

Volcanic Resilience of Garachico, Tenerife

A Scientific Report

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Introduction

This report assesses the volcanic resilience of Garachico (**Fig 1a & b**), a town that experienced a devastating volcanic eruption in 1706. To assess the town's volcanic resilience, we collected qualitative (survey) and quantitative (fieldwork) data. This municipality was chosen because a volcanic drill will take place here in late September 2025. The drill aims to assess the island's response to any future volcanic emergencies. Alongside the local and regional government, there will be active participation from the citizens of Garachico. The simulation will be monitored by organisations such as IGN (Spain's National Geographic Institute), CSIC (Spain's National Research Council), INVOLCAN (the Canary Islands' Volcanology Institute) and others (Devos, 2024).

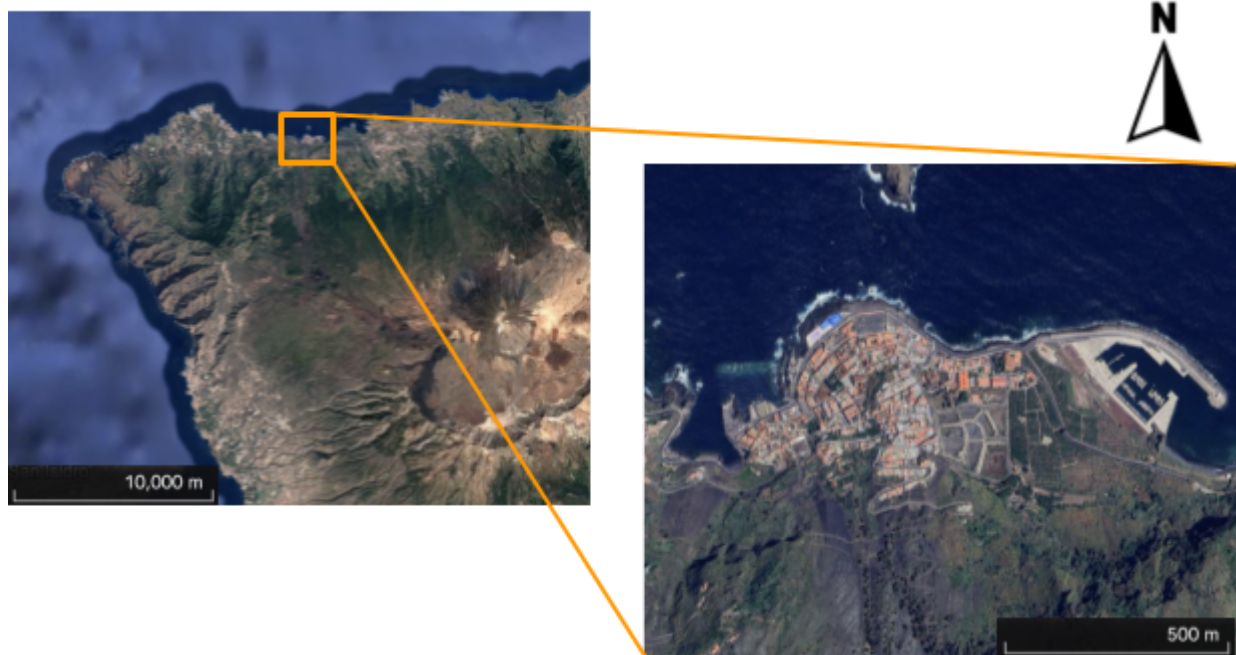


Fig. 1a and 1b - An aerial view of the N-E of Tenerife (a) and a magnified view of the center of Garachico (b).

Historical Volcanic Context

Geological setting:

Exposures along the Northwest rift zone of Tenerife display the rich history of volcanic activity spanning 690,000 years (Romero Ruiz & Beltrán Yanes, 2015). From the central Pico Viejo to the older North-West Teno massif, successions of basaltic lava flows and volcanic ash were emplaced during effusive to moderately explosive eruptions (Longpré & Felpeto, 2021).

Socioeconomic background of Garachico (1706): *Translated from 'El Impacto de las Coladas de 1706 en la Ciudad de Garachico. (Tenerife, Islas Canarias, España)', Investigaciones Geográficas (Romero Ruiz & Beltrán Yanes, 2015).*

Prior to the Montaña Negra eruption, Garachico was a historical bay town used for its port, built upon a lava delta, surrounded by slopes, valleys and cliffs. Post-eruption, the topography of this area was mostly unchanged, apart from the formation of the cone and the expansion of the lava deltas (which extended seawards). During the time of eruption, Garachico was rich in resources, such as sugar cane, wine, and cereals. Subsistence farming was practiced, mostly growing maize and potatoes, which created economic stability.

Montaña Negra – Garachico 1706

Following the first recorded historic eruptions in Tenerife: Siete Fuentes, Fasnia, and Arafo in 1704-05 (Longpré & Felpeto, 2021), seismicity continued on the island. Handwritten records described “horrible, intense, and continuous” rumbles from beneath the feet of residents of Garachico (Romero Ruiz & Beltrán Yanes, 2015).

On the 4th of May 1706, high above the municipality, there was seismic activity. Residents were unaware that this activity was a precursor to another eruption. The new vent tore open the Earth, forming a 850 metre-long fissure at an altitude of 1,300 metres (m) (Firth & McGuire, 1999). Lava flows soon formed and began their descent towards the communities below (Romero Ruiz & Beltrán Yanes, 2015). By the evening of the following day, large chunks of hot lava began to break off the flows and descend the sheer cliffs, increasing the danger of the event. At the same time, pulverised volcanic rock rose above the vent and moved towards the South-West at a maximum of 3 kilometres per hour (Firth & McGuire, 1999), expanding the area impacted by the eruption.



Fig. 2 - Painting of the 1706 eruption in Garachico. Bordanova oil Canvas (1887). 'Private collection of Luis Lopez de Ayala and Anzar, Marquis of Villafuerte'. (Ruiz and Yanes, 2007, pg 157)..

It took a few days for the full extent of the eruption to be felt in the coastal town of Garachico, 6km (**Fig 2**) away from the vent (**Fig 9**). Lava flows created immense vapour clouds when they interacted with seawater. Additionally, the hot lava flows reached the port, accumulating land up to 150m into the sea, burning everything in its path (Romero Ruiz & Beltrán Yanes, 2015). After 40 days of eruption, the activity ended on the night of 13 July.

During and after the eruption, the highlands of Garachico (>800m) were destroyed, with a land mass of 5.92 km² covered by volcanic fallout. Although significant damage affected this land mass, the economic impact was negligible, as this land was used for herding, logging, and beekeeping. Vegetation suffered significant impact.

Fallout from Montaña Negra covered 2.8km² of the Garachican midlands (500-800m), with an approximate 29.4% of total volcanic fallout reaching these altitudes. Lava flows impacted fields and houses, where most agricultural land was designated to subsistence farming. The significant loss suffered by the local economy led large numbers of residents to migrate away from Garachico.

Only 9.6% of total volcanic fallout reached Garachico's coastal areas, occupying 0.79 km². However, the eruption had long-lasting impacts on the community. High concentrations of large, cultivated areas, dense population, water storage, and hydro infrastructure allowed Garachico to be defined as a highly vulnerable area. Effusive flows destroyed the port, burning down much of the town's infrastructure and housing, flowing 350m seaward, with a total area of 5.3 hectares. After the eruption, the city lost its economic hub, architectural heritage, and land mass for agricultural uses.

Modern-day Garachico is a historic time capsule of Canarian traditions, culture, and aesthetic beauty (**Fig 3**), with a thriving and welcoming community. It successfully balances tourism and self-identity. Investigating the town's resilience against volcanic hazards underpins this research and the future safety of Garachico.



Fig. 3 - Photograph of Garachico centre, facing North, taken by author (LG).

Methodology

3.1 - Fieldwork

The volcanic resilience fieldwork was a collaborative effort involving GeoIntern Group C, Dr. Thomas Jones (UK Research Institute), and Dr Pier Paolo Comida (Lancaster University) to quantify the dispersal of tephra around Montaña Negra (Arenas Negras). The study focused on tephra deposits from the Chinyero and Arenas Negras eruptions, aiming to quantify deposit volumes and assess hazard implications. The work involved measuring tephra deposit thickness spatially from each vent, with the data used to construct isopach maps (maps showing thickness of ash/tephra deposits) in QGIS (Wallace et al., 2022; **Section 4.1**). Permission from the Gobierno de Canarias was required as it is a site of the Special Nature Reserve (Reserva Natural Especial), usually protecting the area from this kind of work (Gobierno de Canarias, 1994; Gobierno de Canarias, 2007).



Fig. 4 - A map of Tenerife with the approximate field working area highlighted. Created using Google Earth, 2025.

Sampling sites were strategically selected using topographic maps, prioritising flat ground with minimal vegetation to minimise the effects of post-depositional remobilisation and biological disturbance (e.g., tree roots) (Wallace et al., 2022). GPS coordinates were recorded at each site to enable spatial modelling and simulate hypothetical tephra dispersal patterns for future eruptions near populated areas.

Fieldwork was conducted between the 14th and 21st July 2025, with 54 tephra deposit sites recorded during daily surveys. Routes were pre-planned and often required departing from hiking trails to reach suitable sampling locations. Measurement sites are shown in Fig. 5 and Fig. 6. Deeper deposits were prioritised to provide a more robust minimum volume estimate given the limited timeframe. Some vent-proximal areas could not be sampled due to recent lava flows or steep terrain, where tephra was expected to be discontinuous or affected by erosion (Kobayashi and Okuno, 2022).

At each location, a pit was excavated using a shovel until a palaeosol or lava flow was encountered. Care was taken to identify and remove accidental inclusions such as bombs or large clasts (see **appendix 7.1**), which might otherwise distort the stratigraphic interpretation. Depths were

measured using a tape measure, from the base of the remobilised or biological layer to the top of the palaeosoil or lava flow. Pit walls were carefully cleaned to expose a continuous and representative stratigraphic profile (Spence et al., 2005) and any signs of digging had to be covered up to comply with the terms of the working permit (Gobierno de Canarias, 2007).

Secondary deposits, including organic-rich soil layers or remobilised tephra transported by flash floods, were excluded from thickness measurements to avoid distorting the isopach maps and volume calculations. In cases where multiple tephra layers were preserved (**see appendix 7.2**) (e.g., Chinyero overlying Arenas Negras), both were measured separately using the same method. The lower layer was assumed to be from the Arenas Negras eruption as it happened before the Chinyero eruption (see Section 2).

Samples were only collected from tephra layers that appeared to be primary deposits with minimal post-depositional disturbance. Sampling was conducted from top to bottom of each layer, avoiding biological material and remobilised sections. The cleaned tephra was placed into sealed plastic bags, which were then tightly taped to preserve particle structure for later grain size distribution (GSD) analysis (Osman et al., 2022; Bonadonna and Costa, 2013).

3.2 - Survey

The volcanic resilience survey (**see appendix 3**) was created collaboratively with all other GeoIntern students. Questions were altered in order to be more specific to Garachico. Our survey consisted of 17 questions, with multiple choice, "select all", ranked scale, and short answer questions. The aims of the survey were to assess residents' awareness of volcanic hazards, understand where they receive information, and determine where the residents' trust resides in communication sources.

On the first day of survey work (14/07/2025), all group members discussed the goals of the project, deliverables required, and the logistics of splitting field work and survey tasks. That afternoon, all group members visited the central municipality of Garachico and observed potential challenges to the evacuation, which included a lack of accessibility, infrastructure oversights, and other notes about the layout of the town. In order to easily distribute the survey, we printed out flyers with a QR code and designed three

posters to inform the locals of Garachico of our intentions of surveying (see appendix).

Survey data was then collected in Garachico over the following week. Flyers were distributed to residents on the streets, put in shops and restaurants, and posted on doors. Survey responses were also acquired through interpersonal communication by asking residents on the streets and asking them questions. On the final day of survey response collection (22/07/2025), a more centralised, large-group approach was used. With permission from the mayor of Garachico, Jose Heriberto, we set up a table in the principal plaza, Plaza de Libertad. This table was brightly decorated, and free refreshments were used to entice residents to our table to answer the survey.

3.3 - Thematic Data Analysis

Thematic analysis is a way to identify and analyse patterns within a dataset (Braun & Clarke, 2006) in Neuendorf (2019) whereby the end result should highlight the most salient constellations of meanings within the dataset (Joffe, 2012). Our goal from coding the surveys was to identify patterns and themes from participants, in order to understand how the community of Garachico and Tenerife as a whole can be better prepared for a volcanic eruption, why residents in Garachico are hesitant to make an emergency plan, and what the residents of Garachico are expecting from the simulation taking place in September 2025.

We began by open coding the survey responses for different questions. Open coding is the process of combing through the data for themes, ideas and categories, marking similar passages of text with a code label for comparison and analysis. See the tables in **appendix 4** for a list of some of the open codes for each question. Then from these open codes, we conducted axial coding, which is finding connections and relationships between the open codes. This highlighted the most common concerns, barriers and expectations from the people of Tenerife and Garachico.

3.4 - Google Earth Remote Mapping of Infrastructure Vulnerability

In order to determine any possible susceptibility to volcanic hazards, especially ashfall, we performed an evaluation through Google Earth of the

roof types and water deposits in Garachico and surrounding rural areas. Google Earth allowed us to inspect the building types accurately and over a wide area. We digitally traced rooftops manually in seven areas by utilising the polygon tool. These areas were: central Garachico, San Pedro de Daute, La Cruces, El Tanque, San Juan del Reparo, Genovés, and El Guincho (**see appendix 6.1**)

Results & Data Analysis

4.1 - Field (Quantitative) Data

The isopach maps below are useful in showing the projected wind direction of the Garachico (1706) and Chinyero (1909) volcanic eruptions. Figs. 5 and 6 below show the thickness of the tephra deposits. When aligned with the wind rose diagrams, these approximate the wind direction during the volcanic eruptions.

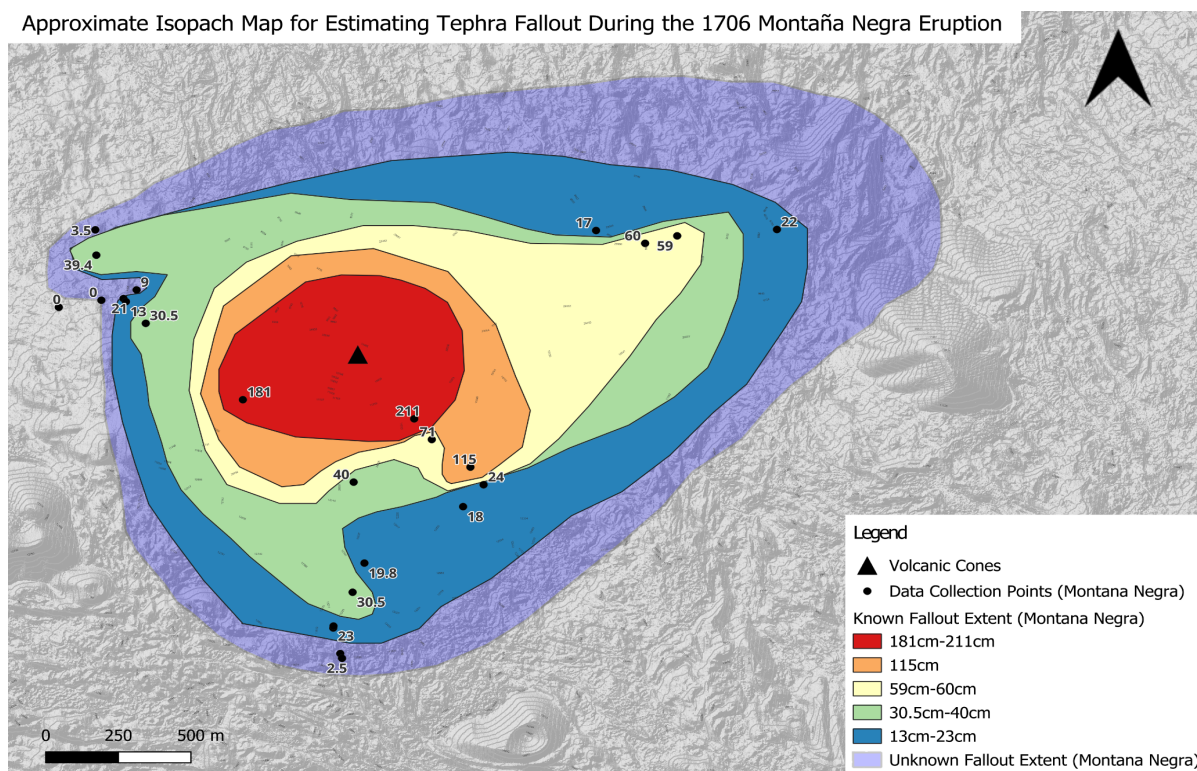
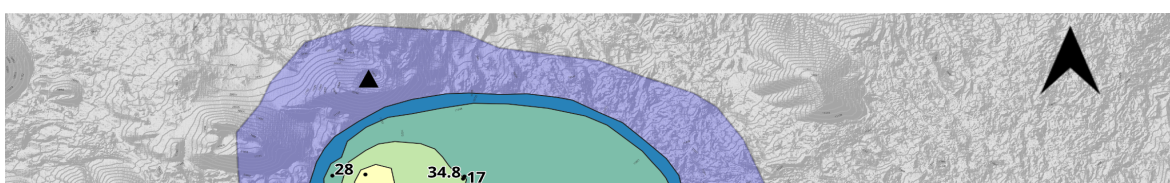


Fig. 5 - An isopach map of the collected tephra deposits from the 1706 Montaña Negra Eruption, showing their thickness (in cm). Created in QGIS, 2025

As to be expected, the thickest deposits are nearest to the cone, southwest and southeast of it. This implies a southerly wind direction. The third



thickest deposit is to the southeast. However, the wind seems to have come from the north and curved to the NE, as many deposits are found to the NE.

Fig. 6 - Approx Isopach Map for Estimating Tephra Fallout During the 1909 Chinyero Eruption.

The Chinyero deposits are relatively simple, as multiple deposits, including the thickest, are found to the north. This implies a south to north wind direction.

The Impact of a Possible Future Volcanic Eruption on Garachico

In our survey question 3.3 (**see appendix 3.6**) , we asked participant's opinions concerning 'how likely certain volcanic hazards may impact' their community. The 'Volcanic Hazards Graph' shows the results determined by the number of respondents who stated that their community would be 'very likely' to be impacted by each hazard. As shown, most responded that their community would be impacted by seismic activity or volcanic ash (tephra) fall, followed by lava flows and volcanic gases. However, this is contradicted by literature.

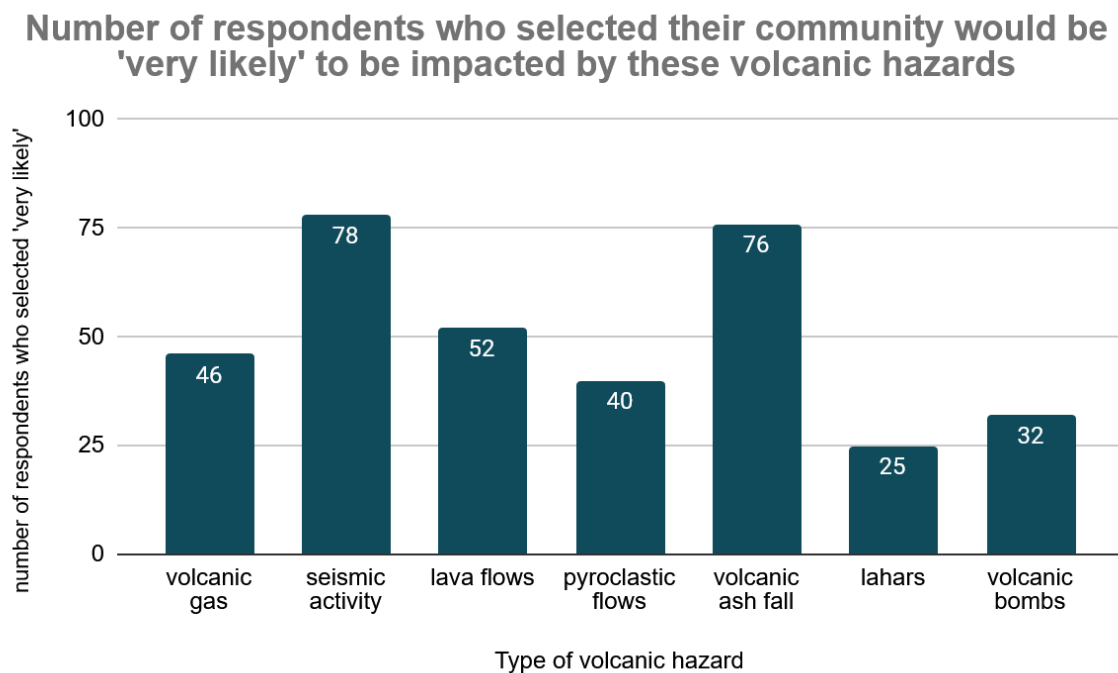


Fig. 7 - Volcanic hazards graph. Respondents' opinions of how likely volcanic hazards are to impact them. Created using data from survey question 2.3

According to Solana and Aparicio (1999), lava flows would be the primary hazard, due to the steepness of the cliff slope. This favours the formation of lava channels and tunnels, which are common in Canarian eruptions and allow for a quicker displacement of lava. Figure 9 shows that all municipal villages within the general width of the eruptive fracture plus the distance from any possible vents to the sea would be at risk. Tephra fall may become hazardous if the wind direction blows from south to north, similar to Chinyero in 1909 (**Fig 6**). Nevertheless, recent average wind data for Tenerife has shown the direction to be south-east to north-west, implying that there would be minimal risk to those communities (**Fig 8**).

Extreme geohazards can trigger cascading effects that are difficult to predict and prepare for, meaning they are not normally taken into account during personal and organisational hazard assessment. Seismic activity would cause landslides, which could bury the main town, one centimetre of ashfall is enough to add 19kg of weight and collapse flat roofs (**Fig 10**), and fires on the highlands may be caused by hot ashfall (Lopez-Saavedra et al., 2021; Solana & Aparicio, 1999).

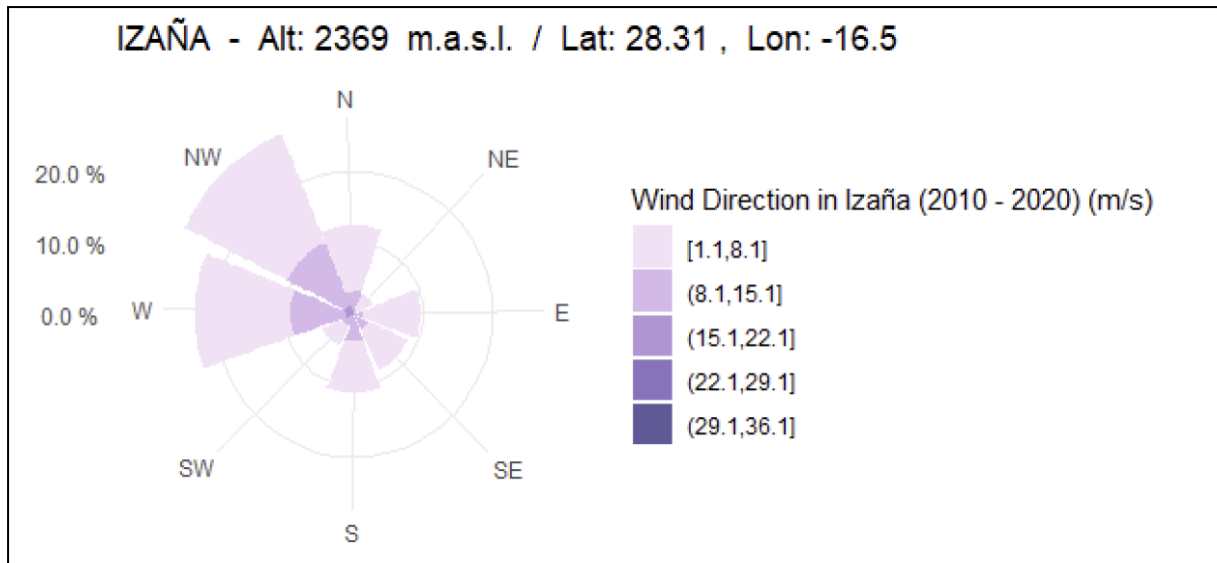


Fig. 8 - Rose diagram of average wind speed & direction data from 2010-2020. Data collected from Izaña Observatory near Teide National Park, the closest wind station to Garachico. Created using Rstudio.

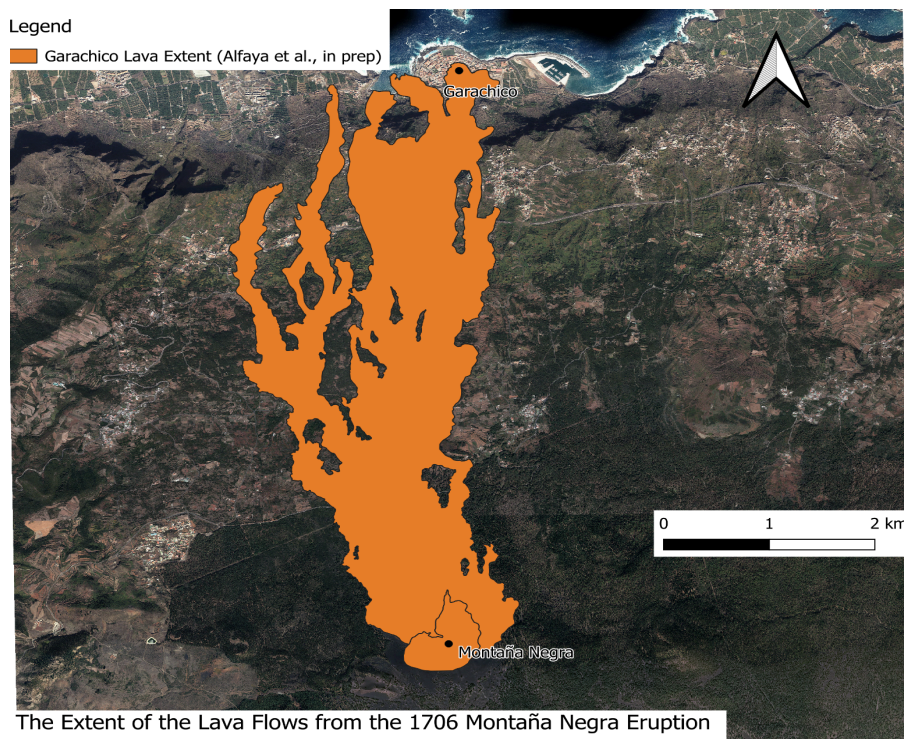


Fig. 9 - Map showing the extent of the 1706 Garachico lava flows, as adapted from Alfaya et al., in prep.

Infrastructure Vulnerability Analysis: Roof Types and Water Deposits

Roof types and water reservoirs within the municipality were identified to determine their structural weaknesses in the event of an ashfall (**Fig 10**).

The red polygons represent the flat roofs which are more prevalent than slanted roofs (blue polygons). The type of roof will determine how resilient a building is. Accumulating ash will increase weight on top and cause the planar structures to collapse; rainfall would accelerate this. In contrast, pitched roofs are often less susceptible to collapse because tephra fall deposits cascade down the slopes, sufficiently decreasing weight.

We also identified many water reservoirs (yellow polygons), particularly in rural areas. These are essential to domestic and agricultural purposes and so are vulnerable to contamination by ash. This would reduce the quality of water, posing a threat to the health of the citizens and food safety. Returning to normality would be more prolonged if water reservoirs are compromised.

The present spatial data set is a screening of infrastructure resilience in the region. It establishes the areas which might need structural support or may be given a priority in future eruptions.

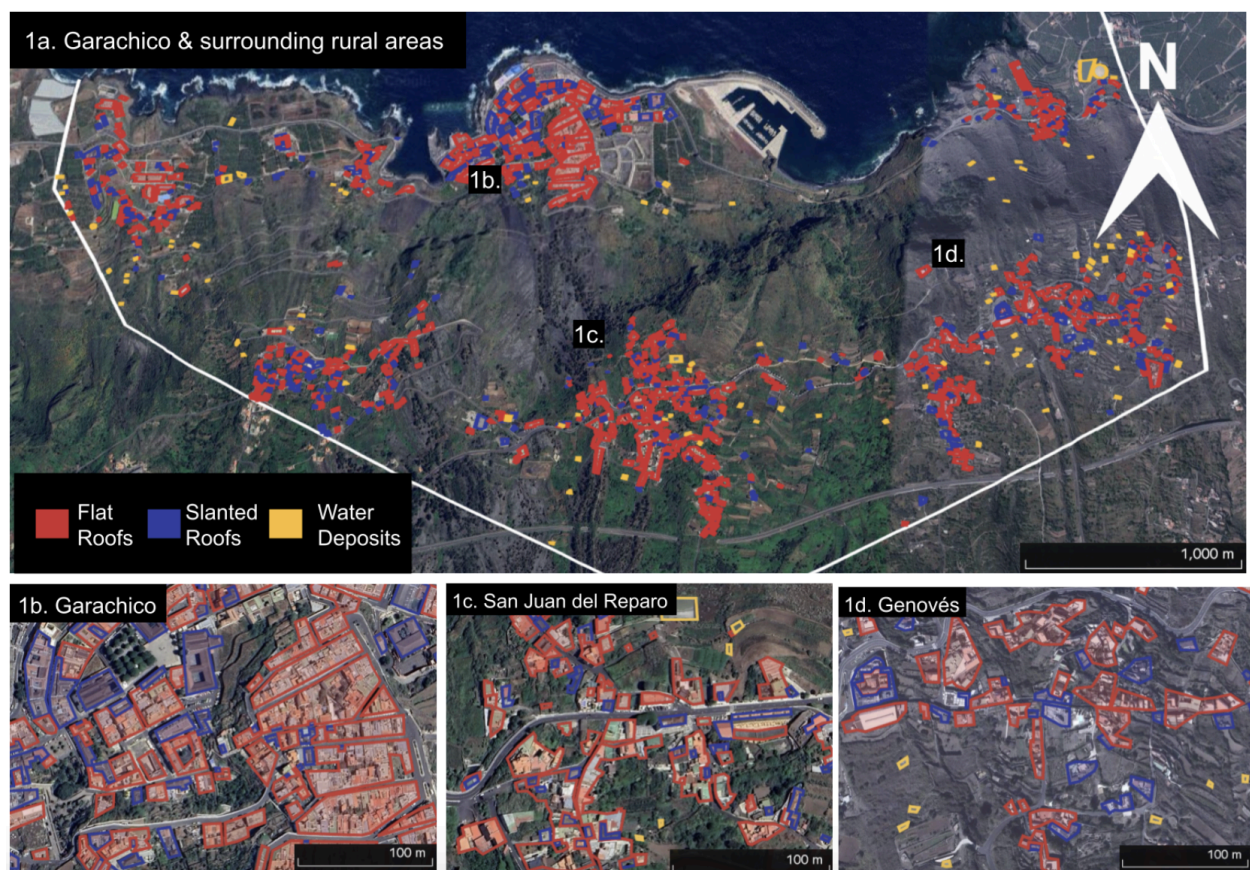


Fig. 10 - Map of the study area (white line) : Roof Types and Water Deposits within our area of study (North of Garachico Municipality).

These findings are consistent with those observed in the 2021 Tajogaite eruption on La Palma, during which a post-eruption impact analysis of 764 buildings conducted gave an understanding of roof susceptibility to tephra fall-out at the >20cm isopach (Reyes-Hardy et al., 2024). Despite the fact that 11 percent of the buildings surveyed would have had a 75 percent probability of collapsing in case clean-up fails to occur, only 10 roofs collapsed (1.3%). Which illustrates the significance of efficient tephra removal, if safe to do so. The roofs most susceptible to failures were of metallic, fibre cement and plastic sheets. This data underlines the role of roof cover in building stability, which promotes the importance of constant maintenance and readiness in volcanic areas that could be vulnerable to ash fall such as Garachico.

4.2 - Interviews (Qualitative)

We conducted two interviews during the course of our research (see interview responses in **appendix 2**).

José Heriberito - Mayor of Garachico

On the 16th of July 2025, we interviewed José Heriberito, the Mayor of Garachico, at the 'Agencia de Empleo y Desarrollo Local de Garachico' (town hall). With the help of Javi Diaz, a previous Geointern Local Scholar, we asked Heriberito about Garachico's current state of volcanic readiness and preparedness ahead of the simulation at the end of September. As the mayor, he is aware that there has been an increase in volcanic activity in recent years; however, the traffic light system still indicates green, which he disagrees with - *'it should be yellow'*. If a volcanic eruption were to occur, he told us that the **'main issue is that the water supply comes from Teide, so water channels will be cut'**, and there is only a **'small port for an evacuation route, as roads are not fit for evacuation.'** These are important factors to bear in mind when creating a resilient community, both socially and through infrastructure.

Heriberto explained that they have not communicated with the residents/commuters of Garachico regarding official advice and do not currently have an evacuation plan in place. The reason for their lack of

preparedness is because there has been no instruction from IGN and the Canarian government to provide more information on volcanic risk. Collectively, they are ***'not providing evacuation information until after the simulation,'*** and then they will set up a *'centralised discourse'* for what they are going to tell people. During the 2024 Vilaflor resident survey, Agustina Beltrán Cano, Mayor of Vilaflor (19/07/2024) also wished for ***'a call for consolidating information from INVOLCAN, IGN, and CSIC into a single discourse to avoid conflicting messages and ensure coordinated efforts. The mayor also emphasised on the need of these institutions to work together,'*** (GeoTenerife, 2024, Vilaflor Resident Survey) showing that there is encouragement for these organisations to cooperate. He hopes that people will have enough knowledge on evacuation once the simulation has been conducted. Although we noted that if he waits, a volcanic eruption could occur before September and thus Garachico would still be at risk.

Heriberto used the forest fire of 2007 as an example to highlight their vulnerable community, which was determined when the local government organised an evacuation. His reflection on the event: ***'It was hard to evacuate because elderly people didn't want to leave, and also there are more remote rural close communities that are hard to involve in plans.'*** Similar comments were made by Agustina Beltrán Cano (19/07/2024) when she was interviewed for the 2024 Vilaflor residents survey and stated ***'During the 2012 forest fire evacuation, some residents were reluctant to leave their homes and had to be physically removed due to their resistance to evacuating.'*** (GeoTenerife, 2024, Vilaflor Resident Survey) supporting José Heriberito's comment. These vulnerable demographics were important for us to incorporate into the study, so we decided to visit these areas and gain insight into their understanding of preparedness. Upon finishing our interview, he was eager to receive our results and interpretations

Roberto Hernández - Deputy Head of IES Garachico

On the 16th and 17th July 2025, we spoke with Roberto Hernández, the Deputy Head of the Garachican high school, IES. He discussed his role in volcanic resilience in the community as a teacher.

When we initially met with Roberto, we discussed the lack of communication from the local authorities/IGN, which was a common theme throughout this interview. He stated that as an academic institution,

they 'do not receive any information from IGN'; however, he said he would 'expect to get some information in the weeks before a hazard; if not, they are really lost.'

Due to this lack of communication, there is no strategy in place for a volcanic eruption, and nothing in the curriculum regarding risks of volcanic hazards.

'The schools have general evacuation plans in case of a fire or earthquake, which are tested at the start of every term,' but volcanic hazards are not taken into consideration. If a volcanic event were to take place, they would follow the general evacuation plan, which may increase the students'/staff's safety, as this will not incorporate volcanic hazards.

This is a note that can also be seen in the 2023 tourist volcanic readiness survey, where they found that *'None of the hotels had any internal procedures/ risk officers that would be responsible for liaising with guests in the case of a volcanic emergency,'* (GeoTenerife, 2023, Tourist Volcanic Readiness Survey) similarly to how the school would have to rely on local authorities to come to them in the event of a volcanic eruption.

Roberto's anxiety was evident when saying, ***"I'm really worried about local people, not even just for this village, the surrounding ones too,"*** as he felt they require the information because ***'they live in a high-risk area, but they don't have any information.'***

During our second interview with Roberto, we discussed what changes he would like to see. He suggested the *"town council and cabildo need to cooperate"*, and create accessible resources, in order to educate the town. This contrasts with the 2024 Vilaflor resident survey where *'44.6% of respondents identify the municipal government (ayuntamiento), as the reliable source of information in Vilaflor'* (GeoTenerife, 2024, Vilaflor Resident Survey) as Roberto receives no information from the Town hall or Cabildo which is why he suggested they need to cooperate better. Roberto's goal is to implement basic measures and organise a plan for the school. To help him reach his goal, Jess made a poster to inform students how to be prepared and what to do in the case of a volcanic eruption (**see appendix 1.7**). It is currently being reviewed by IGN to ensure this is in parallel with their guidelines.

4.3 - Survey (Quantitative/Qualitative)

Overall our survey received **167 responses**. Using Thematic analysis, we have extracted qualitative data to identify key themes and gaps in the communities resilience

Question 2.1 - 'Where do you reside?'

47.9% of the responses we received belonged to people who currently reside in Garachico, alongside 45.4% of respondents being from elsewhere in Tenerife, which is positive as it suggests we have a good representation of the population of Tenerife.

Question 3.1 - 'Do you know that you are currently in an area with a history of volcanic activity?'

96.9% of answers were "Sí", meaning almost everyone we surveyed is aware of the volcanic history of the island. This suggests that people would likely adopt resilience schemes, as they have chosen to reside in an area they know is volcanically active.

Question 3.2 - 'What are your preferred sources of information you go to in the event of volcanic unrest or activity?'

News coverage was the preferred source of information, with 63.8% of respondents selecting it (See Fig. 11). This could pose issues as news media are known for having a bias and spreading misinformation.

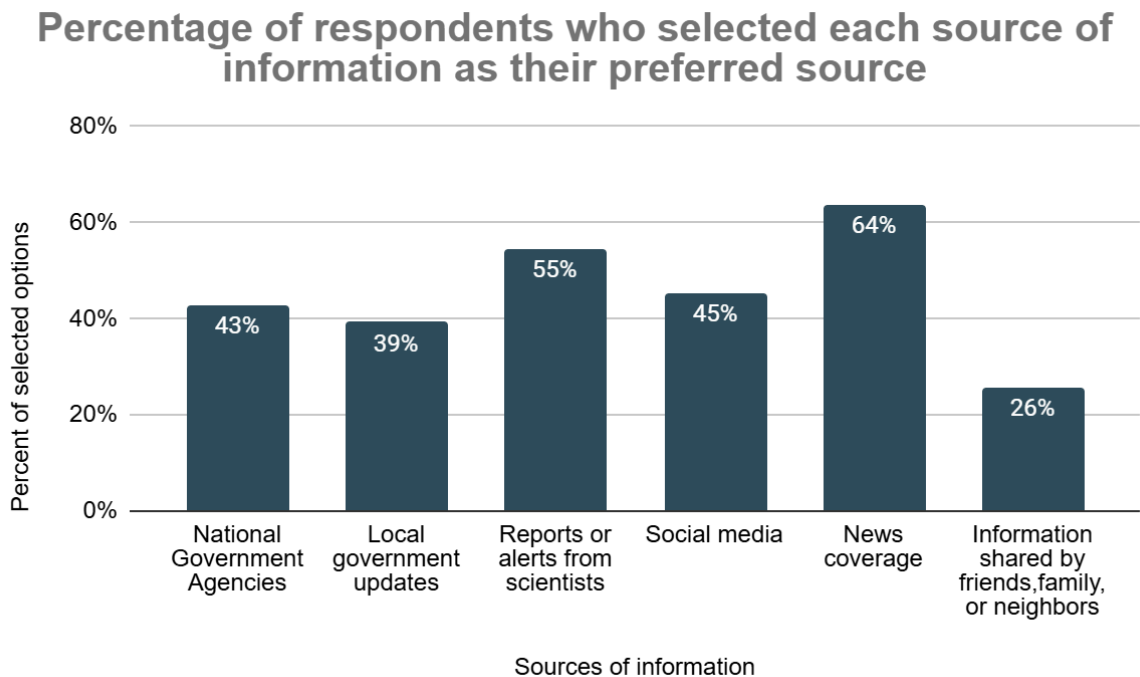


Fig. 11 - Percentage of respondents who selected certain sources of information as their preferred source. Data taken from our survey, see appendix 3.13.

These results contrast the 2024 Vilaflor resident survey as they found that 'The largest group of respondents, 25.5%, identified the government website as being where they would look for information' (GeoTenerife, 2024, Vilaflor Resident Survey) which contrasts with our results of both question 3.2 and 8.1, where local government updates is the second lowest preferred source to go to with 39% and public officials was the second to last, least trusted source of information with 11.70%. Identifying who the locals trust is a key piece of information for volcanic resilience, as communities are less likely to take information into consideration if it's given to them by an untrusted source, so ensuring people feel supported by local authorities and the information they will need to distribute is a key start in volcanic preparation.

Question 3.4 - 'Are you aware that a volcanic drill is going to take place?'

39.5% of responders were not aware of the drill being carried out, this means that ~66 people have not been informed by local authorities about the simulation, showing a serious lack of information distribution.

Question 3.6 - 'Do you have a personal, household, or family emergency plan in the event of a volcanic hazard?'

87.7% of answers suggest that people do not have an emergency plan, this means that in the event of a volcanic hazard, residents would not know

themselves what to do and would rely solely on local authorities, putting more stress onto officials to guide everyone efficiently.

Question 4.1 - 'Please briefly describe your emergency plan.'

For both the spanish and english surveys, we received 0 results for this question, this is likely due to the high number of respondents not having a plan to describe, however for those who answered that they do have a plan, not being able to describe it could mean that it isn't fully completed, the local authorities should distribute a flexible base plan for locals to adapt upon.

Thematic Analysis of responses to survey question 5.1: 'What has prevented you from making an emergency plan?'

Analysing figure 12, it's clear that 'cognitive barriers' are the biggest reason as to why people have not made an emergency plan, making up 38% of the pie chart. This implies that people are not aware of the risks within Garachico or the likelihood of an eruption. One response we received was *"I think nothing is going to happen"*. This shows that the local authorities are not making the population aware of the risks of a volcanic eruption, or the local authorities are minimising the gravity of volcanic hazards. This is a very dangerous mindset to have, as people will not prepare for a risk they don't believe exists. When an eruption does occur, there will be large amounts of confusion and fear, making it much more dangerous and difficult to respond to. The idea of carelessness surrounding volcanic preparedness is also seen in the 'Time constraints and Behavioural Inertia' category, which makes up 19% of the pie chart (**Fig 11**). Many responses in this nature were people simply stating that they didn't have *"time"* or they didn't see it as a priority in their lives at the moment. Again, this is evidence of the mindset where people feel it is not something they need to be concerned about in their lives, and such neglect could lead to greater risks in the future if an eruption were to occur.

Continuing to examine figure 12, the category that occupies the second highest percentage is 'information deficits', with 35%. This suggests that a large number of our survey participants feel uninformed and therefore have not made an emergency plan. This is likely due to a lack of awareness of local emergency plans, and is clearly evidenced by the following responses we received: *"Nobody has informed me about it"*, suggesting that

residents are not being informed by local authorities about how to be prepared, and *"I haven't had the time, nor do I know what it takes to do it"*, implying that local authorities aren't helping people be prepared, nor stressing the necessity of an emergency plan to reduce risks. Reliance on the local authorities for information is also clear in the final section of the pie chart, 'Waiting for external guidance'. The quotes *"I suppose if there was [a risk] they would have warned us"* and *"I hope that the authorities and specialists convey this to us clearly"* show that people are not receiving any information, so they are fully reliant on the authorities to inform them when there is a disaster.

In the 2023 Tourist Volcanic Readiness survey this was also noted as they stated *'it is clear that there are potential gaps in residents understanding of the potential volcanic hazards in Tenerife; over 30% of those surveys believed that volcanic eruptions were improbable to very improbable.'* (GeoTenerife, 2023, Tourist Volcanic Readiness Survey) supporting our analysis that information deficits make up 35% of locals' reasoning behind not having an emergency plan.

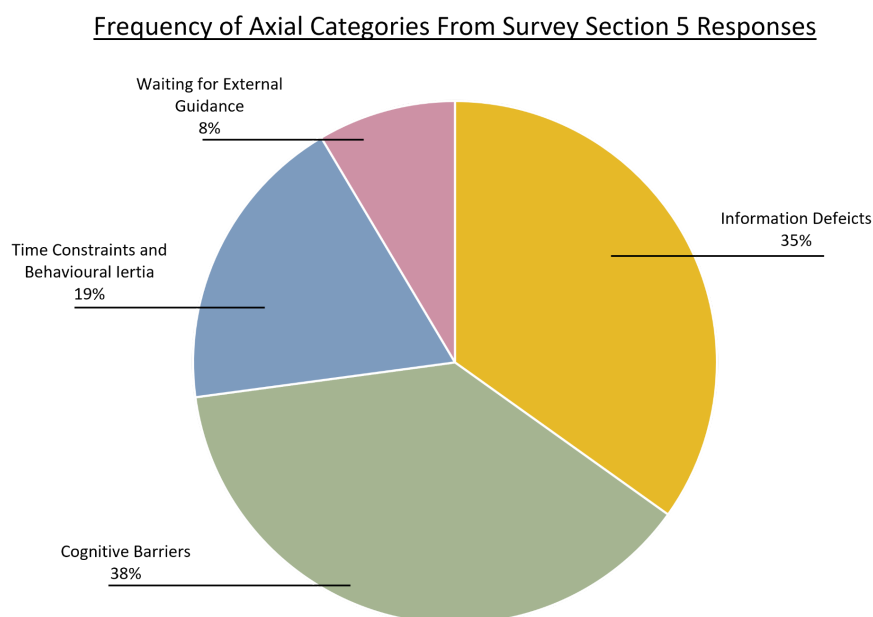


Fig. 12 - Pie chart to show the result sections from Question 5.1- What has prevented you from making an emergency plan?

Thematic Analysis of responses to survey question 6.1: 'What do you expect from the volcanic drill?'

Thematic analysis from question 6.1 (**Fig 13**) in the survey determined that 49% of respondents expected to learn about evacuation procedures and volcanic risk after the simulation. Common answers revolved around preparedness and mitigating risk. For example, one person expected to *"Receive information on what to have prepared and what to do in case of an emergency."* Another person answered *"The population should be taught what to do at each moment of volcanic emergency"*, which shows the lack of education from agencies to the residents.

As surveyors, we were not surprised that this was the highest percentage of answers, as residents were stressing the same points to us in person when engaging with them.

The second most common response related to the people's knowledge (29%). They hoped that after September, they would be more educated on volcanic hazards, which is reflected in our interview with Roberto Hernández (**section 4.2 above**). Key quotes extracted include: *"Clarify many uncertainties."*, *"Be well informed."*, *"(instill) Greater knowledge in the population."* We believe it would be beneficial to the public, especially the students, to be educated on the risks of volcanoes and what to do in an emergency.

14% of respondents wanted to see an improvement in the authorities' coordination, effectiveness, and overall organisation. The answers revealed they were interested in seeing the local government's response to the drill and how they dealt with it.

The quotes that stood out in this section were: *"See the response of the administration, which in principle is the one that has to be better prepared."* and *"See the coordination of the organisations and the reaction of the people."* Our perception of these responses is that after the drill, Garachico's residents want to experience more communication between them, their local government, and agencies like IGN and El Volcan.

The last section, labelled as 'community engagement and action', made up the last 9%. The answers we chose related to creating an island-wide plan so that Tenerife has the same information and works together with Garachico if a volcanic event occurs. The most representative quotes are: *"Coordination."*, *"Let us internalize it and make it practical."*, *"Clear guidelines for the population"*. If the residents/workers see these changes implemented, then their confidence and volcanic resilience will drastically increase.

Frequency of Axial Categories From Survey Section 6.1 Responses

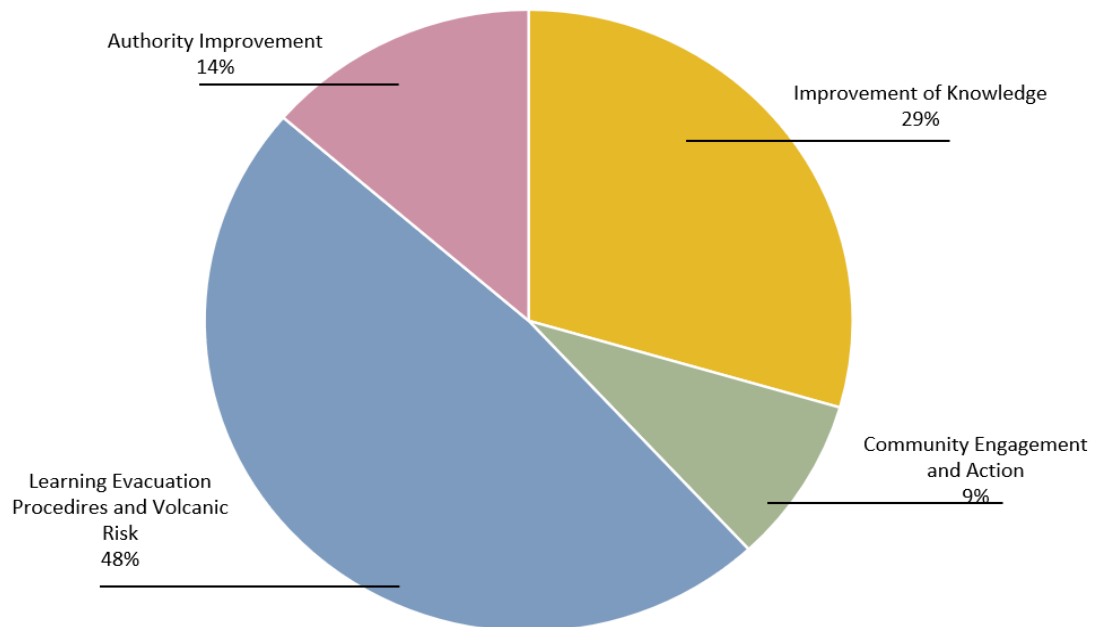


Fig. 13 - Pie chart showing result sections for question 6.1 - 'What do you expect from the volcanic drill?'

Question 7.1 - 'Which of these emergency items do you have ready?'

The item with the lowest percentage selected was respiratory protection, with 20.2% (**Fig 14**). This shows a lack of awareness as it is arguably one of the most important items to have in the event of a volcanic eruption seeing as ash can cause respiratory issues, so protecting your mouth and nose from it is vital.

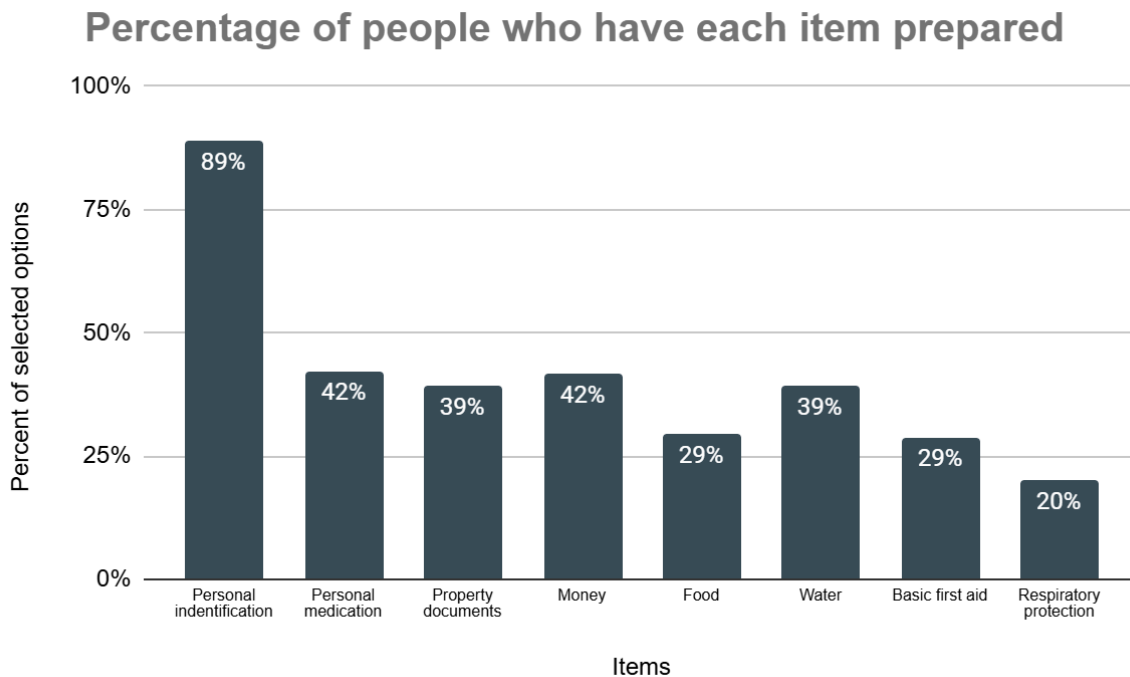


Fig. 14 - Percentage of respondents who have selected personal items prepared in emergency bags.

Analysis of survey question 8.1 - 'Please rate the following information sources based on how much you would trust them in the event of a volcanic hazard.'

Looking at question 8.1 in the survey, where we asked participants to rate how trustworthy they felt different sources of information were, we can see that the theme of lack of information continues throughout the survey questions.

Fig. 15 shows a plot of the percentages of respondents who selected that they find certain information sources 'extremely reliable' and we can see two of the lowest percentages are Civil authorities (31.5%) and Public officials (11.7%), suggesting that the people of Garachico do not consider their local authorities the most reliable sources of information compared to Scientists, which has the highest percentage of people choosing 5* (63%).

This could pose challenges in case of a volcanic emergency, as only a smaller number of the respondents fully trust their local authorities, so it's possible that in case of an eruption they may discard information given to them as they don't deem it trustworthy enough. It is likely that this lack of trust is due to local authorities not providing locals with current information. If preparation guidance and plans were distributed among the community

there is a higher possibility that locals would put more faith in the civil authorities and public officials, as there would be transparency and trust. On the other hand, Fig. 13 shows that the second most trusted source of information, with 47.5% of respondents rating it extremely reliable, is Disaster response authorities (e.g., Directorate General for Safety and Emergencies). This is promising as it means the locals have a good level of trust so in the event of a volcanic emergency, people are likely to listen to the designated disaster response authorities and follow their orders as they trust them to keep them safe.

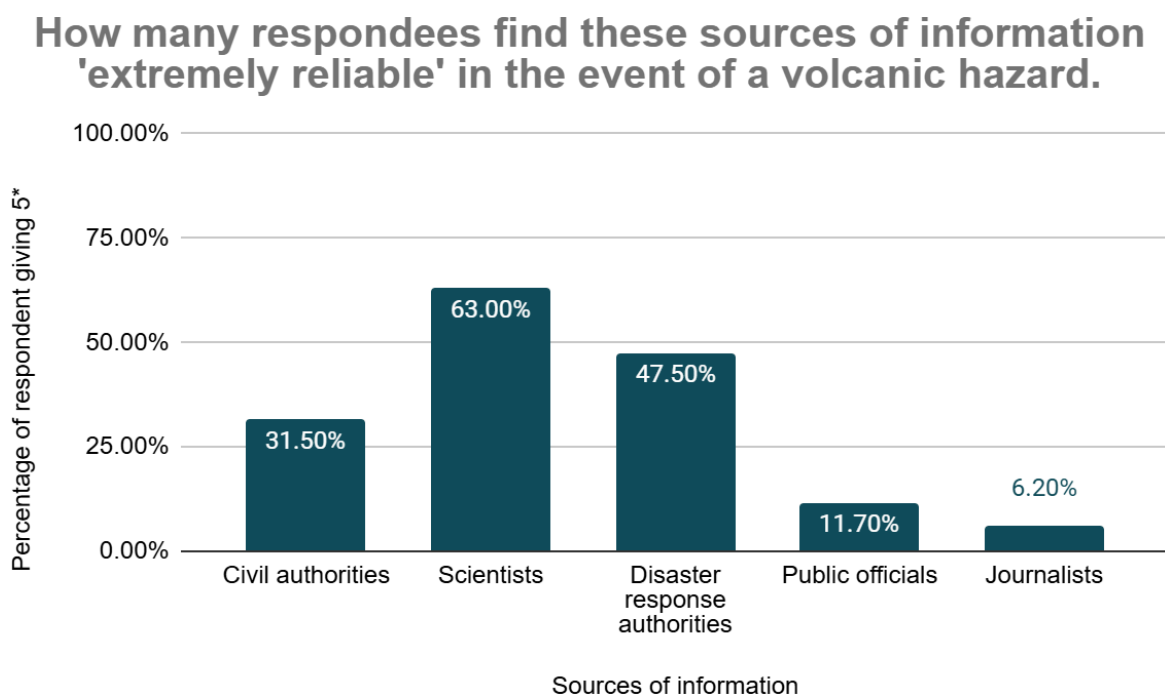


Fig. 15 - Bar chart showing results for question 8.1 - 'Please rate the following information sources based on how much you would trust them in the event of a volcanic hazard. Use a scale from 1 to 5, where 1 means 'Not at all trustworthy' and 5 means 'Extremely trustworthy.'

Question 9.1 - 'What is your age?'

The lowest percentage of respondents were found in the 75+ category (1.2%), this could be a significant limitation, as people in this age category tend to be some of the most vulnerable demographics so having their input in volcanic resilience is vital. When interviewing José Heriberito, he mentioned struggling to involve the more vulnerable demographics in plans. A way to overcome this could be holding volcanic preparedness

talks in places that the elderly visit often, such as The Asociacion De Mayores Mar Y Lava.

Question 9.2 - 'what is your gender?'

The answers to the survey were relatively balanced based on gender, with 50.3% identifying as female and 47.9% as male. This means our survey is accurately representing both gender demographics in garachico, without a significant bias towards one.

Question 9.3 - 'Would you or a family member require extra assistance during a volcanic emergency?'

Similar to that of the 2024 Vilaflor Resident survey where *'29.4% of respondents live in households with at least one individual that would require assistance in the case of an evacuation.'* (GeoTenerife, 2024, Vilaflor Resident Survey), 26.4% of the answers implied they would need extra assistance. This information is helpful to the local authorities to gauge how many people would need extra assistance. It may also be a good prompt for the town hall and local authorities to carry out their own survey to grasp specific personal vulnerability in the area to incorporate into their evacuation plans.

Thematic analysis to survey question 9.4 - 'Do you have any additional comments or suggestions regarding volcanic hazards or how the community can be better prepared?'

Thematic analysis of question 9.4 (**Fig 16**) uncovered five connecting axial codes which express the respondents' concerns and suggestions on how the community can be better prepared for volcanic hazards.

'Public Education and Awareness' was the most common code from this question (**Fig. 16**) with 35% of the responses mentioning something relating to this code. This shows that the need for sustained and structured education efforts regarding volcanic risk and preparedness is high within Tenerife. Suggestions from the residents include "[volcanic awareness] being a compulsory subject in schools" and "reminders... on the [volcanic] situation every few years".

The second most common code was, 'Information Transparency and Trust', to which 20% of our respondents noted the importance of honest and clear communication from authorities and the scientific community, which would

ideally improve the public's trust in these services. The respondents specifically want "reliable information without hiding anything", suggesting that the population does not trust the authorities and scientific community, likely due to a lack of shared information. This can be seen during our interview with José Heriberito (2025), who stated that they are 'not providing evacuation information' and have had no communication with the residents of Garachico regarding any volcanic official advice.

'Communication methods and accessibility' was a code that 18% of respondents mentioned, which included addressing the population's preferred modes of communication, especially in reaching different demographics in the population, including elderly residents in remote communities and children in schools. Heriberito (2025) mentioned that the remote rural communities are hard to involve in plans' which further shows the need to address certain modes of communications for different residents. This is highlighted in our survey responses, whereby 20% of respondents were over the age of 61 (**see appendix 4.4**), meaning that a large percentage of the population needs to have accessible evacuation plans and clear communication with the authorities.

Similarly, 18% of respondents mentioned the code 'Evacuation and preparedness planning', which shows the need for detailed, practical and inclusive evacuation strategies and drills. This code was also found very frequently within the thematic analysis of question 6.1 of the survey. It was the most common throughout the entire survey, which implies evacuation preparedness is on the forefront of people's minds.

9% of residents noted that they would like to see an increase in the role of scientists who monitor volcanic activity within the education of the population. We at GeoIntern have attempted this through creating a poster to educate students in a high school within Garachico (**see appendix 1.6**).

Frequency of Axial Categories From Survey Section 9.4 Responses

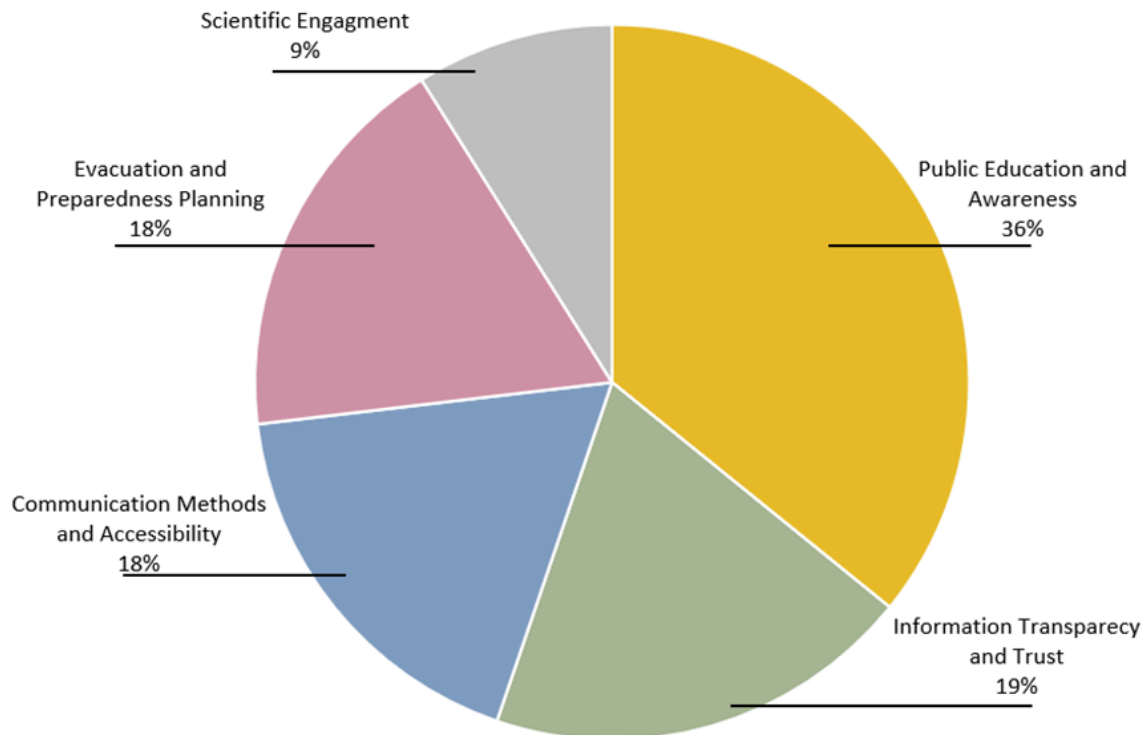


Fig. 16 - pie chart of percentage of axial categories from survey section 9.4 responses

Discussion

5.1 - Fieldwork

Post 2021 Tajogaite eruption impact assessments of 764 primary buildings in La Palma identified that collapsed roofs by tephra fall deposits were mostly located within the >20cm tephra isopach (*Bonadonna et al., 2022*). Our data (**Fig 5**) implies that a 450m radius around Montaña Negra has minimum tephra thicknesses between 181cm - 211cm (base not found). Where the 13cm - 23cm isopach is at a distance of 2km to the N/NE, 750m to the NW, and 900m S from the vent. Chinyero, produced >20cm at 2km N, and 850m southwards from the cone.

Assuming that the infrastructure of La Palma is similar to Tenerife, it could be implied that during an eruption similar to the 1706 - Montaña Negra eruption would pose a threat of roof collapse within a <2.5km radius from the cone.

Tephra fall deposit thicknesses are greatly influenced by wind direction and speed, as seen in Figs. 5 and 6, where the reported wind direction during both eruptions moved in a similar manner. Which does not fit into the modern day average of NW wind directions (**Fig 8**). This is significant in the case of an eruption in the same area, as the Tajogaite eruption had roof failure for fall deposits beyond 20cm when debris was unable to be removed (Reyes-Hardy et al., 2023).

Effects on Water

This dispersal also affects the water storage and deposits, as tephra has an acidic coating, decreasing pH levels down to 6.5. Resulting in safe water consumption concerns. (USGS, 2022). Turbidity is also increased when tephra interacts with water, where flash floods can turn into lahars particularly from streams (USGS, 2022). The toxicity is also increased as soluble salts are introduced to the water (Ca, Na, K, Mg, Al, Cl, S and F), where in streams of water it produces a short-lived pulse. In lakes and reservoirs the volume of new reactants in the water generally have negligible health effects associated with it.

Effects on Transport

Tephra deposits as low as 1mm in thickness have the ability to seriously reduce visibility in the transport sector. Roads become an issue due to the loss of traction between the vehicle's tires and the road surface. Significant damage to any engine type can be expected, as fine-grained tephra can block and clog up vital machinery. Normal service for ground travel requires clean-up initiatives to remove and dispose of tephra from the roads, facilities and vehicles. (USGS, 2015a).

Effects of Energy

Widespread ashfall can lead to significant power outages, disrupting communities, emergency services, and critical infrastructure (USGS, 2015b). Controlled outages are often needed for cleanup initiatives and safety reasons, giving communities sufficient time to prepare for intermittent power outages. Non-controlled problems such as insulator flashover (electrical arcing) is common through ash contamination. Paired with disruption to generator facilities and damaged power lines; communities can experience rapid distress, particularly during the night (USGS, 2015b).

Resource Management

Cleanup of tephra is required to maintain the integrity of roofs and the safety of evacuation by road. Figures 5 and 6 can infer a roof cleanup zone from 15cm-40cm isopach depths, where priority should be assigned to essential service buildings (e.g. hospitals). Where an exclusion zone for non-specialist vehicles (e.g. civil guard) in susceptible areas to tephra fall deposits. When the centre of the vent is identified; approximations of lava flows, direction, wind direction and speeds are constrained, the emergency services must be deployed to start the cleanup and evacuation processes. Prioritising high risk areas and the most vulnerable residents. Cleanup of roads is essential for evacuating communities away from the exclusion zone; as 1mm of ashfall is capable of causing major disruptions (USGS, 2015a). Evacuation priority is needed for communities in the path of lava flows where it should be assumed that they can reach the sea (**Fig 9**). Unless there is significant evidence to suggest otherwise. When implementing policy and personnel to assigned tasks, eruption duration needs to be considered, as the 2021 Tajogaite La Palma eruption lasted 85 days, which can be considered prolonged and unexpected. There must be total transparency and cooperation in the communications between the members of Plan de Emergencias Volcánicas de Canarias (PEVOLCA) (Gobierno de Canarias, 2010) and the residents of affected areas.

5.2 - Interviews

The interview with José Heriberito was insightful, he believes that there should be a '*centralised discourse*' between The Cabildo, IGN and Town Council to make preparedness more efficient. Time was spent understanding how the Cabildo requires its own assistance with communicating with the more vulnerable demographics, such as the elderly and rural communities, within hazard management plans as he finds it difficult to incorporate them.

Speaking to Roberto (2025), the common themes we gathered were that the school receives no information based around volcanic resilience and they would appreciate even basic guidance. Personally, he felt there needed to be more communication between The Town Council and The Cabildo.

5.3 - Survey

Our volcanic resilience survey in Garachico has highlighted a clear gap in public awareness, trust, and preparedness regarding volcanic hazards. Most residents lack emergency plans due to cognitive barriers, information

deficits, and an over reliance on authorities for guidance. There is widespread mistrust in local officials, with residents expressing greater confidence in scientists and disaster response agencies. Survey responses consistently revealed a desire for better public education on volcanoes and hazards, more transparent communication, and clearer, more accessible evacuation planning. Residents also expect future drills to bridge these gaps by informing, engaging, and coordinating the community and authorities more effectively.

Reflections and Recommendations

6.1 - Reflections

On reflection of our field work, we discovered a number of limitations: In some pits, the remobilised (horizon layer), contaminated the pits, creating a 'false' layer or horizon, potentially indicating multiple tephra fall deposits; where it was unlikely to appear, given knowledge of previous eruptions. Blocks and bombs also created a boundary where we assumed the base would be located. It is important to dig a wide enough pit and safely remove these objects if they are loose, to carry on digging. When observing the shallow deposits (1mm-3mm), it is important to hand sample the tephra deposits as many forest fires have left behind charcoal which look identical to ash/scoria until it is rubbed between your fingers.

Upon reflection of our survey, our results would have been more relevant if we were stricter on surveying people who spent much of their time in the municipality. Our survey showed that only 47.9% of respondents live in Garachico, while 45.5% of respondents live in another area of Tenerife (**see appendix 4.5**). We only asked where people live, and recommended changing it to ask "where do you live and work?" The answers should be multiple choice, and each answer should include both where respondents live and work. There was an uneven distribution of age demographics of our respondents, with the majority being aged 18-30 and 46-60 (**see appendix 4.4**). Additionally, not enough people were surveyed to gain a full understanding about the level of preparedness of residents of Garachico. More in-person surveying and outreach with the local government would increase survey accuracy. In the future, researchers should target a specific, yet wider range of audiences, in order to create an even distribution of responses.

Furthermore, according to Pablo Gonzalez (2025) of the Consejo Superior de Investigaciones Científicas (CSIC), the overall survey design was not representative of the island as a whole. Due to the selection of a town with an upcoming drill announced in January, Gonzalez stated that it was more likely that Garachico would know more about volcanic preparedness than most other towns, and this would lead to a biased result. Therefore, he recommended that an additional survey should be randomly disseminated across the island for a comparative study.

6.2 - Recommendations for Garachico's Authorities

The results of our survey and discussions with locals magnified the gap in communication between them and the authorities. We believe the best way to increase the public's confidence and preparedness is to create easily accessible virtual and physical resources. It is imperative for the public to be educated on the volcanic risks of living and/or working in the area, and what they must do before, during, and after a volcanic emergency in order for the society to be more resilient (German et al., 2022).

From our surveying in Garachico we have come up with a number of recommendations we believe the authorities in Garachico would find useful.

- We recommend creating posters that can be displayed in schools, shops, or community gathering spaces (e.g. Asociación De Mayores Mar Y Lava, Parroquia de Santa Ana, Pabellón Municipal).
- It was perceived that the locals commonly use WhatsApp to stay connected, so a 'Garachico community group chat' could be created by the authorities for those who do not have social media.
- Legacy news media coverage was the preferred source of information. GeoTenerife and the ayuntamiento should build relationships with local media outlets to increase volcanic awareness and education. This is especially important as German et al. (2022) found that media coverage is the most significant variable affecting volcanic preparedness.
- German et al. (2022) claims that the public would most likely adhere to both local and national government emergency plans or advice. GeoTenerife could collaborate with IGN and other official agencies to create these resources and then work closely with the local government to implement them in the areas suggested above. This

would ensure that accurate, official information is shared around the town to assist in a smoother evacuation.

6.3 - Recommendations for Future GeoInterns

Reflecting on our project, we have identified some areas that would have improved our research and suggestions for next year's interns.

- Spend more time outside of central Garachico, surveying rural and urban communities.
- Set up a table in the town center for more than one day– it was very efficient.
- Keep the survey as short as possible, with only the most useful questions– otherwise, people are less inclined to complete it.
- Try to speak in Spanish, especially when approaching people. We discovered if you speak English, locals are less likely to engage.
- Identify influential people and interview them (the mayor, teachers, priests, etc)
- If the town has a social media page, act promptly to ensure they can post the survey
- Negative feedback suggested that pamphlets under doors felt invasive and they perceived us as trustworthy - take time to communicate with them.
- Encourage shop owners to distribute 5-10 additional posters to customers
- Encourage people surveyed to share the survey link in WhatsApp and Facebook group.

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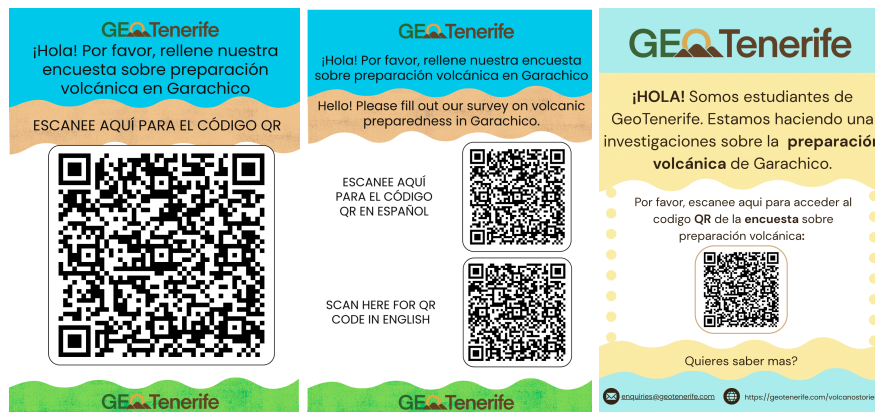
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Appendix

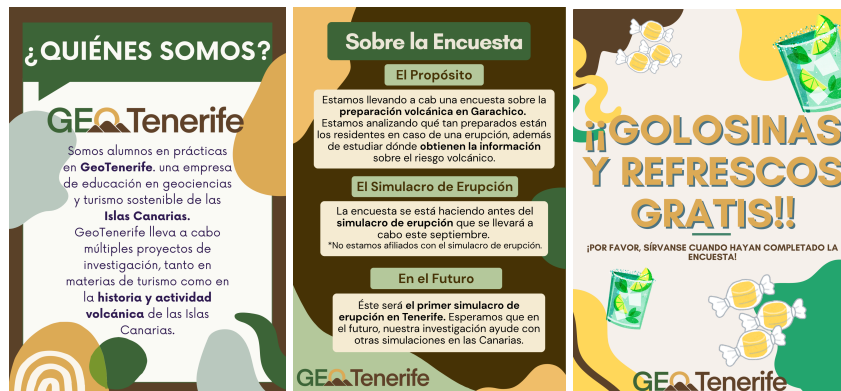
Appendix 1: Flyers and Posters used in Surveying



1.1: Flyer Version 1

1.2: Flyer Version 2

1.3: Flyer Version 3



1.4: Poster 1

1.5: Poster 2

1.6 Poster 3



Appendix 1.7: Poster for Secondary School Students, created by authors,
Sources used: Yandell, J. (2025) ¿Qué hacer en caso de una erupción volcánica?

Appendix 2: Interview responses:

For all of our interviews, GeoInterns wrote down questions that we wished to be answered and gave them to our translators (Javi Diaz and Sergio Alfaya) to ask to the interviewees, throughout the interview our translators would sum up what had been said which we then wrote down in note form. These points are the notes which were taken:

Appendix 2.1: Interview with Roberto Hernández

First interview (16/07/2025)

- "Really worried"
- "Don't know anything"
- "Don't have any information"
- "Expect to get some information in the weeks before if not they are really lost"
- "They require the information because they live in high risk area"
- "Wait for local authorities or cabildo"
- "General evacuation plan for fire and earthquake plans > test at the start of every term"
- "Personal point of view he knows what to do but not from a professional point of view"
- "Town council and cabildo need to cooperate"
- "Don't know enough"
- "First information comes from town council and cabildo"
- "No information from IGN"
- "We have been working with students from science, biology, geology etc to look into plans but they need professional opinions"
- "The volcanic risk is really high and we don't know anything, it's incredible"
- "I'm really worried about local people, not even just for this village, the surrounding ones too"
- No teaching about hazards

Second interview with Roberto (17/07/2025)

- To implement basic measures to start organising a plan in the school

- Our finished report so he can grasp the volcanic resilience in the area and what needs to be done better
- A guide with basic information (he had an exhibition from the cabildo on volcanoes and climate change but it was more to educate on what they were rather than what to do in the event of an emergency)
- He wanted to know what to do if there is an eruption.

Appendix 2.2: Interview with José Heriberto (16/07/2025)

- 2004: volcanic crisis increased seismic activity, during this the volcanic traffic light was orange. This led to the start of monitoring: checking water galleries, measuring gas levels etc.
- Recent years there is an increase in volcanic activity but the traffic light is still in green
- You need to be careful when communicating with the people (the eruption in la palma has changed mindsets)
- Personally he thinks the light should be turned to yellow
- Eruptions are in the mind of the population - having people think about them will help people engage.
- Main issue is that the water supply comes from Teide so water channels will be cut in an eruption
- Small port as an evacuation route as roads are not fit for evacuation
- On the last day of the celebration (3rd August) they roll blocks down the hill to simulate the eruption and they will speak about the hazard and project footage of the volcanic eruption on the walls of the town

Appendix 3: Survey Questions

Appendix 3.1: Survey Introduction:

Section 1 of 8

Encuesta sobre la preparación volcánica de Garachico (SPN)

B I U ↺ ↻

Esta encuesta forma parte de un proyecto de investigación dirigido por un grupo de estudiantes en colaboración con GeoTenerife y el IGN España, centrado en comprender la resiliencia volcánica en Garachico.

Nuestro objetivo es evaluar el conocimiento de los peligros volcánicos en su zona, cómo de preparado se siente y qué tipo de información o apoyo podría necesitar.

Esta encuesta nos ayudará a reunir datos importantes para informar a las autoridades locales y mejorar la preparación de la comunidad.

Le agradeceríamos que dedicara entre 3 y 5 minutos a rellenar esta encuesta.

Esta encuesta y el almacenamiento de datos permanecerán anónimos en todo momento.

Mientras tanto, también puede explorar Volcano Stories, el proyecto de investigación de acceso abierto de GeoTenerife donde compartimos recursos, actualizaciones e invitamos al público a formular preguntas:

Traducción realizada con la versión gratuita del traductor DeepL.com

[GeoTenerife Website](#)

[Volcano Stories - The Volcanic Readiness Project](#)

Appendix 3.2: Survey Section 1.1:

Confirmo que soy mayor de 18 años y autorizo el uso de mis respuestas para la investigación.

Short answer text

Appendix 3.3: Survey section 2.1

¿Dónde vive? *

☐ Garachico
 ☐ En otro lugar de Tenerife
 ☐ Otra Isla Canaria
 ☐ Fuera de las Islas Canarias

Appendix 3.4: Survey section 3.1

Section 2 of 8

Encuesta sobre la preparación volcánica

Description (optional)

¿Sabe que se encuentra en una zona con antecedentes de actividad volcánica?

☐ Si
 ☐ No

Appendix 3.5: Survey Section 3.2

¿Cuáles son sus fuentes de información preferidas a las que acude en caso de disturbios *
o actividad volcánica? Marque todas las que corresponda.

- ☐ Agencias gubernamentales nacionales
- ☐ Información actualizada sobre la administración local
- ☐ Informes o alertas de científicos (por ejemplo, IGN España)
- ☐ Redes sociales (por ejemplo, Facebook, Instagram o X)
- ☐ Cobertura informativa (televisión, radio o otros medios de difusión)
- ☐ Información compartida por amigos, familiares o vecinos

Appendix 3.6: Survey Section: 3.3

¿Qué probabilidad cree que tiene su comunidad de verse afectada por los siguientes riesgos volcánicos? *

	Muy probable	Probable	Tal vez	Improbable	Muy improb...	No sé lo que...
Gas volcánico	☐	☐	☐	☐	☐	☐
Actividad sis...	☐	☐	☐	☐	☐	☐
Corrientes d...	☐	☐	☐	☐	☐	☐
Corrientes pi...	☐	☐	☐	☐	☐	☐
Caída de ce...	☐	☐	☐	☐	☐	☐
Lahares	☐	☐	☐	☐	☐	☐
Bombas vol...	☐	☐	☐	☐	☐	☐

Appendix 3.7: Survey Section: 3.4

¿Sabe que se va a realizar un simulacro de erupción volcánica? *

- ☐ Sí
- ☐ No

Appendix 3.8: Survey Section: 3.5

¿Tiene preparada una «bolsa de viaje» con artículos de emergencia?

- ☐ Sí
- ☐ No

Appendix 3.9: Survey Section: 3.6

¿Dispone de un plan de emergencia personal, doméstico o familiar en caso de peligro volcánico?

- ☐ Sí, para mi familia/hogar
- ☐ Sí, para mi
- ☐ Sí, para ambos
- ☐ No

Appendix 3.10: Survey Section 4.1

Si has contestado que sí, tienes un plan de emergencia.



Description (optional)

Describe brevemente su plan de emergencia.

Long answer text

Appendix 3.11: Survey Section 5.1:

Section 4 of 8

Usted respondió que no, no tiene un plan de emergencia.



Description (optional)

Describe brevemente qué le ha impedido elaborar un plan de emergencia.

Long answer text

Appendix 3.12: Survey Section 6.1

Section 5 of 8

Si ha respondido afirmativamente, es consciente de que se está realizando un simulacro de erupción volcánica.



Description (optional)

¿Qué espera del simulacro volcánico? *

Long answer text

Appendix 3.13: Survey Section 7.1

Section 6 of 8

Si has respondido que sí, ya tienes listos los artículos de emergencia de tu «bolsa de viaje».

Description (optional)

¿Cuál de estos artículos de emergencia tienes preparado? *

☐ Identificación personal

☐ Medicamentos personales

☐ Documentos de propiedad

☐ Dinero

☐ Comida

☐ Agua

☐ Primeros auxilios básicos

☐ Protección respiratoria

Appendix 3.14: Survey Section 8.1

Section 7 of 8

Califique las siguientes fuentes de información según el grado de confianza que le inspirarían en caso de peligro volcánico. Utilice una escala del 1 al 5, donde 1 significa 'Nada fiable' y 5 'Extremadamente fiable'.

Description (optional)

Autoridades civiles

12345

☆

☆

☆

☆

☆

Científicos (por ejemplo, IGN España)

12345

☆

☆

☆

☆

☆

47

Autoridades de respuesta ante catástrofes (por ejemplo. Dirección General de Seguridad y Emergencias)

1	2	3	4	5
☆	☆	☆	☆	☆

Funcionarios públicos

1	2	3	4	5
☆	☆	☆	☆	☆

Periodistas

1	2	3	4	5
☆	☆	☆	☆	☆

Appendix 3.15: Survey section 9.1

Section 8 of 8

Sección demográfica



Description (optional)

¿Qué edad tiene? *

- ☐ 18-30
- ☐ 31-45
- ☐ 46-60
- ☐ 61-75
- ☐ 75+
- ☐ Prefiero no decirlo

Appendix 3.16: Survey section 9.2

¿Cuál es su género? *

- ☐ Hombre
- ☐ Mujer
- ☐ No binario
- ☐ Prefiero no decirlo
- ☐ Other...

Appendix 3.17: Survey Section 9.3

¿Usted o algún miembro de su familia necesitaría asistencia especial durante una emergencia volcánica?

- ☐ Sí
- ☐ No

Appendix 3.18: Survey Section 9.4

¿Tiene algún comentario o sugerencia respecto al riesgo volcánico o sobre cómo la comunidad puede estar mejor preparada?

Long answer text

Appendix 4: Analysis Tables

Appendix 4.1 Table 1: Representing the Thematic analysis and coding of survey question 9.4

Do you have any additional comments or suggestions regarding volcanic hazards or how the community can be better prepared?		
Open Codes	Open Codes	Example Quotes
Public Education and Awareness	- Early education on volcanic hazards - Risk education in schools - Periodic scientific updates	"There should be a compulsory subject in schools..." "To educate the population from a very young age..." "Reminders and scientific data on the situation every few years..."
Communication Methods and Accessibility	- Inclusion of elderly in communication plans - Use of text alerts - Multi-channel communication strategies - In-person meetings with neighbours	"I would like you to send text messages to the phone number of those affected." "The town hall should be notified house by house." "Having a streamlined site..." "...face-to-face meetings"
Evacuation and Preparedness Planning	- Evacuation infrastructure planning - Inclusion of pets in evacuation plans - Clear evacuation signage - Low media engagement of some residents	"Having a streamlined site for possible evacuation for both people and pets." "Have signs in the village indicating evacuation routes." "The town hall should be notified house by house."
Information Transparency and Trust	- Demand for transparency in communication - Reliable, transparent, and timely information - Public trust and distrust in political and scientific leadership	"Give reliable information without hiding anything..." "The population has not been informed seriously..." "It is necessary for the information to arrive through different channels..." "Who can we trust in the event of a volcanic risk?"
Scientific Engagement	- Trust in scientific monitoring - Scientific risk communication - Advance warning to reduce panic - Evidence-based communication	"Let the scientists, who are the ones who know, do their job and monitor these phenomena..." "Reporting with scientific evidence." "Information as far in advance as possible to avoid panic."

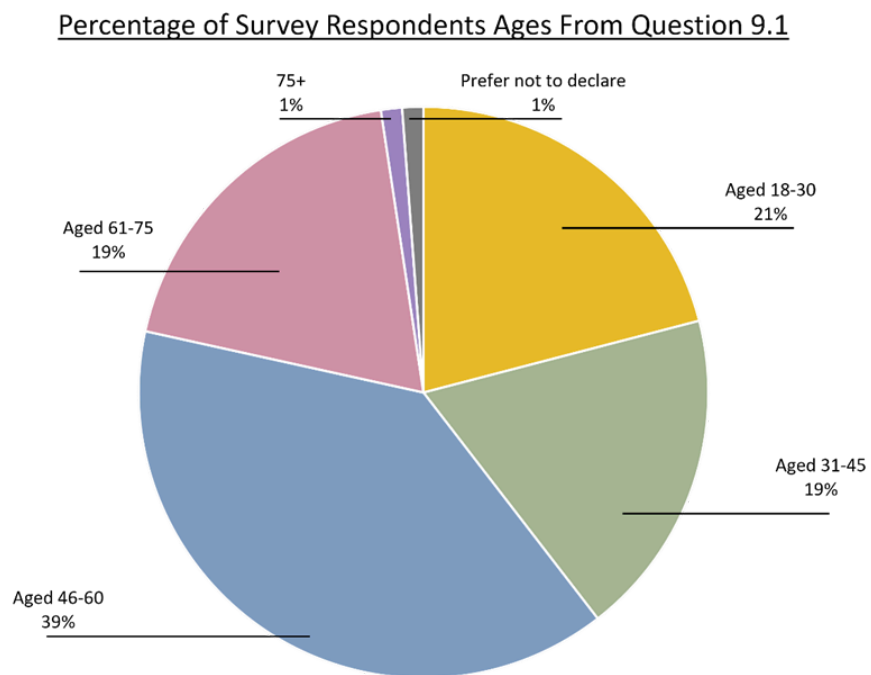
Appendix 4.2 Table 2 representing the thematic analysis and coding of question 5.1

What has prevented you from making an emergency plan?		
Axial Codes	Open Codes	Example Quotes
Information Deficits	- No information - Misinformation and disinformation - Lack of awareness of emergency procedures - Not knowing what to do	"Nobody has informed me about it." "I haven't had the time, nor do I know what it takes to do it."
Cognitive Barriers	- Perception of no imminent risk - Denial or minimization - Belief that nothing will happen - Overreliance on scientific monitoring - Living in 'low-risk' area	"I think nothing is going to happen." "I don't think there will be a volcanic eruption in Tenerife anytime soon." "I normally reside in one of the areas with the lowest volcanic risk."
Time Constraints and Behavioural Inertia	- No time - Speed of life / distractions - Lack of habit / foresight - Neglect or carelessness	"Time." "Neglect." "It has passed me by."
Waiting for External Guidance	- Expect authorities to inform them - Waiting for specific instructions or alerts - Belief that a warning will come if necessary	"I suppose if there was [a risk], they would have warned us." "I'm waiting to see where it's safe to travel." "I hope that the authorities and specialists convey this to us clearly."

Appendix 4.3: table 3 Representing the thematic analysis and coding of question 6.1

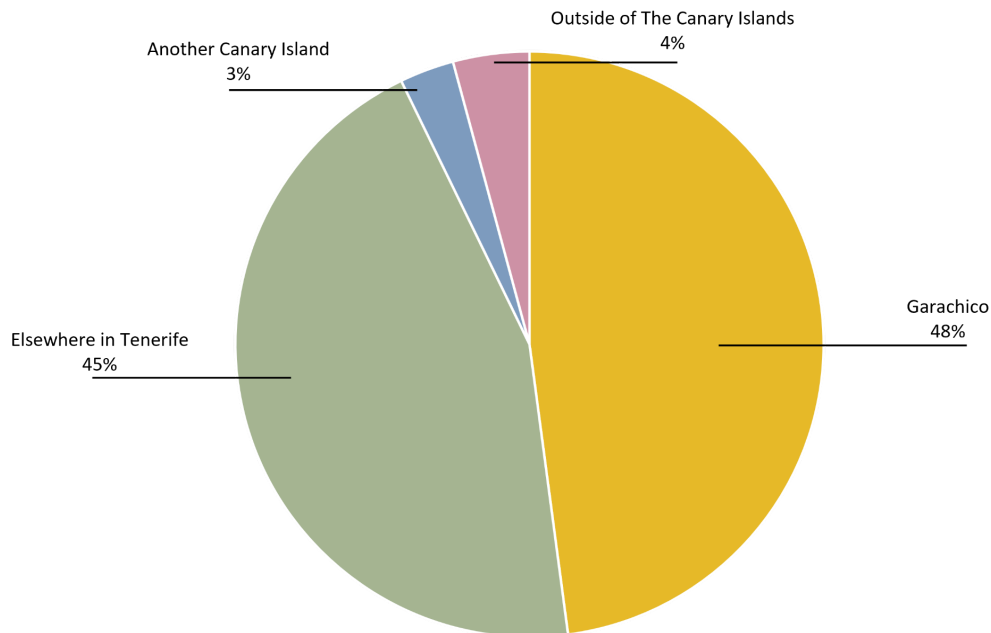
What do you expect from the volcanic drill?		
Axial Codes	Open Codes	Example Quotes
Improvement of knowledge	- Gaining knowledge - More Education - Accurate information - Future Implementation	"Clarify many uncertainties." "Be well informed." "Greater knowledge in the population."
Community engagement and action	- Nation wide implementation - Guiding others	"Coordination." "Let us internalize it and make it practical." "Clear guidelines for the population."
Learning evacuation procedures and volcanic risk	- Instructions on how to act - Preparedness - Mitigating risk	"Receive information on what to have prepared and what to do in case of emergency." "The population be taught what to do at each moment of volcanic emergency."
Authority improvement	- Coordination - Effectiveness - organisation	"See the response of the administration, which in principle is the one that has to be better prepared." "See the coordination of the organisations and the reaction of the people."

Appendix 4.4: pie chart created by authors, representing the percentage of survey respondents ages from section 9.1



Appendix 4.5: pie chart created by authors, representing the percentage of survey respondents residences from survey question 2.1

Percentage of Survey Respondents residence from Question 2.1



Appendix 5.1

Chineyero historical information:

Chinyero - 1909:

The most recent eruption that occurred on the island of Tenerife was the 1909 eruption of Chinyero. Displaying violent pulsating strombolian explosive activity due to rapid ascension of a compositionally discrete magma batch within the crust (*Di Roberto et al., 2016*).

Starting on 18th November 1909, this fissure eruption occurred along the NW Santiago rift, which coincided with increasing concern following seismic intensity, dating back to 1908. Following the increased frequency and intensity of seismic events, the fumaroles of Pico del Teide were reactivated shortly before the eruption (*Romero Ruiz & Beltrán Yanes, 2015*). The total eruptive length of the fissure was 500m, incorporating 6 vents along this ridge, producing braided lava flow fields comprising two main branches extending to the North and West (*Solana, 2012*). The North branch reached 1.2km and the Western branch was split again by topographic highs, reaching a maximum distance of 4.5km from the cone(*Di Roberto et al., 2016*).

On the second day of the eruption, activity was concentrated to two main vents, then merging to a single vent of El Chinyero on the 21st of November (*Di Roberto et al., 2016*). South-westerly winds were prominent

until the 21st, where tephra fall deposits accumulated in the North. During the same period lava flowed to the south, reaching maximum flow on the 23rd of November (*Romero Ruiz & Beltrán Yanes, 2015*). This effusive output coincided with a decrease in explosive activity, where small explosions occurred every 10 minutes; eventually seizing on the 26th (*Romero Ruiz & Beltrán Yanes, 2015*). Finally, after 10 days, the Chinyero eruption was declared finished.

Appendix 6.1



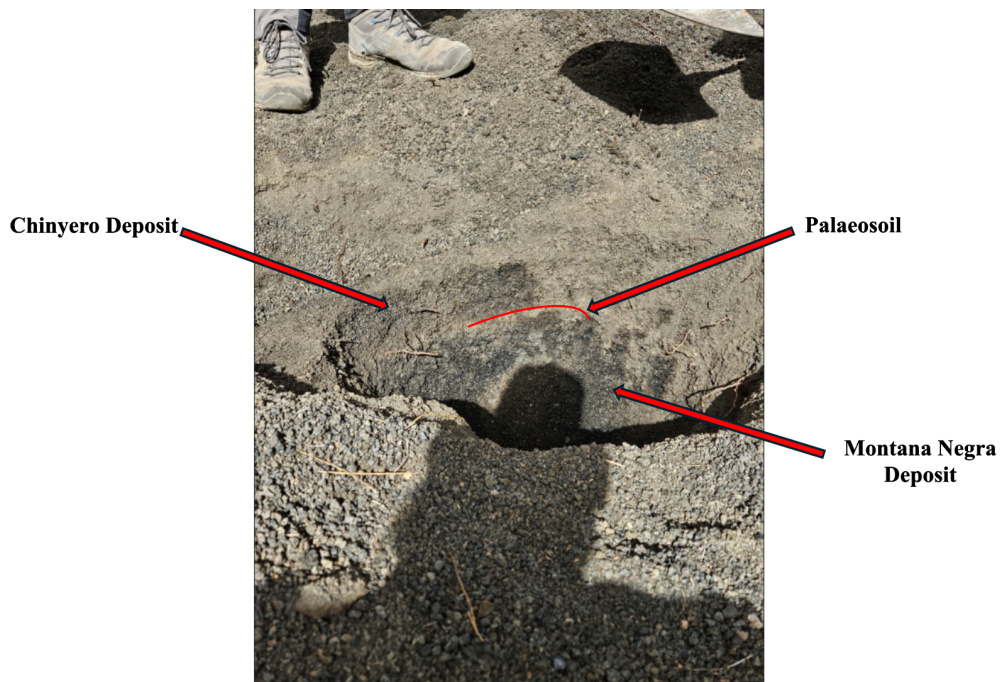
An annotated map showing the rural and urban areas we surveyed in the Municipality of Garachico.



Appendix 7.1

Annotated picture showing an example of a recorded hole where bombs and blocks had to be removed.

Appendix 7.2



Annotated picture showing an example of a recorded hole where two tephra fall deposits from separate eruption events are seen and are separated by a biological/remobilised layer.