Determining if Seasonal Change Impacts Land Cover Classification's Accuracy

Mark Svendsen , Daniel Unger , I-Kuai Hung , Yuhui Weng

Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962, USA

Abstract

Unsupervised and Supervised land cover maps of East Texas will be derived using Landsat 8 satellite data to determine if seasonal changes in electromagnetic spectral signatures affects land cover map accuracy. If successful, our study will statistically ascertain whether leaf on or leaf off months produce higher accuracy land cover map products. The Landsat 8 satellite data will be gathered from 2013-2020 and will be employed to create the multiple land cover maps that enclose a four-county area in East Texas. The current assumption is that seasonal change in light reflectance has little effect on the land cover map accuracy. This study will test the validity of this assumption within a variety of landscape environments ranging from rural, urban, and forested areas. Traditionally a land cover map's accuracy is dictated by the satellite's radiometric resolution, which pertains to the amount of data that each pixel can hold within an image and is measured in terms of bits. Each bit represents a value of 0 or 1, if an image has only 2-bits, then it has 4 possible outcomes, or alternately can differentiate 4 different levels of reflectance. Landsat 8 has a 12-bit radiometric resolution, this means that each pixel can represent a reflectance value between 0 to 4,095. Similar studies have been conducted in the past; however, this is the first of its kind to evaluate the newer Landsat 8 data range on this large of scale, with a diverse topography, and paired with its use of statistical analysis to evaluate the effect of increased radiometric resolution on land cover map accuracy.

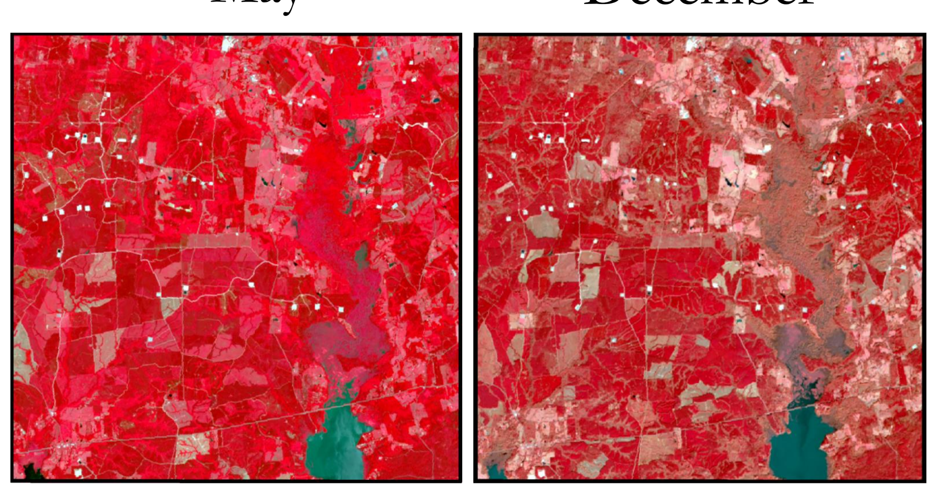


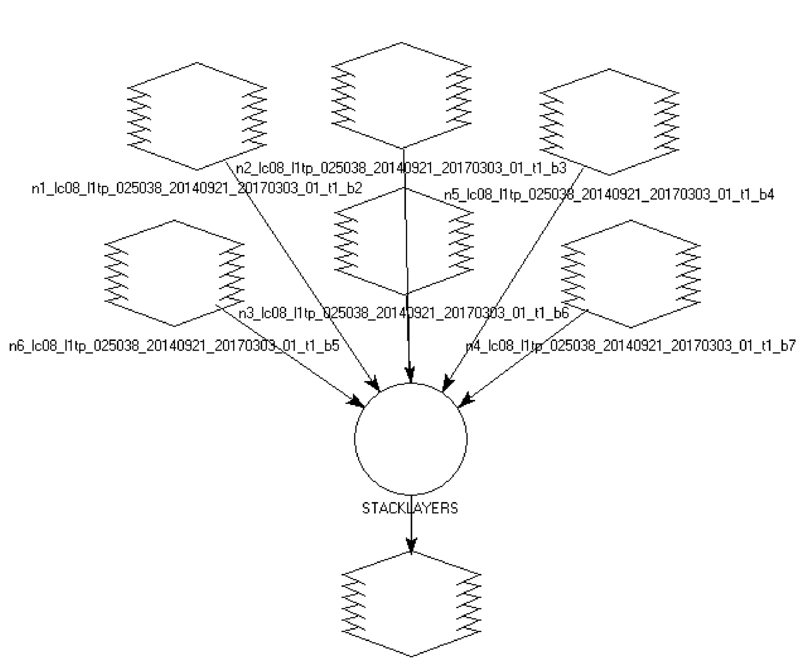
Figure 1: A visual comparison between two colored infrared Landsat 8 images. In the May image the trees are leafed out resulting in the image being brighter red than the December image due to it being a dormant season with the leaves being off.

Objectives

The study has three main objectives, the primary objective is to produce multiple land cover maps and assess their accuracy then sort them into two categories of leaf on or leaf off. The secondary objective is to compare each groups overall accuracy, as well as each land cover maps user and producer accuracy score using a t-test, to determine if the two groups have an accuracy that is statistically different from each other. The last objective is to determine if there is a statistical difference between the accuracy of an unsupervised and supervised land cover classification maps.

Image Stacking

Landsat 8 data comes with 11 individual band layers that are required to be stacked to be presented as one image. This study will be using bands 2-7, the stacking process of the project will be conducted in Erdas and using this layer stacking model. The model on the right takes the individual band layer files and stacks them into one final output image.



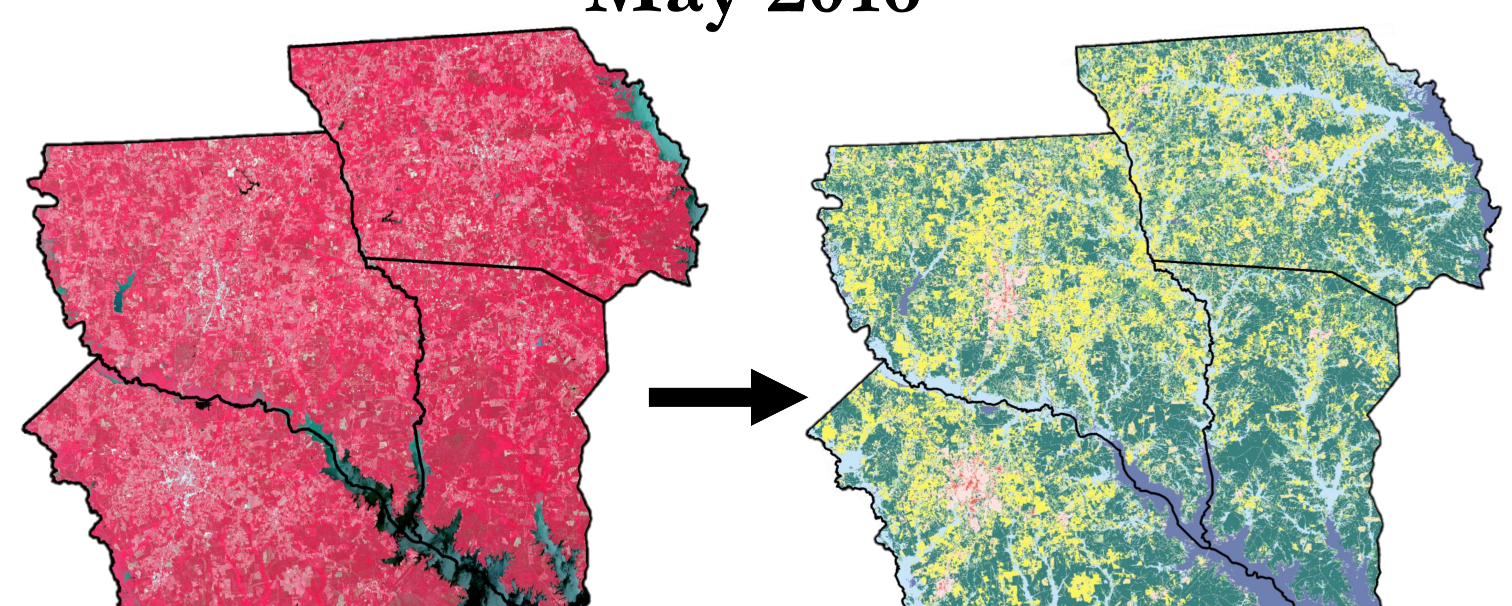
Arthur Temple College of Forestry and Agriculture
Geographic Information Systems Laboratory

Purpose

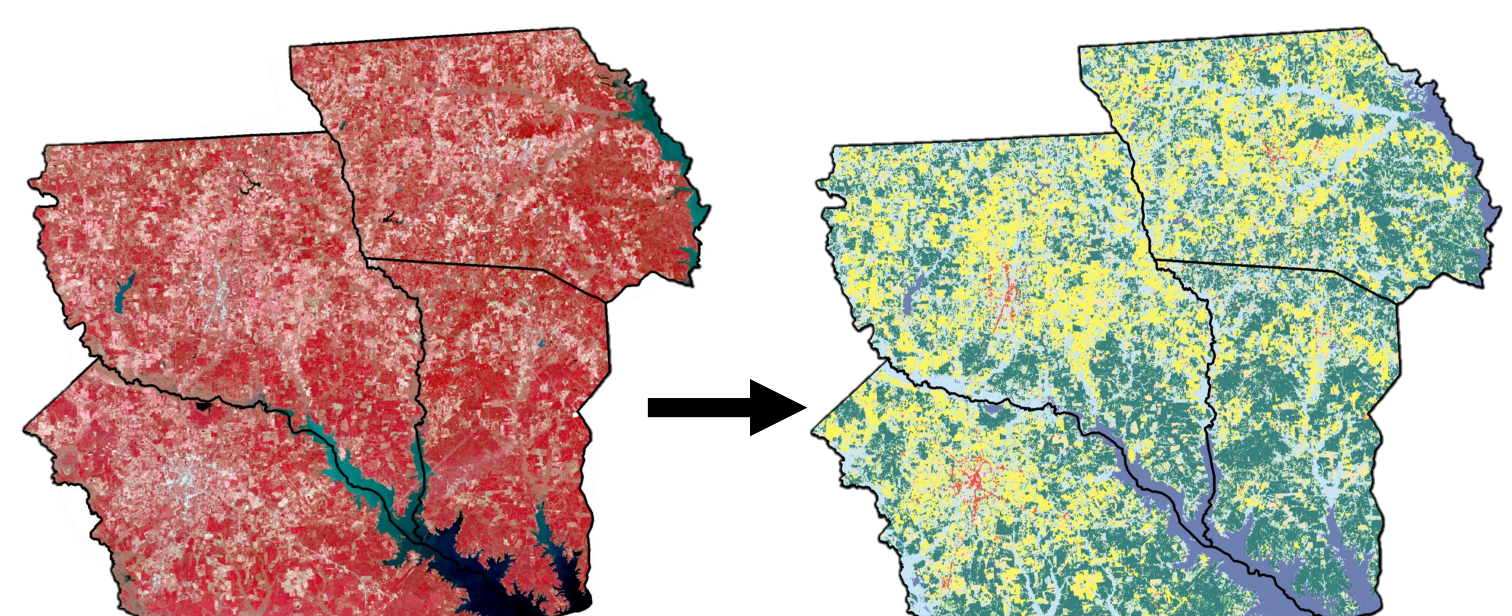
The purpose of the study is to use Landsat 8 data to determine if seasonal change impacts the total accuracy of land classification maps. Land cover maps can be employed in many different applications and each one benefits from higher accuracy products. For example, in natural resource management land cover maps are used in forest management, a higher accuracy map can be employed to find stricter boundaries between tree species within the same forest. This reason shows the importance of this study and how its results might be useful for future studies where land cover maps are produced.

Unsupervised Classification

May 2016



December 2018



Legend

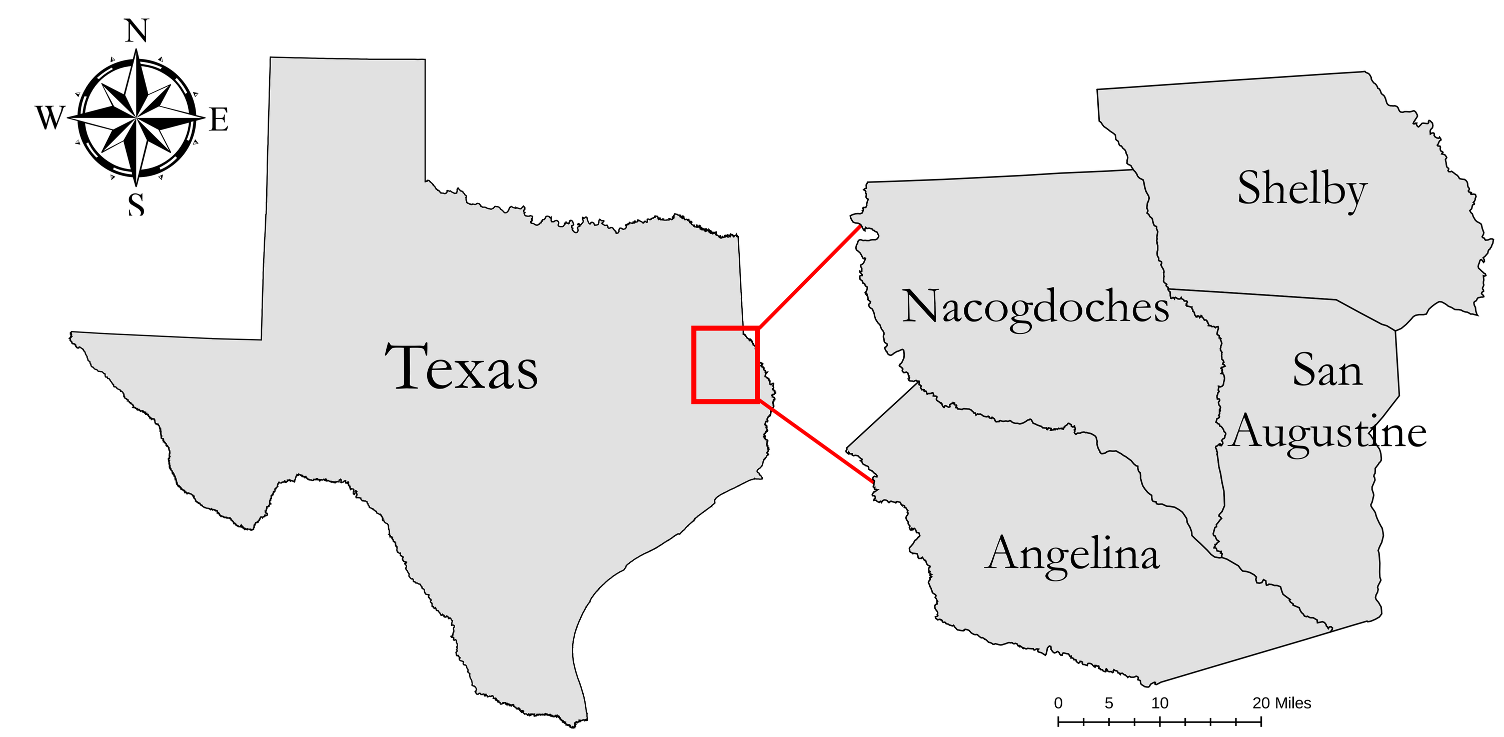
Pasture	Pine	Urban: Low
Grassland	Hardwood	Urban: Medium
Barren	Mixed Forest	Urban: High
Water	Woody Wetlands	

Figure 2: The color-infrared images on the right were classified in Erdas using the unsupervised tool to create the unsupervised maps on the right.

Reference Data

Each classification map will be compared to historical digital orthophoto quadrangles (DOQ) with a similar acquisition date to that of the initial Landsat 8 image. This color- infrared orthophoto on the right is an image that is taken in December 2018 the same month as the December satellite image above, this image paired with other orthophotos will be used to determine each month's classification accuracy.

Study Area



Methods

The unsupervised and supervised classification maps will be derived in Erdas Imagine, the unsupervised maps will be created using 100 spectral classes, 50 iterations, and a convergence threshold of .975 for each image. A convergence threshold of .975, specifies that as soon as 97.5% or more of the pixels stay within the same spectral class between each iteration the process will stop. The 100 spectral classes will be recoded to eleven information categories; urban low intensity, urban medium intensity, urban high intensity, pine, hardwood, mixed forest, pasture, barren, water, woody wetlands, and grassland. The recode process will be conducted using the recode tool in Erdas Imagine, to combine like spectral classes. The supervised classification land cover maps will be created using from 100-250 training sites, with 10-20 training sites per spectral class. Each training site with have a minimum of 100 pixels to ensure that each site is a good depiction of the region and to minimize the effects of outliers in surface reflection. The training sites will be spread out throughout the study area, to combat any variation in spectral signatures within the same identification category.

Accuracy Assessment

May — REFERENCE

	Cover Type	Water	Pine	Hardwood	Mixed Forest	Pasture	Barren	Urban: Low	Urban: Medium	Urban: High	Woody Wetlands	Total	User's Accuracy
CLASSIFIED	Water	**10**									3	13	76.9%
	Pine		**37**		1						1	39	94.9%
	Hardwood		5	**7**	2	1					2	17	41.2%
	Mixed Forest		5	2	**21**	2						30	70.0%
	Pasture			1	2	**12**	2					17	70.6%
	Barren					2	**0**					2	0.0%
	Urban: Low							**0**	1	1		2	0.0%
	Urban: Medium								**0**			0	N/A
	Urban: High									**2**		2	100.0%
	Woody Wetlands	1	2	3	2						**20**	28	71.4%
	Total	11	49	13	28	17	2	0	1	3	26	150	
	Producer's Accuracy (%)	90.9%	75.5%	53.8%	75.0%	70.6%	0.0%	N/A	0.0%	66.7%	76.9%	Overall	72.7%

December — REFERENCE

	Cover Type	Water	Pine	Hardwood	Mixed Forest	Pasture	Barren	Urban: Low	Urban: Medium	Urban: High	Woody Wetlands	Total	User's Accuracy
CLASSIFIED	Water	**15**									3	18	83.3%
	Pine		**43**		3							46	93.5%
	Hardwood		2	**8**	1						3	14	57.1%
	Mixed Forest		4	2	**18**						2	26	69.2%
	Pasture		1	1	1	**16**						19	84.2%
	Barren					2	**0**					2	0.0%
	Urban: Low							**0**				0	N/A
	Urban: Medium					1		1	**0**			2	0.0%
	Urban: High									**1**		1	100.0%
	Woody Wetlands		1	4							**17**	22	77.3%
	Total	15	51	15	23	19	0	1	0	1	25	150	
	Producer's Accuracy (%)	100.0%	84.3%	53.3%	78.3%	84.2%	N/A	0.0%	N/A	0.0%	68.0%	Overall	78.7%

Figure 2: An error matrix was produced for both the May and December unsupervised classification maps and the preliminary results show that growing seasons months have a lower accuracy than dormant months, however, this results will be repeated with more data as the reaserach continues.