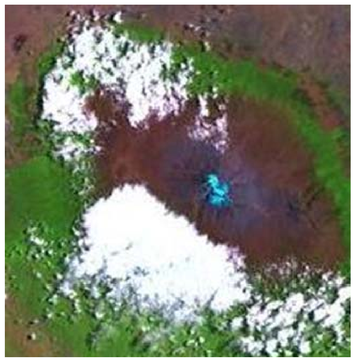
Mt. Kilimanjaro's Receding Glaciers

Background

Mt. Kilimanjaro is located in northeastern Tanzania, and is Africa's highest summit at 5,895 meters. Scientists have monitored glacial recession since 1978. Research revealed that ice caps have been shrinking since the 1850's. However, the rate of retreat rapidly increased in the 1990's. Some scientists predict that the ice caps will disappear by 2020.



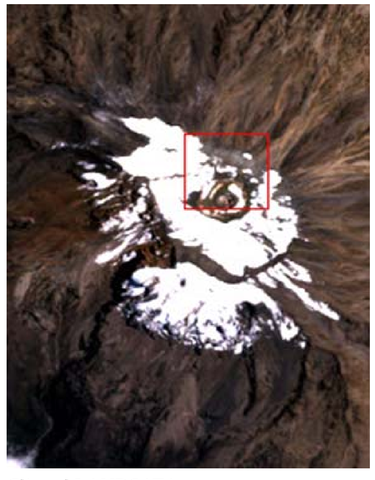
September 1999 LANDSAT TM image

Research Question

Clearly, vanishing ice caps is not a new phenomena. The goal of this research is to archive the shrinking area of the ice caps in the past three decades.

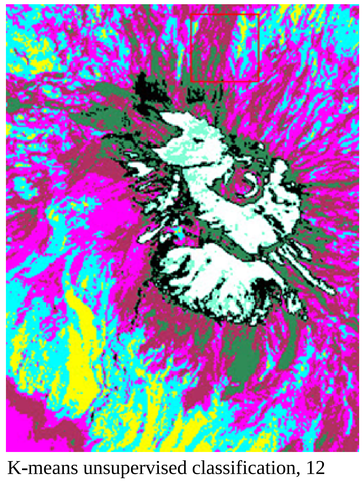
Methodology

The research used four LANDSAT TM images: August 1986, September 1999, August 2001, and September 2008. The images are from the same season so that weather patterns remained constant. Using band ratioing,I then conducted K-Means unsupervised classification, generating 12 classes with 20 iterations. Subsequently, I conducted accuracy assessments and generated post-classification change detection statistic reports.



Clipped LANDSAT image

Image after band ratioing

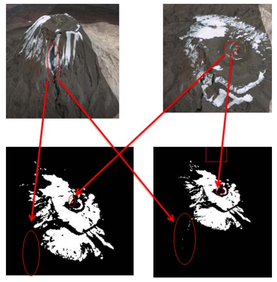


K-means unsupervised classification, 12

Post classification combination from 12 classes to two classes on snow and rock

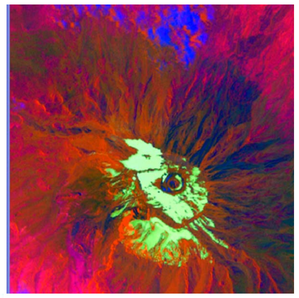
Benefits of Band Ratioing

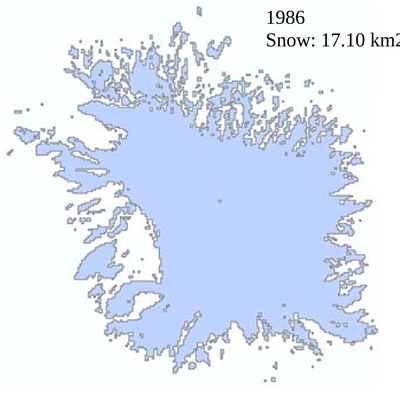
I used band ratioing in order to reduce noise, redundancy and shadows. The illustration below shows that a band ratioed image captures snow that is covered by shadow and would normally be misclassified as rock. It also classifies rock that would otherwise be mistaken for snow and be misclassified. This method takes advantage of the inverse relationship between the high reflectance of snow in the green band and the high absorption in the mid-infrared band. My alternative approach was principle component analysis, which uses the MNF method. I conducted both methods on the same scene and then linked the two derived images with the original image. Based on this pre-cursory research, I determined that band ratioing was more effective in this case.



Right: A demonstration of the MNF method on Mt. Kilimanjaro's ice cap

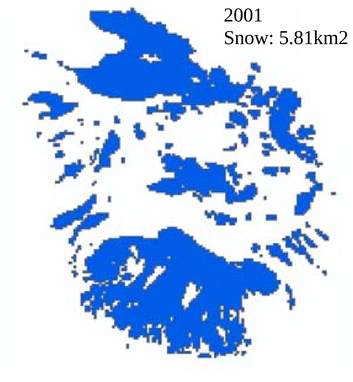
Left: The bottom left image show an image classified without band ratioing, compared with the bottom right image that is classified with band ratioing.





1986
Snow: 17.10 km2

1999
Snow: 9.21 km2

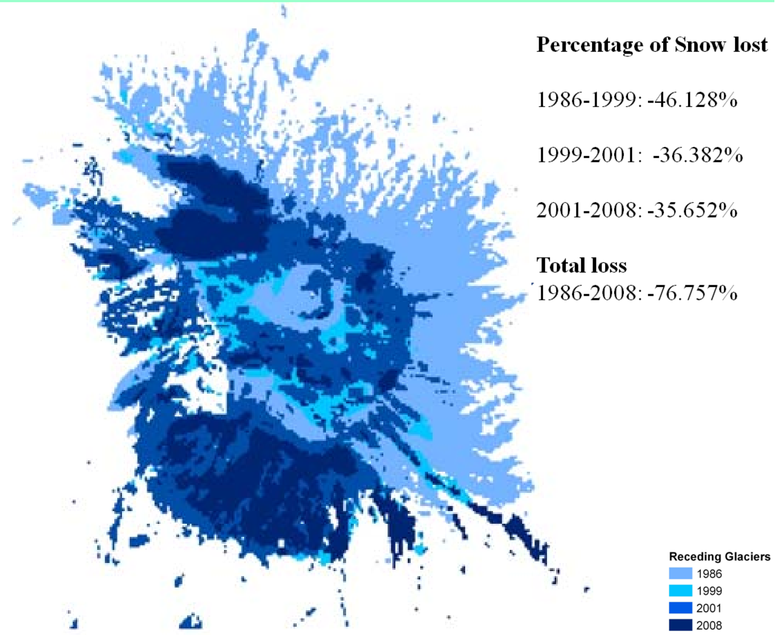


2001
Snow: 5.81km2

2008
Snow: 3.74 km2

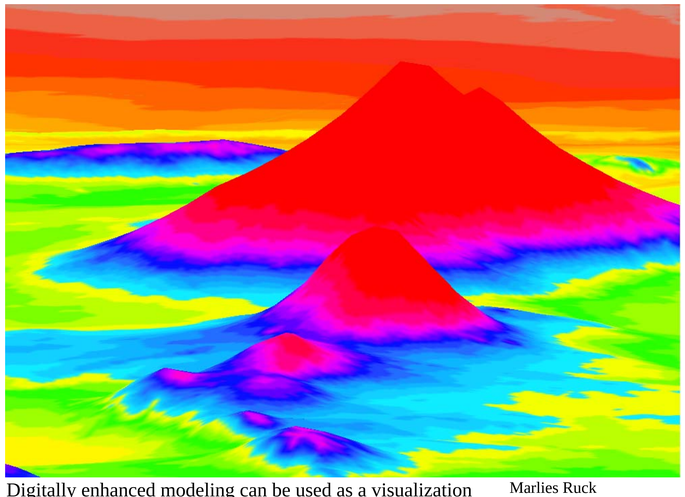
Sources of Error

My overall accuracy assessment was 99%. However, there are potential sources of error that should be accounted for. For instance, although all the images were from the same season, they were taken from two different months: August and September. This was unavoidable because the other images had too much cloud cover. This heightens the chance that a seasonal change of weather patterns could influence the results. However, any weather influence would imply that my results were conservative. My initial state was in August 1986 and my final state was in September 2008, and since it is later in the year there should be more snow. My estimate is also conservative because I measured the shrinking ice cap's area, and did not account for



Analysis

Mt. Kilimanjaro's glaciers are retreating at an alarming rate. In 1986 the ice cap areas measured approximately 17 squared kilometers, but this figure declined by 76% over the course of three decades. The ice cap area is now barely 3.7 squared kilometers. This has three implications. First, scientists identified a causal relationship between vanishing glaciers and increased forest fires. This has led to change in species composition and a downward shift of upper forest line by several hundred meters. In fact, in the past 70 years one third of Mt. Kilimanjaro's forests have disappeared. Second, scientists have begun scrambling to collect data from Mt. Kilimanjaro before its ice caps vanish because they are incredible archives of climate data. The glaciers capture pollen and pollutants that reflect season temperature variations. Mt. Kilimanjaro is a powerful resourceful for tracking climate change and traces back 11,700 years. Third, vanishing glaciers will be detrimental to the local economy. Tourism brings more foreign currency into Tanzania than any other industry, and Mt. Kilimanjaro plays a large role in attracting visitors.



Digitally enhanced modeling can be used as a visualization

Marlies Ruck
May 6, 2010
Intro to Remote Sensing

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Sources
*GLOVIS
*Google Earth
*Hemp, Andreas. "Climate Change and Its Impact on the Forests of Kilimanjaro." *African Journal of Ecology Volume* 47.1 (March 2009): pg. 3-10. *Thompson, Lonnie. "Receding Glaciers Erase Records

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