Cumbre Vieja volcanic eruption: Cartographic animation on a 3D print



The 2021 eruption of the Cumbre Vieja volcano, situated on La Palma in the Canary Islands, was an event with significant impact on both society and the environment. [1, 2] It is important to visualise the dynamics of such volcanic events for raising public awareness and advancing scientific research.

Emerging technologies like 3D printing and geoanimation can help understand complex processes happening in the environment and their further effects.



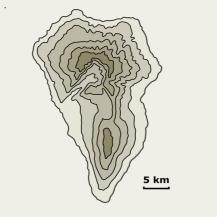
from explosive pyroclastic flows to the steady advance of lava rivers, impacting air travel with volcanic ash releases and leading to airspace closures. Lava fountains created mesmerizing scenes, but triggered evacuations as molten rock flowed downhill, causing substantial damage to homes and infrastructure, including complete destruction of the town of Todoque. The ongoing eruption sparked discussions on long-term effects on the local ecosystem and potential landscape changes.

The economic fallout was significant, affecting businesses, tourism, and local industries. The event emphasizes the dynamic nature of our planet, underscoring the need for continuous monitoring and prediction efforts to protect vulnerable communities from volcanic activity.



THE ISLAND

La Palma is the most northwestern island of Canary Island, Spain. The 708 km² paradise has a population of 85,840. The local economy thrives on a combination of agriculture, particularly banana cultivation, and tourism, as visitors are drawn to the island's lush forests, volcanic craters and black sand beaches.



IMPRINT

Mapping Project Winter Semester 2023/2024 Technical University of Munich

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AIMS OF THE PROJECT

1. Creation of a physically accurate 3D model of a La Palma segment, employing a Digital Elevation Model (DEM) as the foundation. [3]

2. Processing of remote sensing and Volunteered Geographic Information datasets to extract intricate details regarding the dynamic day-to-day alterations in lava flow patterns and the consequential impact on the infrastructure.

3. Development of an animation presenting the story of the eruption including rescue efforts and the aftermath in the form of a surface-projected video suited with narration.

DATA AND METHODS

In our project documenting the island's volcanic activity, we utilised data from the Copernicus Emergency Mapping Service for lava cover layers and Digital Elevation Model (DEM), alongside land cover data from OpenStreetMap.

compositions The map were generated using QGIS, integrating a 3D terrain model created with the DEMto3D plugin. The map animation, a pivotal element of our presentation, was crafted in ArcGIS Pro, with calculation of the number destroyed buildings of by performing multiple intersections.

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KILOMETERS OF ROADS DESTROYED, INCLUDING NORTH-SOUTH HIGHWAY	HECTARES OF FARMLAND COVERED BY LAVA	BUILDINGS DESTROYED	INHABITANTS DISPLACED	ESTIMATED LOSSES IN EURO	Sources Copernicus Emergency Mapping Service • Openstreetmap • Srtm © Munich 2024

Fig 1. Mockup of the final product with projected animation and laser-cut contour map

This design, including an extruded contour map of the island, was then translated into a physical form through laser engraving and cutting in plywood using the Epilog FusionPro 32 machine. Then, the 3D model was produced, customized in UltiMaker Cura, and printed on UltiMaker S5 machines.

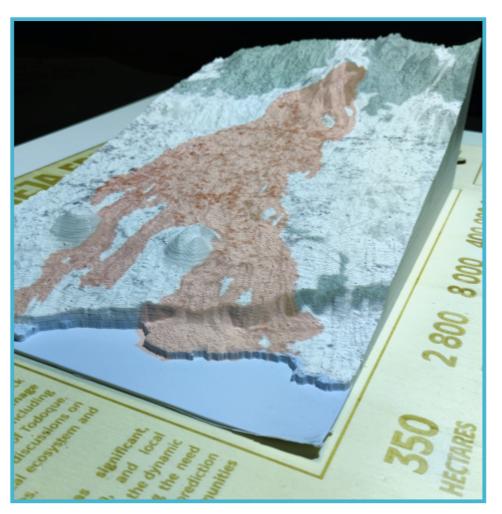


FINAL RESULT

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The concluding video, projected onto the model positioned at the base, begins by introducing viewers to the local conditions. It then delves into an explanation of the eruption, showcasing the lava flow over the course of 86 days. The video concludes by providing insights into the long-term impacts, including displacement, land forced degradation, and economic repercussions.

Our project demonstrates the successful integration of various technologies, resulting in an innovative cartographic animation that bridges the physical and digital realms. It can be used to educate about the eruption and its effects or serve as a tool for teaching about disaster management..



KEYWORDS

volcanic eruption, disaster management, storytelling, spatio-temporal analysis, 3D printing.

VIDEO OF THE ANIMATION

https://youtu.be/S_hzNCBQB9w



REFERENCES

[1] Longpré, M.-A. (2021). Reactivation of Cumbre Vieja volcano. *Science* (Vol. 374, Issue 6572, pp. 1197–1198). American Association for the Advancement of Science.

[2] Carracedo, J. C., Troll, V. R.,

To augment the informational content, the animation's base incorporating essential details about the island and the eruption was designed in Inkscape.

Fig 2. Photo of the final product: laserengraved base, 3D print with projection and laser-cut contour map

The final animation, featuring photos and videos of the island, was edited in Sony Vegas, incorporating Al-generated voiceover from ElevenLabs and music composed in Soundraw.

Fig 3. Photo of the final product: projection of final lava cover and location of destroyed buildings and roads Day, J. et al. (2022). The 2021 eruption of the Cumbre Vieja volcanic ridge on La Palma, Canary Islands. *Geology Today* (Vol. 38, Issue 3, pp. 94–107). Wiley.

[3] Digital Elevation Models of the Cumbre Vieja Volcano in La Palma, Spain. Technical Report (2022). Copernicus Emergency Mapping Service.

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