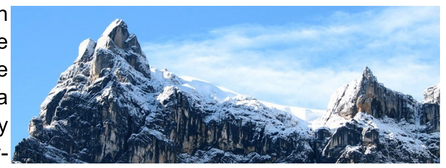
Change Detection of Vegetation and Glacier in Puncak Jaya from 1994 to 2015

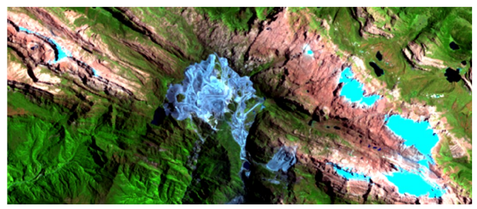
Project Description

Glacier retreat has triggered much public attention as a sensitive indicator of global warming. Puncak Jaya is located near the equator, so there is little variation in the mean temperature during the year and the glaciers fluctuate on a seasonal basis very slightly. However, analysis of historical satellite imagery of these glaciers show significant retreat since the 1850s. If recent trends continue, it is estimate that all of Puncak Jaya's glaciers will disappear within 20 years.

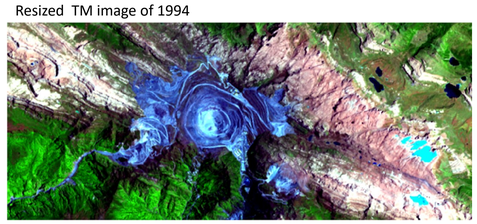


The Grasberg mine is situated towards the west of Puncak Jaya glaciers, and it is the largest gold mine and the second largest copper mine in the world. The rapid expansion of Grasberg mine makes it one of the most polluting mines around the world. The large amount of environmental hazard will destroy the rainforest as well as the drinking water for local population. This project aims to measure the amount of ice that has melted in Puncak Jaya between two data sets from 1994 to 2015. Also, the project will explore whether the development of Grasberg Mine near Puncak Jaya has affected the surrounding vegetation.

Data and Methodology



Resized TM image of 1994



Resized OLI image of 2015

Landsat 5 TM and Landsat 8 OLI images from USGS were used. They are both level 1 data which have been geometrically and radiometrically corrected, and are projected in a UTM projection for zone 53 and set to the WGS84. The TM and OLI image were collected on Sept 17, 1994 and Oct 13, 2015. The interval of acquisition data is within a month, so they could be used to do change detection.

NDVI Analysis

1.Calculating the normalized difference vegetation index (NDVI)

NDVI = (NIR - VIS)/(NIR + VIS). Use the NDVI tool to transform multispectral data into a single image band representing vegetation distribution.

2. *Identify Non-vegetated and vegetated area.*

Using cursor value and color slicing tool to determine the range of NDVI value for non-vegetated and vegetated area.

Classification

1.*Using maximum likelihood method to do the classification*

Maximum likelihood classification assumes that the statistic for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class.

2. *Accuracy assessment*

Using the Confusion Matrix Using Ground Truth ROIs tool under Post Classification toolbox .

3. *Calculating the amount of melted ice*

Using Class Statistic function in Post Classification Toolbox to calculate the area of each land type.

Conclusion

Based on the NDVI analysis, the development of Grasberg Mine had a negative impact on the surrounding vegetation. The area of vegetation as well as the average NDVI decreased during the time period from 1994 to 2015. Based on the maximum likelihood classification method, the area of glaciers in 1994 and 2015 are 3.9 km^2 and 0.6km^2 respectively. There is 3.3km^2 of glaciers melted from 1994 to 2015.

Limitation

1. Some classes I was interested in have similar spectral characteristic, and are classified into same land type through maximum likelihood method, but I can visually determine them as different land types. This is very obvious in 1994 classified image, and the overall accuracy is lower.
2. It is difficult to identify the boundaries and extent of the glacier and mining area because the spatial resolution of spectral bands in TM and OLI sensor is not high enough. But I still decided to use Landsat image because of its availability.

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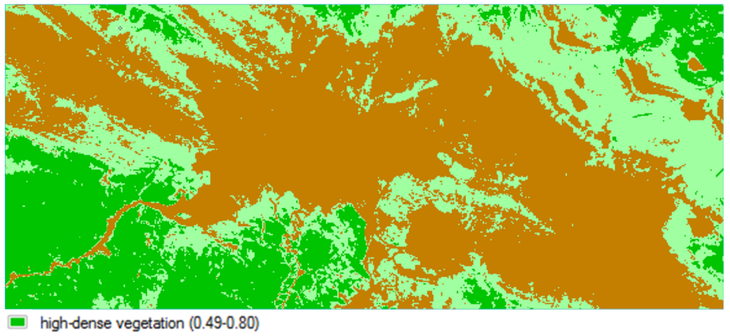
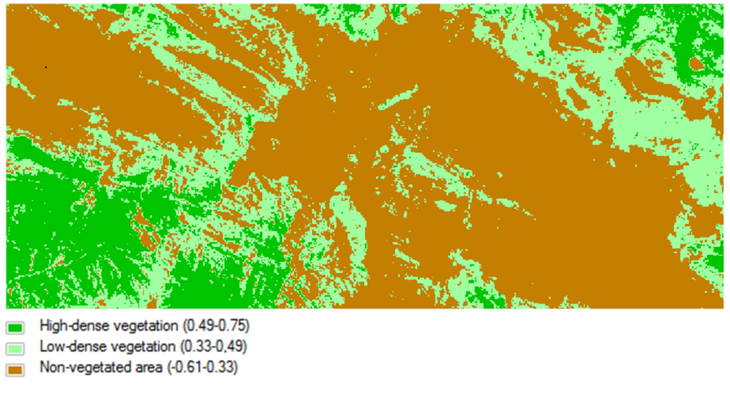
Cartography: Yi Zhong
Data: 7 May. 2018
Projected Coordinate System: GCS_WGS_1984
Source: USGS Earth Explorer

NDVI Analysis

NDVI 2015



NDVI 1994

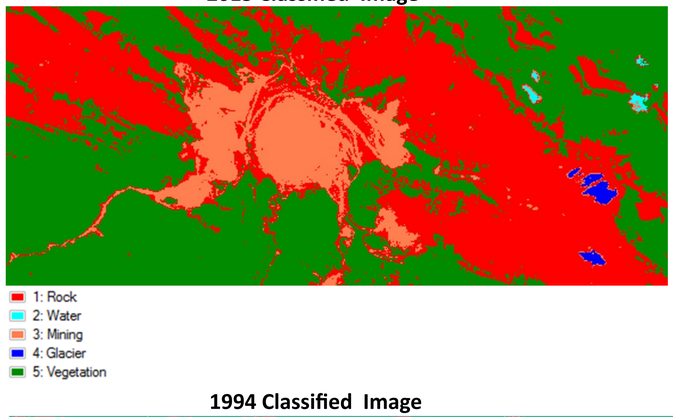


NDVI	Year 2015			Year 1994		
	Non-vegetated	Low-dense vegetation	High-dense vegetation	Non-vegetated	Low-dense vegetation	High-dense vegetation
Min	-0.71	0.27	0.49	-0.61	0.33	0.49
Max	0.27	0.49	0.80	0.33	0.49	0.75
Mean	0.16	0.37	0.57	0.15	0.41	0.61
Standard Deviation	0.09	0.06	0.07	0.10	0.04	0.05
Pixel Count	85935	36415	21404	74053	41650	28247

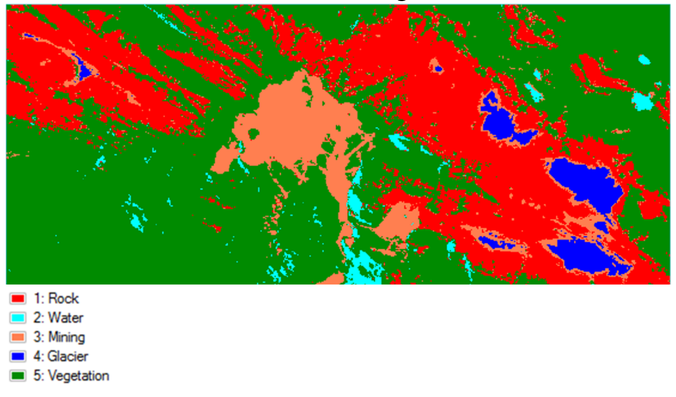
Summary statistics for the NDVI variables in 1994 and 2015 are presented in Table above. The pixel count of vegetated area in 1994 and in 2015 are 69897 and 57819, which indicates that the vegetation area is decreasing in this time period. The average NDVI of low-dense vegetation area and high-dense vegetation area are 0.41 and 0.61 in 1994, and they decrease to 0.37 and 0.57 respectively in 2015. The standard deviation of NDVI in low-dense vegetation area and high-dense vegetation area are 0.04 and 0.05 in 1994, and they increase to 0.06 and 0.07 in 2015. The overall NDVI in 1994 is higher than that in 2015 because of the higher average value with lower standard deviation. Thus, the vegetation in 1994 is greener and denser than that in 2015. The expansion of Grasberg mining has a negative effect on the surrounding vegetation.

Supervised Classification

2015 Classified Image



1994 Classified Image



The confusion matrix report pairs ROIs with the classes of a classification image to show what percentage of the ROI pixels were or were not contained in a resulting class. The overall accuracy of 1994 and 2015 classified image are 79% and 95%.

Class Summary	Year 1994		Year 2015	
	Pixel Count	Area(km^2)	Pixel Count	Area(km^2)
Vegetation	79727	71.8	69614	62.7
Mining	13844	12.5	14189	12.8
Water	2501	2.3	268	0.2
Rock	43382	39.0	59041	53.1
Glacier	4300	3.9	642	0.6

Table above shows pixel count and area of each land type in 1994 and 2015. The area of vegetation, glacier and water bodies diminished by 9.1 km2, 2.1 km2 and 3.3 km2. There is about 84 percent of glacier melted during the time period. On average there is 0.165 km2 glacier lost per year. I expect that to intensify with time due to the increasing average temperatures, and as the glacier gets smaller it will melt faster because it has less overall mass.