Change Detection of Mount Nyiragongo Post Eruption

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ABSTRACT

The dangerous nature of volcanic eruptions makes them incredibly difficult but important to study. Having a better understanding of how large of an area is affected by an eruption will allow governments to decide on evacuation and preventative procedures. The goal of my project is to answer a very simple question, “How can we use remote sensing to quantify the area of land affected by a volcanic eruption?” The study area, Mount Nyiragongo is a stratovolcano near the border of the Democratic Republic of the Congo and Rwanda. It erupted on January 17th, 2002, during which the lava lake that was located within the crater of the volcano drained. The lava flows reached Goma Town, causing massive destruction within the city, and left many people homeless. An unsupervised classification of Landsat 7 images from before and after the eruption were used to show the amount of damage done to Goma Town during this eruption.

Introduction

- Mount Nyiragongo is an active stratovolcano that is often set off by seismic activity due to it’s location near the East African Rift.
- It is located near the border of the Democratic Republic of the Congo and Rwanda. Due to political unrest in the area, it is very difficult for scientists to study this volcano.
- The lava produced is alkali-rich and is extremely fluid due to the low levels of silica. This creates foiditic rocks.
- It began erupting on January 17th, 2002. The southern flank of the mountain cracked, draining the lava lake that was within the crater.
- Lava flows made it all the way through the town of Goma, into Lake Kivu.

Study Area

![Study Area Map](image1.png)

- Figure 1. This figure shows the region that the volcano is located in.

Goma Town: Before and After the Eruption of Mount Nyiragongo

![Before and After Images](image2.png)

- Top row (left to right): Figure 2. Landsat 7 false natural color image before the eruption, 12/11/01. Figure 3. Landsat 7 false natural color image after the eruption, 01/15/03.
- Bottom row (left to right): Figure 4. Unsupervised classification result of the before image. Figure 5. Unsupervised classification result of the after image.

Methods

- Landsat 7 images were obtained through the USGS EarthExplorer website for December 11, 2001 and January 15, 2003.
- These images are displayed as a false color image using the bands 6-4-3.
- Unsupervised classification was used on the images to determine the area of land affected by the lava flow.
- The classification was done with 200 clusters and a 0.99 convergence value.
- These classes were sorted into 6 main classes: Noise, Water, Vegetation, Bare Rock, Urban, Lava Flow.
- An accuracy assessment was done on both images, the points were chosen with equalized random distribution parameters.

Discussion

- The band combination for the images is 6-4-3. Band six is a thermal band that helped differentiate between scars from past eruptions and the fresh eruption. Band 4 is near infrared that helped identify vegetation. Band 3 makes the urban areas show up varying shades of purple.
- The overall accuracy assessment of the first image was 86.80%. The overall accuracy assessment of the second image was 92.33%
- There were 12,964 pixels that changed to lava flow from the before image to the after image.
- This is an area of 11.67 km².

Conclusions

- Because of it’s history of flank eruptions, and numerous parasitic cones scattered around the area, the city of Goma is at risk for damages and loss of life from the volcano.
- Despite this risk, the city’s population is increasing quickly because of political unrest.
- The low viscosity of the lava makes flank eruptions dangerous because there is little time to evacuate once the eruption has started.
- This makes early prediction important, however since ground research is difficult in this area, remote sensing can be a useful tool to study the precursory indications of eruptions.

References