the local hard drive using ERDAS Imagine software. After the NDVI data were imported, the individual tiles for a single date were mosaicked to create a single image. The mosaicked images were then subset to the Kansas political boundaries using a vector data file. Lastly, the Kansas images were reprojected from Sinusoidal to Lambert Conformal Conic, Clarke 1866, NAD27 using the nearest neighbor resampling technique.

Product Generation

Product 1, Raw NDVI.

After pre-processing the data, the MODIS NDVI composites were clipped to the state boundary to create the raw NDVI data set. The valid data range for raw NDVI is –2000 to 10,000.

Product2, Scaled NDVI.

To generate a visual product, raw NDVI values ranging from -2000 to 10,000) were rescaled to 0-200. A linear color ramp was then applied to each image to where intensities of browns to greens represent relatively low NDVI to high NDVI values.

GeoTIFF Export

All statewide NDVI composites were exported from ERDAS Imagine files to GeoTIFF files.

File Name Convention: File names consist of three letters identifying the MODIS sensor (‘mod’), the spatial resolution of the data (‘250’), an underline ('_'), the year, the composite period number, the product (‘NDVI’), and ('_'), and the terms "raw" or "scaled" indicating the data value range. For example, the file named mod250_2003p13NDVI_scaled.tif contains the MODIS NDVI composite Period 13 dating from July12 to July27, 2003.

Table 4. MODIS NDVI composite periods and corresponding calendar days.

16-day Composite Period	Start Date	End Date
1	January 1	January 16
2	January 17	February 1
3	February 2	February 17
4	February 18	March 5
5	March 6	March 21
6	March 22	April 6
7	April 7	April 22
8	April 23	May 8
9	May 9	May 24
10	May 25	June 9
11	June 10	June 25
12	June 26	July 11
13	July 12	July 27
14	July 28	August 12
15	August 13	August 28
16	August 29	September 13
17	September 14	September 29
18	September 30	October 15
19	October 16	October 31
20	November 1	November 16
21	November 17	December 2
22	December 3	December 18
23	December 19	December 31

Appendix 1

Scenes used to create the county-tiled satellite image database.

County	Path/Row	Image Date		
		Spring	Summer	Fall
Allen	27/34	04/22/2003	07/03/2003	10/23/2003
Anderson*	27/33	04/22/2003	07/03/2003	10/23/2003
	27/34	04/22/2003	07/03/2003	10/23/2003
Atchison	27/33	04/22/2003	07/03/2003	10/23/2003
Barber	29/34	04/12/2003	07/17/2003	09/19/2003
Barton	29/33	04/12/2003	07/17/2003	09/19/2003
Bourbon	26/34	04/28/2002	07/09/2002	10/05/2002
Brown	27/32	04/22/2003	07/03/2003	10/07/2003
Butler	28/34	04/21/2003	07/10/2003	10/14/2003
Chase	28/33	04/21/2003	07/10/2003	10/14/2003
Chautauqua	27/34	04/22/2003	07/03/2003	10/23/2003
Cherokee	26/34	04/28/2002	07/09/2002	10/05/2002
Cheyenne*	31/32	04/15/2002	07/20/2002	09/30/2002
	31/33	04/15/2002	06/18/2002	09/30/2002
Clark*	29/34	04/12/2003	07/17/2003	09/19/2003
	30/34	04/24/2002	07/29/2002	09/15/2002
Clay	28/33	04/21/2003	07/10/2003	10/14/2003
Cloud*	29/32	04/12/2003	07/17/2003	10/05/2003
	29/33	04/12/2003	07/17/2003	09/19/2003
Coffey*	27/33	04/22/2003	07/03/2003	10/23/2003
	27/34	04/22/2003	07/03/2003	10/23/2003
Comanche	29/34	04/12/2003	07/17/2003	09/19/2003
Cowley	28/34	04/21/2003	07/10/2003	10/14/2003
Crawford	26/34	04/28/2002	07/09/2002	10/05/2002
Decatur*	30/32	04/24/2002	07/29/2002	09/15/2002
	30/33	04/24/2002	07/29/2002	09/15/2002
Dickinson	28/33	04/21/2003	07/10/2003	10/14/2003

Doniphan	27/32	04/22/2003	07/24/2002	10/07/2003
Douglas	27/33	04/22/2003	07/03/2003	10/23/2003
Edwards	29/34	04/12/2003	07/17/2003	09/19/2003
Elk	27/34	04/22/2003	07/03/2003	10/23/2003
Ellis*	29/33	04/12/2003	07/17/2003	09/19/2003
	30/33	04/24/2002	07/29/2002	09/15/2002
Ellsworth	29/33	04/12/2003	07/17/2003	09/19/2003
Finney*	30/34	04/24/2002	0721/2002	09/15/2002
	30/33	04/24/2002	07/29/2002	09/15/2002
Ford	30/34	04/24/2002	07/29/2002	09/15/2002
Franklin	27/33	04/22/2003	07/03/2003	10/23/2003
Geary	28/33	04/21/2003	07/10/2003	10/14/2003
Gove	30/33	04/24/2002	07/29/2002	09/15/2002
Graham	30/33	04/24/2002	07/29/2002	09/15/2002
Grant	31/34	04/15/2002	06/18/2002	09/30/2002
Gray	30/34	04/24/2002	07/29/2002	09/15/2002
Greeley	31/33	04/15/2002	06/18/2002	09/30/2002
Greenwood	27/34	04/22/2003	07/03/2003	10/23/2003
Hamilton*	31/33	04/15/2002	06/18/2002	09/30/2002
	31/34	04/15/2002	06/18/2002	09/30/2002
Harper	28/34	04/21/2003	07/10/2003	10/14/2003
Harvey	28/34	04/21/2003	07/10/2003	10/14/2003
Haskell	30/34	04/24/2002	07/29/2002	09/15/2002
Hodgeman*	30/33	04/24/2002	07/29/2002	09/15/2002
	30/34	04/24/2002	07/29/2002	09/15/2002
Jackson	27/33	04/22/2003	07/03/2003	10/23/2003
Jefferson	27/33	04/22/2003	07/03/2003	10/23/2003
Jewell	29/32	04/12/2003	07/17/2003	10/05/2003
Johnson	27/33	04/22/2003	07/03/2003	10/23/2003

Kearny*	31/33	04/15/2002	06/18/2002	09/30/2002
	31/34	04/15/2002	06/18/2002	09/30/2002
Kingman*	28/34	04/21/2003	07/10/2003	10/14/2003
	29/34	04/12/2003	07/17/2003	09/19/2003
Kiowa	29/34	04/12/2003	07/17/2003	09/19/2003
Labette	27/34	04/22/2003	07/03/2003	10/23/2003
Lane	30/33	04/24/2002	07/29/2002	09/15/2002
Leavenworth	27/33	04/22/2003	07/03/2003	10/23/2003
Lincoln	29/33	04/12/2003	07/17/2003	09/19/2003
Linn*	26/34	04/28/2002	07/09/2002	10/05/2002
	27/33	04/22/2003	07/03/2003	10/23/2003
Logan	31/33	04/15/2002	06/18/2002	09/30/2002
Lyon*	27/33	04/22/2003	07/03/2003	10/23/2003
	27/34	04/22/2003	07/03/2003	10/23/2003
Marion*	28/33	04/21/2003	07/10/2003	10/14/2003
	28/34	04/21/2003	07/10/2003	10/14/2003
Marshall	28/32	04/21/2003	07/10/2003	10/14/2003
McPherson	28/33	04/21/2003	07/10/2003	10/14/2003
Meade	30/34	04/24/2002	07/29/2002	09/15/2002
Miami	27/33	04/22/2003	07/03/2003	10/23/2003
Mitchell	29/33	04/12/2003	07/17/2003	09/19/2003
Montgomery	27/34	04/22/2003	07/03/2003	10/23/2003
Morris	28/33	04/21/2003	07/10/2003	10/14/2003
Morton	31/34	04/15/2002	06/18/2002	09/30/2002
Nemaha	28/32	04/21/2003	07/10/2003	10/14/2003
Neosho	27/34	04/22/2003	07/03/2003	10/23/2003
Ness	30/33	04/24/2002	07/29/2002	09/15/2002
Norton*	30/32	04/24/2002	07/29/2002	09/15/2002
	30/33	04/24/2002	07/29/2002	09/15/2002

Osage	27/33	04/22/2003	07/03/2003	10/23/2003
Osborne	29/33	04/12/2003	07/17/2003	09/19/2003
Ottawa	28/33	04/21/2003	07/10/2003	10/14/2003
Pawnee*	29/33	04/12/2003	07/17/2003	09/19/2003
	29/34	04/12/2003	07/17/2003	09/19/2003
Phillips	30/32	04/24/2002	07/29/2002	09/15/2002
Pottawatomie	28/33	04/21/2003	07/10/2003	10/14/2003
Pratt	29/34	04/12/2003	07/17/2003	09/19/2003
Rawlins	31/32	04/15/2002	07/20/2002	09/30/2002
Reno*	28/34	04/21/2003	07/10/2003	10/14/2003
	29/34	04/12/2003	07/17/2003	09/19/2003
Republic	29/32	04/12/2003	07/17/2003	10/05/2003
Rice	29/33	04/12/2003	07/17/2003	09/19/2003
Riley	28/33	04/21/2003	07/10/2003	10/14/2003
Rooks	30/33	04/24/2002	07/29/2002	09/15/2002
Rush	29/33	04/12/2003	07/17/2003	09/19/2003
Russell	29/33	04/12/2003	07/17/2003	09/19/2003
Saline	28/33	04/21/2003	07/10/2003	10/14/2003
Scott	30/33	04/24/2002	07/29/2002	09/15/2002
Sedgwick	28/34	04/21/2003	07/10/2003	10/14/2003
Seward	30/34	04/24/2002	07/29/2002	09/15/2002
Shawnee	27/33	04/22/2003	07/03/2003	10/23/2003
Sheridan	30/33	04/24/2002	07/29/2002	09/15/2002
Sherman	31/33	04/15/2002	06/18/2002	09/30/2002
Smith*	29/32	04/12/2003	07/17/2003	10/05/2003
	29/33	04/12/2003	07/17/2003	09/19/2003
Stafford*	29/33	04/12/2003	07/17/2003	09/19/2003
	29/34	04/12/2003	07/17/2003	09/19/2003
Stanton	31/34	04/15/2002	06/18/2002	09/30/2002

Stevens	30/34	04/24/2002	07/29/2002	09/15/2002
Sumner	28/34	04/21/2003	07/10/2003	10/14/2003
Thomas	31/33	04/15/2002	06/18/2002	09/30/2002
Trego	30/33	04/24/2002	07/29/2002	09/15/2002
Wabaunsee*	27/33	04/22/2003	07/03/2003	10/23/2003
	28/33	04/21/2003	07/10/2003	10/14/2003
Wallace	31/33	04/15/2002	06/18/2002	09/30/2002
Washington*	28/32	04/21/2003	07/10/2003	10/14/2003
	28/33	04/21/2003	07/10/2003	10/14/2003
Wichita	31/33	04/15/2002	06/18/2002	09/30/2002
Wilson	27/34	04/22/2003	07/03/2003	10/23/2003
Woodson	27/34	04/22/2003	07/03/2003	10/23/2003
Wyandotte	27/33	04/22/2003	07/03/2003	10/23/2003

Counties that were split between two scenes are noted with an asterisk. Many split counties use two scenes from the same date. However, some split counties use scenes from two different dates.

Appendix 2

ASTER scene dates and locations in the KSID archive as of May 2004.

County Majority	Date	Scene Name
Barber	05/16/2001	Ba_051601fcc.tif
Bourbon	04/25/2001	Bb_042501fcc.tif
Bourbon	06/12/2001	Bb_ln_061201fcc.tif
Brown	08/06/2001	Br_dp_080601fcc.tif
Butler	07/21/2001	Bu_gw_cs_mn_072101fcc.tif
Cherokee	06/12/2001	Ck_061201fcc.tif
Cowley	08/29/2001	Cl_082901fcc.tif
Cheyenne	06/06/2001	Cn_060601fcc.tif
Cheyenne	06/15/2001	Cn_ra_061501fcc.tif
Cheyenne	06/15/2001	Cn_ra_sh_th_061501fcc.tif
Chatauqua	08/06/2001	Cq_080601fcc.tif
Crawford	06/12/2001	Cr_ck_061201fcc.tif
Crawford	10/02/2001	Cr_ck_100201fcc.tif
Douglas	08/06/2001	Dg_sn_080601fcc.tif
Dickinson	10/16/2001	Dk_101601fcc.tif
Finney	06/24/2001	Fi_gy_062401fcc.tif
Greeley	06/15/2001	Gl_wh_hm_061501fcc.tif
Gove	06/24/2001	Go_sh_06242001fcc.tif
Grant	05/23/2001	Gt_st_mt_sv_052301fcc.tif
Greenwood	08/06/2001	Gw_wo_wl_080601fcc.tif
Gray	04/30/2001	Gy_fi_hg_043001fcc.tif
Gray	04/30/2001	Gy_fo_043001fcc.tif
Hamilton	06/15/2001	Hm_st_061501fcc.tif
Harper	10/16/2001	Hp_su_101601fcc.tif
Haskell	06/24/2001	Hs_sw_sv_062401fcc.tif
Jewell	12/01/2001	Jw_sm_120101fcc.tif
Lane	06/24/2001	Le_sc_fi_ns_062401fcc.tif
Logan	05/23/2001	Lg_go_052301fcc.tif
Meade	04/30/2001	Me_sw_043001fcc.tif
Montgomery	08/06/2001	Mg_ek_cq_wl_080601fcc.tif
Morris	07/21/2001	Mr_cs_ly_072101fcc.tif
Marshall	07/21/2001	Ms_nm_072101fcc.tif
Morton	05/23/2001	Mt_sv_052301fcc.tif
Nemaha	07/21/2001	Nm_pt_072101fcc.tif
Ness	04/30/2001	Ns_le_tr_043001fcc.tif
Norton	04/30/2001	Nt_043001fcc.tif
Norton	06/24/2001	Nt_dc_062401fcc.tif
Norton	04/30/2001	Nt_pl_043001fcc.tif
Osage	08/06/2001	Os_cf_080601fcc.tif
Rawlins	05/23/2001	Ra_dc_052301fcc.tif

Rice	05/16/2001	Rc_bt_051601fcc.tif
Riley	10/16/2001	Rl_101601fcc.tif
Riley	06/10/2001	Rl_pt_061001fcc.tif
Riley	07/21/2001	Rl_pt_wb_072101fcc.tif
Salina	10/16/2001	Sa_101601fcc.tif
Salina	05/16/2001	Sa_lc_051601fcc.tif
Stafford	05/16/2001	Sf_rn_051601fcc.tif
Sedgwick	06/10/2001	Sg_061001fcc.tif
Sedgwick	06/10/2001	Sg_hv_061001fcc.tif
Sedgwick	10/16/2001	Sg_su_101601fcc.tif
Sherman	06/24/2001	Sh_gh_nt_dc062401fcc.tif
Stanton	06/15/2001	St_mt_061501fcc.tif
Seward	06/24/2001	Sw_sv_062401fcc.tif
Thomas	05/23/2001	Th_sh_052301fcc.tif
Trego	05/16/2001	Tr_ro_051601fcc.tif
Wallace	06/06/2001	Wa_060601fcc.tif
Wallace	06/15/2001	Wa_lg_061501fcc.tif
Wallace	06/06/2001	Wa_sh_060601fcc.tif
Wichita	05/23/2001	Wh_sc_052301fcc.tif
Washington	10/16/2001	Ws_ms_101601fcc.tif
Washington	06/10/2001	Ws_ms_061001fcc.tif