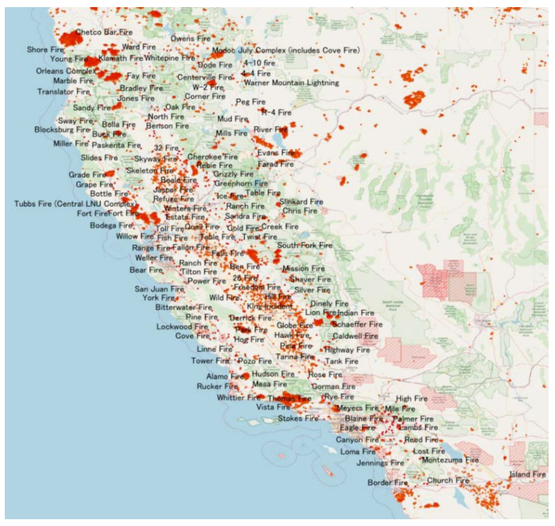
Forestation Change Detection in Los Angeles Wildfires

Background

Wildfire is one of the most disastrous event around the world, as it burn large area of forest and often times it will also burn buildings and threaten human's life. Wildfire is usually triggered by dry climate, volcano ash, hot wind and so on, but can be caused by human as well: a used cigarette thrown by a visitor who is unaware of environmental protection, or illegally put on a fire by someone.

Wildfire has become frequent in California these years. There were 64 wildfires in record in 2017, the figure on the right shows the area destroyed by wildfire. Many wildfires occur in national forest parks just adjacent to some big cities such as LA and San Francisco.



Remote sensing has been developed for several decades and proved to be a useful tool for large-scale environmental monitoring, conservation goals, spatial analysis and natural resources management.

Two Sand fire (Jul 22, 2016-Aug 3, 2016) and Creek fire (Dec 5, 2017-Jan 9, 2018) happened in Angeles National Forest. It is worthwhile to evaluate the change after these two fires by using some index.

Research Questions

(1) What is the burnt area of each fire?

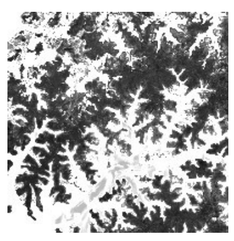
(2) What is the reforestation area after Sand fire within a time period?

Methodology

Burn Area Index (BAI)

To quantitatively analyze the burnt area change, a simple change detection to figure out burnt area is not as efficient as Burn Area Index and reader can see its mathematic expression below.

$$BAI = \frac{1}{(0.1 - Red)^2 + (0.06 - NIR)^2}$$

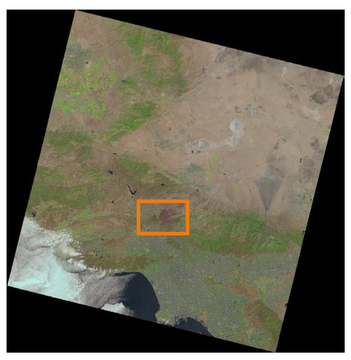


BAI monitoring is based on charcoal amount on the surface, so one image can detect burnt area. Brighter pixels indicate burnt areas (see image on the right). By detecting pixel values, we can use color slicing to categorize burnt area. Also, we can expect reforestation after Sand fire on Creek post-fire image. Therefore, by using just two images, we can figure burnt area caused by two fires as well as a reforestation change detection.

For change detection between two images, a band algebra is available and use Creek fire image minus Sand fire image and finally get change detection for forestation. This time darker pixels indicate better reforestation while brighter pixels indicate deforestation.

Processes

Sand Fire



Landsat 8 Metadata for Sand Fire on August 9, 2016

(Source: USGS Earth Explorer)

Creek Fire

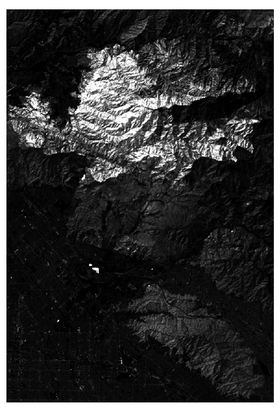
Landsat 8 Metadata for Sand Fire on February 4, 2018

(Source: USGS Earth Explorer)

1. Resize

2. Create Water Mask

3. Radiometric Calibration



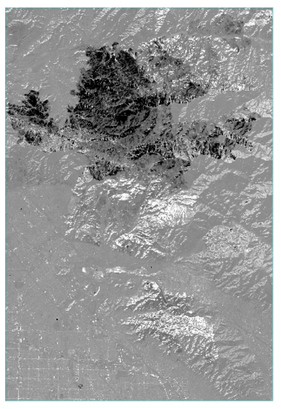
4. Apply BAI

Float(b2)-float(b1)

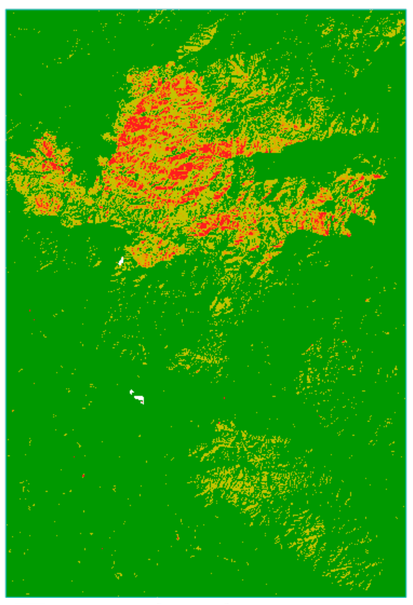
B1= BAI of Sand fire

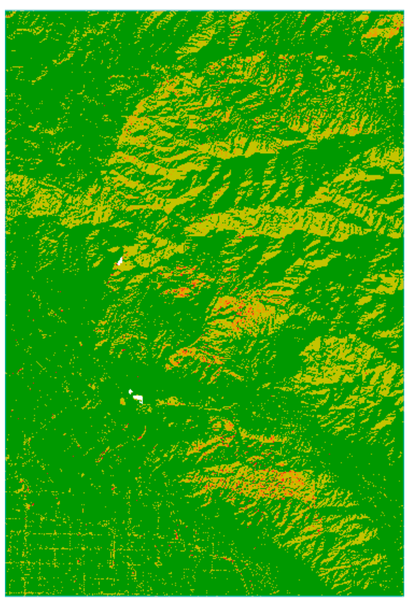
B2= BAI of Creek fire

5-2. Band Algebra

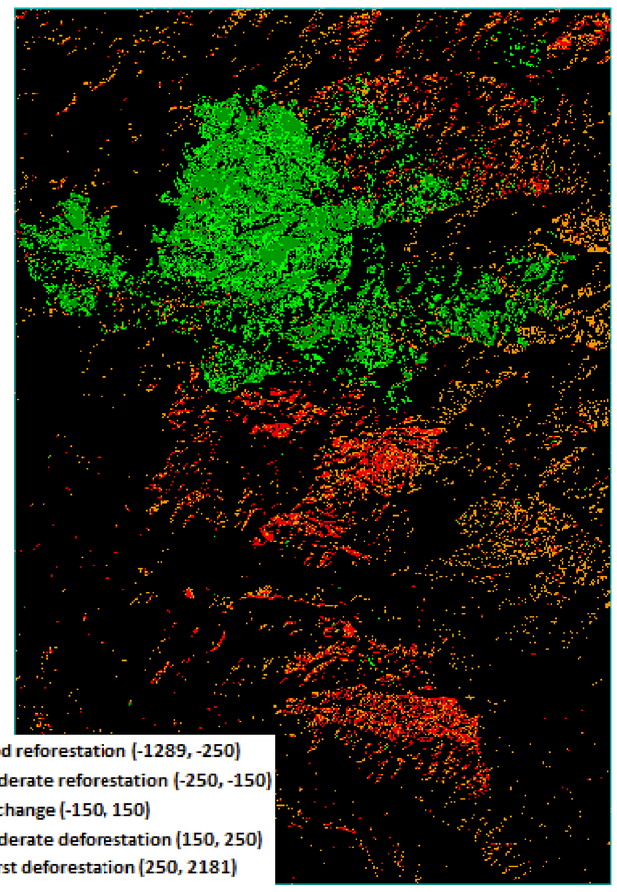


5-1. Color Slicing





6. Color Slicing



CEE 189 Remote Sensing

Jiaheng Hu

CEE Department, Tufts University

Reference and Source

(1) InciWeb

(2) T. Blaschke, Object based image analysis for remote sensing, ISPRS Journal of Photogrammetry and Remote Sensing, Volume 65, Issue 1, 2010, Pages 2-16, ISSN 0924-2716

(3)Chuvieco, E., M. Pilar Martin, and A. Palacios. "Assessment of Different Spectral Indices in the Red-Near-Infrared Spectral Domain for Burned Land Discrimination." *Remote Sensing of Environment* 112 (2002): 2381-2396)

Results

(1)Burnt Area Statistic

By using quick statistic, we can get percentage of each category, and area under each category can be calculated.

Table 1: Basic Statistic for Two Wildfires

total area of the resized image is:

$$\frac{(3813885m - 3781965m)}{1000m/km} \times \frac{(387135m - 365415m)}{1000m/km} = 693.30\ km^2$$

	After Sand Fire		After Creek Fire		Area Change in Each Category (km²)
	Percentage (%)	Area(km²)	Percentage (%)	Area (km²)	
Not Burnt	83.95	578.56	78.75	545.97	-32.59
Slightly Burnt	11.41	79.11	18.56	128.68	49.57
Moderately Burnt	2.56	17.75	2.39	16.57	-1.18
Severely Burnt	2.08	14.42	0.31	2.15	-12.27
Total	100	689.84	100.01	693.37	-

From Table 1, the total burnt area (Not-burnt is excluded) is 79.11+17.75+14.42=111.28 km^2 after Sand fire and 128.68+16.57+2.15 =147.4 km^2 after Creek Fire. If reforestation of Sand fire is negligible within the year, then the area of Creek fire is estimated as 147.4-111.28=36.12 km^2. Compare with official data, we can see that these numbers are smaller (Sand fire: 168 km^2; Creek fire: 63km^2).

(2) Burnt Area Change Detection

Table 2: Burnt Area Change Detection (using BAI)

	percentage	Area (km²)
Good Reforestation	4.27%	29.60
Moderate Reforestation	3.14%	21.77
No Change	85.98%	596.10
Moderate Deforestation	3.79%	26.28
Worst Deforestation	2.82%	19.55
Total	100%	693.30

From Table 2, we can see that the total area of reforestation is a bit greater than deforestation, but notice that the burnt area caused by Sand fire is more than two times as large as that caused by Creek fire.