Appendix B – Region 17

Country and regional profiles of volcanic hazard and risk:

Iceland and Arctic Ocean

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This download comprises the profiles for Region 17: Iceland and Arctic 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.

Region 17: Iceland and Arctic Ocean

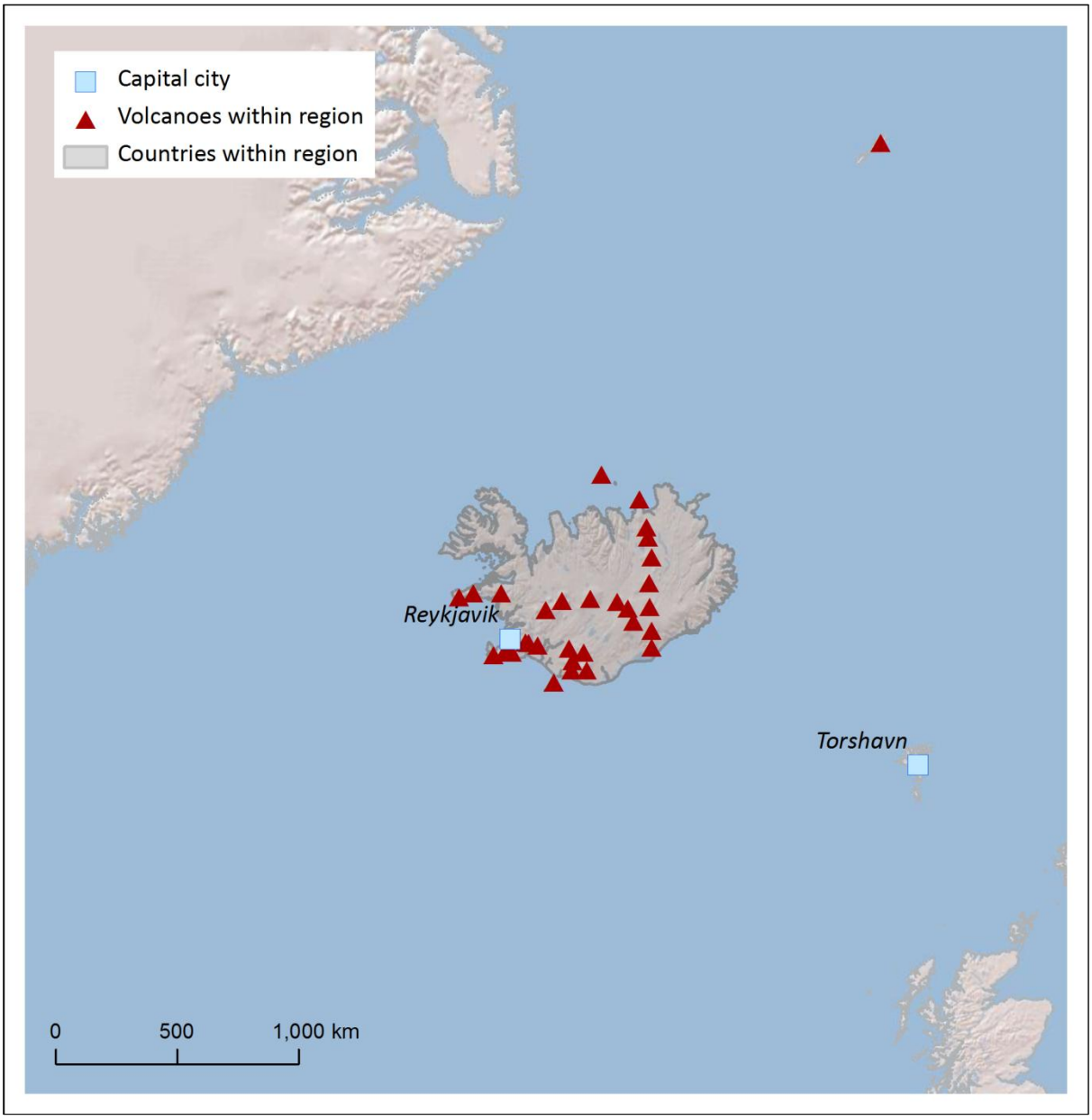

Figure 17.1 The distribution of Holocene volcanoes through the Iceland and Arctic region. The capital cities of the constituent countries are shown.

Description

Region 17: Iceland and Arctic Ocean comprises volcanoes in Iceland and Jan Mayen volcano in the northern Arctic, a volcano in Norwegian territories. Here we discuss all volcanoes of Region 17. The country profile for Norway includes Jan Mayen and two further Norwegian volcanoes in the southern Atlantic (Region 18).

Country	Number of volcanoes
Iceland	30
Norway	1 + 2 from Region 18

Table 17.1 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-three Holocene volcanoes are located in Iceland and the Arctic Ocean, comprising 30 volcanoes in Iceland. These volcanoes are the result of intra-plate hotspot activity with a mid-ocean ridge.

A range of volcano types are present here, though most are stratovolcanoes. The composition of all but four volcanoes is dominantly basaltic. A range of activity styles and eruption magnitudes are recorded through the Holocene, with a range of eruptions from VEI 0 to 6, with about 10% of all eruptions being VEI ≥4.

Fourteen volcanoes have historical records of 146 eruptions, about 81% of which were recorded through direct observations. Just 4% of historical events have involved the production of pyroclastic flows and lahars, with lava flows recorded in 32% of historical eruptions.

VOTW4.22 records loss of life in 5% of eruptions. The population of this region is small, and as such most are considered relatively low risk. However, the hazard is unclassified at about half the volcanoes in this region.

Monitoring is undertaken at all historically active volcanoes in Iceland and the Arctic, with comprehensive monitoring at many of Iceland's volcanoes. See the Iceland country profile for details.

Volcano facts

Number of Holocene volcanoes	33
Number of Pleistocene volcanoes with M≥4 eruptions	6
Number of volcanoes generating pyroclastic flows	6 (16 eruptions)
Number of volcanoes generating lahars	1 (9 eruptions)
Number of volcanoes generating lava flows	22 (220 eruptions)
Number of eruptions with fatalities	12
Number of fatalities attributed to eruptions	10,315
Largest recorded Pleistocene eruption	The largest recorded Quaternary explosive eruption in this region is the Saksunarvatn eruption of

	Grímsvötn, Iceland in 10,180 BP. This eruption measured M6.6.
Largest recorded Holocene eruption	The largest recorded Holocene eruption in this region in LaMEVE is the 3050 BP H3 M5.8 eruption of Hekla.
Number of Holocene eruptions	503 confirmed Holocene eruptions.
Recorded Holocene VEI range	0 – 6 and unknown
Number of historically active volcanoes	14
Number of historical eruptions	146

Number of volcanoes	Primary volcano type	Dominant rock type
2	Caldera(s)	Basaltic (2)
14	Large cone(s)	Andesitic (1), Basaltic (11), Rhyolitic (1), Unknown (1)
2	Shield(s)	Basaltic (2)
7	Small cone(s)	Basaltic (7)
4	Subglacial	Basaltic (4)
4	Submarine	Basaltic (3), Unknown (1)

Table 17.2 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)	2
Large (> VEI 3)	30

Table 17.3 Average recurrence interval (years between eruptions) for small and large eruptions in Iceland and the Arctic.

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 2 years, whilst the ARI for large eruptions is longer, at about 30 years.

Eruption Size

Eruptions are recorded through the Iceland and Arctic region of VEI 0 to 6, representing a range of eruption styles from gentle effusive events, to large explosive eruptions. There is a wide spread of eruption sizes, with the most populous group being VEI 2, with nearly 20% of all Holocene eruptions classed as such. Just over 10% of eruptions here are explosive at VEI ≥4.

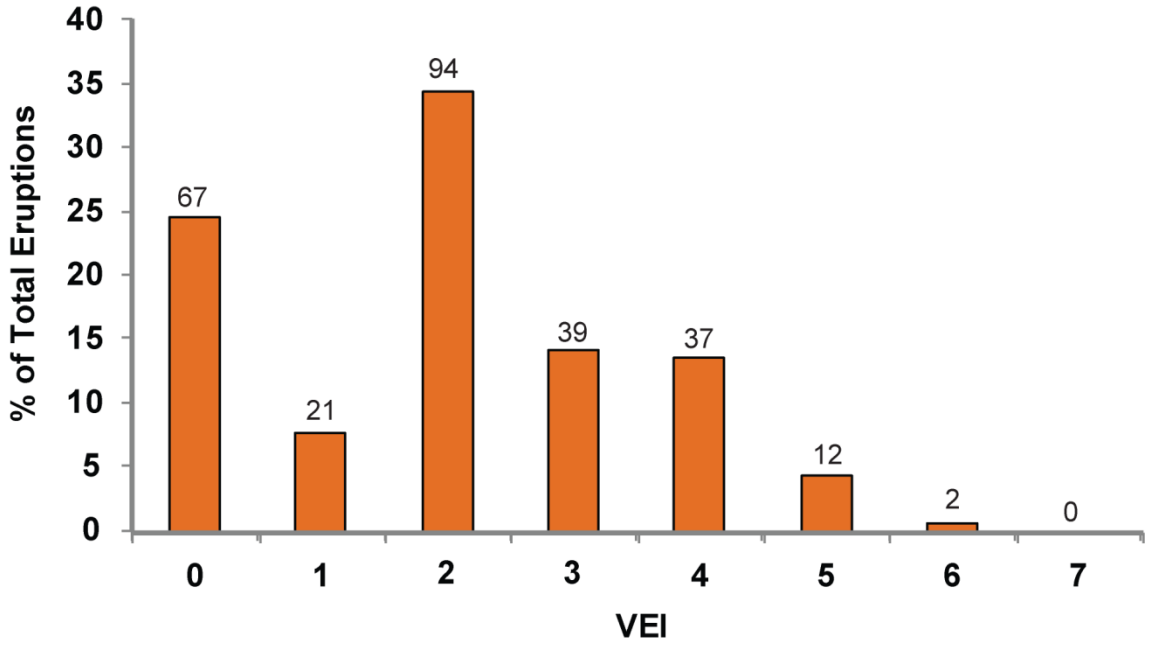

Figure 17.2 Percentage of eruptions in this region recorded at each VEI level; the number of eruptions is also shown. The percentage is of total eruptions with recorded VEI. A further 231 eruptions were recorded with unknown VEI.

Socio-Economic Facts

Total population (2011)	311,058
Gross Domestic Product (GDP) per capita (2005 PPP $)	33,618 (Iceland)
Gross National Income (GNI) per capita (2005 PPP $)	29,176 (Iceland)
Human Development Index (HDI) (2012)	0.906 (Very High, Iceland)

Population Exposure

Number (percentage) of people living within 10 km of a Holocene volcano	7,255 (2.33 %)
Number (percentage) of people living within 30 km of a Holocene volcano	84,738 (27.24 %)
Number (percentage) of people living within 100 km of a Holocene volcano	286,832 (92.21 %)

CLASSIFIED	**Hazard III**		Hekla					
	Hazard II	Jan Mayen	Katla; Grímsvötn; Bárdarbunga; Askja		Reykjanes			
	Hazard I		Snaefellsjökull; Ljósufjöll; Hveravellir; Kverkfjöll; Krafla	Hengill; Grímsnes		Krísuvík; Brennisteinsfjöll		
UNCLASSIFIED	**U – HHR**		**Vestmannaeyjar**; **Eyjafjallajökull**; Tjörnes Fracture Zone; Öraefajökull; Kolbeinsey Ridge					
	U- HR	Bouvet	Prestahnukur; Torfajökull; Fremrinamur; Theistareykjarbunga					
	U-NHHR	Thompson Island	Helgrindur; Hofsjökull; Tindfjallajökull; Tungnafellsjökull; **Esjufjöll**	**Hrómundartindur**				
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 17.4 Identity of the volcanoes in 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
0	6
2	5
1	4
3	3
24	2
3	1

Table 17.5 The number of volcanoes in Iceland and the Arctic Ocean classed in each PEI category.

Risk Levels

Number of Volcanoes	Risk Level
0	III
4	II
12	I
17	Unclassified

Table 17.6 The number of volcanoes in the Iceland and Arctic region classified at each Risk Level.

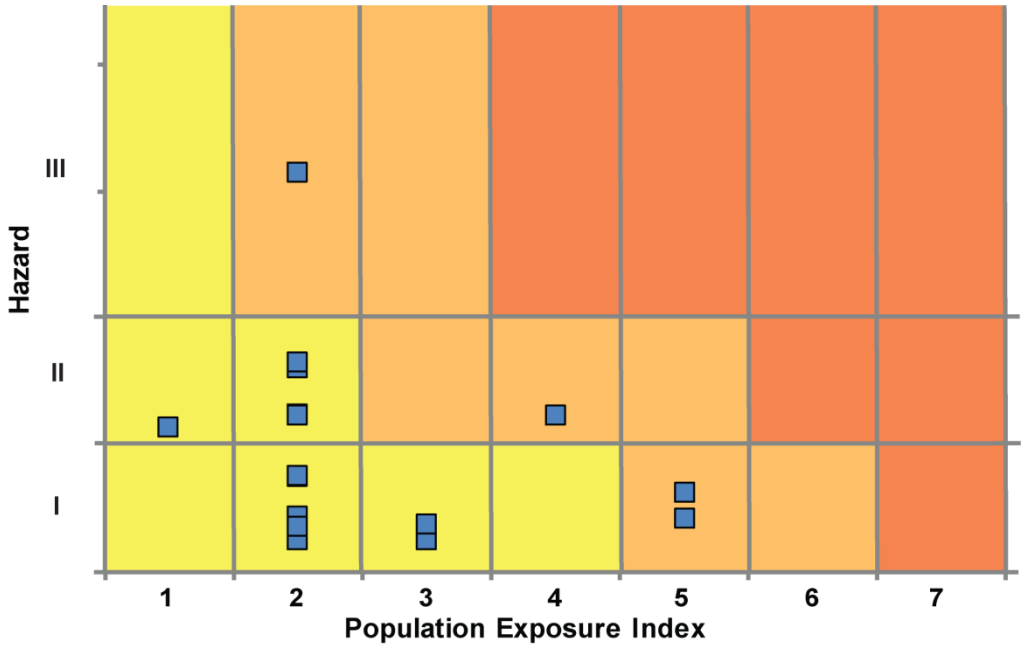

Figure 17.3 Distribution of the classified volcanoes of this region across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

Regional Monitoring Capacity

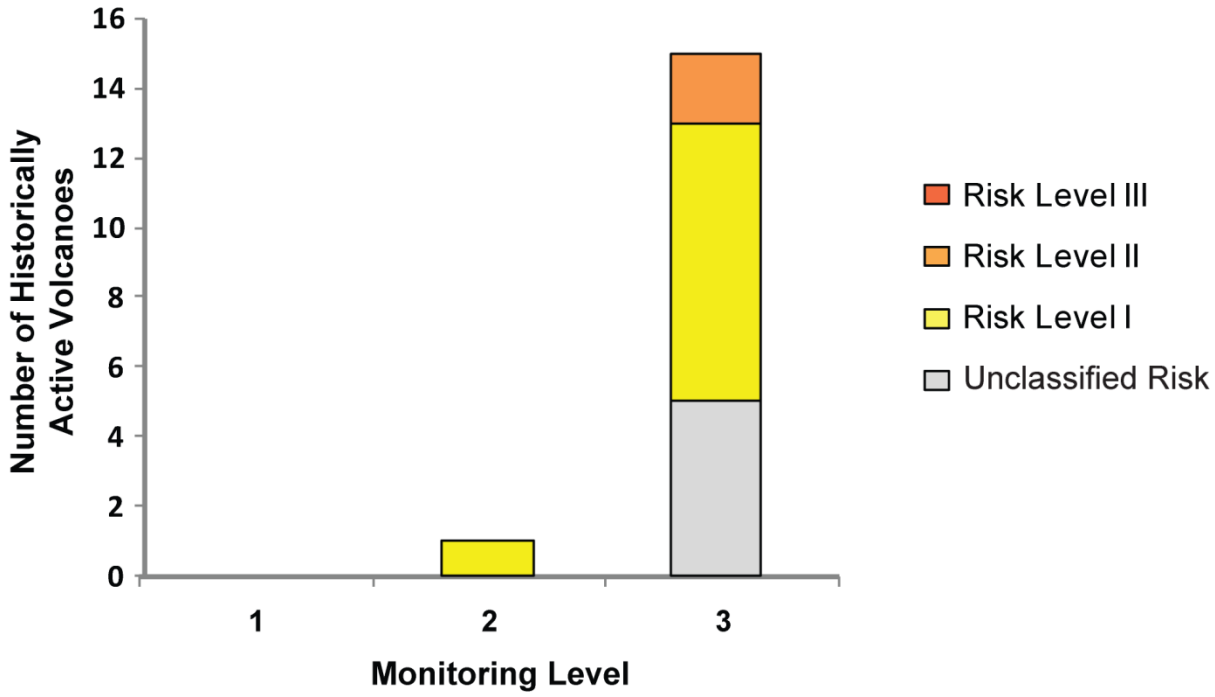

Figure 17.4 The monitoring and risk levels of the historically active volcanoes in Iceland. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Iceland

Description

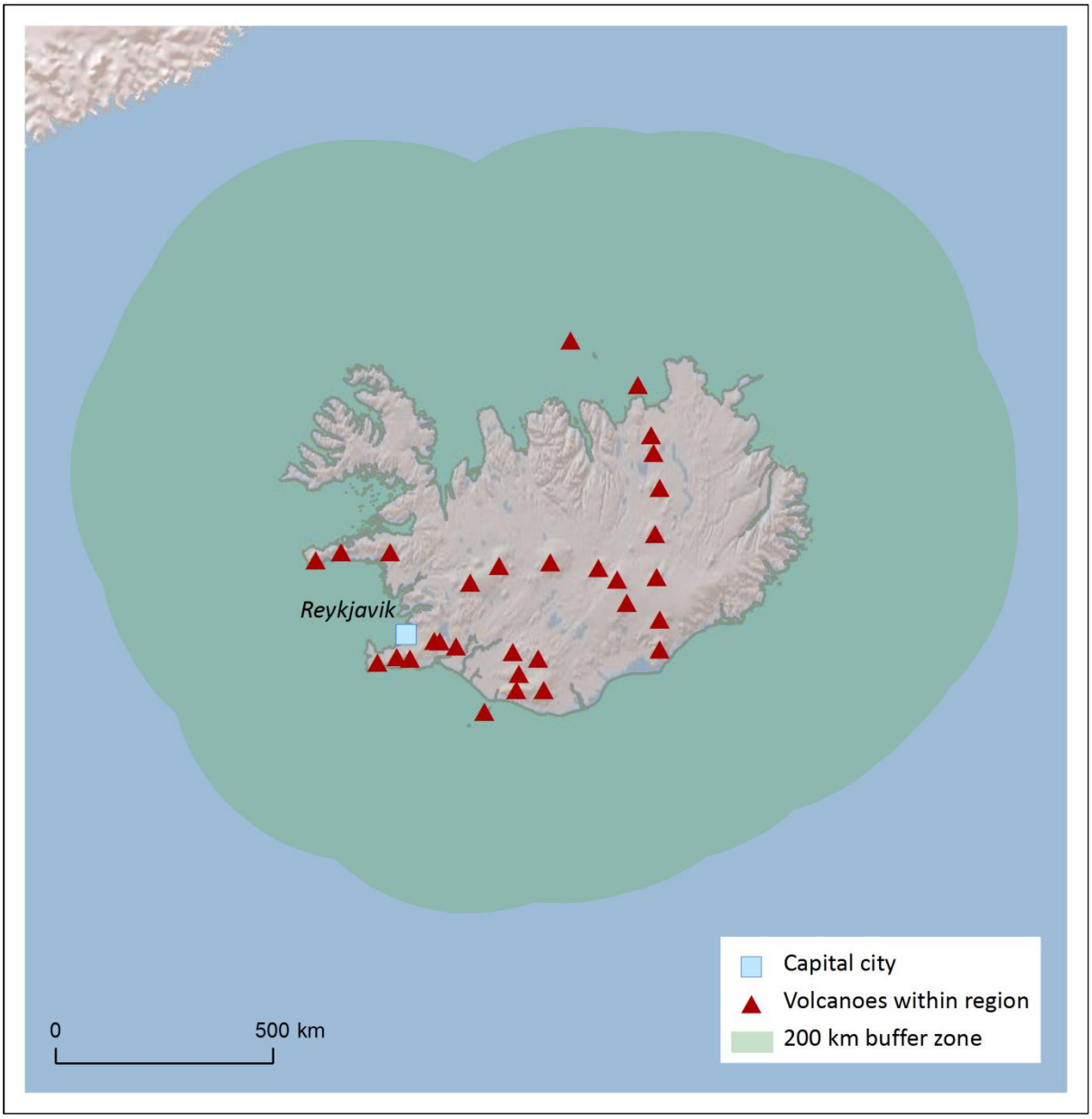

Figure 17.5 Location of Iceland's volcanoes, the capital and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect Iceland.

Volcanism in Iceland is caused by divergence of two tectonic plates (European and North American), as well as a mantle-sourced 'hot-spot'. Active volcanic systems are located along the tectonic plate boundary, which cuts through Iceland roughly from south-west to north-east. The most frequently active volcanoes in recent decades have been Grimsvötn and Hekla.

In Iceland, volcanically active areas are subdivided into volcanic systems. This classification works well for Iceland due to its unique volcano-tectonic setting. One volcanic system may consist of one or more so-called central volcanoes, which may be linked through the sub-surface structure. The volcanic systems are 30-190 km long and 10-30 km wide. Some volcanic systems consist of a single central volcano (e.g. Öræfajökull), while others have a fissure swarm and no central volcano (e.g. Reykjanes). However, many volcanic systems have both (e.g. Hekla, Katla, Grimsvotn). Eruptions may take place in the central volcano and/or on the fissure swam. For example, the effusive Laki eruption in 1783-84 and the highly ash-rich 2011 Grimsvotn eruption were sourced from the same volcanic system but different parts.

Iceland has 28 Holocene volcanic systems listed in the GVP database. Several updates and new data on volcanic systems have been included in the Catalogue of Icelandic Volcanoes (CIV), which will be published by the Icelandic volcano observatory (IMO), University of Iceland, and Icelandic Civil Protection in the beginning of 2015. The CIV includes two additional Holocene volcanic systems, as well as one non-Holocene system that is nevertheless considered important for Icelandic volcanism.

Volcanic activity is highly varied and includes nearly all known types of eruption style, duration, products and composition. Eruptions are frequent with approximately three events per decade. It has been suggested that frequency of activity goes through cycles, and that we may be entering a more active interval. The majority of eruptions have been explosive due to the presence of glaciers on many volcanoes. Most of the frequently occurring eruptions are small (<0.1 km^3 DRE), while the largest flood-basalt eruptions (>10 km^3 DRE) have an approximately 500-1000 year repose interval. The largest explosive eruptions have reached VEI 6 (return period 1-2 per millennium), with the most recent one in 1362 CE.

The most frequent volcanic hazards include jökulhlaups (floods following an eruption under a glacier), tephra fall, and pollution of air and grazing pastures by ash, gases and aerosols. Damage due to lava flows is only likely if an eruption were to occur very close to inhabited areas, such as happened in the 1973 eruption in Vestmannaeyjar. Pyroclastic density currents and tsunamis are known to have occurred, but are relatively minor except in infrequent, large eruptions.

The most hazardous eruptions expected in Iceland are of two different types: (1) large effusive eruption, such as the Laki eruption 1783-84 AD, that lasts weeks or months. It would cause severe pollution by gas and aerosol in Iceland, and impact air quality in the Northern hemisphere; (2) VEI 6 explosive eruption close to inhabited areas, such as the 1362 eruption of Öræfajökull, producing pyroclastic density currents and heavy tephra fall. Additionally, smaller ash-rich eruptions (VEI 3-4) which last weeks to months can significantly damage agriculture in Iceland and cause prolonged air space closures (e.g. Eyjafjallajökull in 2010). In addition, even moderately sized eruptions may be extremely hazardous if they melt through a thick glacier and cause large jökulhlaups.

Loss of life directly caused by volcanic eruptions has fortunately been very modest (<15 people since 1500 CE). However, eruptions have caused a number of fatalities through indirect impact. The 1783-84 Laki eruption caused severe famine due to pollution of graze land and loss of livestock, and over 8,500 people are estimated to have died as a consequence. It is possible that this eruption also caused increased mortality in Europe due to air pollution, but exact scale of impact is not known. In modern times, risk to life remains low. This is a combination of a developed economy, advanced volcano monitoring systems, well-defined civil protection procedures and frequently low proximal

populations, with most Icelandic volcanoes categorised at a low PEI of 2. Damage to infrastructure and economy (in particular roads and bridges) is however, considerable.

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Gudmundsson, M. T., G. Larsen, A. Höskuldsson, and A. G. Gylfason (2008), Volcanic hazards in Iceland, *Jökull*, *58*, 251–268.

Larsen, G., M. T. Gudmundsson, and H. Björnsson (1998), Eight centuries of periodic volcanism at the center of the Iceland hotspot revealed by glacier tephrostratigraphy, *Geology*, *26*(10), 943 –946, doi:10.1130/0091-7613(1998)026<0943:ECOPVA>2.3.CO;2.

Volcano Facts

Number of Holocene volcanoes	30
Number of Pleistocene volcanoes with M≥4 eruptions	6
Number of volcanoes generating pyroclastic flows	6
Number of volcanoes generating lahars	1
Number of volcanoes generating lava flows	21
Number of fatalities caused by volcanic eruptions	?>10,315
Tectonic setting	Rift zone
Largest recorded Pleistocene eruption	The M6.6 Saksunarvatn eruption of Grímsvötn at 10,180 BP.
Largest recorded Holocene eruption	The M5.8 H3 eruption of Hekla at 3,050 BP.
Number of Holocene eruptions	496 confirmed eruptions. 27 uncertain and 7 discredited eruptions.
Recorded Holocene VEI range	0 – 6 and unknown
Number of historically active volcanoes	13
Number of historic eruptions	140

Number of volcanoes	Primary volcano type	Dominant rock type
2	Caldera(s)	Basaltic (2)
13	Large cone(s)	Andesitic (1), Basaltic (10), Rhyolitic (1), Unknown (1)
1	Shield(s)	Basaltic (1)
7	Small cone(s)	Basaltic (7)
4	Subglacial	Basaltic (4)
3	Submarine	Basaltic (3)

Table 17.7 The number of volcanoes in Iceland, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	326,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	33,618
Gross National Income (GNI) per capita (2005 PPP $)	29,176
Human Development Index (HDI) (2012)	0.906 (Very High)

Population Exposure

Capital city	Reykjavik
Distance from capital city to nearest Holocene volcano	24.9 km
Total population (2011)	311,058
Number (percentage) of people living within 10 km of a Holocene volcano	7,254 (2.3%)
Number (percentage) of people living within 30 km of a Holocene volcano	84,737 (27.2%)
Number (percentage) of people living within 100 km of a Holocene volcano	286,831 (92.2%)

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

Reykjavik	113,906

Infrastructure Exposure

Number of airports within 100 km of a volcano	3
Number of ports within 100 km of a volcano	17
Total length of roads within 100 km of a volcano (km)	8,930
Total length of railroads within 100 km of a volcano (km)	0

The Holocene volcanoes are widespread through Iceland and as such, almost the entirety of the country is located within the 100 km radii of these volcanoes. Just small areas to the east and north-west lie beyond 100 km. This places much of the critical infrastructure and main cities, including the capital Reykjavik, within the 100 km exposure radii. Numerous ports, airports and an extensive road network are affected.

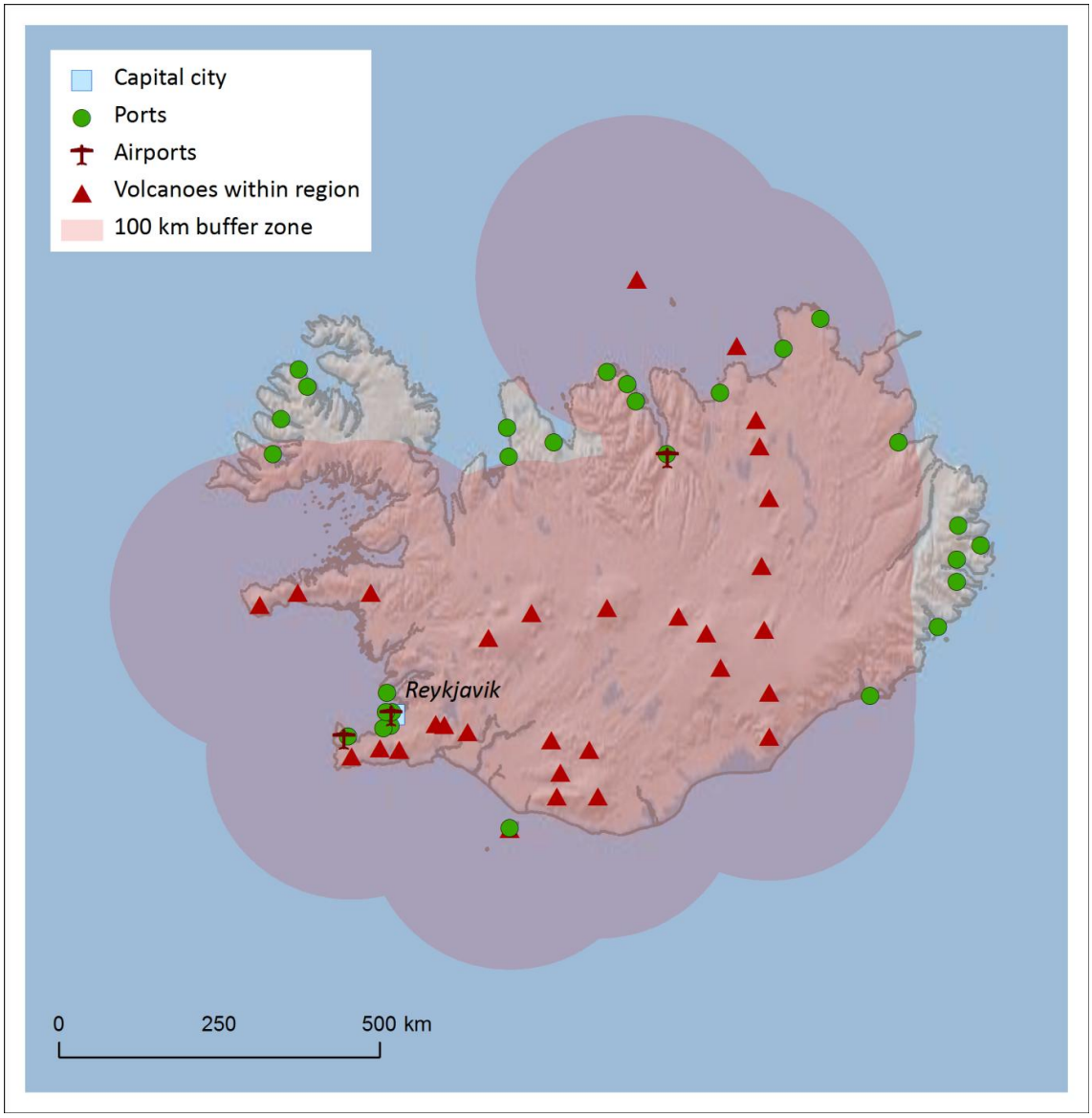

Figure 17.6 The location of Iceland's volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

The volcanoes of Iceland have varying levels of data available in the eruption record. 50% (15) of the volcanoes have appropriate eruptive histories to define the hazard. Eight of these have erupted since 1900. These volcanoes are classified across Hazard Levels I and II, with most at Level I.

Of the unclassified volcanoes, six have no confirmed Holocene age eruptions. The remaining volcanoes have a Holocene record, including five with historical activity.

In Iceland the PEI ranges from low to high, at PEI 2 to 5. With most volcanoes classed at PEI 2, the majority of Icelandic classified volcanoes are classed at Risk Level I, with just four being Risk Level II.

CLASSIFIED	**Hazard III**		Hekla					
	Hazard II		Katla; Grímsvötn; Bárdarbunga; Askja		Reykjanes			
	Hazard I		Snaefellsjökull; Ljósufjöll; Hveravellir; Kverkfjöll; Krafla	Hengill; Grímsnes		Krísuvík; Brennisteinsfjöll		
UNCLASSIFIED	**U – HHR**		**Vestmannaeyjar**; **Eyjafjallajökull**; Tjörnes Fracture Zone; Öraefajökull; Kolbeinsey Ridge					
	U- HR		Prestahnukur; Torfajökull; Fremrinamur; Theistareykjarbunga					
	U- NHHR		Helgrindur; Hofsjökull; Tindfjallajökull; Tungnafellsjökull; **Esjufjöll**	**Hrómundartindur**				
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 17.8 Identity of Iceland'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
Krísuvík	5	II
Brennisteinsfjöll	5	II
Reykjanes	4	II
Hengill	3	I
Grímsnes	3	I
Hekla	2	II
Snaefellsjökull	2	I
Ljósufjöll	2	I
Hveravellir	2	I
Katla	2	I
Grímsvötn	2	I
Bárdarbunga	2	I
Kverkfjöll	2	I
Askja	2	I
Krafla	2	I

Table 17.9 Classified volcanoes of Iceland ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given. Risk Level I – 11 volcanoes; Risk Level II – 4 volcanoes; Risk Level III – 0 volcanoes.

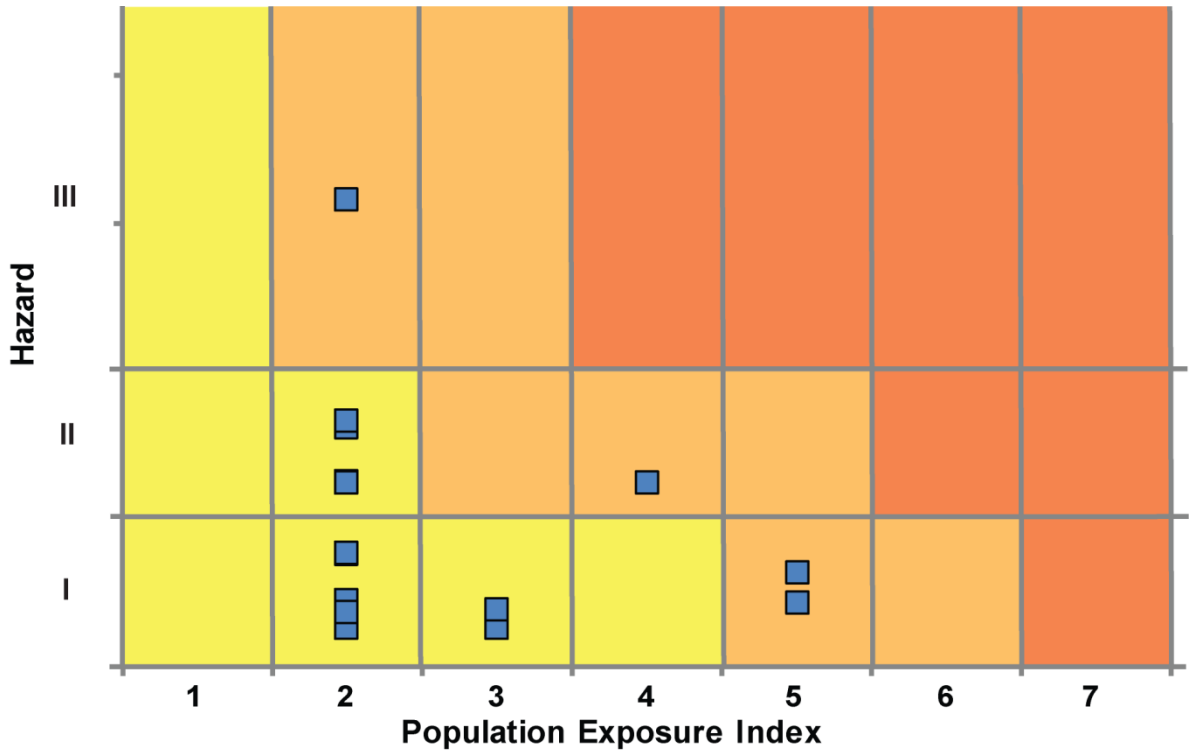

Figure 17.7 Distribution of Iceland's classified volcanoes across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

Historical eruptions are recorded at 13 volcanoes in Iceland. All of these have dedicated ground-based monitoring systems in place, with monitoring conducted by the Iceland Meteorological Office

(IMO). Multiple monitoring systems are used, including seismic analysis and deformation, categorising these volcanoes at Monitoring Level 3. Many of the Holocene volcanoes with activity prior to 1500 AD are also monitored by the IMO.

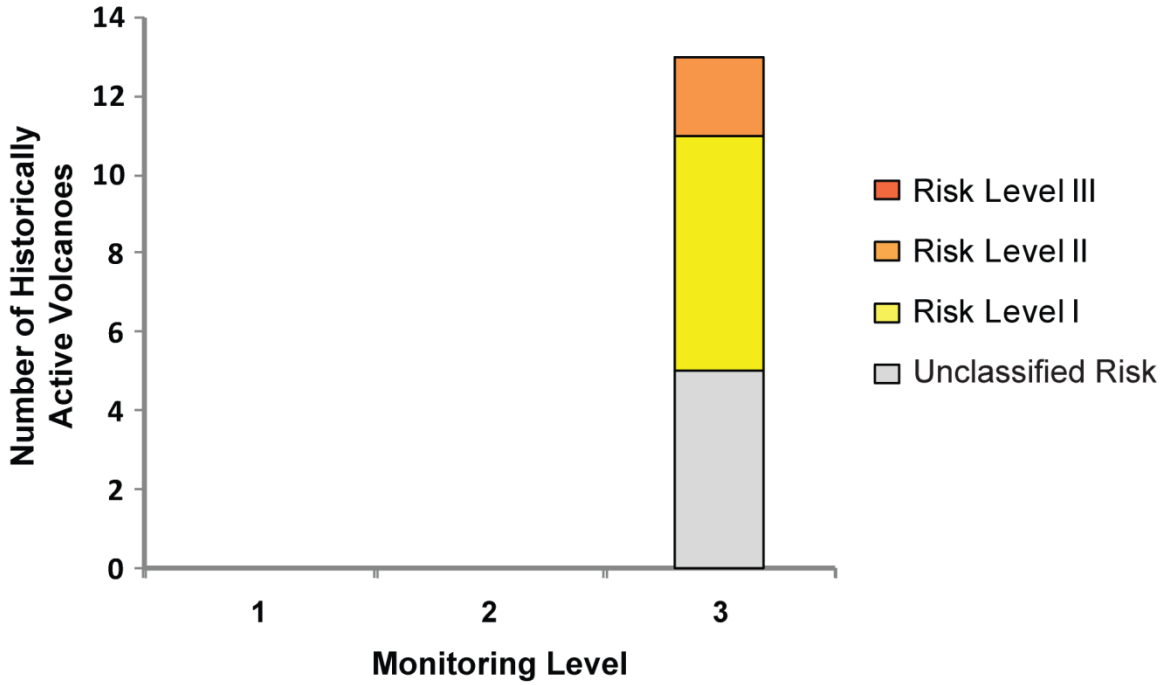

Figure 17.8 The monitoring and risk levels of the historically active volcanoes in Iceland. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Norway

Note that we include discussion of the remote Bouvet and Thompson Island volcanoes of the South Atlantic (Region 18) here.

Description

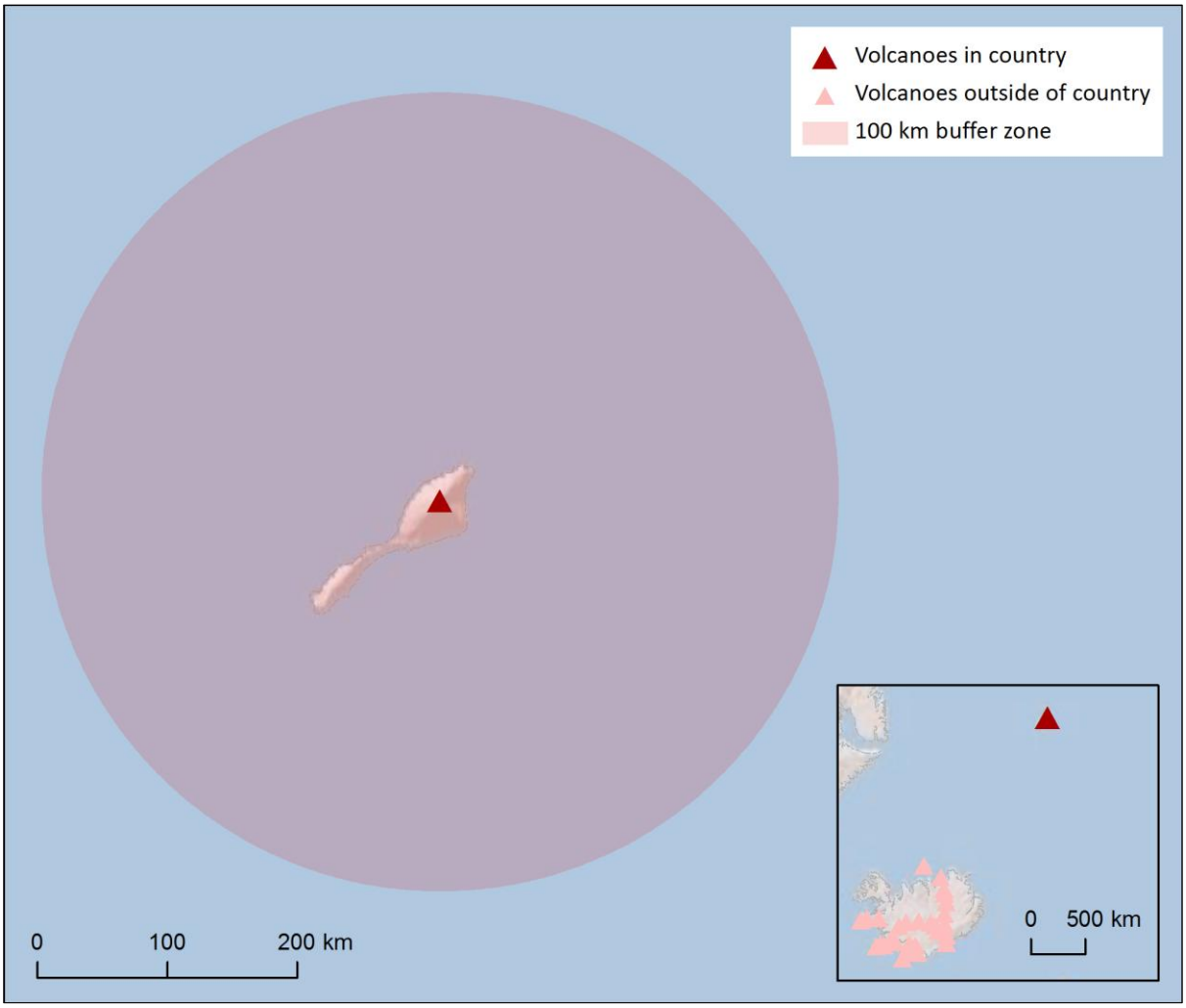

Figure 17.9 The location of Norway's volcano – Jan Mayen in the Iceland and Arctic Ocean region and the extent of the 100 km zone surrounding it.

There is no active volcanism on mainland Norway. An active volcano is found on a Norwegian island of Jan Mayen in the North Atlantic ocean. The small island (53 km long and 2-16 km wide) is situated approximately 550 km north of Iceland and 950 km west of Norway. The island has no residents other than temporary personnel working for the Norwegian Armed Forces or the Norwegian Meteorological Institute. Eighteen people spend the winter on the island, but the population may double (35) during the summer. Since 2010, the island has been closed to tourists.

The northern part of the island is dominated by a stratovolcano, Beerenberg, which is the northernmost active subaerial volcano on Earth. The upper part of Beerenberg is covered by an ice cap. The southern part of the island is a mountainous ridge made of scoria craters, scoria mounds, and lava domes.

Volcanic activity is sourced in a fairly unusual tectonic setting near the intersection of the Jan Mayen Fracture Zone (a transform fault) and the Mohn's mid-ocean ridge. Six eruptions have occurred between 1732 and 1985. All of these eruptions were on flank vents and produced lava flows and scoria cones. The most recent eruptions were in 1970, 1973, and 1985.

The 1970 eruption began on September 18 and continued to January 1971. Intense storms hid the onset of the eruption. A commercial pilot spotted the eruption cloud on September 20. The personnel was evacuated, but returned shortly. The eruption was large, erupting at least 0.5 km^3 of basalt from a 6 km long fissure that ran from sea-level to an elevation of 1,000 m. There were at least five active craters.

The 1985 eruption began on January 6, 1985 and lasted only 35-40 hours. The volume of lava was two orders of magnitude smaller than in 1970-71. Earthquakes with magnitudes up to 5 occurred during the eruption. The eruption was thought to be from a leaky fracture zone not the Jan Mayen magma system proper. The vent was 35 km from the settlement. Personnel were not evacuated.

The Department of Earth Science, University of Bergen has operated seismic stations on Jan Mayen (as part of the National Seismic Network of Norway) since 1961. The three stations on Jan Mayen are used to make daily locations of the local seismicity as well as recording distal earthquakes. The 1985 eruption was the first one to be observed with the local seismic network. Volcanic tremors and low-frequency events were observed on 5 January at 2230 h and 10 hours later the first large earthquake occurred. No visual confirmation of the eruption was made until 6 January at 1630 h. The local network hence provides an efficient tool for monitoring and warning of volcanic activity. However, since there was no change in the local seismicity in the days or months before the 1985 eruption, it seems to be difficult to make long-term predictions of flank eruptions without introducing additional monitoring techniques.

Another volcanic area under Norwegian dependency is Bouvet Island in the South Atlantic Ocean. It is a small (49 km^2) and uninhabited sub-Antarctic island. It lies at the southern end of the Mid-Atlantic Ridge and is the most remote island in the world, approximately 2,200 kilometres south-southwest of the coast of South Africa. There have been no historical eruptions on the island, but the eruption history is not known. The existence of Thompson Island volcano about 70 km north-northeast of Bouvet was reported in 1893 but since this time there is no evidence of its existence.

References:

www.jan-mayen.no/

Havskov, J. and Atakan, K. (1991), Seismicity and volcanism of Jan Mayen Island. Terra Nova, 3: 517–526. doi: 10.1111/j.1365-3121.1991.tb00187.x

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	2
Number of fatalities caused by volcanic eruptions	-
Tectonic setting	Rift zone
Largest recorded Pleistocene eruption	-
Largest recorded Holocene eruption	Three eruptions of VEI 3 are recorded at Jan Mayen in 1732, 1818 and 1970.
Number of Holocene eruptions	8 confirmed eruptions. 2 uncertain and 1 discredited eruption.
Recorded Holocene VEI range	0 – 3 and unknown
Number of historically active volcanoes	1
Number of historic eruptions	6

Number of volcanoes	Primary volcano type	Dominant rock type
1	Large cone(s)	Basaltic (1)
1	Shield(s)	Basaltic (1)
1	Submarine	Unknown (1)

Table 17.10 The number of volcanoes in Norway (Iceland and Arctic Ocean region and Atlantic Ocean region), their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2011)	4,691,849 (mainland Norway)
Gross Domestic Product (GDP) per capita (2005 PPP $)	47,626 (mainland Norway)
Gross National Income (GNI) per capita (2005 PPP $)	47,950 (mainland Norway)
Human Development Index (HDI) (2012)	0.955 (mainland Norway)

Population Exposure

Capital city	Oslo

Distance from capital city to nearest Holocene volcano	1110.7 km
Number (percentage) of people living within 10 km of a Holocene volcano	1 (<1%)
Number (percentage) of people living within 30 km of a Holocene volcano	1 (<1%)
Number (percentage) of people living within 100 km of a Holocene volcano	1 (<1%)

Infrastructure Exposure

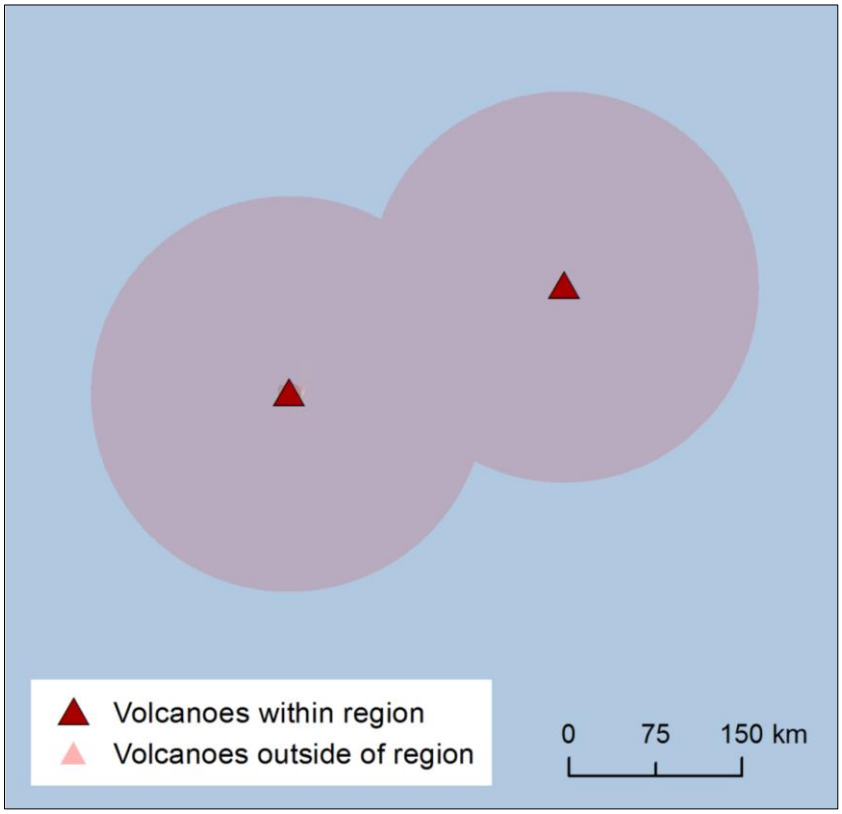

Figure 17.10 The Bouvet and Thompson Island volcanoes in the southern Atlantic Ocean, and the extent of the 100 km zone surrounding them.

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

Hazard, Uncertainty and Exposure Assessments

Of the three Norwegian volcanoes, just Jan Mayen has a sufficient eruption record to determine hazard through calculation of the VHI. This volcano is classified as Hazard Level II. With just one recorded Holocene eruption, Bouvet is unclassified, as is Thompson Island which has no confirmed Holcoene activity.

With no population living within 100 km of the Norwegian volcanoes the PEI is classified at PEI 1. This makes these volcanoes Risk Level I, with no potential to increase in Risk level despite the uncertainty in the Hazard.

CLASSIFIED	**Hazard III**							
	Hazard II	Jan Mayen						
	Hazard I							
UNCLASSIFIED	**U – HHR**							
	U- HR	Bouvet						
	U- NHHR	Thompson Island						
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 17.11 Identity of Norway'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
Jan Mayen	1	I

Table 17.12 Classified volcanoes of Norway 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.

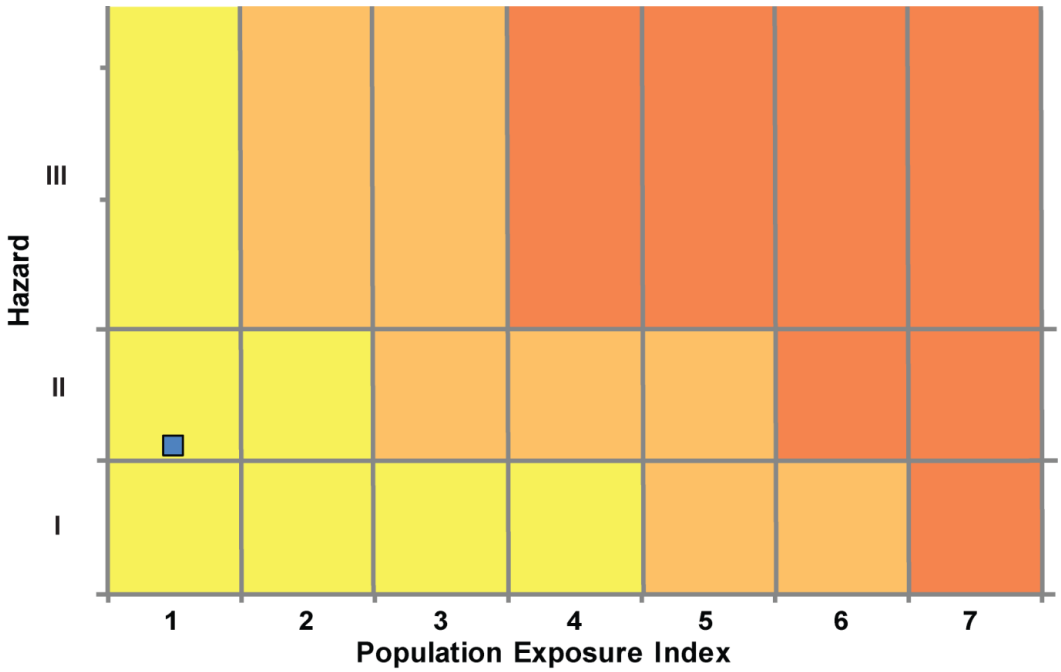

Figure 17.11 Distribution of Norway's classified volcanoes across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

The University of Bergen operates a network of three seismometers on the island of Jan Mayen.

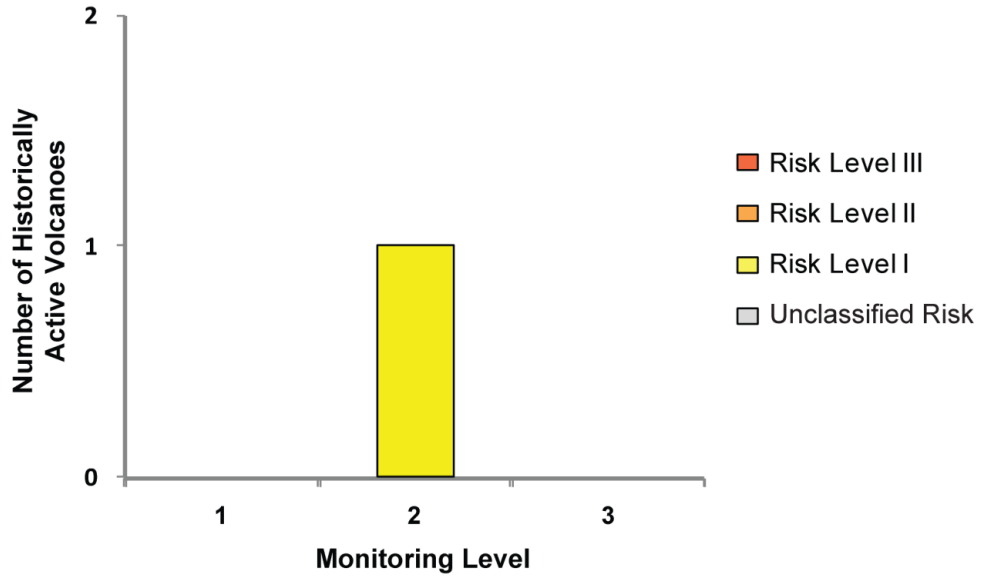

Figure 17.12 The monitoring and risk levels of the historically active volcanoes in Norway. Monitoring Level 1indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.