**Forecasting Lava Flow: Analysis of Potential Lava Flow Paths from Mauna Loa Volcano, HI**

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**Introduction**

The island of Hawaii, located in the Hawaiian Island chain (Figure 2), is home to an active volcano, Mauna Loa, which has the potential of putting local populations at risk in the case of an eruption (Hawaii Center for Volcanology, 2015). In the last 150 years, Mauna Loa has erupted 33 times and twice, the lava flows have covered land that is now a part of Hilo, the most populated census-designated place (USGS). In areas with high population densities, lava flows are dangerous and destructive. This project aims to forecast potential lava flows in the most populated census blocks so communities can be prepared for evacuation if needed.

![Figure 1: Mauna Loa volcano during an eruption.](image1)

![Figure 2: Location of Hawaii, within The Hawaiian Island Chain.](image2)

**Methods**

The first step in our project was to obtain data from Hawaii Office of GIS, and add the layers into ArcMap 10.3.1. The information was then projected into Universal Transverse Mercator, North American Datum 1983, Zone 5N. In order to do a lava flow and impact analysis in the event of an eruption of Mauna Loa, information regarding elevation and lava formations from historic flows were analyzed. A slope raster was created by using an elevation layer (Hawaii Office of GIS) as the input raster, and output to be measured in degrees. The slope was then reclassified into 10 different classes. Using the crater of the Mauna Loa Volcano as a starting point and the cost distance tool, a cost-distance and cost-direction layer was created. With the resulting layers, a cost path analysis was conducted with the input raster as the historic lava formations, along with the cost-distance and cost-direction layers. This resulted in a layer depicting the potential flow path, based upon historic lava formations, and the least cost path from the crater to the formations using the slope of the volcano.

Additionally, census data was downloaded from Social Explorer (www.socialexplorer.com) to assess the population density of potentially impacted areas by lava flow. We then created buffers of 1 and 2 miles around our predicted lava flows. These buffers are important because lava may take a slightly different path than our predicted flows and this accounts for the possible inaccuracy. We used these buffers to determine which census blocks would be most in danger from lava flows. This was determined by using Excel to calculate the percentage of each census block that was located within the 1 mile buffer from our predicted lava flows. The percentage of each census block was multiplied by its population density to display the census blocks that are in the most danger.

![Figure 3: This image illustrates how our predicted lava flows match well with the hazard zones determined by the USGS.](image3)

![Figure 4: Predicted lava flow overlaps with census blocks of various population densities.](image4)

**Results**

Once our predicted lava flows were displayed on the map of Hawaii, we could check the validity of these flows by comparing our results with the volcanic hazard zones determined by USGS. Our predicted lava flows matched strongly with the hazard zones determined by USGS, demonstrating the legitimacy of these predicted flows (Figure 3).

We discovered that 26 census blocks in Hawaii are located in areas that are 1 mile from our predicted lava flow paths. These census blocks are in the most danger of confronting lava flow if Mauna Loa erupts. Of these 26 census blocks, some have higher population densities making them more at risk in the case of an eruption. As shown in figure 5, the area on the East side of the island has the most census blocks that fall along the predicted lava flow path with high population densities. Two census blocks in the northwest are in danger as well as three census blocks on the South end of the island.

**Discussion**

Although the U.S. Geological Survey’s Hawaiian Volcano Observatory monitor the rift zones of Mauna Loa 24/7, lava travels quicker on steeper ground and therefore requires a faster evacuation plan than areas located on less steep ground. According to the University of Hawaii at Hilo, when Mauna Loa erupted in the early 1990’s, the residents of Kalapana, HI had days and sometimes weeks to evacuate. On the other hand, when Mauna Loa erupted in 1950 the residents of Ho’okena Mauka had a mere six hours to evacuate. These differences in evacuation times was due to the steepness of the ground that directly affected the speed of lava flow (University of Hawaii). This demonstrated the importance of this model to predict the census blocks that must be prepared to quickly evacuate.

The census blocks highlighted in Figure 5 should be the focus of evacuation plans in Hawaii. These census blocks are more likely to encounter lava flow in the case of an eruption and also have high population densities. It is important to note that in Figure 5, the census block to the south with moderate danger is highlighted because a large percentage of it overlaps with our predicted lava flow paths. However, this census block has a very low population density and therefore should not be focused on as strongly as the census blocks to the east for evacuation plans.

**Conclusion**

In the case of Mauna Loa erupting, the census blocks to the east of the island and to the northwest of the island should be the focus of developing evacuation plans. This is based on a least-cost path analysis that uses percentage change of the slope from Mauna Loa crater to locations of historic lava flow. The population density of each census block was taken into account to find the census blocks in most danger (Figure 6).

**Sources**


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![Figure 5: Census blocks in the most danger, determined from predicted lava flow paths and population densities.](image5)