Appendix B – Region 18

Country and regional profiles of volcanic hazard and risk:

Atlantic Ocean

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This download comprises the profiles for Region 18: Atlantic Ocean only. For the full report and all regions see Appendix B Full Download. Page numbers reflect position in the full report. The following countries are profiled here:

Brown, S.K., Sparks, R.S.J., Mee, K., Vye-Brown, C., Ilyinskaya, E., Jenkins, S.F., and Loughlin, S.C. (2015) Country and regional profiles of volcanic hazard and risk. In: S.C. Loughlin, R.S.J. Sparks, S.K. Brown, S.F. Jenkins & C. Vye-Brown (eds) *Global Volcanic Hazards and Risk,* Cambridge: Cambridge University Press.

This profile and the data therein should not be used in place of focussed assessments and information provided by local monitoring and research institutions.

Region 18: Atlantic Ocean

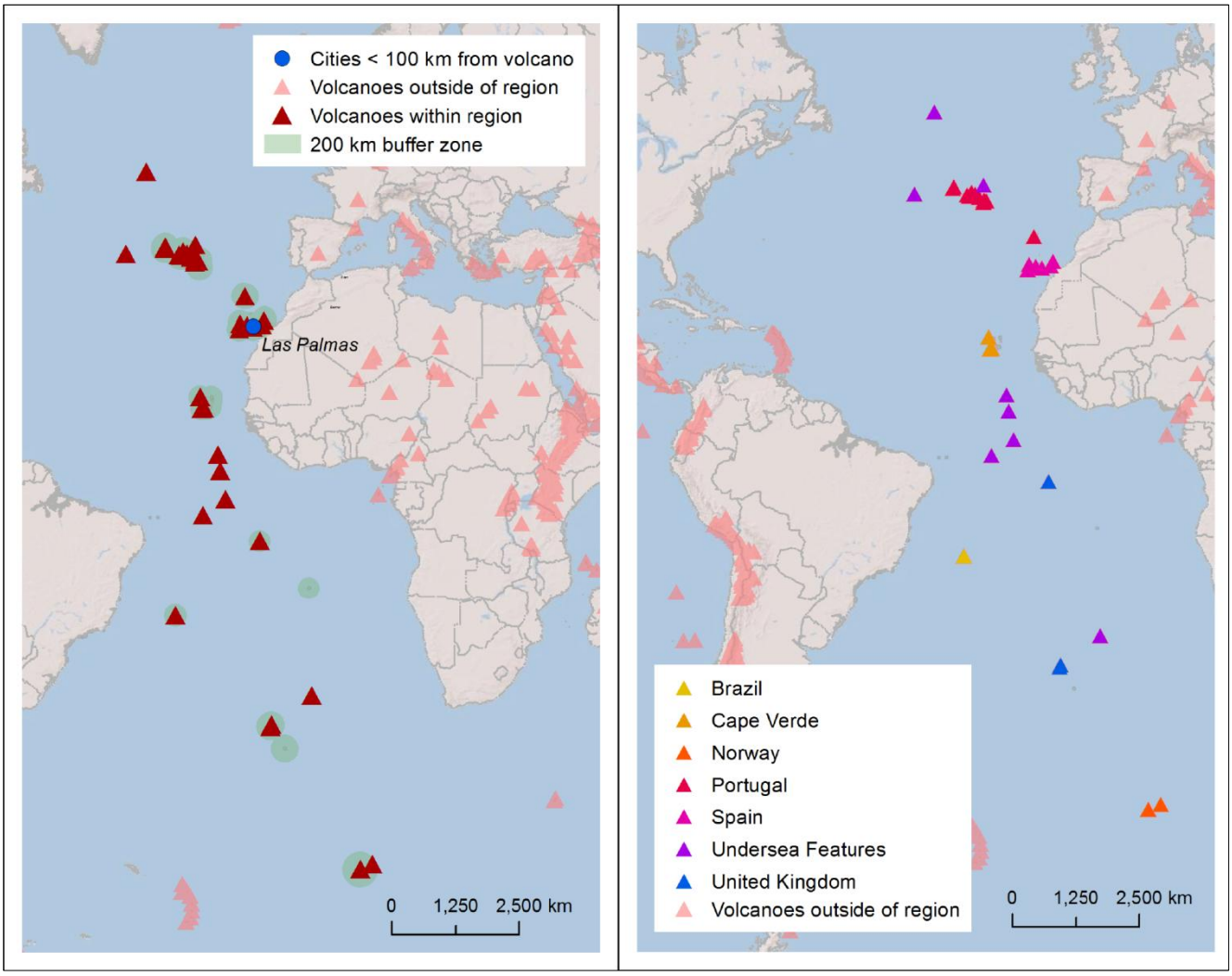

Figure 18.1 The distribution of Holocene volcanoes through the Atlantic Ocean region. The capital cities of the constituent countries are shown. The host countries are identified on the right.

Description

Region 18: the Atlantic Ocean comprises volcanoes throughout the Atlantic, from an unnamed seamount in the north to the Norwegian territory of Bouvet in the south. Six countries are represented here. All are included in this regional discussion, and individual country profiles are provided, however see Region 17 for the Norway profile.

This profile and the data therein should not be used in place of focussed assessments and information provided by local monitoring and research institutions.

Country	Number of volcanoes
Brazil	1
Cape Verde	3
Norway (See Region 17)	2
Portugal – Azores	14
Spain – Canary Islands	6
UK	3

Table 18.1 The countries represented in this region and the number of volcanoes. Volcanoes located on the borders between countries are included in the profiles of all countries involved. Note that countries may be represented in more than one region, as overseas territories may be widespread.

Thirty-seven Holocene volcanoes are located in the Atlantic Ocean. Most of these are in the Azores. Volcanism here is largely related to intra-plate hotspot processes in the ocean crust, with several volcanoes on or near the mid-Atlantic Ridge. Considerable submarine volcanism occurs at the mid-Atlantic ridge, where rifting processes generate voluminous basalt flows.

Excluding the submarine volcanism of the Mid-Atlantic Ridge, eleven volcanoes in this region are classed as submarine. The dominant volcano types are stratovolcanoes, with numerous such volcanoes present through the Azores and Cape Verde in particular. Five volcanoes comprise fissure vents and or pyroclastic cones, and four shield volcanoes are found. The rock type through this region is dominantly basaltic, though ranges from basaltic to trachytic.

A range of activity styles and eruption sizes are recorded throughout the Holocene, with eruptions of VEI 0 to 5. About 70% of eruptions here have been small, at VEI 0 to 2, however over 18% of eruptions have been large explosive VEI ≥4 events. These VEI ≥4 eruptions have largely been restricted to the Azores, with just one in the Canary Islands. Four VEI 5 eruptions are recorded at Agua de Pau and Furnas in the Azores, the most recent of which was the 1630 eruption of Furnas, which caused property damage and loss of life.

Twenty volcanoes have historical records of 58 eruptions, 95% of which were recorded through direct observations. Pyroclastic flows are recorded in 9% of historical events, whilst 57% produced lava flows.

Lives were lost in 16% of historical eruptions (9 events at 6 volcanoes – San Jorge, Furnas, Fayal, Pico in the Azores; La Palma in the Canary Islands and Fogo in Cape Verde). Most volcanoes have small to medium local populations, and as such most volcanoes in this region are classed at Risk Level II. However, the hazard is not classified at about 80% of the region's volcanoes.

Of twenty historically active volcanoes in this region, 14 have one or more dedicated seismometer for volcano monitoring.

Volcano facts

Number of Holocene volcanoes	37

Number of Pleistocene volcanoes with M≥4 eruptions	6
Number of volcanoes generating pyroclastic flows	8 (17 eruptions)
Number of volcanoes generating lahars	3 (4 eruptions)
Number of volcanoes generating lava flows	16 (111 eruptions)
Number of eruptions with fatalities	9
Number of fatalities attributed to eruptions	541
Largest recorded Pleistocene eruption	The largest recorded eruption in this region during the Quaternary is the DHF I: Fasnia Formation (Lower Grey Member) eruption of Tenerife, Canary Islands. This M6.5 event occurred at 289 ka.
Largest recorded Holocene eruption	There are four eruptions of VEI 5 recorded at Agua de Pau and Furnas.
Number of Holocene eruptions	166 confirmed Holocene eruptions.
Recorded Holocene VEI range	0 – 5 and unknown
Number of historically active volcanoes	20
Number of historical eruptions	58

Number of volcanoes	Primary volcano type	Dominant rock type
17	Large cone(s)	Andesitic (1), Basaltic (8), Foiditic (3) Phonolitic (1), Trachytic /Andesitic (4)
4	Shield(s)	Basaltic (4)
5	Small cone(s)	Basaltic (5)
11	Submarine	Basaltic (1), Unknown (10)

Table 18.2 The volcano types and dominant rock types of the volcanoes of this region according to VOTW4.0.

Eruption Frequency

VEI	Recurrence Interval (Years)
Small (< VEI 4)	5
Large (> VEI 3)	230

Table 18.3 Average recurrence interval (years between eruptions) for small and large eruptions in the Atlantic Ocean.

The eruption record indicates that on average small- to moderate- sized eruptions of VEI <4 occur in this region with an average recurrence interval (ARI) of about 5 years, whilst the ARI for large eruptions is longer, at about 230 years.

Eruption Size

Eruptions are recorded through the Atlantic Ocean region of VEI 0 to 5, representing a range of eruption styles from gentle effusive events to large explosive eruptions. VEI 2 events dominate the record, with nearly 50% of all Holocene eruptions classed as such. Over 18% of eruptions here are explosive at VEI ≥4.

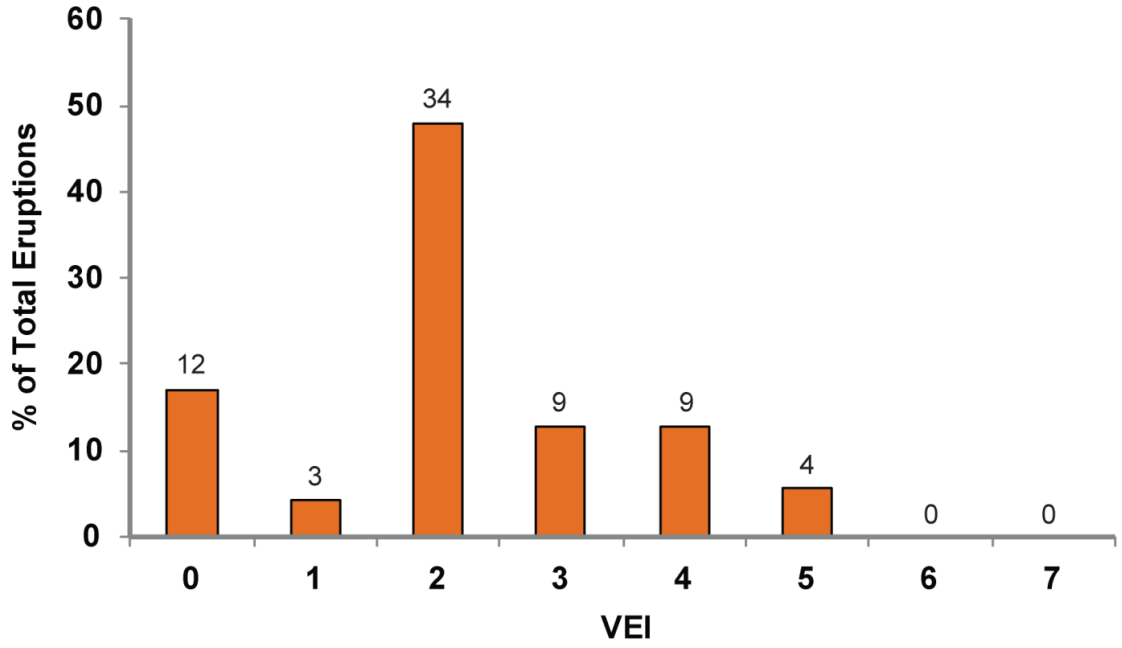

Figure 18.2 Percentage of eruptions in this region recorded at each VEI level; the number of eruptions is also shown. The percentage is of total eruptions with recorded VEI. A further 95 eruptions were recorded with unknown VEI.

Socio-Economic Facts

Gross Domestic Product (GDP) per capita (2005 PPP $)	3,616 (Cape Verde)
Gross National Income (GNI) per capita (2005 PPP $)	3,609 (Cape Verde)
Human Development Index (HDI) (2012)	0.586 (Medium, Cape Verde)

Infrastructure Exposure

Number of airports within 100 km of a volcano	17
Number of ports within 100 km of a volcano	17
Total length of roads within 100 km of a volcano (km)	1,570
Total length of railroads within 100 km of a volcano (km)	0

CLASSIFIED	**Hazard III**			Furnas	Agua de Pau			
	Hazard II			San Jorge	Sete Cidades; La Palma; Tenerife			
	Hazard I				Fogo			
UNCLASSIFIED	**U – HHR**	Unnamed (381020); Unnamed (381040); **Unnamed (385052)**	**Don Joao de Castro Bank**; **Monaco Bank; Tristan da Cunha; Nightingale Island**	Pico	**Fayal**; **Terceira; Hierro**	Lanzarote	Picos Volcanic System	
	U- HR	Bouvet		Flores	Gran Canaria		Madeira	
	U-NHHR	Unnamed (381030); Unnamed (385010); Unnamed (385020); Unnamed (385030); Unnamed (385040); Trindade; Thompson Island	Corvo; Ascensión	Graciosa; **Brava**	Fuerteventura	Sao Vicente		
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 18.4 Identity of the volcanoesin this region in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

Population Exposure Index

Number of Volcanoes	Population Exposure Index
0	7
2	6
2	5
10	4
6	3
6	2
11	1

Table 18.5 The number of volcanoes in the Atlantic Ocean classed in each PEI category.

Risk Levels

Number of Volcanoes	Risk Level
1	III
5	II
1	I
30	Unclassified

Table 18.6 The number of volcanoes in the Atlantic Ocean region classified at each Risk Level.

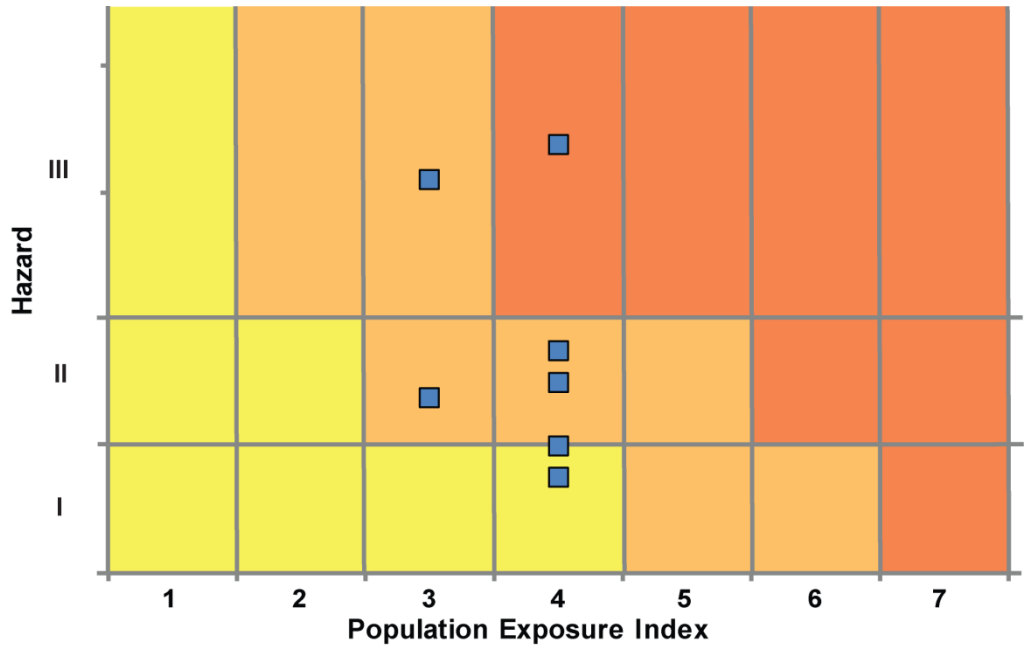

Figure 18.3 Distribution of the classified volcanoes of this region across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

Regional Monitoring Capacity

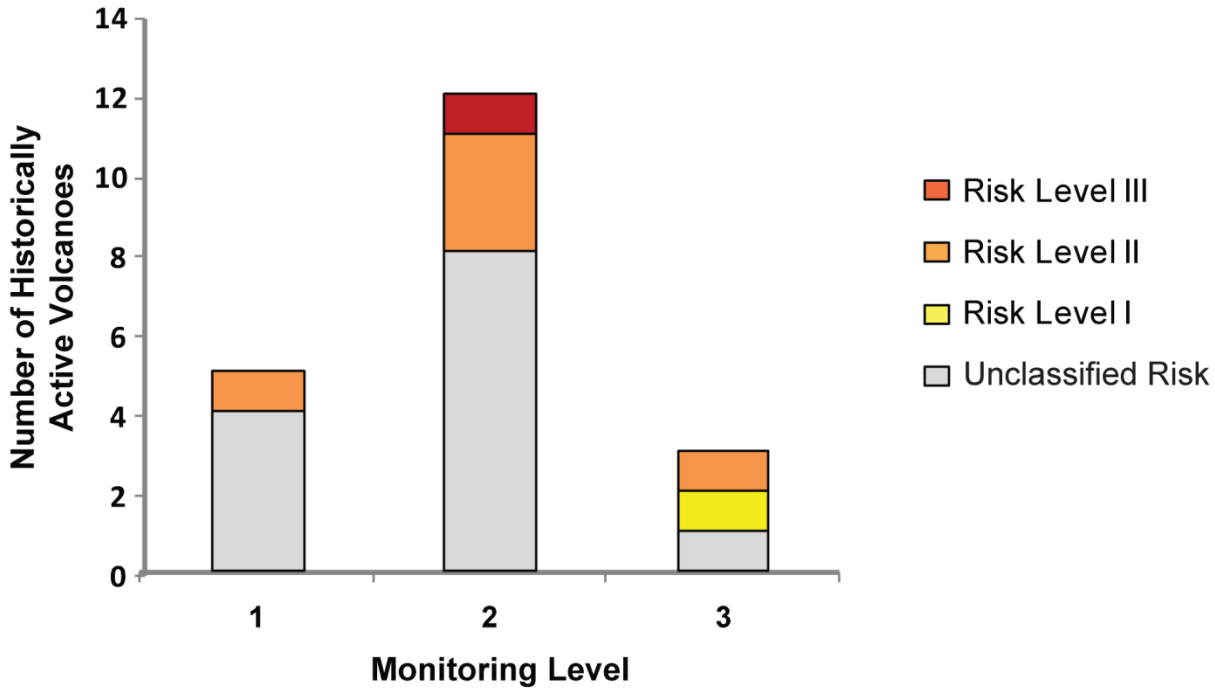

Figure 18.4 The monitoring and risk levels of the historically active volcanoes in the Atlantic Ocean. Monitoring Level 1indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Brazil

Description

One volcano, Trindade, forms an island of the same name lying about 1,100 km off the coast of Brazil. This volcano lies at the eastern end of a chain of submarine volcanoes extending from Brazil's coast and is related to intra-plate processes.

No Holocene eruptions are recorded at Trindade, however the youngest activity, which constructed a pyroclastic cone and extensive lava flows, is considered no older than Holocene (Almeida, 1961 in VOTW4.22). With no detailed eruptive history, the hazard level of this volcano cannot be determined.

Only a small contingent of the Brazilian Navy resides on the island of Trindade, with no permanent population located here or within 100 km of the volcano.

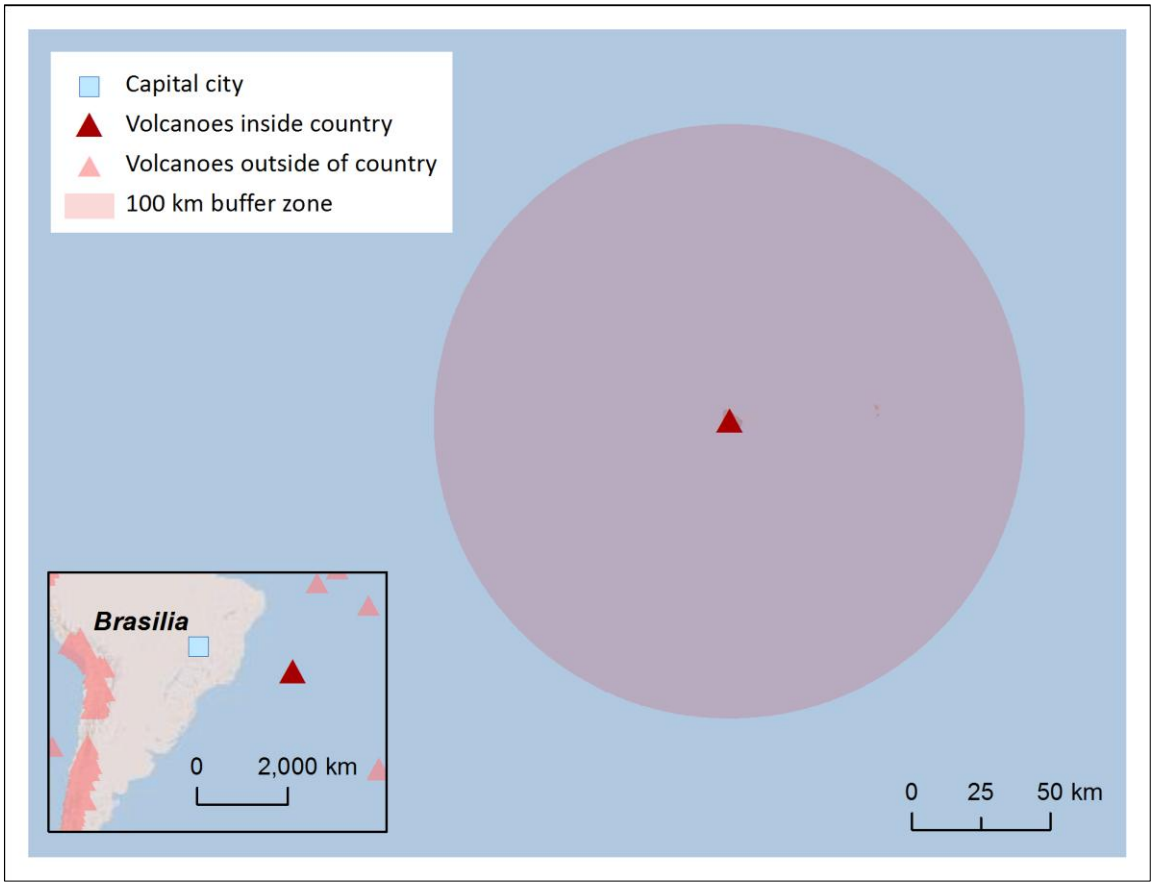

Figure 18.5 Location of Brazil's volcano, Trindade, and a 100 km radius surrounding it.

Volcano Facts

Number of Holocene volcanoes	1
Number of Pleistocene volcanoes with M≥4 eruptions	-

This profile and the data therein should not be used in place of focussed assessments and information provided by local monitoring and research institutions.

Number of volcanoes generating pyroclastic flows	-
Number of volcanoes generating lahars	-
Number of volcanoes generating lava flows	-
Number of fatalities caused by volcanic eruptions	-
Tectonic setting	Intra-plate
Largest recorded Pleistocene eruption	-
Largest recorded Holocene eruption	-
Number of Holocene eruptions	-
Recorded Holocene VEI range	-
Number of historically active volcanoes	-
Number of historic eruptions	-

Number of volcanoes	Primary volcano type	Dominant rock type
1	Large cone(s)	Foiditic (1)

Table 18.7 The number of volcanoes in Brazil, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	198,833,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	10,278
Gross National Income (GNI) per capita (2005 PPP $)	10,152
Human Development Index (HDI) (2012)	0.730 (High)

Population Exposure

Capital city	Brasília
Distance from capital city to nearest Holocene volcano	2013.6 km
Total population (2011)	203,429,773
Number (percentage) of people living within 10 km of a Holocene volcano	0 (0%)
Number (percentage) of people living within 30 km of a Holocene	0 (0%)

volcano

Number (percentage) of people living within 100 km of a Holocene volcano	0 (0%)

Ten largest cities, as measured by population and their population size:

Sao Paulo	10,021,295
Rio de Janeiro	6,023,699
Salvador	2,711,840
Fortaleza	2,400,000
Belo Horizonte	2,373,224
Brasilia	2,207,718
Curitiba	1,718,421
Manaus	1,598,210
Recife	1,478,098
Porto Alegre	1,372,741

Infrastructure Exposure

Number of airports within 100 km of a volcano	0
Number of ports within 100 km of a volcano	0
Total length of roads within 100 km of a volcano (km)	0
Total length of railroads within 100 km of a volcano (km)	0

The Trindade volcano is located at over 1000 km off the coast of Brazil, thus no areas of mainland Brazil lie within 100 km of a Holocene volcano. The Trindade and Martim Vaz islands are small and hence lie in their entirety within 100 km of the Trindade volcano, and as such all infrastructure here is exposed. No permanent settlements exist here, however a Brazilian Navy Base is located on Trinidade < 5 km from the volcano.

Hazard, Uncertainty and Exposure Assessments

With no confirmed Holocene eruptions recorded at Trindade volcano in Brazil hazard assessment through the calculation of the VHI cannot be undertaken and this volcano is therefore unclassified.

There is no permanent population living within 100 km of Trindade with the exception of a small contingent of the Brazilian Navy, hence a PEI of 1. Despite the absence of a hazard classification, this points to this volcano being ranked at Risk Level I.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I							
UNCLASSIFIED	**U – HHR**							
	U- HR							
	U-NHHR	Trindade						
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 18.8 Identity of Brazil's volcanoes in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

National Capacity for Coping with Volcanic Risk

No volcanoes in Brazil have recorded historical eruptions and no information is available at the time of the writing of this report to indicate that regular ground-based monitoring is undertaken at any Holocene volcanoes in Brazil.

Cape Verde

Description

There are three Holocene volcanoes in Cape Verde as listed in VOTW4.0: Brava, Fogo and Sao Vicente. Fogo was most recently active in 2014-2015. Recent dating of rocks on Brava suggests that Holocene eruptions occurred here. Holocene lavas are described on Sao Vicente by Mitchell-Thomé, (1976) in VOTW4.0), however Holm et al. (2008) date activity here at 6.6 to 0.3 Ma. We include Sao Vicente in analysis here due to its inclusion in VOTW4.0. In their investigations of volcanic hazard in Cape Verde, Faria and Fonseca (2014) do not consider Sao Vicente as an active volcano, instead considering Santo Antão, north of Sao Vicente, as a potentially active centre, though the last dated activity here was about 90,000 years ago. Whilst Sao Vicente and Santo Antão are in the north, Brava and Fogo are in the south. All are stratovolcanoes related to a mantle hotspot.

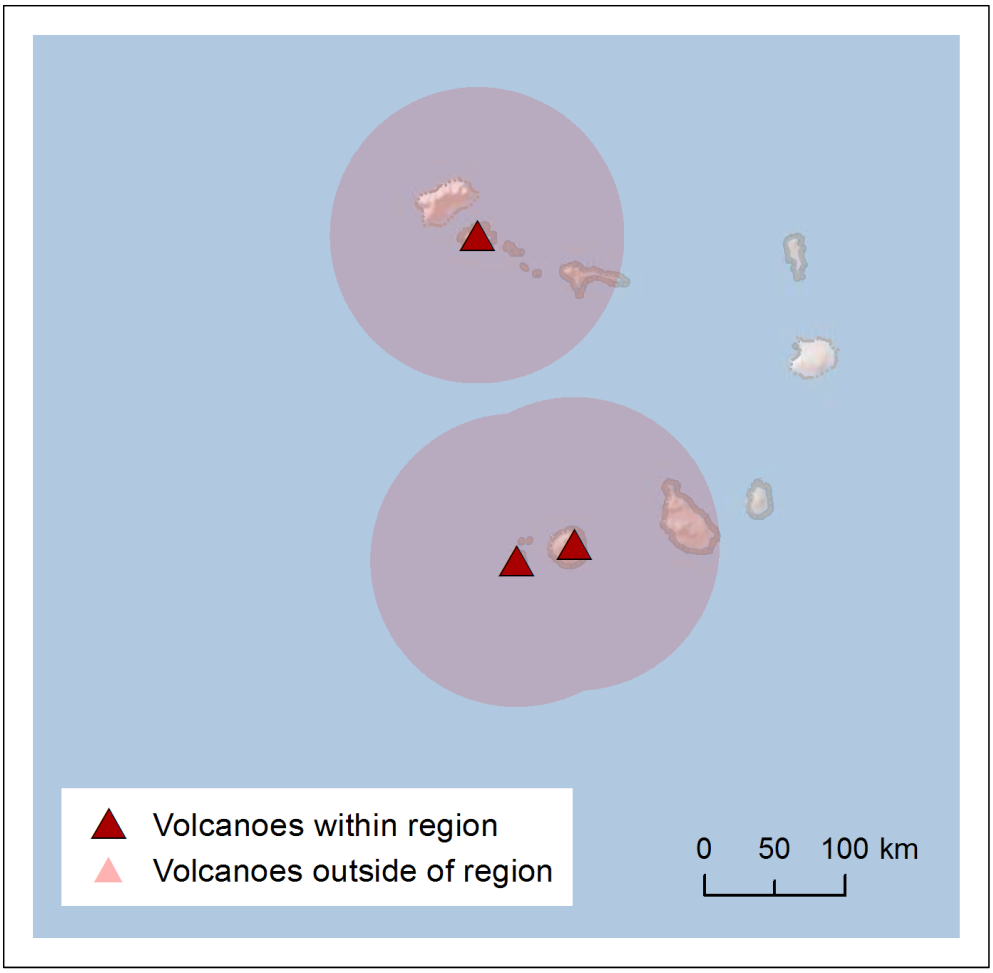

Figure 18.6 The location of the Cape Verde volcanoes and a 100 km buffer zone surounding them.

Brava is the westernmost island of the southern Cape Verde Islands. The age of the last eruption is unknown; however, frequent seismic swarms suggest the island is still active. Carbonantite lavas and pyroclastic deposits are also present on Brava, which are presumed to be Holocene to Pleistocene in age (Mourão et al., 2010).

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Fogo is the only historically active volcano in the Cape Verde Islands. Fogo is a stratovolcano with a 9 km wide collapse structure just NE of the centre of the island. The infilled collapse scar is open to the east and has a 1 km high horse-shoe shape wall. Within the collapse scar is a steep-sided cone, Pico, rising >1 km above the collapse floor. Pico had a period of very frequent eruptions from the time of Portuguese settlement in 1500 until about 1760, which are not listed individually in VOTW4.22, however the National Institute for Meteorology and Geophysics has identified separate sixteen separate events in this time, including a large eruption in 1680. Since then, ten historical eruptions have been recorded with lava flows sometimes reaching the eastern coast. Its last known eruption was the effusive eruption of November 2014 to February 2015.

Only Fogo has a record of historic eruptions, however, both Brava and Santa Antão have had historic felt seismicity and recorded seismic and geothermal activity. These latter volcanoes have a geological record of eruptions, including some explosive events. Faria and Fonseca (2014) consider the volcanic hazard levels to be highest on Fogo, Brava and Santa Antão and hence monitoring efforts are focussed here. They describe the lava flow hazard on Fogo as being particularly high along the eastern coast and within the collapse scar, and indeed during the 2014-2015 eruption numerous buildings were destroyed by lavas here. In Brava they describe the volcanic hazard awareness among the population and authorities as very low due to the absence of historical eruptions.

The National Institute for Meteorology and Geophysics (INMG) of the Cape Verde Government monitors the Fogo, Brava and Santa Antão volcanoes using networks of broadband seismometers (7 on Fogo, 2 on Brava, 4 on Santo Antão, 1 on Sao Vicente and 1 on Sal) and, on Fogo, three tiltmeters. Monitoring and civil protection were established on Fogo Volcano after the 1995 eruption. In 2010, it was recognised that Brava may pose a threat and monitoring was established.

Faria and Fonseca (2014) describe how a warning system is operational on Fogo, using an alert level system of five levels. If anomalous activity is detected, a warning is sent to the National Civil Protection Service, which is responsible for risk management in Cape Verde. Were unrest or activity to increase at the other volcanoes, as detected through the monitoring network, then warning systems would be established for these.

See also:

Faria, B., and Fonseca, J.F.B.D. (2014) Investigating volcanic hazard in Cape Verde Islands through geophysical monitoring: network description and first results. *Nat. Hazards Earth Syst. Sci*. 14, 485-499.

Heleno da Silva, S.I.N., Day, S.J., and Fonseca, J.F.B.D. (1999) Fogo Volcano, Cape Verde Islands: seismicity-derived constraints on the mechanism of the 1995 eruption. *Journal of Volcanology and Geothermal Research*, 94:219-231.

Holm, P.M., Grandvuinet, T., Friis, J., Wilson, J.R., Barker, A.K. and Plesner, S. (2008) An 40Ar-39Ar study of the Cape Verde hot spot: Temporal evolution in a semistationary plate environment. *Journal of Geophysical Research*, 113, B08201.

Mourão, C., Mata, J., Doucelance, R., Madeira, J., Silveira, A.B.D., Silva, L. C., & Moreira, M. (2010). Quaternary extrusive calciocarbonatite volcanism on Brava Island (Cape Verde): a nephelinite-carbonatite immiscibility product. *Journal of African Earth Sciences*, *56*(2), 59-74.

Ribeiro, O. (1960) A Ilha do Fogo e as sua Erupções. Justa de Investigação do Ultramar, Lisboa.

Volcano Facts

Number of Holocene volcanoes	3
Number of Pleistocene volcanoes with M≥4 eruptions	1
Number of volcanoes generating pyroclastic flows	-
Number of volcanoes generating lahars	No lahars are recorded in VOTW4.22 however lahar deposits are observed in Fogo (considered likely to be historical), Brava and Sao Antão.
Number of volcanoes generating lava flows	1
Tectonic setting	Intraplate
Largest recorded Pleistocene eruption	The M5.7 Cão Grande pumice of Santo Antão at 200 ka.
Largest recorded Holocene eruption	7 eruptions of VEI 2 are recorded at Fogo between 1785 AD and 1995 AD. An eruption identified in 1680 at Fogo does not have an attributed size and is not considered separately in VOTW4.22, however it is considered to have been a large explosive event.
Number of Holocene eruptions	11 according to VOTW4.22, with a further 15 identified by Ribeiro (1960).
Recorded Holocene VEI range	1 – 2 and unknown
Number of historically active volcanoes	1 (Fogo)
Number of historic eruptions	11 according to VOTW4.22, with a further 15 identified by Ribeiro (1960).

Number of volcanoes	**Primary volcano type**	**Dominant rock type**
3	Large cone(s)	Basaltic (1), Foiditic (2)

Table 18.9 The number of volcanoes in Cape Verde, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	496,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	3,616
Gross National Income (GNI) per capita (2005 PPP $)	3,609
Human Development Index (HDI) (2012)	0.586 (Medium)

Population Exposure considering the location of Fogo, Brava and Sao Vicente*

Capital city	Praia
Distance from capital city to nearest Holocene volcano	87.1 km
Total population (2011)	516,100
Number (percentage) of people living within 10 km of a Holocene volcano	96,368 (18.7%)
Number (percentage) of people living within 30 km of a Holocene volcano	144,129 (27.9%)
Number (percentage) of people living within 100 km of a Holocene volcano	462,061 (89.5%)

*The exposed population is calculated based on the VOTW4.0 listing of Fogo, Brava and Sao Vicente as Holocene volcanoes. Of these, only Fogo has a confirmed Holocene eruption record. If the population exposure were calculated considering Fogo only, we would only include the islands of Brava, Fogo and Santiago within the 100 km radius, which account for a population of about 300,000; whilst within 30 km it is only the population of Fogo exposed (~33,000). Santo Antão is considered by Faria and Fonseca (2014) as a potentially active centre. This ~40 x 20 km island, home to about 44,000, comprises overlapping volcanic centres with the youngest activity being identified in the west.

Largest cities, as measured by population and their population size:

Praia	113,364

Infrastructure Exposure

Number of airports within 100 km of a volcano	2
Number of ports within 100 km of a volcano	3
Total length of roads within 100 km of a volcano (km)	>100 km
Total length of railroads within 100 km of a volcano (km)	0

The three Holocene volcanoes of the Cape Verde islands are located on separate small islands, which are fully within the 100 km radius of each volcano. Not all Cape Verde islands are within 100 km distance of these volcanoes, however, the main island Santiago and capital, Praia, lie within 100 km of the southernmost two volcanoes – Fogo and Brava. Although not described in the table here, an extensive road network is therefore affected and much of the critical infrastructure in the Cape Verde islands. The Pleistocene volcano of Santa Antão is home to about 44,000 people and hence significant infrastructure.

Hazard, Uncertainty and Exposure Assessments

Of Cape Verde's volcanoes, only Fogo has a sufficiently extensive eruption record to determine the hazard through the calculation of the VHI without significant associated uncertainties. This volcano is classified at Hazard Level I, with a historical record dominated by VEI 2 eruptions and the most recent activity (2014-2015) being VEI 0.

Neither Brava nor Sao Vicente have any confirmed Holocene eruptions on record, and as such these are unclassified. Brava has recorded unrest since 1900 AD, with the occurrence of minor seismicity.

The PEI in Cape Verde ranges from moderate to high. Despite the largest population within 100 km, with a PEI of 4 and Hazard Level I, Fogo is classed at Risk Level I. The risk is unclassified at Brava and Sao Vicente due to the absence of a hazard classification.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I				Fogo			
UNCLASSIFIED	**U – HHR**							
	U- HR							
	U- NHHR			**Brava**		Sao Vicente		
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 18.10 Identity of Cape Verde's volcanoes in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

Volcano	Population Exposure Index	Risk Level
Fogo	4	I

Table 18.11 Classified Volcanoes of Cape Verde ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given. Risk Level I – 1 volcano; Risk Level II – 0 volcanoes; Risk Level III – 0 volcanoes.

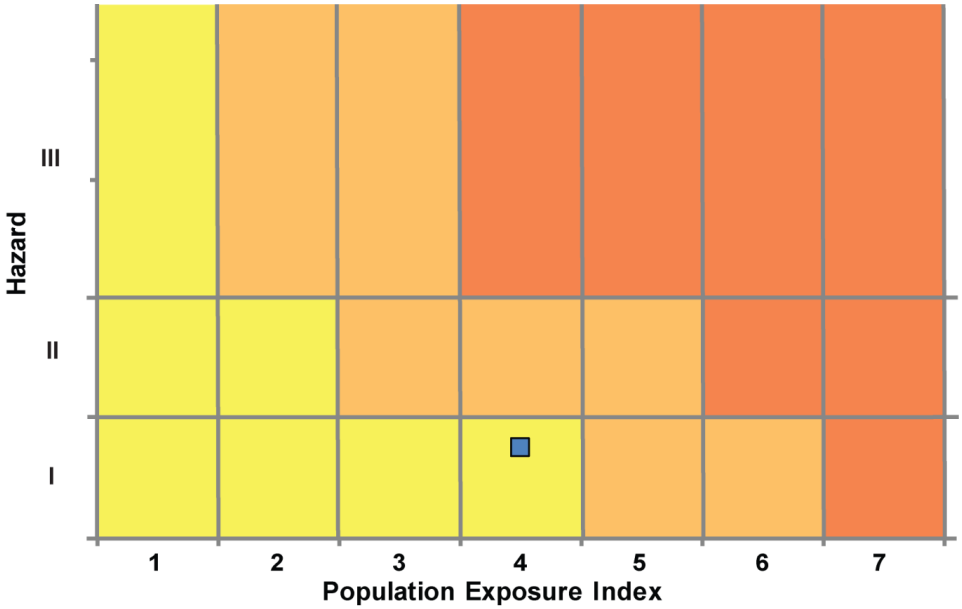

Figure 18.7 Distribution of Cape Verde's classified volcanoes across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels: Risk Level I - III.

National Capacity for Coping with Volcanic Risk

The historically active Fogo is monitored by the Instituto Nacional de Meteorologia e Geofísica (National Institute for Meteorology and Geophysics) using a network of seismometers and tiltmeters. Fifteen seismometers are distributed throughout Cape Verde, focussed on the three largest islands Fogo, Santa Antão and Brava, considered with greatest Hazard by Faria and Fonseca (2014).

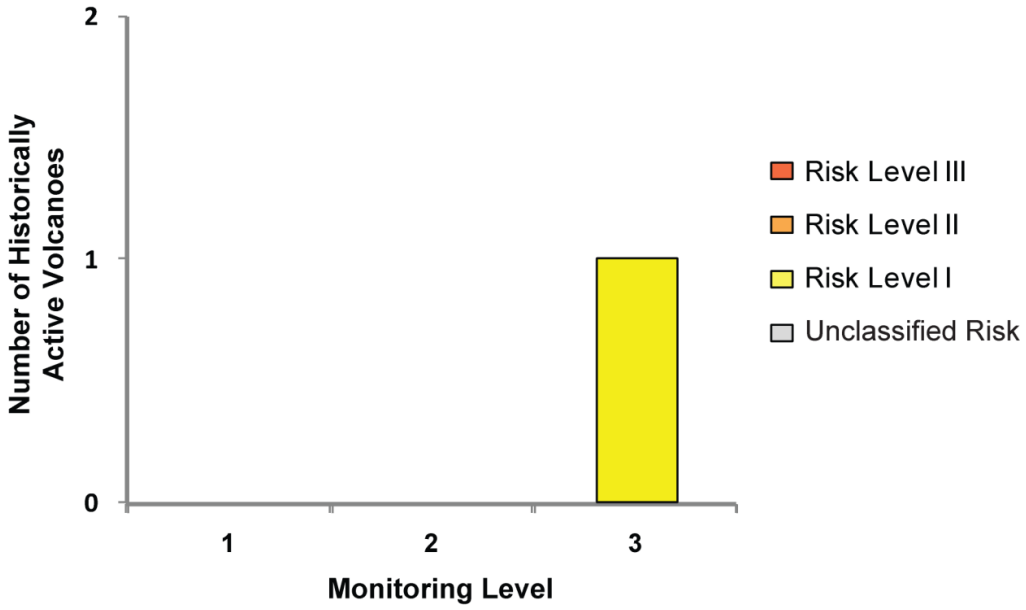

Figure 18.8 The monitoring and risk levels of the historically active volcanoes in Cape Verde. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Portugal - The Azores

Description

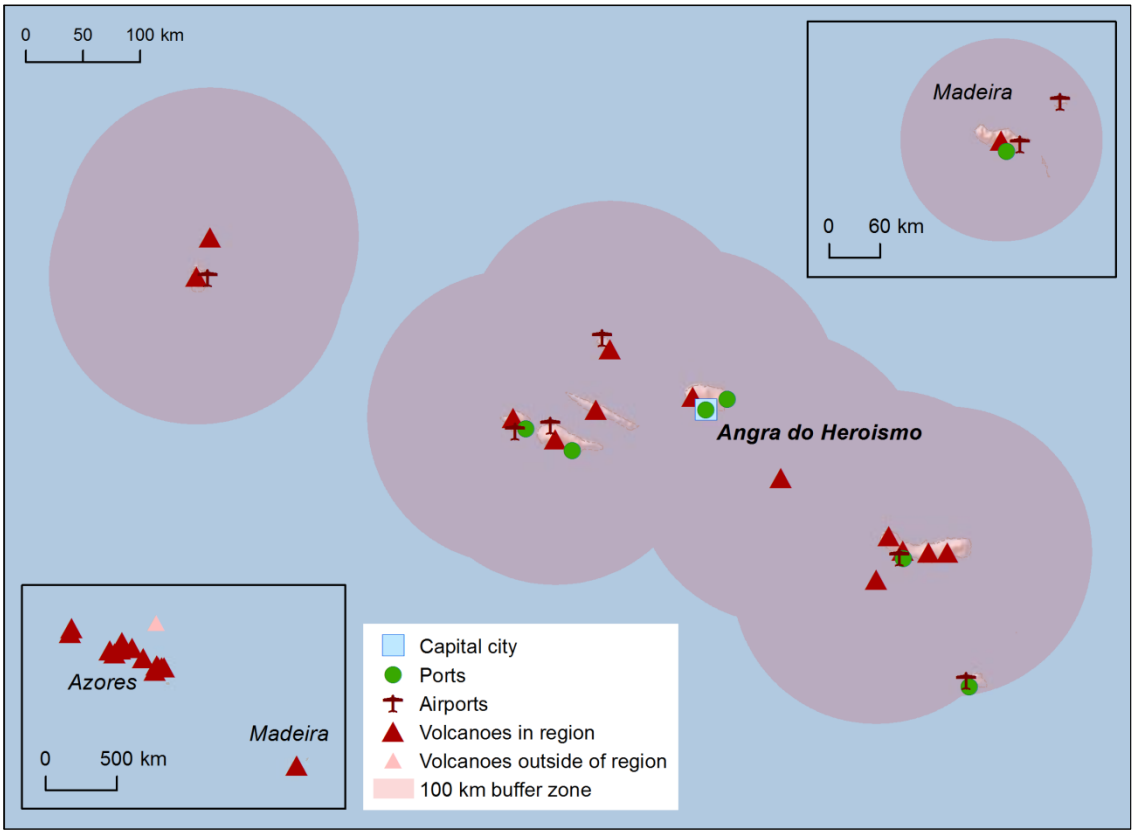

Figure 18.9 Location of the volcanoes in the Azores and a 100 km radius zone (pink) surrounding each volcano.

Fourteen Holocene volcanoes are located in the Azores. Volcanism here is due to the presence of a mantle plume intra-plate processes and tensional processes due to the presence of the Mid-Atlantic Ridge. Most volcanoes here are stratovolcanoes, and the composition of the rocks is most commonly basaltic.

Seventy-four eruptions of Holocene age are recorded, at VEI 0 to 5, indicating a range of activity from mild to large explosive events. Twenty-eight of these eruptions were recorded post-1500 AD.

One of the largest Holocene eruptions here was the VEI 5 eruption of Furnas in 1630. This produced pyroclastic flows and tephra fall, and resulted in significant damage and loss of life. Most activity has been dominated by Strombolian and Hawaiian eruption styles producing scoria and lava flows (Gaspar et al., 2011).

The size of the local population varies at each volcano, but throughout the Azores about 240,000 people live within 10 km of a Holocene volcano.

The Centre for Volcanology and Geological Risk Assessment (CVARG) of the Azores University advises the regional and local civil protection authorities on volcanic issues. The Observatório Vulcanológico

e Sismológico da Univ. dos Açores (CIVISA) is responsible for monitoring of the volcanoes here, using geophysical, geodetic and geochemical monitoring networks.

A permanent seismic network is operational and additional mobile seismometers are available. Permanent and temporary geodetic stations are also available. If unrest or eruptions are detected, the CVARG Crisis cabinet is activated and data is transmitted to the regional and local civil protection authorities.

See also:

Gaspar, J.L., Queiroz, G., Ferreira, T., Amaral, P., Viveiros, F., Marques, R., Silva, C., and Wallenstein, N. (2011) Geological hazards and monitoring at the Azores (Portugal), Earthzine, www.earthzine.org/2011/04/12/geological-hazards-and-monitoring-at-the-azores-portugal/

Observatório Vulcanológico e Sismológico da Univ. dos Açores: www.cvarg.azores.gov.pt/Paginas/home-cvarg.aspx

Volcano Facts

Number of Holocene volcanoes	14
Number of Pleistocene volcanoes with M≥4 eruptions	4
Number of volcanoes generating pyroclastic flows	7
Number of volcanoes generating lahars	3
Number of volcanoes generating lava flows	8
Number of fatalities caused by volcanic eruptions	?>525
Tectonic setting	11 Rift zone, 3 intra-plate
Largest recorded Pleistocene eruption	The M6.1 Caldera forming eruption of 24,691 BP at Sete Cidades.
Largest recorded Holocene eruption	The M6 Seara Cerrado da Ladeira (A) eruption of Sete Cidades at 5 ka and the M6 eruptions of Units C and E at Furnas at 1,784 and 1,300 BP respectively.
Number of Holocene eruptions	74 confirmed eruptions. 3 uncertain eruptions.
Recorded Holocene VEI range	0 – 5 and unknown
Number of historically active volcanoes	10

Number of historic eruptions	28

Number of volcanoes	Primary volcano type	Dominant rock type
9	Large cone(s)	Andesitic (1), Basaltic (5), Trachytic /Andesitic (3)
1	Shield(s)	Basaltic (1)
2	Small cone(s)	Basaltic (2)
2	Submarine	Basaltic (1), Unknown (1)

Table 18.12 The number of volcanoes in the Azores, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Gross Domestic Product (GDP) per capita (2005 PPP $)	21,317
Gross National Income (GNI) per capita (2005 PPP $)	20,557
Human Development Index (HDI) (2012)	0.816

Population Exposure

Capital city (Azores)	Ponta Delgada, Angra do Heroísmo, Horta
Distance from capital city to nearest Holocene volcano	<5 km
Total population (2011, source: Instituto Nacional de Estatistica, Statistics Portugal: censos.ine.pt)	514,557 (including the Azores and Madeira)
Number (percentage) of people living within 10 km of a Holocene volcano	240,349 (46.6%)
Number (percentage) of people living within 30 km of a Holocene volcano	487,994 (94.8%)
Number (percentage) of people living within 100 km of a Holocene volcano	498,308 (96.8%)

Infrastructure Exposure

Number of airports within 100 km of a volcano	8
Number of ports within 100 km of a volcano	7
Total length of roads within 100 km of a volcano (km)	1,270
Total length of railroads within 100 km of a volcano (km)	0

The islands of the Azores are volcanic, meaning that the numerous towns and infrastructure of the Azores are located close to volcanic centres, including numerous ports and airports and an extensive road network.

Hazard, Uncertainty and Exposure Assessments

There are varying levels of information available in the eruption records of the volcanoes in the Azores. Just four volcanoes, <30%, have a sufficiently detailed record to define the hazard. These volcanoes are classified across Hazard Levels II and III, all with Holocene eruptions of VEI ≥3. San Jorge is the only classified volcano with activity since 1900 AD.

The remaining ten volcanoes are unclassified. Of these two, Corvo and Graciosa, have no confirmed Holocene eruptions on record. All others have a Holocene record, including historical activity at Don Joao de Castro Bank, Pico, Picos Volcanic System, Fayal, Terceira and Monaco Bank, including eruptions since 1900 AD at the latter three volcanoes.

The PEI ranges from 2 to 6, low to high in the Azores, with the largest populations and highest PEI found at Picos Volcanic System and Madeira. At a PEI of 4, the Hazard Level III volcano Agua de Pau is classed with the highest Risk Level in the Azores at III. The remaining classified volcanoes are Risk Level II.

CLASSIFIED	**Hazard III**			Furnas	Agua de Pau			
	Hazard II			San Jorge	Sete Cidades			
	Hazard I							
UNCLASSIFIED	**U – HHR**		**Don Joao de Castro Bank; Monaco Bank**	Pico	**Fayal**; **Terceira**		Picos Volcanic System	
	U- HR			Flores			Madeira	
	U- NHHR		Corvo	Graciosa				
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 18.13 Identity of the Azores' volcanoes in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

Volcano	Population Exposure Index	Risk Level
Agua de Pau	4	III
Sete Cidades	4	II
Furnas	3	II
San Jorge	3	II

Table 18.14 Classified volcanoes of the Azores ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given. Risk Level I – 0 volcanoes; Risk Level II – 3 volcanoes; Risk Level III- 1 volcano.

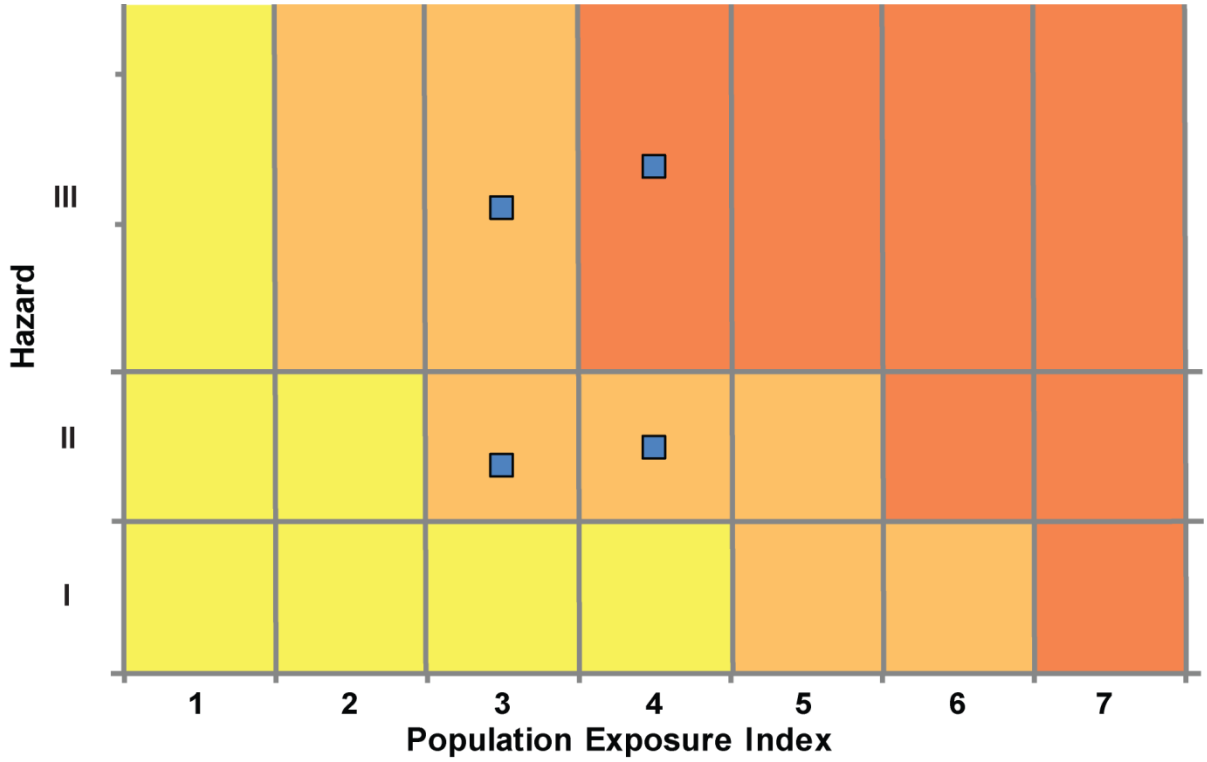

Figure 18.10 Distribution of the Azores' classified volcanoes across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

Ten volcanoes have records of historical activity in the Azores. The Observatório Vulcanológico e Sismológico da Univ. dos Açores (CIVISA) is responsible for monitoring of the volcanoes here, using seismic and deformation stations. At the time of the writing of this report the specifics of equipment at individual volcanoes are not known.

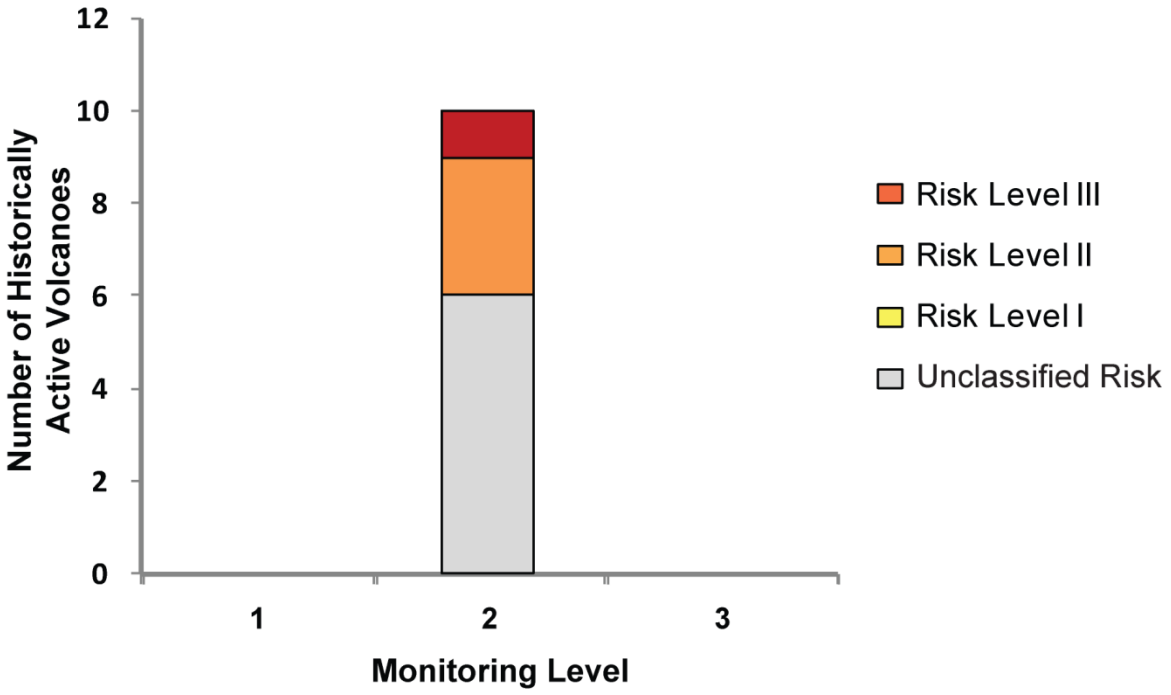

Figure 18.11 The monitoring and risk levels of the historically active volcanoes in the Azores. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Spain – Canary Islands

Description

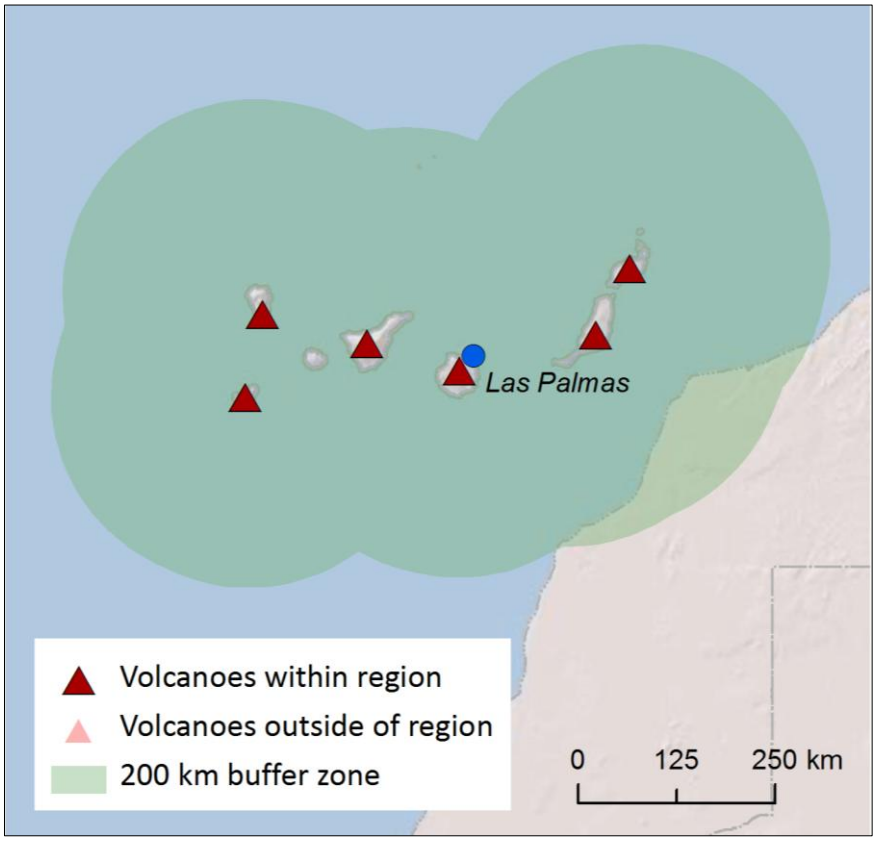

Figure 18.12 Location of volcanoes in the Canary Islands and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect the Canary Islands.

Six Holocene volcanoes are located in the Canary Islands. Volcanism here is due to intra-plate processes which have produced these basaltic centres. Volcano form varies, with two stratovolcanoes, a shield volcano and three fissure vents.

Seventy-four confirmed eruptions of Holocene age are recorded from five volcanoes. Fuerteventura has undated activity of suspected late Holocene age. These Holocene eruptions were of VEI 0 to 4, with mild to large explosive eruptions. The largest Holocene eruption was that of Tenerife about 2,000 years ago. The size of most Holocene eruptions (80%) is unknown.

In addition to a few unconfirmed eruptions, four volcanoes – La Palma, Tenerife, Lanzarote and El Hierro – have produced thirteen historical eruptions. These events are recorded as VEI 2, though violent Strombolian episodes are suspected. The submarine 2011 eruption of El Hierro is the exception, with no attributed size. This is the most recent eruption in the Canary Islands, and began with about three months of increased seismicity and deformation, prior to the submarine eruption.

This profile and the data therein should not be used in place of focussed assessments and information provided by local monitoring and research institutions.

The record is such that the hazard assessment for most of the Canary Island volcanoes is associated with considerable uncertainty and most volcanoes here are unclassified. Given the nature of volcanic islands, much of the population lives in close proximity to the volcanoes, and indeed Marrero et al. (2012) recommend that the Emergency Plan should include the possibility of evacuating more than 100,000 people in the event of an eruption warning in the Central Volcanic Complex of Tenerife.

The Instituto Geografico Nacional (IGN) is the official monitoring organisation in the Canary Islands, responsible for a national seismic network and volcano monitoring system. The IGN uses a monitoring alarm system that is triggered by earthquakes of magnitude 2.5 and above for regional seismicity. In the active volcanic islands the threshold magnitude is much lower, at <1.5. Additionally on El Hierro and Tenerife a dense deformation monitoring network of GPS monitors are in place, allowing daily and sub-daily velocity determinations with millimetre resolution. The IGN has been funded by the Spanish government for volcano monitoring since 2004.

In addition to the IGN, several research teams at different institutions and universities also conduct research and monitoring in the Canary Islands. The Consejo Superior de Investigaciones Cientificas (CSIC) and Laboratory of Astronomy and Geodesy (LAG-UCA; Cadiz University) maintain monitoring networks at El Hierro, Tenerife and Lanzarote. INVOLCAN is the National Centre for Volcanology, the Canary Islands Volcanological Institute, who aims to improve volcanic risk management in the Canary Islands.

Volcanic activity levels are determined by the monitoring and research teams and communicated to the decision-makers who decide on and communicate alert levels. The authorities are the Dirección General de Protección Civil del Gobierno de Canarias, at the regional level) and the Spanish Government (Dirección General de Protección Civil y Emergencias). The IGN is officially responsible for declaring alerts, but it is the Civil Defence and the decision makers whose publish the alerts and set the Emergency Response Levels and the colour of the Volcanic Traffic Light, according to the scientific information received. There is a non-official Volcanic Activity Level (VAL), developed and managed by IGEO-CSIC and LAG-UCA teams during the El Hierro volcanic process.

Several different systems are currently used in the Canary Islands and the Volcanic Emergency Plan is currently under revision. A clear set of protocols and response plans may be beneficial here.

See also:

IGN: www.ign.es/ign/main/index.do

INVOLCAN: www.involcan.org/

CSIC: www.csic.es/web/guest/historia

Marrero, J.M., Garcia, A., Llinares, A., Rodriguez-Losada, J.A., and Ortiz, R. (2012) A direct approach to estimating the number of potential fatalities from an eruption: Application to the Central Volcanic Complex of Tenerife Island. *Journal of Volcanology and Geothermal Research*, 219-220: 33-40.

Marti, J., Geyer, A., Andujar, J., Teixido, F., and Costa, F. (2009) Assessing the potential for future explosive activity from Teide-Pico Viejo stratovolcanoes (Tenerife, Canary Islands). *Journal of Volcanology and Geothermal Research*, 178: 529-542

Marti, J., Sobradelo, R., Felpeto, A., and Garcia, O. (2012) Eruptive scenarios of Phonolitic volcanism at Teide-Pico Viejo volcanic complex (Tenerife, Canary Islands). *Bull. Vulcanol*. 74:767-782

Volcano Facts

Number of Holocene volcanoes	6
Number of Pleistocene volcanoes with M≥4 eruptions	1
Number of volcanoes generating pyroclastic flows	1
Number of volcanoes generating lahars	-
Number of volcanoes generating lava flows	5
Number of fatalities caused by volcanic eruptions	?16
Tectonic setting	Intraplate
Largest recorded Pleistocene eruption	The M6.5 eruption of the DHFI Fasnia Formation Lower Grey Member at Tenerife at 289 ka.
Largest recorded Holocene eruption	The M4.7 Montaña Blanca, Pico Viejo eruption of Tenerife at 2,030 BP.
Number of Holocene eruptions	74 confirmed eruptions. 6 uncertain eruptions, 1 discredited.
Recorded Holocene VEI range	0 – 4 and unknown
Number of historically active volcanoes	4
Number of historic eruptions	13

Number of volcanoes	Primary volcano type	Dominant rock type
2	Large cone(s)	Basaltic (1), Phonolitic (1)
1	Shield(s)	Basaltic (1)
3	Small cone(s)	Basaltic (3)

Table 18.15 The number of volcanoes in the Canary Islands, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2013) (Instituto Nacional de Estadistica)[1]	2,092,826

[1] www.ine.es/jaxi/tabla.do

Population Exposure

Capital city (Canary Islands)	Santa Cruz, Las Palmas
Distance from capital city to nearest Holocene volcano	<40 km
Number (percentage) of people living within 100 km of a Holocene volcano	2,092,826 (100%)

Largest cities, as measured by population and their population size:

Las Palmas	378,495

Infrastructure Exposure

Number of airports within 100 km of a volcano	6
Number of ports within 100 km of a volcano	5
Total length of roads within 100 km of a volcano (km)	300
Total length of railroads within 100 km of a volcano (km)	0

The volcanic Canary Islands are small, each measuring no more than 100 km across, meaning that the 100 km radii around the volcanoes here covers this island group in its entirety. This therefore places all the towns, ports and critical infrastructure proximal to the volcanoes, inclusive of the capitals.

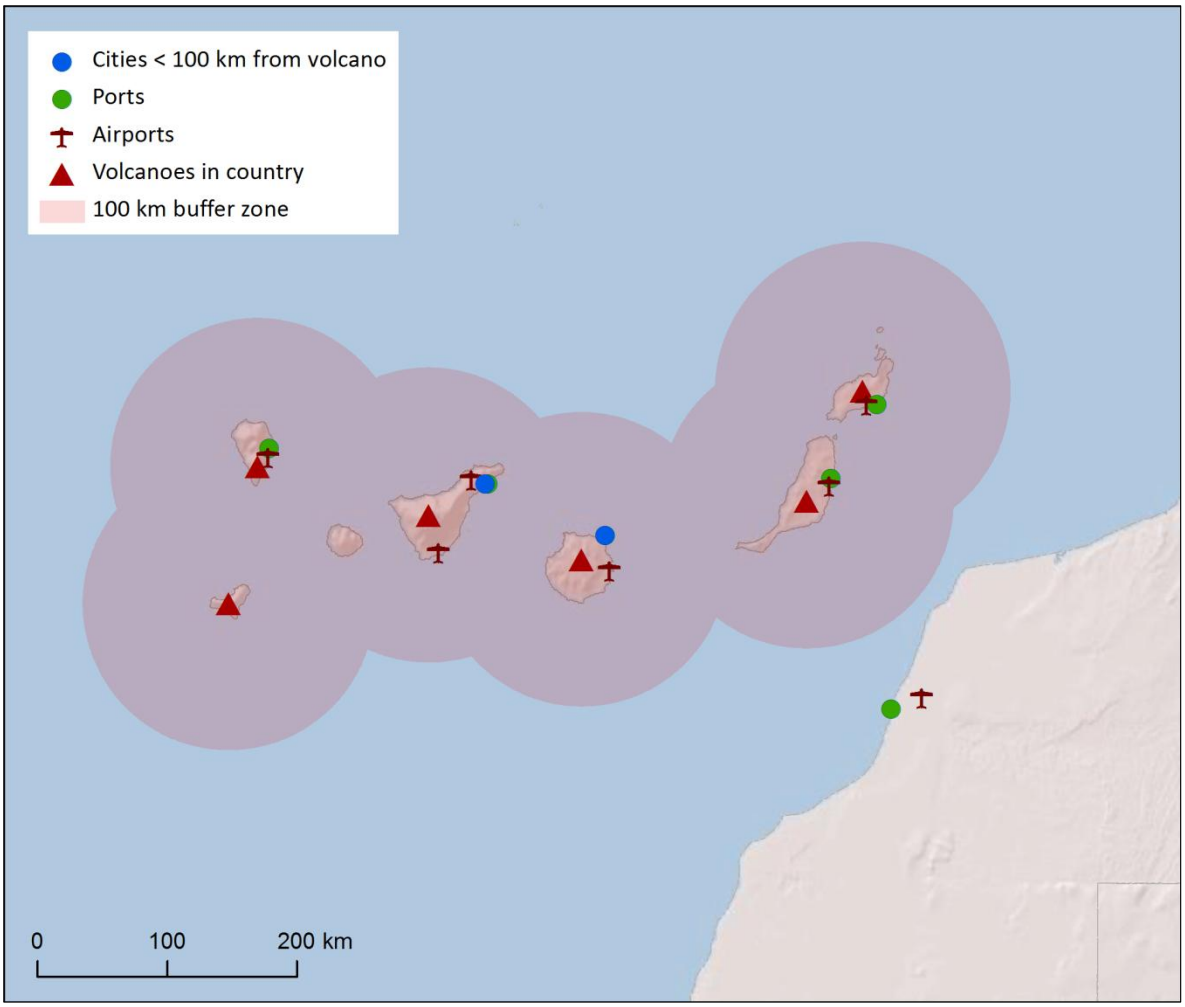

Figure 18.13 The location of the Canary Island volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

The amount of data available in the eruption records of the Canary Island volcanoes is variable. La Palma and Tenerife have sufficient details to define the hazard through the calculation of the VHI without large associated uncertainties. The remaining five volcanoes cannot have a hazard level classified. These unclassified volcanoes include Fuertoventura, which has no confirmed Holocene activity, and Hierro and Lanzarote which both have historical eruptions, including the 2011 eruption of Hierro.

La Palma has a higher hazard score than Tenerife here due to more frequent historical eruptions, including one which produced a pyroclastic flow. However, no eruptions of greater than VEI 2 are recorded at La Palma, whilst Tenerife has a record of VEI 3 and VEI 4 events. Indeed, Marti et al. (2008) describe how explosive events have occurred at central and flank vents of Tenerife and Marti et al. (2012) calculate the volcanic threat at Tenerife using the NVEWS method, which designates

this as a 'very high threat volcano', and calculate a probability of a large explosive eruption of magnitude 4 or above of 13.6% for the next 100 years using Extreme value theory.

The population of the Canaries is such that the volcanoes have moderate to high PEI levels at 4 and 5. The two classified volcanoes are classed at Risk Level II. Although here the population residing in the Canaries is considered, the tourist population must also be considered, with Marti et al. (2011) determining a mean daily hotel occupancy rate in 2009 of 52,000 on Tenerife alone. It must also be stressed that here the population is considered in concentric circles around the volcanoes, where as topographic features in particular are recognised for controlling the extent of the hazards and in Tenerife the hazard is recognised as particularly focussed on the northern side of the volcano, with the southern flank of Tenerife protected by the Cañadas caldera wall, which would act to restrain propagation of flows in this direction.

CLASSIFIED	**Hazard III**							
	Hazard II				La Palma; Tenerife			
	Hazard I							
UNCLASSIFIED	**U – HHR**				**Hierro**	Lanzarote		
	U- HR				Gran Canaria			
	U- NHHR				Fuerteventura			
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 18.16 Identity of the Canary Island volcanoes in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

Volcano	Population Exposure Index	Risk Level
La Palma	4	II
Tenerife	4	II

Table 18.17 Classified volcanoes of the Canaries ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given. Risk Level I – 0 volcanoes; Risk Level II – 2 volcanoes; Risk Level III – 0 volcanoes.

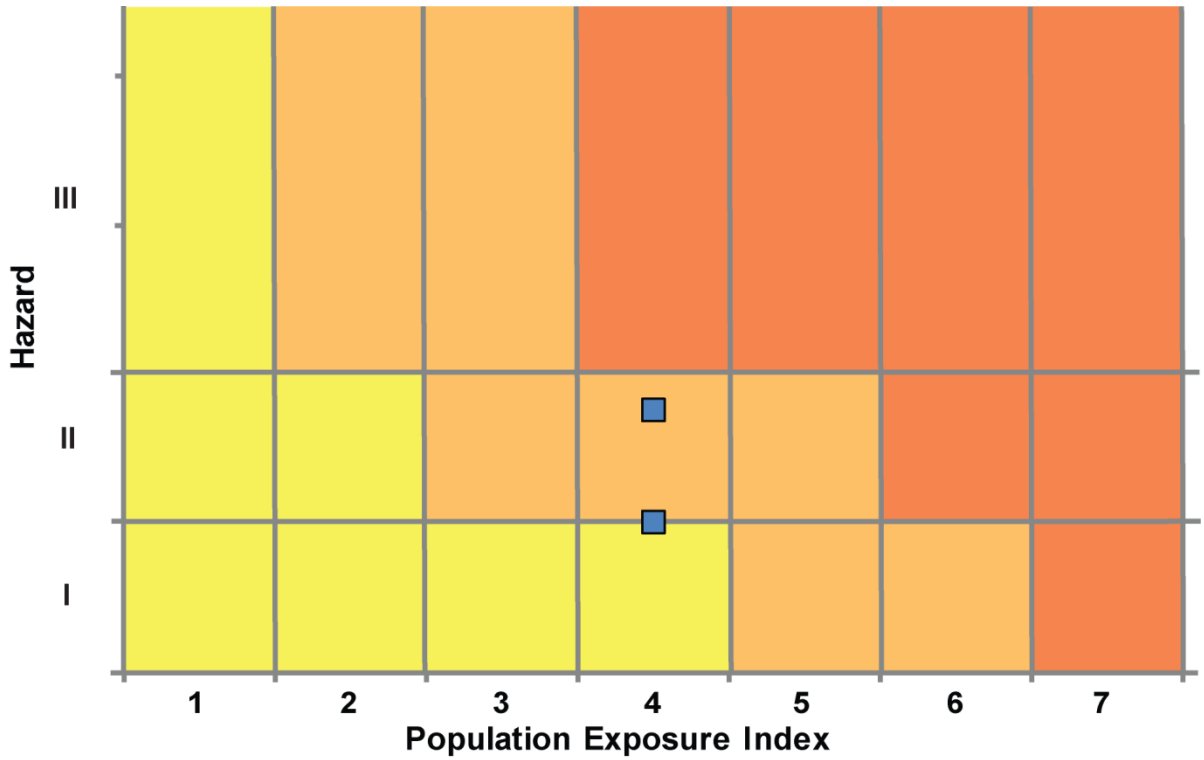

Figure 18.14 Distribution of the Canary Island classified volcanoes across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

Four volcanoes in the Canary Islands have records of historical activity. Monitoring is undertaken by a number of different groups in the Canaries. The official monitoring institution is the National Geographic Institute (Instituto Geografico Nacional, IGN) maintain permanent volcano monitoring networks comprising seismic and deformation stations on all of the islands, with dense monitoring networks on El Hierro and Tenerife. The other islands have seismic stations of the national seismic network. However, the Institute of Geosciences (IGEO-CSIC) in collaboration with the Laboratory of Astronomy and Geodesy (LAG-UCA, Cadiz University) manage networks at El Hierro and Tenerife (seismic and deformation) and seismic stations on Lanzarote. INVOLCAN and ITER (the Institute of Technology and Renewable Energies) operate a network of GPS stations throughout the Canary Islands as well as a geochemical network. INVOLCAN, ITER and the Andalusian Institute of Geophysics of the University of Grenada have plans for installation of a seismic network.

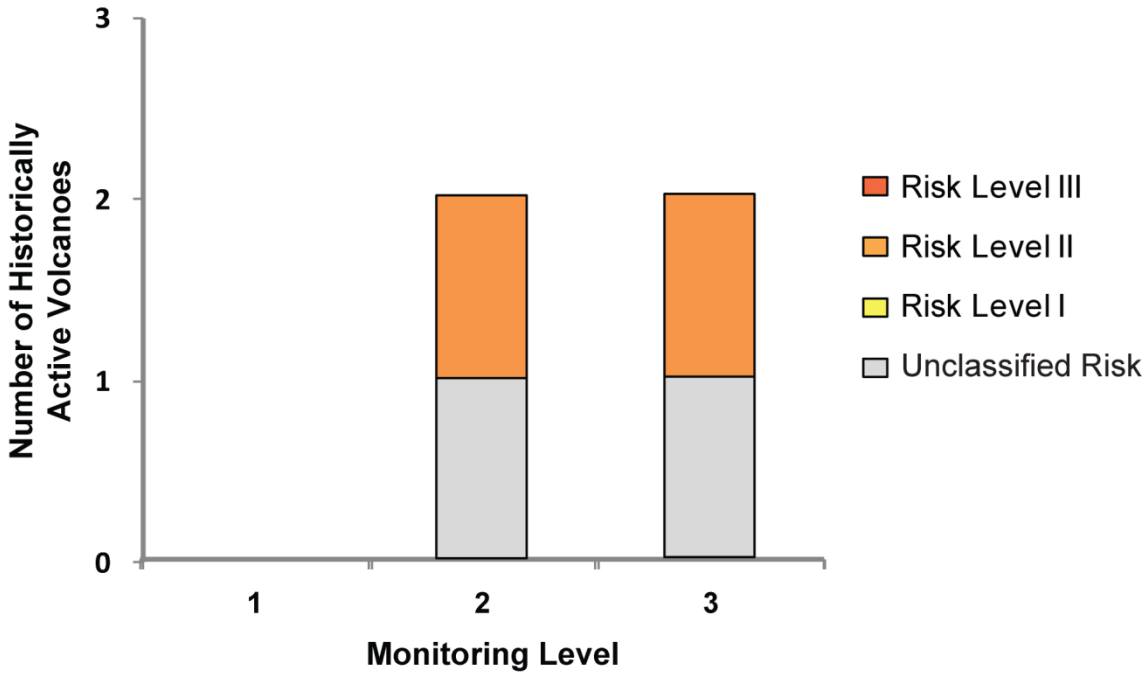

Figure 18.15 The monitoring and risk levels of the historically active volcanoes in the Canary Islands. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

UK – Tristan da Cunha, Nightingale Island, Ascension

Description

Tristan da Cunha and Ascension are part of the British Overseas Territory of St Helena, Ascension and Tristan da Cunha. Tristan da Cunha comprises a group of islands: Tristan da Cunha Island, Nightingale Island, Inaccessible Island and Gough Island. The islands are the surface expression of volcanic edifices related to the Mid-Atlantic spreading Ridge.

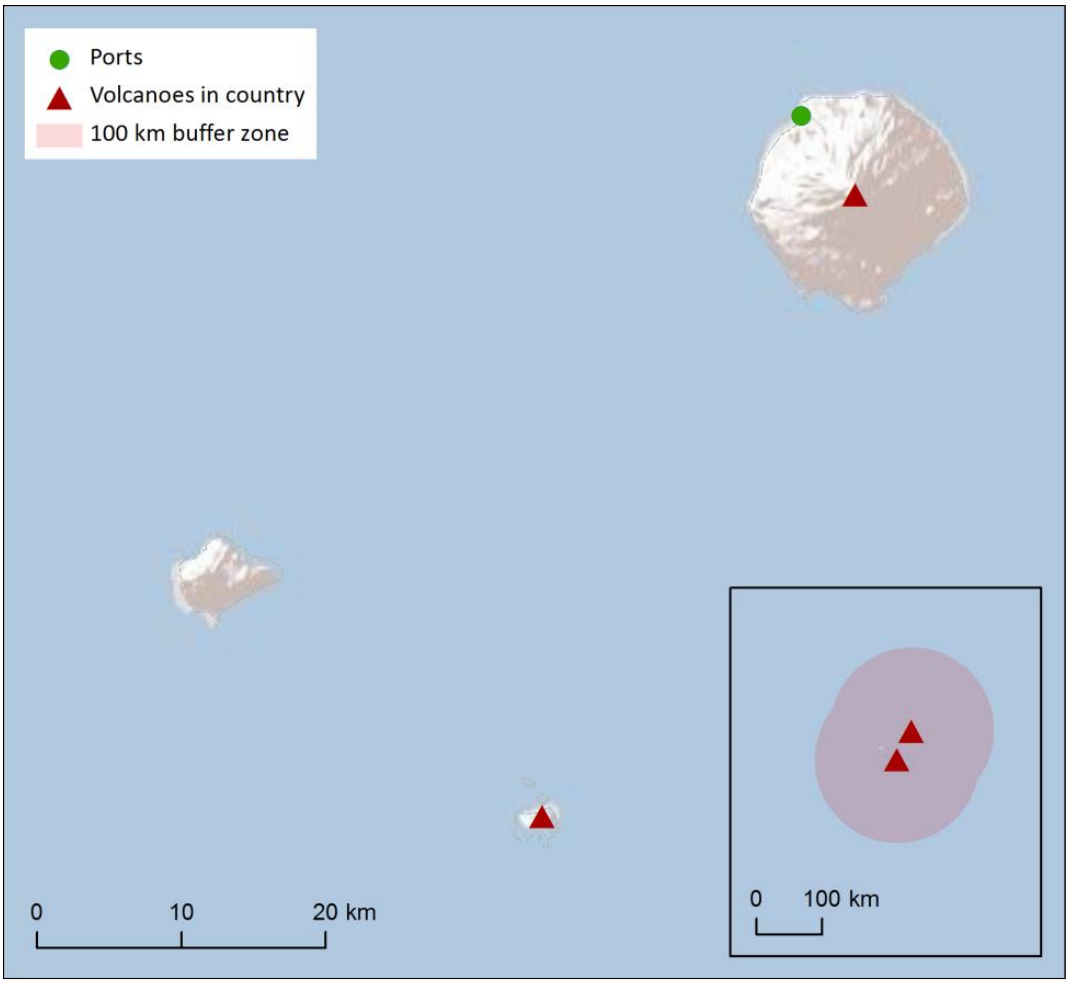

Figure 18.16 The location of the south Atlantic UK volcanoes of Tristan da Cunha and Nightingale Island. (Inset) A 100 km radius is seen around the volcanoes.

The overseas territory has three Holocene volcanoes: Tristan da Cunha, Nightingale and Ascension. Tristan da Cunha's last eruption occurred in 1961-62 with the formation of a lava dome and lava flow in the north-west of the island close to the settlement of Edinburgh-of-the-Seven-Seas. Tristan da Cunha is a trachy-balastic shield volcano with numerous parasitic cones on its flanks. The youngest summit lava has been dated at 5±1 ka and the youngest parasitic cone is 3±1 ka (Hicks et al., 2012).

Nightingale Island is part of the Tristan da Cunha archipelago and is located approximately 30 km to the southwest of Tristan da Cunha Island. Nightingale is a trachy-andesitic stratovolcano. In 2004 a seismic swarm was felt by islanders on Tristan da Cunha between the end of July and December. Pumice rafts were seen by fishermen and some eventually washed up on some of Tristan da Cunha's

beaches. The events were located to a submarine eruption 37-55km south-southeast of Tristan da Cunha and is assumed to be a flank eruption of Nightingale volcano (O'Mongain et al., 2007).

Ascension Island is 3750 km north of Tristan da Cunha and lies just 90 km west of the Mid-Atlantic Ridge (MAR). Ascension is a basaltic stratovolcano predominantly comprising lava flows, pyroclastic deposits and scoria. A felsic complex in the centre and east of Ascension comprises a series of predominantly trachytic with some rhyolitic and basaltic lava flows and domes. The lower relief southern, western and northern parts of the island are dominated by mafic lava flows punctuated by numerous scoria cones. There has been no historical volcanic activity recorded on Ascension Island. The last eruption is unknown; however, it is proposed to have been late Holocene in age (Jicha et al., 2013).

Currently, the only monitoring stations on Tristan da Cunha are two CTBTO hydro-acoustic stations and an IRIS seismometer installed on Tristan to detect nuclear explosions and global tectonic earthquakes respectively. The British Geological Survey acts as a de facto remote volcano observatory for the South Atlantic but there is no contract or dedicated sustainable resource for this role beyond the BGS 'national capability' funding. As such, there is currently no dedicated volcano monitoring in the British Overseas Territory of St Helena, Ascension Island and Tristan da Cunha. The helicorder plots are checked daily by BGS staff for unusual activity. Should likely volcanic earthquakes be detected, BGS staff would communicate with FCO, CCS, the Islands' Administration Office and arrange to visit to check for evidence of volcanic activity on the island and potentially enhance monitoring capacity.

As the islands of Tristan da Cunha, Nightingale and Ascension are small, the entire populations live within 10 km of the volcanoes. Nightingale has no settlement; however, it is only c.40 km from the settlement on Tristan da Cunha, therefore an eruption on Nightingale would impact Tristan da Cunha islanders. The permanent population on Tristan da Cunha is 264. There is no permanent population on Ascension Island, with the majority of islanders (880 as of 2010) under a contract of employments to stay on the island.

See also:

O'Mongain, A., Ottemoller, L., Baptie, B., Galloway, D., and Booth, D., 2007, Seismic activity associated with a probable submarine eruption near Tristan da Cunha, July 2004-July 2006. *Seismological Research Letters*, 78, p. 375-382.

Hicks, A., Barclay, J., Mark, D.F., and Loughlin, S., 2012, Tristan da Cunha: Constraining eruptive behavior using the 40Ar/39Ar dating technique. *Geology*, 40, p. 723-726.

Jicha, B.R., Singer, B.S., and Valentine, M.J., 2013, 40Ar/39Ar Geochronology of Subaerial Ascension Island and a Re-evaluation of the Temporal Progression of Basaltic to Rhyolitic Volcanism. *Journal of Petrology*, 54, p. 2581-2596.

Volcano Facts

Number of Holocene volcanoes	3
Number of Pleistocene volcanoes with M≥4 eruptions	-

Number of volcanoes generating pyroclastic flows	-
Number of volcanoes generating lahars	-
Number of volcanoes generating lava flows	1
Number of fatalities caused by volcanic eruptions	-
Tectonic setting	Rift zone
Largest recorded Pleistocene eruption	-
Largest recorded Holocene eruption	The 1961 VEI 2 eruption of Tristan da Cunha.
Number of Holocene eruptions	3 confirmed eruptions
Recorded Holocene VEI range	0 – 2 and unknown
Number of historically active volcanoes	2
Number of historic eruptions	3

Number of volcanoes	Primary volcano type	Dominant rock type
2	Large cone(s)	Basaltic (1), Trachytic/Andesitic (1)
1	Shield(s)	Basaltic (1)

Table 18.18 The number of volcanoes in the UK islands of the south Atlantic, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	?<300
Gross Domestic Product (GDP) per capita (2005 PPP $)	-
Gross National Income (GNI) per capita (2005 PPP $)	-
Human Development Index (HDI) (2012)	-

Population Exposure

Capital city	Edinburgh of the Seven Seas (settlement on Tristan da Cunha), Georgetown (Ascension)
Distance from capital city to nearest Holocene volcano	<10 km
Number (percentage) of people living within 10 km of a	100%

Holocene volcano	
Number (percentage) of people living within 30 km of a Holocene volcano	100%
Number (percentage) of people living within 100 km of a Holocene volcano	100%

Infrastructure Exposure

Number of airports within 100 km of a volcano	0
Number of ports within 100 km of a volcano	3
Total length of roads within 100 km of a volcano (km)	0
Total length of railroads within 100 km of a volcano (km)	0

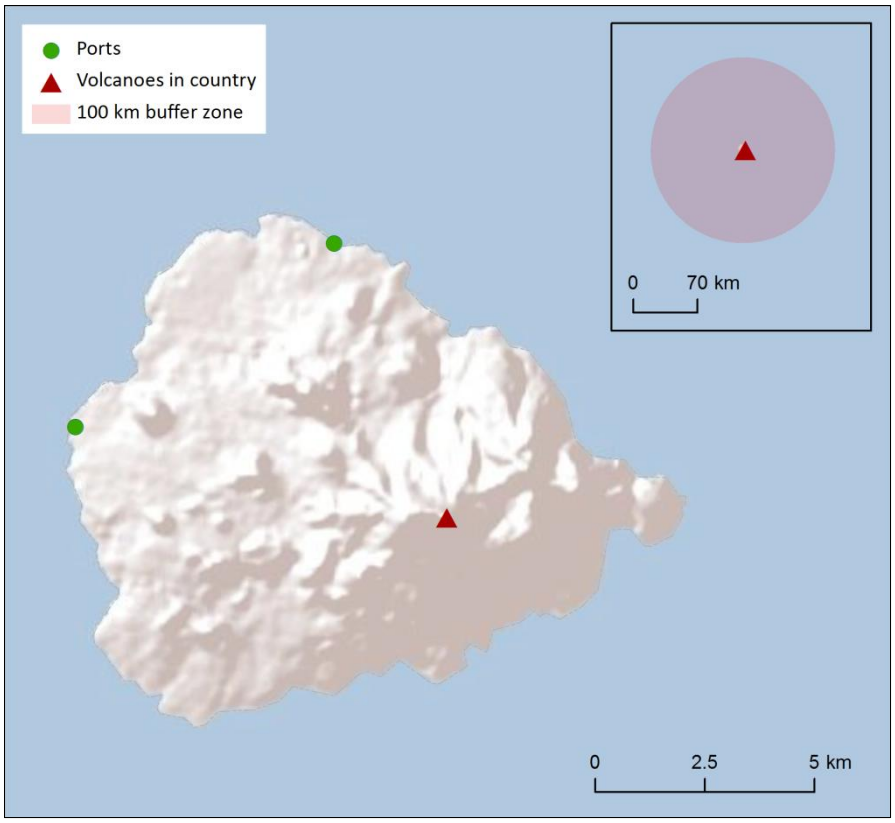

Figure 18.17 The location of Acension's volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

The islands of Tristan da Cunha, Nightingale Island and Ascension are remote outposts of the UK in the central and southern Atlantic. Settlements on Tristan da Cunha and Ascension lie within 10 km of the volcanoes, and hence all infrastructure on these islands is exposed within the 100 km radii of the volcanoes.

Hazard, Uncertainty and Exposure Assessments

The eruption records for the UK volcanoes of the Atlantic Ocean are not sufficiently extensive to permit the calculation of the VHI and the determination of hazard levels. These volcanoes are therefore unclassified. Ascension has no confirmed Holocene activity, however both Tristan da Cunha and Nightingale Island have post-1900 AD eruptions.

The small population close to the three volcanoes here makes these PEI 2, a low population exposure index.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I							
UNCLASSIFIED	**U – HHR**		**Tristan da Cunha; Nightingale Island**					
	U- HR							
	U-NHHR		Ascensión					
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 18.19 Identity of volcanoes in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

National Capacity for Coping with Volcanic Risk

Both Tristan da Cunha and Nightingale Island have records of historical activity. No information is available at the time of the writing of this report to indicate the presence of dedicated ground-based monitoring at Nightingale Island, however one British Geological Survey monitored seismometer is used at Tristan da Cunha.

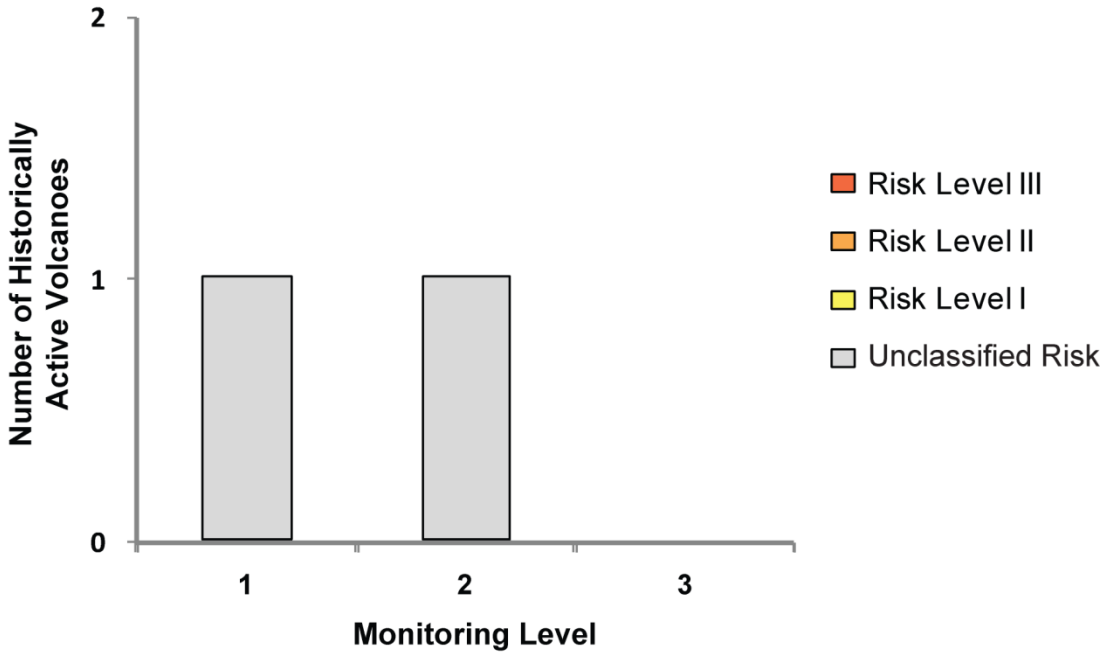

Figure 18.18 The monitoring and risk levels of the historically active volcanoes in Tristan da Cunha and Nightingale Island. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.