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Monitoring Kilauea Volcano's Eruption in 2018 Using Various Remote Sensing Techniques

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Introduction

Monitoring volcanic eruptions is essential, as early warnings can be issued in case of emergency. In this study, we used Sentinel-1-A InSAR, Landsat 7 & 8 thermal infrared and airborne LiDAR to monitor the Kilauea volcano's East Rift Zone (ERZ) eruption of 2018.

Objectives

One of our objectives was to estimate the volume of lava erupted solely using space-borne equipment. Other objectives were to perform the time series analysis to see the change that took place in elevation and coherence. Our last objective was to compare InSAR and LiDAR results and see if they both could be combined to monitor the volcanic eruption.

Data sources

Since the eruption took place between May and August, 2018, we used 11 Sensintl-1-A SAR images that were captured between April 20 and August 18, 2018. We also used four Landsat 7 and four Landsat 8 thermal infrared images and two airborne LiDAR datasets in this study.

Methodology

We first generated the interferograms for displacement images. Then we developed a code in MATLAB that would automatically estimate the volume of lava. Our procedure was based on several conditions. Thresholds for the conditions were set using sensitivity analysis. If the temperature of any pixel in thermal image was greater than 50°C, it would be considered valid. After that, if NDVI of the same pixel before the eruption was 0.2, then the pixel would be considered as forest, otherwise it would be considered as bare land. If the pixel was considered forest and if the displacement was less than 15 mm, then the pixel would be considered as wildfire and excluded from further analysis. At last, if the temperature difference between two thermal images was less than 30°C, then the pixel would be considered as geothermal source and would be excluded from further analysis.

Results

1. Estimated volume

Total volume of lava estimated was 7.9801×10^6 m^3.

2. Time-series analysis

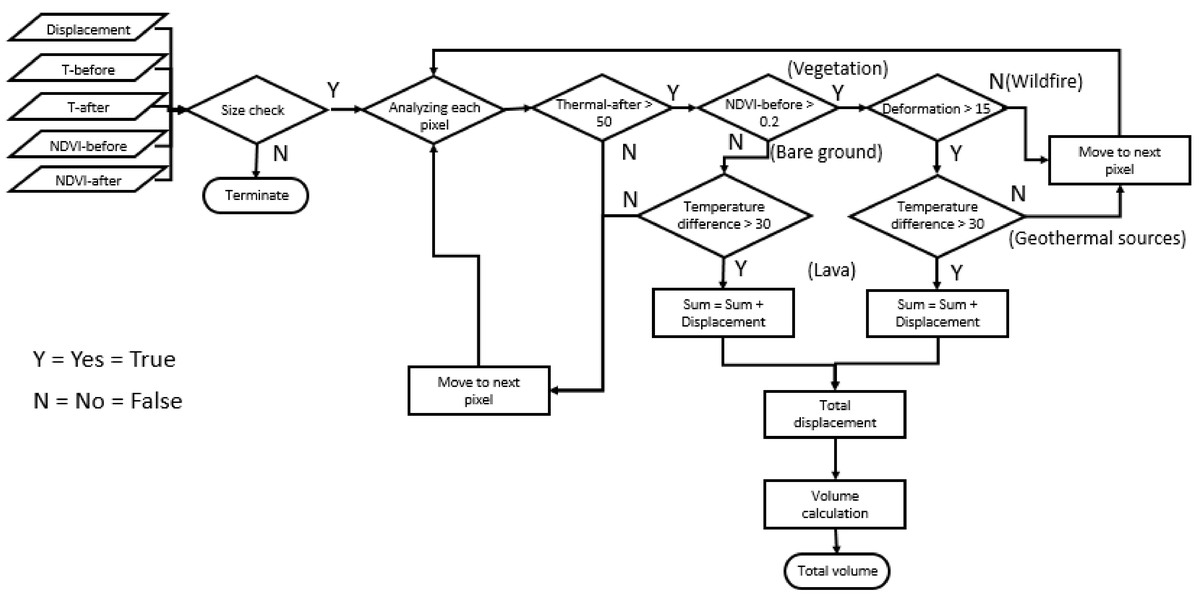
We performed a time series analysis on a point, which was situated on the Vacation Island. We found that the point was very active during the whole time span of the study. Movement of the point can be seen in time series. We also generated the time series for coherence of the same point and found that coherence was steadily high up to July 1 and decreased suddenly and rapidly since July 13. We found that lava had inundated the area and due to high temperature, coherence was lost.

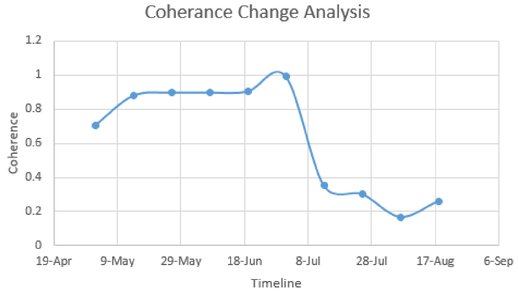
Volumes estimated

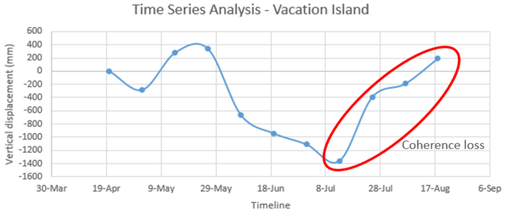
Satellite	Acquisition date	Sentinel-1 A acquisition date	Volume of lava
Landsat 8	May 14, 2018	May 14, 2018	1.4292×10^4 m^3
Landsat 7	May 22, 2018	May 26, 2018	7.0282×10^5 m^3
Landsat 7	June 07, 2018	June 07, 2018	1.4775×10^6 m^3
Landsat 8	June 15, 2018	June 19, 2018	2.8921×10^5 m^3
Landsat 8	July 1, 2018	July 1, 2018	3.4609×10^5 m^3
Landsat 7	July 09, 2018	July 13, 2018	3.0470×10^3 m^3
Landsat 7	July 25, 2018	July 25, 2018	4.8951×10^6 m^3
Landsat 8	August 02, 2018	August 06, 2018	2.5208×10^5 m^3

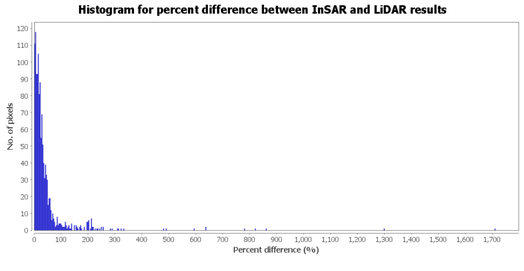
3. Comparing InSAR and LiDAR

We found that InSAR and LiDAR results are very similar. Hence, can be combined to monitor the volcanic eruption.









Conclusions

We estimated the volume of lava erupted during Kilauea volcano's eruption in 2018 to some extent. Although primitive, our method can be used on any effusive volcano. Our method is cost-effective, hence, usable by anyone. Accuracy and precision of our method can be further improved by L band SAR and satellites with higher temporal resolution. Also, temperature and coherence are inversely related to each other.

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Interests: Remote sensing of volcanoes, monitoring hazard-prone sites

Future plans: Interested in doctoral education, would like to work in academia throughout my career.