How does the geomorphometry of a volcanic island influence the stability of its flanks?

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1. Introduction

The devastating consequences of the **volcanic flank collapse** of Anak Krakatau in 2018 show that we need to improve our **understanding** of processes involved in the **failure of volcanic islands**. Various factors are known to influence the instability of a volcanic edifice. Investigations are often **restricted to the subaerial** parts of a volcano, due to the additional challenges involved in marine research. The **majority** of a volcanic island's edifice, however, is **submarine** and needs to be included.

Therefore, we study the morphology of the entire edifice, from summit to seafloor. We are searching systematically for correlations between the morphology and the instability of volcanic islands world-wide.

3. First Results

So far, we **extracted outlines** and calculated basic **morphometric parameters** for four volcanic edifices in the Canary Islands (Tab 1). The **optimization of the delineation process** is key for minimizing the manual editing and will allow us to **increase** the number of **volcanos** investigated for a more statistically significant analysis.

Island	Area [km²]	Perimeter [km]	Total Height [m]	Mean Slope [°]
El Hierro	3278.02	483.66	5274.48	11.97
La Gomera	5106.14	650.79	4945.15	9.78
La Palma	5890.34	875.39	6224.60	10.32
Tenerife	10532.98	1082.14	7221.67	9.74

Table 1: *First morphometric parameters of the Canary Islands*

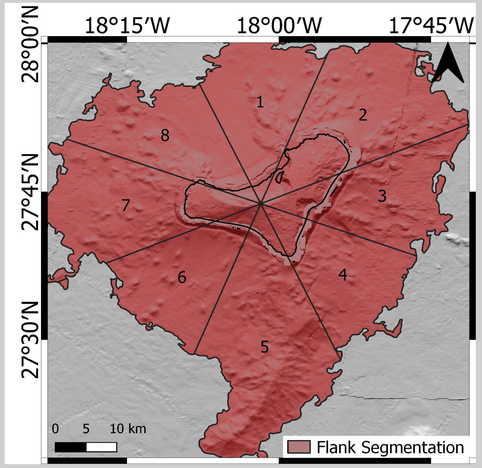

***Figure 3**: The volcanos will be segmented into eight flanks, which can be analysed individually*

5. Outlook

We will divide the volcanic islands into **two groups** based on data availability:

1. **GEBCO-based**: only those parameters showing minimal deviations are calculated and entered into the database
2. **Where high-resolution** data is available, volcanic islands are investigated in detail.

We will **segment islands** of the second group into **flanks** to investigate them separately (Fig 3). This will enable us to determine, whether **specific flanks** (i.e. the steepest) are **more likely to fail**, regardless of their absolute values. In the future we plan to include tectonic settings and environmental factors, such as rainfall patterns.

Reference: (1) van Wees, R., Tournigand, P-Y., O'Hara, D., Grosse, P., Kereszturi, G., Campforts, B., Lahitte, P. & Kervyn, M. (April 2021) *Quantifying the morphometric evolution of stratovolcanoes through erosion* Poster presented at EGU 2021

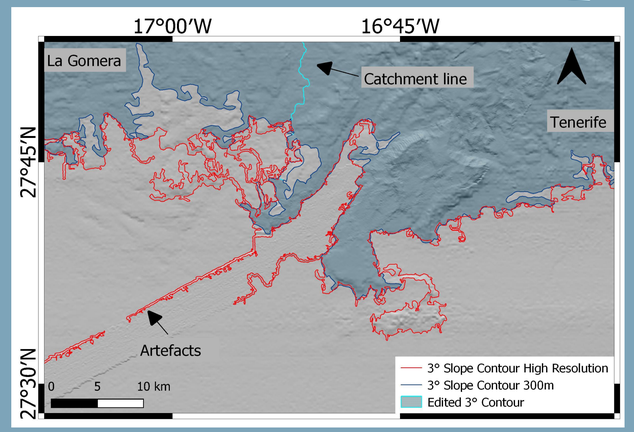

Figure 1: *The 3° slope contour of the resampled grid (dark blue line) is less sensitive to artefacts and small scale changes. River valleys (light blue) are good lineations for separating volcanic edifices.*

2. Methods

We combine **high-resolution** (50-100 m) **bathymetry** and topography data from various sources (i.a. GMRT, EMODNET). Our **semi-automatic** approach for **delineation** of the **volcanic edifices** (modified from Roos v. Wees (1)) aims to distinguish the volcanic edifice from the surrounding seafloor by:

- Down sampling the raster to 300 m cell size
- Plotting of the **3° slope contour line**
- Manual editing (artefacts, separation of volcanic edifices), based on derivatives and catchment delineations. (Fig 1)

We extract **morphometric parameters**, such as height, area, volume etc., enter them into a database and describe them **statistically**.

4. Can GEBCO help?

The lack of high resolution (HR) bathymetry data is restricting our investigation to a few well-mapped archipelagos. Therefore, we are **testing** the usefulness of **low-resolution grids** with global coverage, such as GEBCO. We find that, while the delineation is not as precise (Fig. 2), the deviation of the parameters from the HR vary (Tab 2). Some **basic parameters** such as area and volume could potentially be **calculated from GEBCO**, if no other data is available.

Island	Δ Area	Δ Perimeter	Δ Water depth	Δ Height a.s.l.
El Hierro	5.9 %	37.2 %	2.9 %	15.6 %
La Gomera	1.2 %	-0.8 %	-0.4 %	28.3 %
La Palma	-1.1 %	33.7 %	0.2 %	-2.1 %
Tenerife	-3.3 %	9.5 %	-0.1 %	-3.0 %

Table 2: *Deviation of GEBCO from High-Resolution Grid in in %*

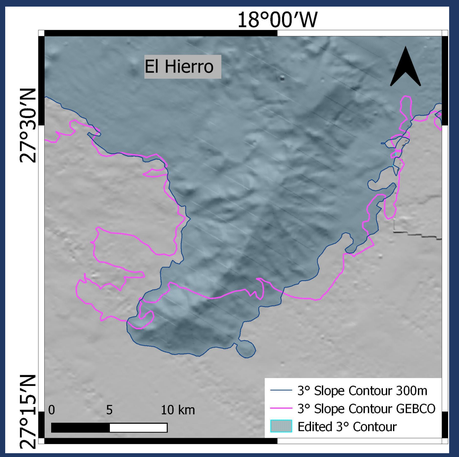

Figure 2: *The 3° slope contour of the GEBCO grid (pink line) diverges strongly from the edited volcanic outline in some places*