Appendix B – Region 10

Country and regional profiles of volcanic hazard and risk:

Kamchatka and Mainland Asia

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This download comprises the profiles for Region 10: Kamchatka and Mainland Asia 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 10: Kamchatka and Mainland Asia

Region 10: Kamchatka and Mainland Asia comprises volcanoes from the China-Pakistan border in the west to Kamchatka in the east. Five countries are represented here. The country profiles for China and Russia include additional volcanoes from outside of this region (Table 10.1).

Country	Number of volcanoes
China	11 + 3 from Region 7
DPRK	3
Mongolia	5
Republic of Korea	3
Russia	120 + 1 from Region 1

Table 10.1 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.

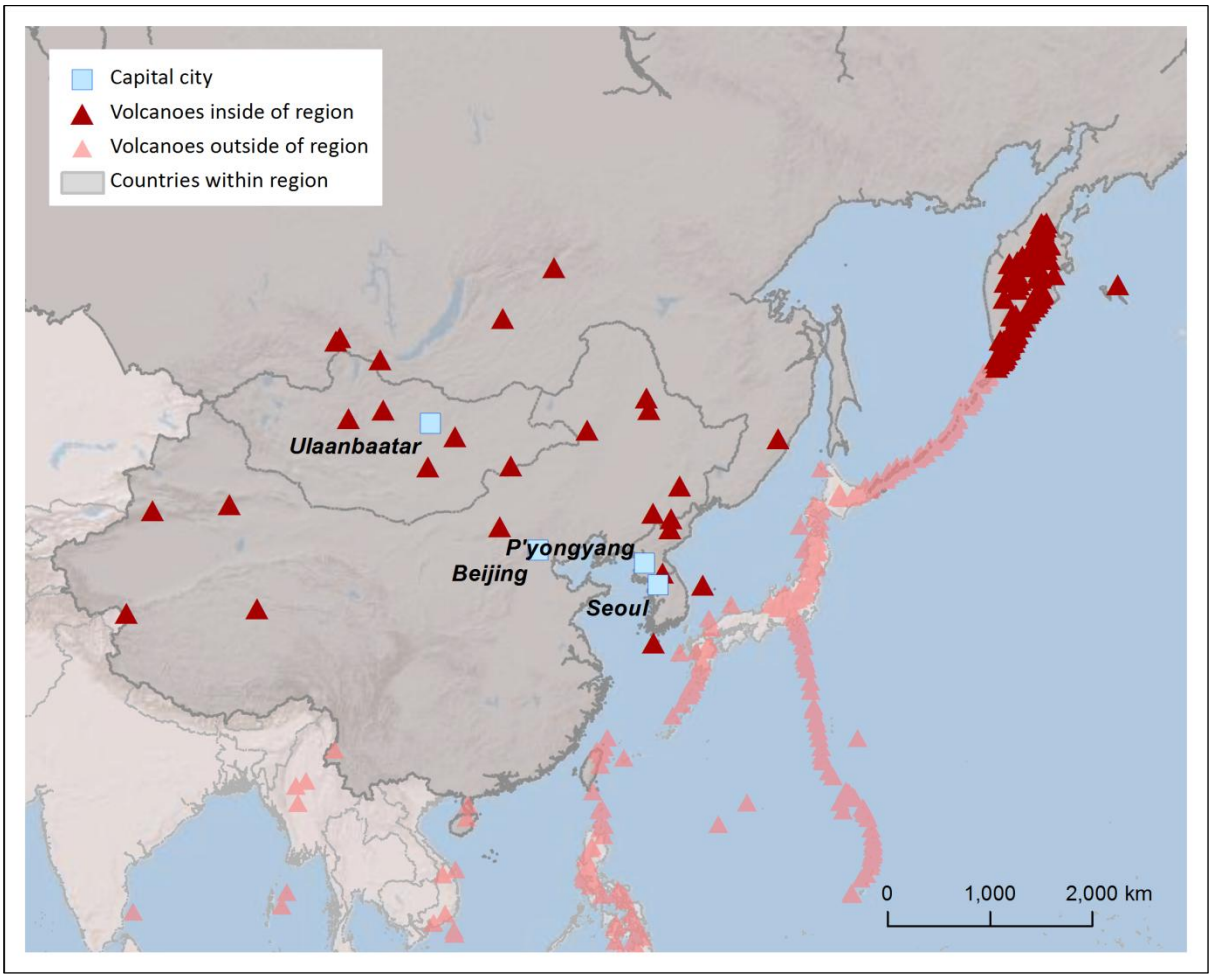

Figure 10.1 The distribution of Holocene volcanoes through the Kamchatka and Mainland Asia region. The capital cities of the constituent countries are shown.

Description

140 Holocene volcanoes are located in Kamchatka (Russia) and Mainland Asia. Most of these volcanoes (120) are in Russia, dominantly on the Kamchatka Peninsula. Volcanism here is largely due to the subduction of the Pacific Plate beneath the Eurasian Plate, with volcanoes of the mainland being chiefly controlled through tensional processes.

A range of volcano morphologies are present in this region, though stratovolcanoes and other large cones dominate (74). Shield volcanoes, volcanic fields and cinder cones are also common features. Although a range of rock types are present, the composition is mostly mafic to intermediate with basaltic and andesitic compositions most common.

Along with volcano form and composition, a range of activity styles and eruption sizes are recorded throughout the Holocene, with eruptions of VEI 0 to 7. The most common eruption sizes are VEI 2 to 4, with about 80% of eruptions being designated as such, indicating that moderately explosive volcanism is a common feature of activity here. About 20% (107) of recorded sized eruptions have been large explosive VEI ≥4 events. These eruptions have been restricted to 22 volcanoes in Russia, Changbaishan on the China-DPRK border and Ulreung, Republic of Korea. The largest Holocene eruption in this region was the VEI 7 eruption of Changbaishan about 950 years ago. Large explosive eruptions are recorded from 22 volcanoes back into the Pleistocene.

Twenty-eight volcanoes have historical records of 337 eruptions, 95% of which were recorded through direct observations. 16% of historical events have involved the production of pyroclastic flows and 12% have resulted in lahars. 26% of historical eruptions have records of lava flows.

Just 1% of historical eruptions in this region have resulted in loss of life, largely due to the low population in this region. Most volcanoes (85%) have low proximal population, and as such are considered relatively low risk. However, the hazard (VHI) is not classified at 90% of the volcanoes here.

Of the historically active volcanoes, half have dedicated monitoring systems in place, with monitoring undertaken by the Institute of Volcanology and Seismology – KVERT in Russia, the China Seismological Bureau and Volcano Research Centre in China, and scientists in North Korea in collaboration with overseas research groups.

Volcano facts

Number of Holocene volcanoes	140
Number of Pleistocene volcanoes with M≥4 eruptions	22
Number of volcanoes generating pyroclastic flows	26 (136 eruptions)
Number of volcanoes generating lahars	13 (47 eruptions)
Number of volcanoes generating lava flows	46 (227 eruptions)
Number of eruptions with fatalities	5
Number of fatalities attributed to eruptions	20

Largest recorded Pleistocene eruption	The largest recorded Quaternary eruption occurred at Diky Greben in Kamchatka at 443 ka with the M7.6 eruption of the Golygin Ignimbrite.
Largest recorded Holocene eruption	The 950 BP M7.4 eruption of Changbaishan is the largest recorded Holocene eruption in this region in LaMEVE.
Number of Holocene eruptions	781 confirmed Holocene eruptions.
Recorded Holocene VEI range	0 – 7 and unknown
Number of historically active volcanoes	28
Number of historical eruptions	337

Number of volcanoes	Primary volcano type	Dominant rock type
10	Caldera(s)	Andesitic (5), Basaltic (4), Dacitic (1)
74	Large cone(s)	Andesitic (37), Basaltic (31), Dacitic (3), Trachytic/Andesitic (2), Unknown (1)
4	Lava dome(s)	Andesitic (1), Basaltic (2), Dacitic (1)
47	Shield(s)	Andesitic (2), Basaltic (45)
38	Small cone(s)	Andesitic (5), Basaltic (26), Phonolitic (1), Trachytic/Andesitic (1), Unknown (5)
5	Submarine	Dacitic (1), Unknown (4)
1	Unknown	Unknown (1)

Table 10.2 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)	1
Large (> VEI 3)	20

Table 10.3 Average recurrence interval (years between eruptions) for small and large eruptions in Kamchatka and West Asia.

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 a year, whilst the ARI for large eruptions is longer, at about 20 years.

Eruption Size

Eruptions are recorded through the Kamchatka and Western Asia region of VEI 0 to 7, representing a range of eruption styles from gentle effusive events to very large explosive eruptions. VEI 2 events dominate the record, with nearly 50% of all Holocene eruptions classed as such, and about 80% of eruptions are VEI 2 to 4. 19% of eruptions here are explosive at VEI ≥4.

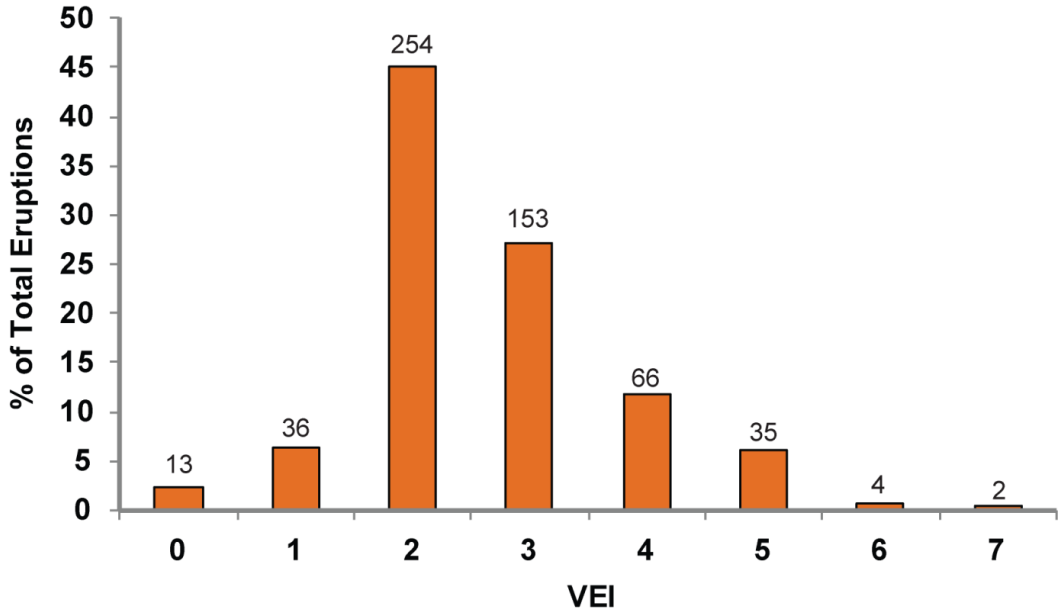

Figure 10.2 Percentage of eruptions in this region recorded at each VEI level; the number of eruptions is also shown. The percentage is of total eruptions with recorded VEI. A further 218 eruptions were recorded with unknown VEI.

Socio-Economic Facts (excluding North Korea)

Total population (2011)	1,551,803,374
Gross Domestic Product (GDP) per capita (2005 PPP $)	4,178 – 27,541 (Mean 13,486)
Gross National Income (GNI) per capita (2005 PPP $)	4,245 – 28,231 (Mean 13,271)
Human Development Index (HDI) (2012)	0.675 – 0.909 (Medium to Very High, Mean 0.768 High)

Population Exposure

Number (percentage) of people living within 10 km of a Holocene volcano	415,094 (0.03 %)
Number (percentage) of people living within 30 km of a Holocene volcano	3,787,660 (0.24 %)
Number (percentage) of people living within 100 km of a Holocene volcano	32,410,044 (2.09 %)

CLASSIFIED	**Hazard III**		Bezymianny; Shiveluch	Koryaksky; Avachinsky				
	Hazard II		Karymsky; Maly Semiachik; Kikhpinych; Krasheninnikov; Tolbachik; Kliuchevskoi					
	Hazard I		Mutnovsky; Gorely; Zhupanovsky; Kostakan					
UNCLASSIFIED	**U – HHR**		Koshelev; **Ilyinsky**; **Zheltovsky**; **Ksudach**; Opala; **Akademia Nauk**; **Kronotsky**; **Kizimen**; Ushkovsky; Khangar; **Ichinsky**; Alney-Chashakondzha; **Kunlun Volcanic Group**	**Changbaishan**		Wudalianchi		
	U- HR		Kambalny; Yavinsky; Diky Greben; Kurile Lake; Khodutka; Tolmachev Dol; Vilyuchik; Barkhatnaya Sopka; Veer; Bakening; Zavaritsky; Bolshoi Semiachik; Taunshits; **Uzon**; Gamchen; Komarov; Vysoky; Piip; Cherpuk Group; Bolshoi-Kekuknaysky; Shisheika; Terpuk; Sedankinsky; Gorny Institute; Kinenin; Bliznetsy; Titila; Elovsky; Nylgimelkin; Spokoiny; Ostry; Severny; Udokan Plateau; Tianshan Volcanic Group	Arshan; Taryatu-Chulutu; Ulreung	Halla	Turfan; Jingbo; Longgang Group		
	U- NHHR		Mashkovtsev; Kell; Belenkaya; Ozernoy; Olkoviy Volcanic Group; Plosky; Piratkovsky; Ostanets; Otdelniy; Golaya; **Asacha**; Visokiy; Unnamed; Bely; Bolshe-Bannaya; Dzenzursky; Schmidt; Unnamed; Udina; Zimina; Kamen; Maly Payalpan; Bolshoi Payalpan; Akhtang; Kozyrevsky; Romanovka; Uksichan; Kulkev; Geodesistoy; Anaun; Krainy; Kekurny; Eggella; Cherny; Unnamed; Verkhovoy; Pogranychny; Zaozerny; Bliznets; Kebeney; Uka; Fedotych; Leutongey; Tuzovsky; Mezhdusopochny; Shishel; Alngey; Kaileney; Plosky; Snezhniy; Iktunup; Snegovoy; Iettunup; Voyampolsky; Vitim Plateau; Tunkin Depression; Oka Plateau; Azas Plateau; Unnamed; Bus-Obo	Khanuy Gol; Middle Gobi	Keluo Group; Xianjindao; Dariganga Volcanic Field	Unnamed; Unnamed; Sikhote-Alin; Honggeertu; Ch'uga-ryong		
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 10.4 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
9	5
4	4
8	3
119	2
0	1

Table 10.5 The number of volcanoes in Kamchatka and Mainland Asia classed in each PEI category.

Risk Levels

Number of Volcanoes	Risk Level
0	III
4	II
10	I
126	Unclassified

Table 10.6 The number of volcanoes in the Kamchatka and Mainland Asia region classified at each Risk Level.

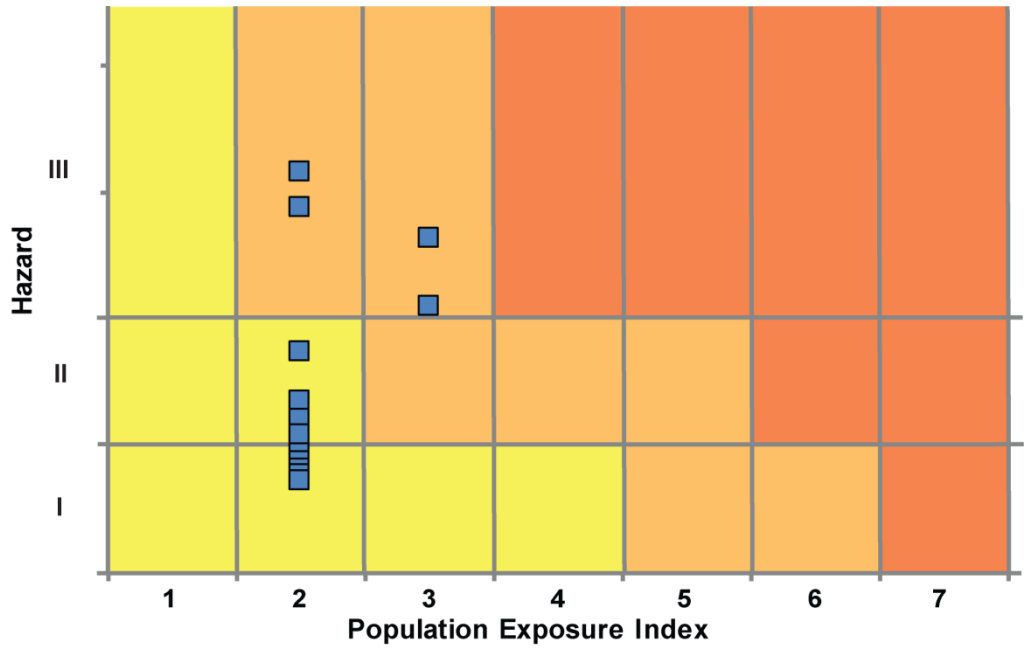

Figure 10.3 Distribution of the classified volcanoes of this region across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

Regional Monitoring Capacity

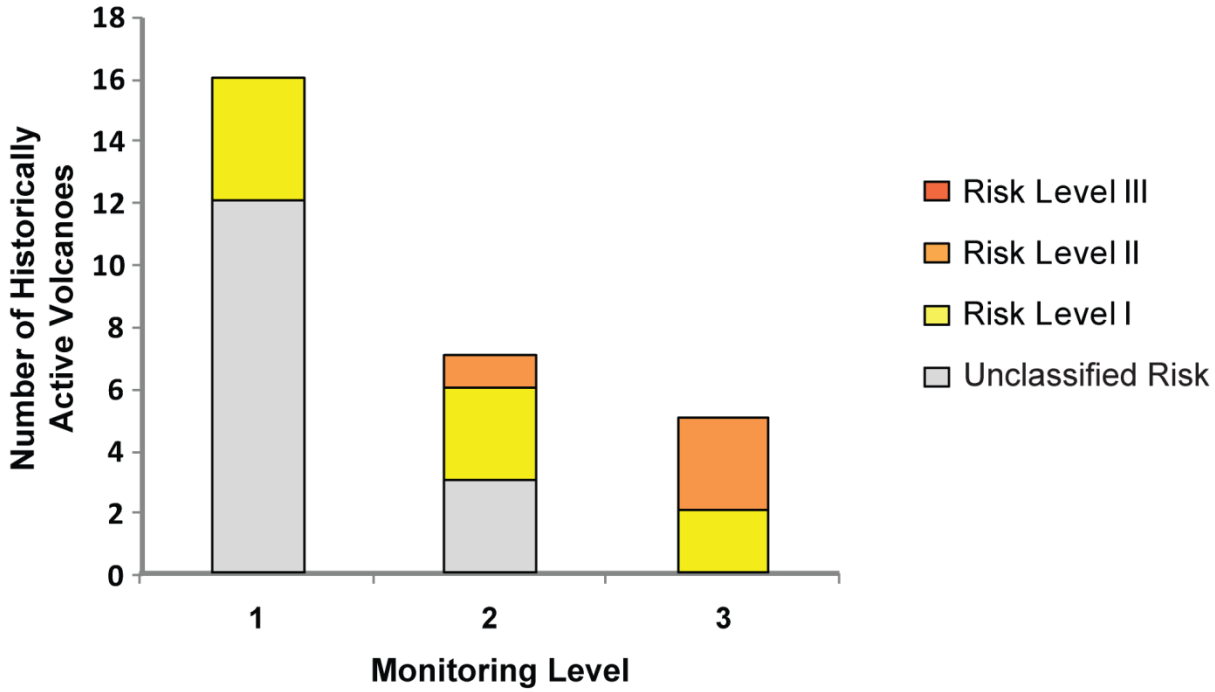

Figure 10.4 The monitoring and risk levels of the historically active volcanoes in the Kamchatka and Mainland Asia. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

China

Note that we include Hainan Dao, Leizhou Dao and Tengchong from Region 7 in this profile.

Description

Figure 10.5 Location of China'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 China.

Fourteen Holocene volcanoes are located in China, in three broad groups – one in the south, one in the west and one in the north-east. These volcanoes are related to intra-plate processes. All but the stratovolcano Changbaishan, on the border with the Democratic People's Republic of Korea (DPRK), are volcanic fields, and small pyroclastic and cinder cones. Changbaishan is Trachytic/andesitic, whilst the small cones are largely much more mafic, with basaltic compositions.

Twenty-two confirmed eruptions are recorded in China during the Holocene, from ten volcanoes. These measured VEI 2 to 7, indicating a range of activity from mild to very large explosive events. The largest Holocene eruption was that of Changbaishan in 1000 AD, which deposited tephra as far as Japan. This volcano also has a Pleistocene record of VEI 7 activity.

Four volcanoes have records of nine historical eruptions, measuring VEI 2 to 3 with over half of these being of unknown size. No historical eruptions are reported to have caused property damage or fatalities.

Throughout China about 380,000 people live within 10 km of a Holocene volcano, with over 23.4 million within 100 km of one or more volcanoes. As such, many of the volcanoes individually have very large local populations increasing the risk. Changbaishan has a moderate PEI, with about 30,000 within 30 km and over 1.6 million living within 100 km.

The China Seismological Bureau in the Institute of Geology monitor Changbaishan, Tenchong and Wudalianchi, the former two having experienced recent unrest. Due to the history of large explosive eruptions, monitoring is dominantly focussed at Changbaishan, where seismic, deformation and geochemical monitoring is undertaken. As this volcano borders the DPRK monitoring is undertaken separately across the border. The China Seismological Bureau is undertaking risk assessments, and currently grades Changbaishan at Risk Levels 3-4 (Potential risk to Conceivable threat), Tengchong as Risk level 3 (Potential risk) and Wudalianchi as Risk level 2 (no risk in the near future).

The Asian Disaster Reduction Center (ADRC) produced a report on Disaster Risk Reduction in China in 2012 however they do not consider volcanic hazards in this report. They describe the disaster management system in China, comprising a number of laws and the China National Committee for Disaster Reduction (NCDR) and the efforts of China to address the Hyogo Framework for Action. For full details of the disaster management system in China, see the ADRC report.

See also:

Hong, H. Et al., (2003) Volcano monitoring and risk assessing in China. IUGG 2013 abstract. www.jamstec.go.jp/jamstec-e/iugg/htm/abstract/abst/v11/016211-1.html

Institute of Geology, China Earthquake Administration: www.eq-igl.ac.cn/en/index.htm

ADRC China profile:
www.adrc.asia/nationinformation.php?NationCode=156&Lang=en&NationNum=22

Volcano Facts

Number of Holocene volcanoes	14, inclusive of one on the border with the DPRK
Number of Pleistocene volcanoes with M≥4 eruptions	1
Number of volcanoes generating pyroclastic flows	2
Number of volcanoes generating lahars	1
Number of volcanoes generating lava flows	3
Number of fatalities caused by volcanic eruptions	?15

Tectonic setting	Intra-plate
Largest recorded Pleistocene eruption	The M7 Oga eruption of Changbaishan at 448 ka.
Largest recorded Holocene eruption	The 950 BP Baegdusan-Tomakomai tephra eruption from Changbaishan on the border with the DPRK at M7.4.
Number of Holocene eruptions	22 confirmed eruptions. 4 uncertain eruptions and 1 discredited eruption.
Recorded Holocene VEI range	2 – 7 and Unknown
Number of historically active volcanoes	4
Number of historical eruptions	9

Number of volcanoes	Primary volcano type	Dominant rock type
1	Large cone(s)	Trachytic / Andesitic (1)
13	Small cone(s)	Basaltic (9), Phonolitic (1), Trachytic / Andesitic (1), Unknown (2)

Table 10.7 The number of volcanoes in China, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	1,376,569,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	7,418
Gross National Income (GNI) per capita (2005 PPP $)	7,945
Human Development Index (HDI) (2012)	0.699 (Medium)

Population Exposure

Capital city	Beijing
Distance from capital city to nearest Holocene volcano	336.6 km
Total population (2011)	1,336,718,015
Number (percentage) of people living within 10 km of a Holocene volcano	381,848 (<1%)
Number (percentage) of people living within 30 km of a Holocene volcano	2,745,202 (<1%)

Number (percentage) of people living within 100 km of a Holocene volcano	23,492,100 (1.8%)

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

Shanghai	14,608,512
Taipei	7,871,900
Beijing	7,480,601
Hong Kong	7,012,738
Wuhan	4,184,206
Chongqing	3,967,028
Chengdu	3,950,437
Tianjin	3,766,207
Shenyang	3,512,192
Harbin	3,229,883

Infrastructure Exposure

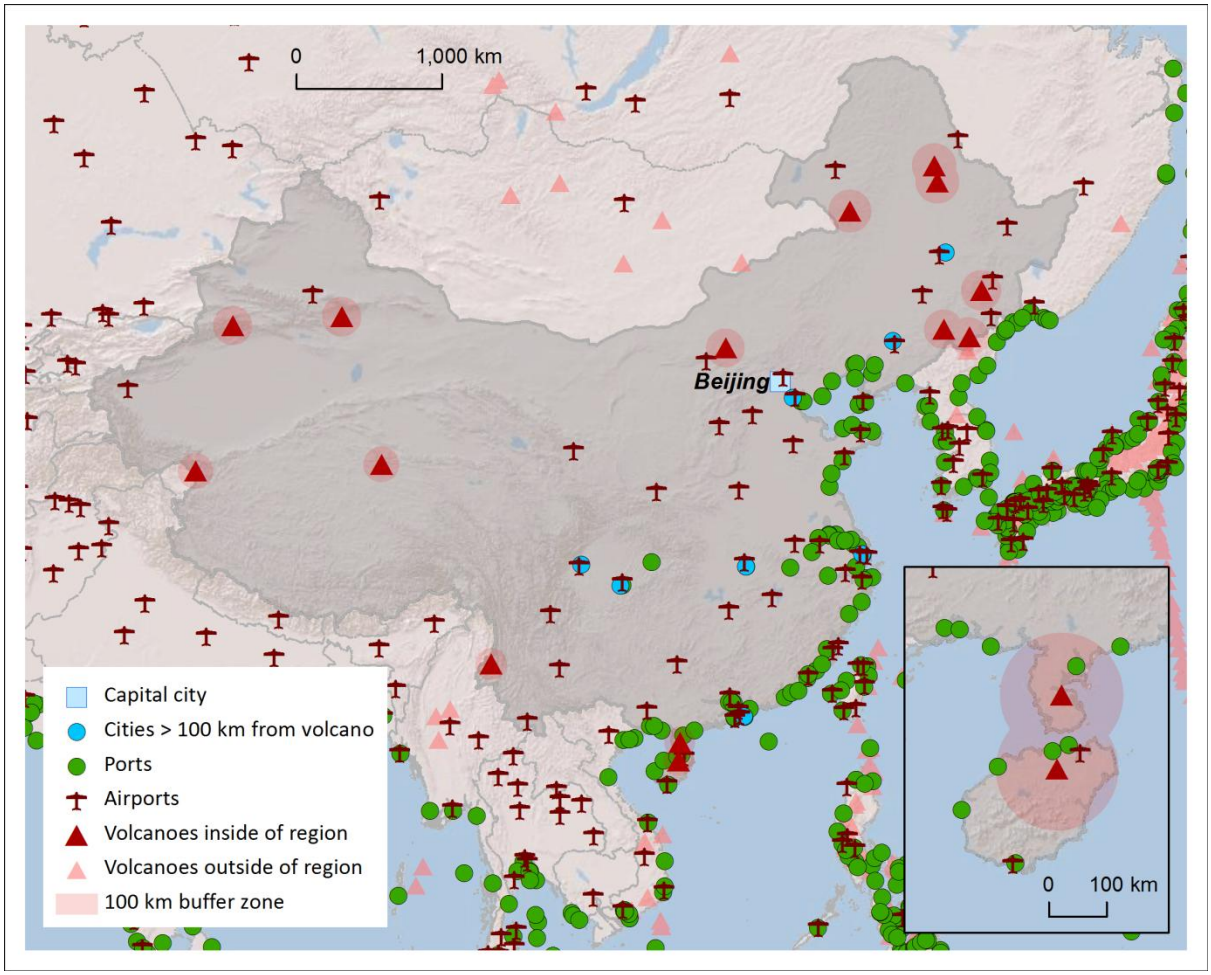

Figure 10.6 The location of China's volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Number of airports within 100 km of a volcano	1
Number of ports within 100 km of a volcano	4
Total length of roads within 100 km of a volcano (km)	12,059
Total length of railroads within 100 km of a volcano (km)	2,645

The volcanoes of China are widespread throughout the country. Those volcanoes in the west of the country are inland, away from the coast and ports, and distal to the largest cities in China which are concentrated in the east of the country. The Hainan Dao and Leizhou Bandao volcanoes in the south have ports and an airport within 100 km radius. Further airports are located in the radii of the northern volcanoes, though none of the ten largest cities are exposed. An extensive road and rail network falls within the radii. Some of the volcanoes here are located on the border with surrounding countries, with their 100 km radii extending into these countries including Myanmar, the DPRK, Mongolia and the Tibet Autonomous Region.

Hazard, Uncertainty and Exposure Assessments

The eruption record for the volcanoes in China are not sufficiently extensive or detailed to enable assessment of the hazard through the calculation of the VHI without large uncertainties, and these volcanoes are therefore unclassified. Out of the 22 confirmed Holocene eruptions here, only seven have a known VEI. Four volcanoes have a historical eruption record, two of which have erupted since 1900 AD – Kunlun Volcanic Group and Changbaishan. Changbaishan has a record of three Holocene eruptions of VEI ≥4, including a VEI 7 eruption in 1000 AD.

The PEI in China ranges from low to very high, with over half the volcanoes having PEI 5 – 7. The risk levels are unclassified as hazard is not known.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I							
UNCLASSIFIED	**U – HHR**		**Kunlun Volcanic Group**	**Changbaishan**		Wudalianchi		Hainan Dao
	U- HR		Tianshan Volcanic Group	Arshan		Turfan; Jingbo; Longgang Group	Tengchong	
	U-NHHR		Unnamed		Keluo Group	Honggeertu		Leizhou Bandao
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 10.8 Identity of China'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

Four Chinese volcanoes have historical records of eruptions. At the time of the writing of this report no information is available to indicate the presence of dedicated ground-based monitoring at Hainan Dao or Kunlun Volcanic Field. However, the Institute of Geology, China Seismological Bureau monitor three: Changbaishan using at least one permanent seismic station, deformation and gas measurements; Wudalianchi using seismic stations; and the Holocene age Tenchong using an integrated monitoring network.

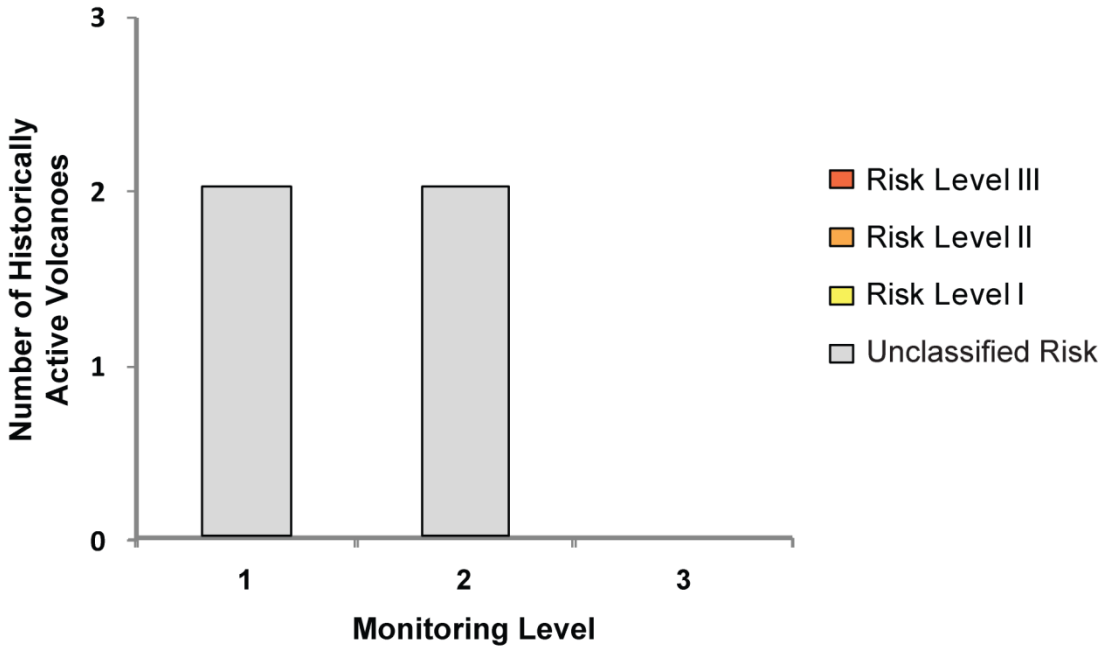

Figure 10.7 The monitoring and risk levels of the historically active volcanoes in China. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Democratic People's Republic of Korea (DPRK)

Description

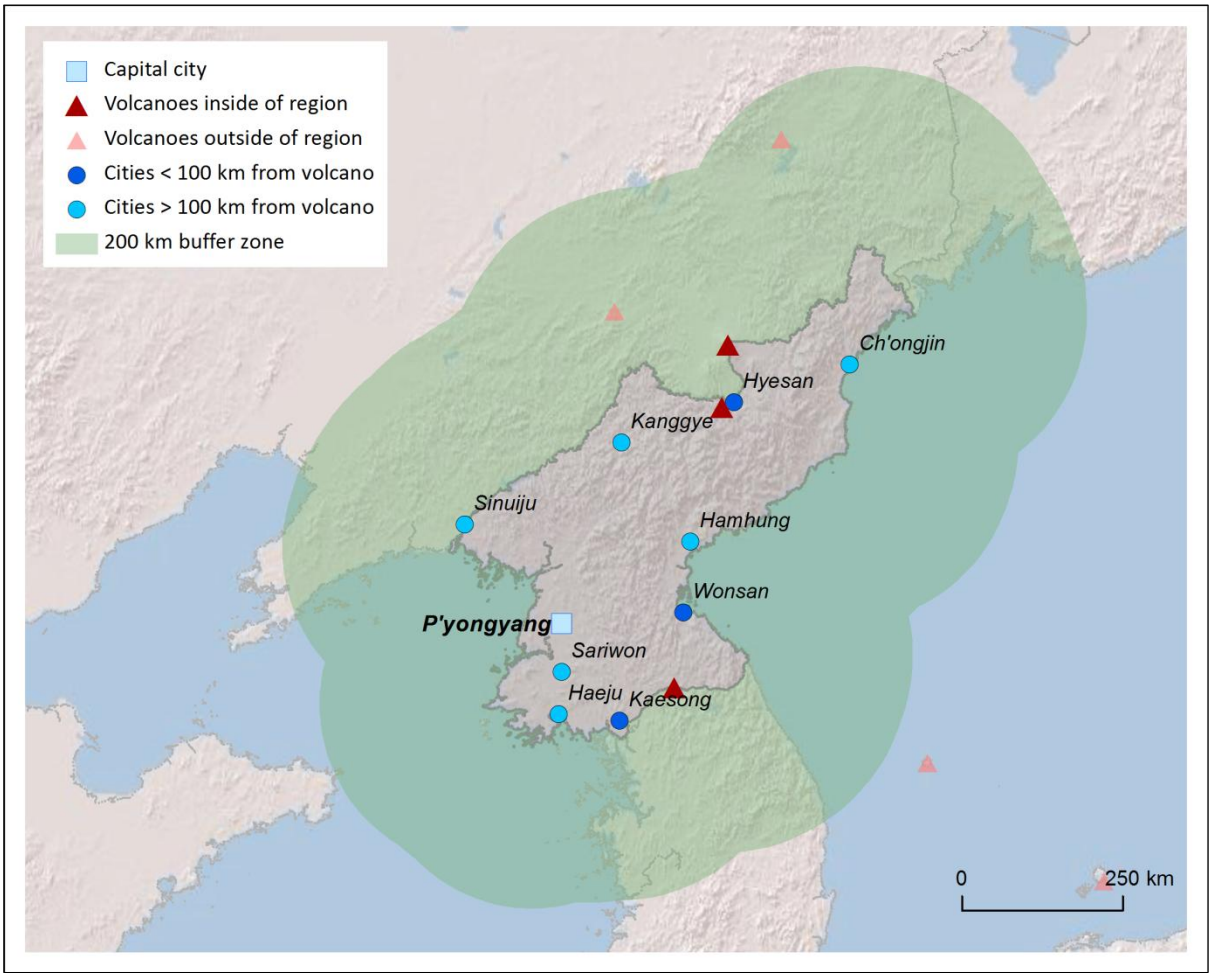

Figure 10.8 Location of the Democratic People's Republic of Korea's volcanoes, the capital and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect the DPRK.

Three Holocene volcanoes are recorded in the DPRK. One lies on the border with the Republic of Korea, whilst two others are located in the north of the country, on the border with China. These volcanoes are related to intra-plate processes, although this is not confirmed.

Changbaishan (the Chinese name for the volcano) is a large stratovolcano on the border with China. It is also known as Baektu, Paektu, Baegdu and Baitoushan, amongst other names. This is the only volcano in the DPRK to have a Holocene record of confirmed eruptions. The other two are suspected of having Holocene age activity.

Eight eruptions of VEI 2 to 7 are recorded at Changbaishan between 2160 BC and 1903. In 1000 AD the Millennium Eruption occurred. At VEI 7 this is one of the world's largest Holocene eruptions, depositing rhyolitic and trachytic tephra as far as northern Japan and forming the present caldera. This caldera, measuring 5 km wide and 850 m deep is now filled by Lake Tianchi.

The eruptive histories of volcanoes in the DPRK are limited, and further research is required to better understand volcanism in this country and the hazards posed.

The China Seismological Bureau has installed monitoring equipment on the China side of Changbaishan. In 2002 - 2005 this began to show seismic activity and deformation of the flanks. Following this, scientists in the DPRK reached out for international collaboration to install monitoring equipment in the DPRK to more fully understand the workings of the volcano. A network of seismometers has been installed in collaboration with scientists from the UK and US. Ongoing collaboration with scientists in the DPRK should permit further understanding of the volcanic processes here and will hopefully expand the DPRK's ability to monitor and research volcanic activity using techniques and research not otherwise easily accessible to them.

See also:

Stone, R. (2013) Sizing up a slumbering giant, *Science*, 6 September 2013: 1060 – 1061.

Volcano Facts

Number of Holocene volcanoes	3, inclusive of one on the border with China and one on the border with the Republic of Korea
Number of Pleistocene volcanoes with M≥4 eruptions	1
Number of volcanoes generating pyroclastic flows	1
Number of volcanoes generating lahars	1
Number of volcanoes generating lava flows	-
Number of fatalities caused by volcanic eruptions	-
Tectonic setting	Intra-plate
Largest recorded Pleistocene eruption	The M7 Oga eruption of Changbaishan at 448 ka.
Largest recorded Holocene eruption	The 950 BP Baegdusan-Tomakomai tephra eruption from Changbaishan on the border with China at M7.4.
Number of Holocene eruptions	8 confirmed eruptions. 5 uncertain eruptions.
Recorded Holocene VEI range	2 – 7 and unknown
Number of historically active volcanoes	1
Number of historical eruptions	4

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

Table 10.9 The number of volcanoes in the DPRK, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	24,763,000
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	Pyongyang
Distance from capital city to nearest Holocene volcano	157.2 km
Total population (2011)	24,457,492
Number (percentage) of people living within 10 km of a Holocene volcano	23,737 (<1%)
Number (percentage) of people living within 30 km of a Holocene volcano	406,248 (1.7%)
Number (percentage) of people living within 100 km of a Holocene volcano	2,430,099 (9.9%)

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

P'yongyang	3,222,000
Hamhung	559,056
Kaesong	338,155
Wonsan	329,207
Ch'ongjin	327,000
Sinuiju	288,112
Haeju	222,396
Kanggye	209,530
Sariwon	154,942
Hyesan	97,794

Infrastructure Exposure

Number of airports within 100 km of a volcano	0
Number of ports within 100 km of a volcano	1
Total length of roads within 100 km of a volcano (km)	4,147
Total length of railroads within 100 km of a volcano (km)	829

The volcanoes in the DPRK border China to the north and the Republic of Korea to the south, thus exposing parts of these countries to the volcanic hazard. Two of the largest cities in the DPRK are located within the 100 km radii – Kaesong and Hyesan, thus exposing an extensive road and rail network. Pyongyang lies at over 150 km from a Holocene volcano.

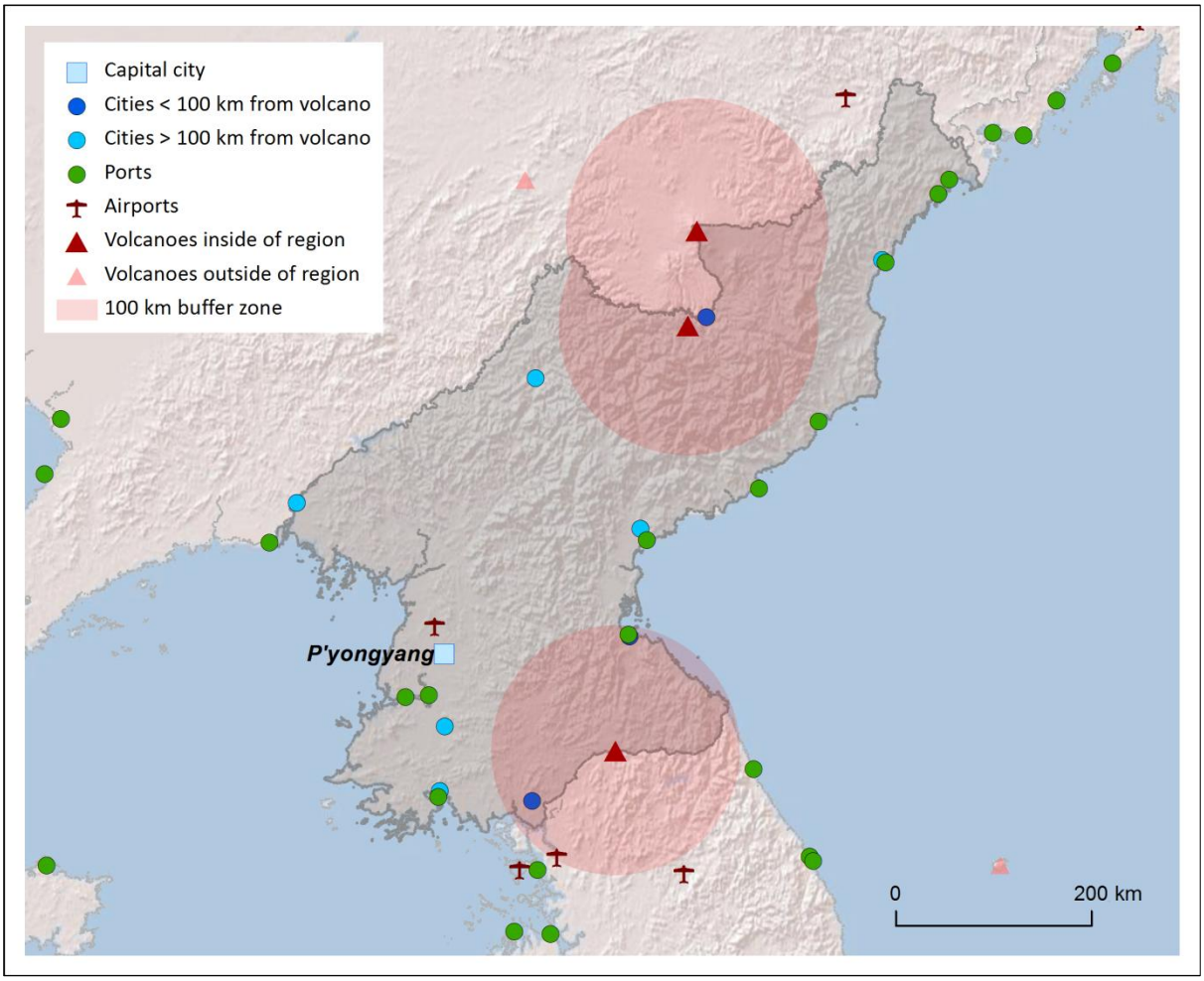

Figure 10.9 The location of the DPRK's volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

Only Changbaishan on the border between the DPRK and China has a Holocene eruption record here; Xianjindao and Ch'uga-ryong have no confirmed Holocene eruptions. Without a detailed eruption record, inclusive of eruption sizes, hazard assessment through the calculation of the VHI is not viable without large uncertainties. These volcanoes are therefore unclassified. Changbaishan, though unclassified, is known to have a record of large explosive eruptions, including two Holocene VEI 4 events and one VEI 7 eruption in 1000 AD. This volcano also has erupted, on a smaller scale, since 1900 AD.

Changbaishan has the lowest PEI in the DPRK, at a PEI of 3. Xianjindao and Ch'uga-ryong both have larger local populations.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I							
UNCLASSIFIED	**U – HHR**			**Changbaishan**				
	U- HR							
	U-NHHR				Xianjindao	Ch'uga-ryong		
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 10.10 Identity of DPRK'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

Only Changbaishan has a historical record of activity. This volcano is monitored on the China side of the border by the China Seismological Bureau using both permanent and mobile seismic stations and mobile deformation stations. In the DPRK, a seismic network comprising six seismic stations was installed and is monitored by scientists at Imperial College London and Cambridge University (UK) along with scientists in North Korea, in a collaborative effort that began in 2011.

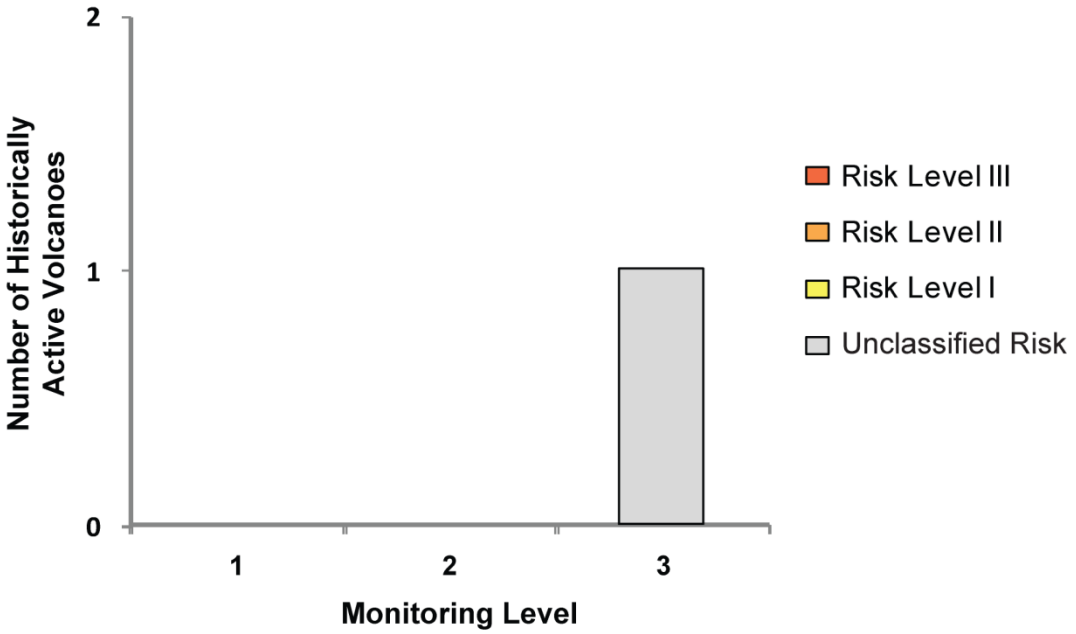

Figure 10.10 The monitoring and risk levels of the historically active volcanoes in the DPRK. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.

Mongolia

Description

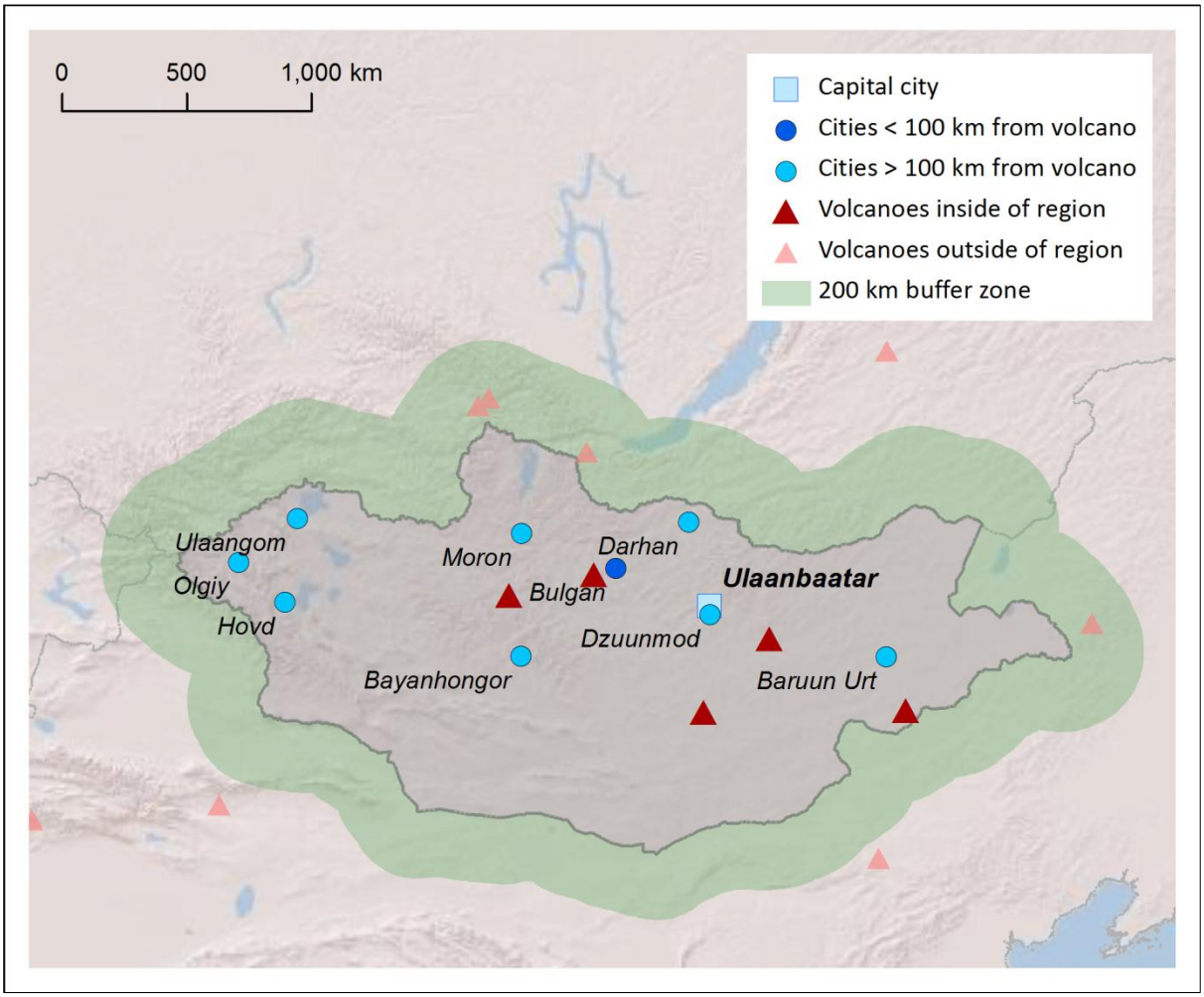

Figure 10.11 Location of Mongolia's volcanoes, the capital and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect Mongolia.

Five Holocene volcanoes are distributed throughout central to eastern Mongolia. These volcanoes are related to intra-plate processes. All volcanoes here are volcanic fields and cinder cones and are dominantly basaltic in composition.

Only one volcano, Taryatu-Chulutu, has an eruption recorded in the Holocene, however Holocene activity is suspected at the others. The eruption of Taryatu-Chulutu occurred in 2980 BC. The eruption size is unknown, however lava flows were produced at this time.

The absence of detailed eruption histories at Mongolia's volcanoes makes assessment of hazard difficult and therefore associated with large uncertainties. Although one of the largest cities in Mongolia, Bulgan, lies about 60 km from Khanuy Gol volcano, all the other volcanoes have moderate proximal population sizes.

The Asian Disaster Reduction Center (ADRC) have presented country reports on hazards in Mongolia since 1998. These do not consider volcanoes as it describes these as extinct. They describe the disaster management system in Mongolia and how the National Emergency Management Agency (NEMA) is "responsible for the implementation of the State disaster protection policy and legislation, as well as for the professional organization of nation wide activities". They also describe the structure of emergency response, numbers of emergency personnel and the activities within Mongolia towards addressing the Hyogo Framework for Action (HFA). See their report (given below) for full details.

See also:

NEMA: nema.gov.mn/

ADRC information on Disaster Risk Reduction of the Member Countries: Mongolia: www.adrc.asia/nationinformation.php?NationCode=496&Lang=en&NationNum=18

Volcano Facts

Number of Holocene volcanoes	5
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	Intra-plate
Largest recorded Pleistocene eruption	
Largest recorded Holocene eruption	The eruption has no known VEI.
Number of Holocene eruptions	1 confirmed eruption.
Recorded Holocene VEI range	Unknown
Number of historically active volcanoes	-
Number of historical eruptions	-

Number of volcanoes	Primary volcano type	Dominant rock type
5	Small cone(s)	Andesitic (1), Basaltic (4)

Table 10.11 The number of volcanoes in Mongolia, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	2,793,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	4,178
Gross National Income (GNI) per capita (2005 PPP $)	4,245
Human Development Index (HDI) (2012)	0.675 (Medium)

Population Exposure

Capital city	Ulan Bator
Distance from capital city to nearest Holocene volcano	185 km
Total population (2011)	3,133,318
Number (percentage) of people living within 10 km of a Holocene volcano	1,391 (<1%)
Number (percentage) of people living within 30 km of a Holocene volcano	13,413 (<1%)
Number (percentage) of people living within 100 km of a Holocene volcano	120,899 (3.9%)

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

Ulaanbaatar	844,818
Darhan	74,300
Olgiy	28,400
Ulaangom	28,085
Hovd	27,924
Moron	27,690
Bayanhongor	23,234
Dzuunmod	17,738
Bulgan	17,348
Baruun Urt	15,805

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)	2,041
Total length of railroads within 100 km of a volcano (km)	191

The Mongolian volcanoes are located through central Mongolia. The Dariganga Volcanic Field lies near the border with China, thus an area of China lies within the 100 km radius of this volcano. Part of eastern Mongolia lies within the radius of the Arshan volcano in north-western China. Being an inland country, no ports are exposed to the volcanic threat. One of the largest cities in Mongolia, Bulgan, lies within 100 km of the Khanuy Gol volcano, exposing the infrastructure here. However the capital, Ulaanbaatar, lies at nearly 200 km distance. A considerable road network is exposed in Mongolia.

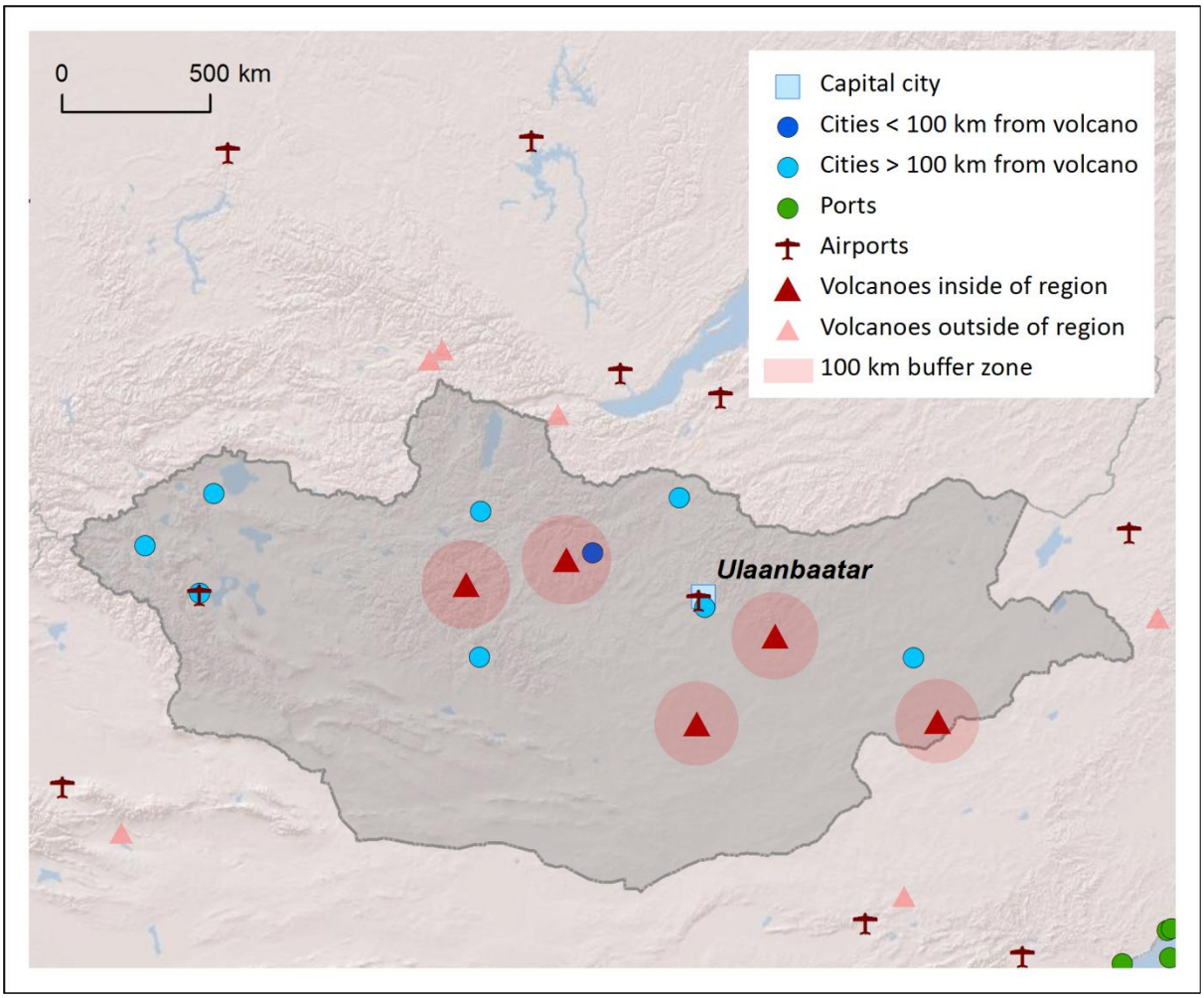

Figure 10.12 The location of Mongolia's volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

Of Mongolia's volcanoes, only Tayatu-Chulutu has a Holocene eruption record, and this comprises just one eruption of unknown size. The absence of extensive eruption histories prevents the assessment of hazard through the calculation of the VHI without large associated uncertainties. These volcanoes are therefore unclassified.

The PEI ranges from low to moderate, from PEI 2 – 4. The risk is unclassified with the absence of hazard information.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I							
UNCLASSIFIED	**U – HHR**							
	U- HR			Taryatu-Chulutu				
	U-NHHR		Bus-Obo	Khanuy Gol; Middle Gobi	Dariganga Volcanic Field			
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 10.12 Identity of Mongolia'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 Mongolia 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 Mongolia.

Republic of Korea

Description

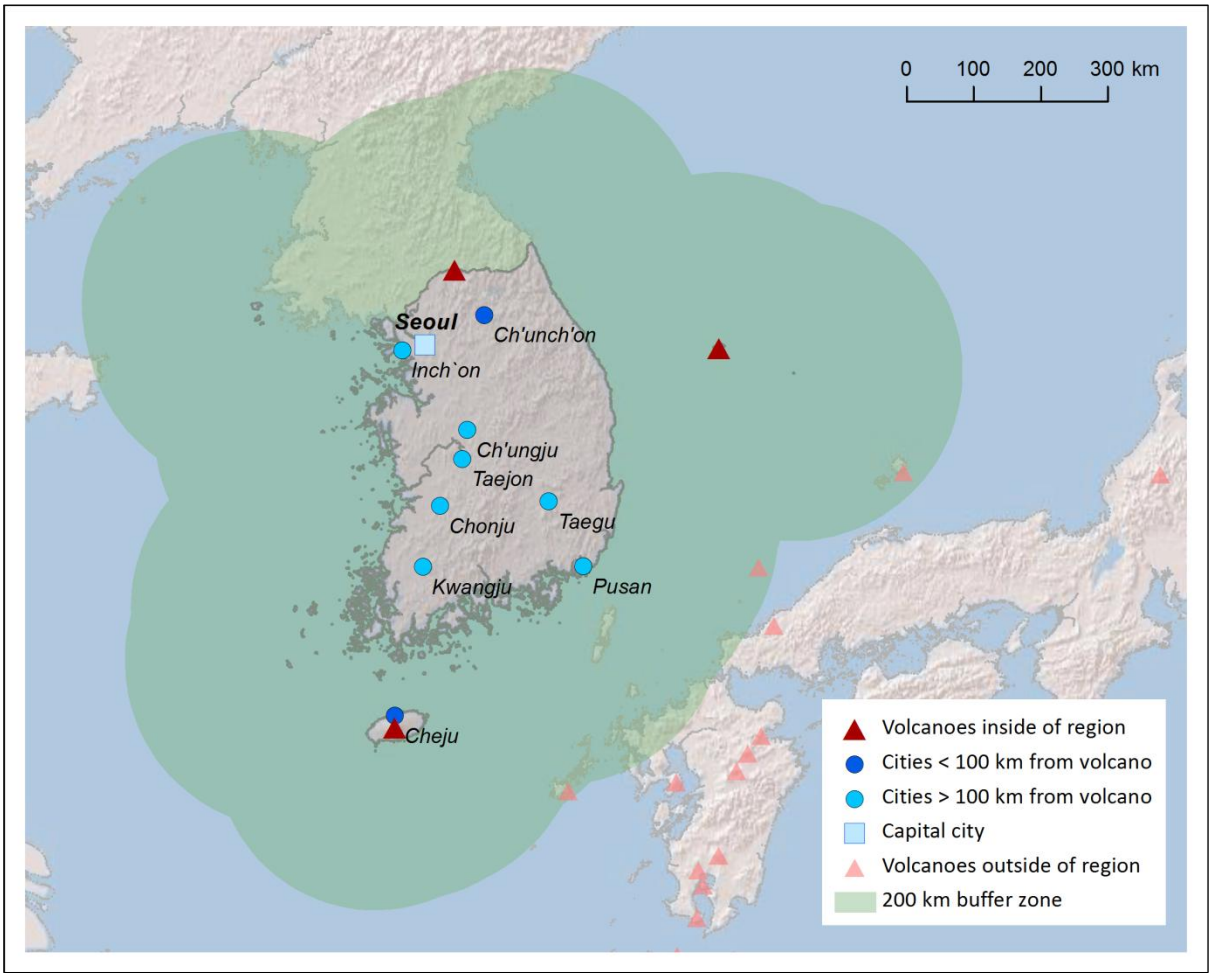

Figure 10.13 Location of the Republic of Korea's volcanoes, the capital and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect the Republic of Korea.

Three Holocene volcanoes are located in the Republic of Korea – Ch'uga-ryong (now called Chugaryeong) on the border with the DPRK, Ulreung (now called Ulleung) off the east coast and Mt. Halla (also called Hallasan, Jeju Island) off the south coast. Volcanism here is attributed to intra-plate processes. We use the older names as currently used in VOTW4.0 for this report.

Ch'uga-ryong and Halla are basaltic shields. Ulreung is more felsic, being a dominantly trachy-andesitic stratovolcano.

Only Ulreung and Mt. Halla have confirmed eruptions recorded during the Holocene, with several eruptions recorded between about 9300 - 6300 BP and 2700 BP. Only one of these eruptions has an attributed size, with the 8750 BC eruption of Ulreung being a VEI 6 eruption which produced pyroclastic flows and deposited ash in central Japan. No historical activity has been recorded, with the most recent activity being the 1002 AD and 1007 AD eruptions of Mt. Halla.

The absence of detailed eruptive histories for the volcanoes in the Republic of Korea, particularly with eruptions of unknown magnitudes, makes assessment of hazard difficult and associated with uncertainties. Both Ulreung and Halla form small populated islands, which are at particular risk due to the logistics of evacuating islands in a timely manner.

Monitoring of Mt. Halla is undertaken by the Jeju Volcanological Institute in collaboration with the Korea Institute of Geoscience and Mineral Resources (KIGAM) through the use of seismic and deformation instrumentation. This institute was founded in 2003 to undertake scientific research and monitoring. The personnel in this institute have some experience of responding to an eruption and have some resources and plans in place to respond to developing unrest and eruptions. Research into volcanic hazards is also ongoing focussed on the potential activity of Baekdusan (Mt. Baekdu, or Changbaishan in Chinese) in the neighbouring DPRK and the potential for the expansion of ash clouds from this volcano into the Republic of Korea.

The Asian Disaster Reduction Center (ADRC) produced a report on hazards in the Republic of Korea in 2008, with five previous versions dating back to 1998. In these they do not consider volcanic hazards. They describe the disaster management system in the country comprising the National Emergency Management Agency (NEMA), the National Disaster Management Institute and the National Institute for Disaster Prevention (NIDP). See the ADRC report for full details.

See also:

Jeju Island Geopark: geopark.jeju.go.kr/english/?mid=0101

Korea Institute of Geoscience and Mineral Resources: www.kigam.re.kr/english/index.asp

Asian Disaster Reduction Center: Republic of Korea: www.adrc.asia/nationinformation.php?NationCode=410&Lang=en&NationNum=21

Volcano Facts

Number of Holocene volcanoes	3, inclusive of one on the border with the DPRK
Number of Pleistocene volcanoes with M≥4 eruptions	1
Number of volcanoes generating pyroclastic flows	2
Number of volcanoes generating lahars	-
Number of volcanoes generating lava flows	1
Number of fatalities caused by volcanic eruptions	-
Tectonic setting	Intra-plate
Largest recorded Pleistocene eruption	The M6.7 Ulreung eruption of 10.7 ka would be the largest Pleistocene eruption recorded here, however as this is also

	included in the Holocene dataset, the M6 Yamato eruption of Ulreung at 42 ka will be considered the largest Pleistocene event.
Largest recorded Holocene eruption	The M6.7 eruption of Ulreung at 10.7 ka producing the Oki tephra is just outside of the Holocene but is included in the Holocene dataset of VOTW4.0.
Number of Holocene eruptions	7 confirmed eruptions.
Recorded Holocene VEI range	6 and Unknown
Number of historically active volcanoes	-
Number of historical eruptions	-

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

Table 10.13 The number of volcanoes in the Republic of Korea, their volcano type classification and dominant rock type according to VOTW4.0.

The shield volcano of Halla has more than 360 monogenetic cones, producing flank eruptions as recently as the 11th century.

Socio-Economic Facts

Total population (2012)	48,943,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	27,541
Gross National Income (GNI) per capita (2005 PPP $)	28,231
Human Development Index (HDI) (2012)	0.909 (Very High)

Population Exposure

Capital city	Seoul
Distance from capital city to nearest Holocene volcano	89.3 km
Total population (2011)	48,754,657

Number (percentage) of people living within 10 km of a Holocene volcano	3,400 (<1%)
Number (percentage) of people living within 30 km of a Holocene volcano	538,158 (1.1%)
Number (percentage) of people living within 100 km of a Holocene volcano	3,997,131 (8.2%)

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

Seoul	10,349,312
Busan (Pusan)	3,678,555
Incheon (Inch`on)	2,628,000
Daegu (Taegu)	2,566,540
Daejeon (Taejon)	1,475,221
Gwangju (Kwangju)	1,416,938
Jeonju (Chonju)	711,424
Cheongju (Ch'ungju)	634,596
Jeju (Cheju)	329,068
Chuncheon (Ch'unch'on)	209,746

Infrastructure Exposure

Number of airports within 100 km of a volcano	3
Number of ports within 100 km of a volcano	1
Total length of roads within 100 km of a volcano (km)	3,953
Total length of railroads within 100 km of a volcano (km)	175

Ulreung lies more than 100 km off the east coast of the Republic of Korea and is about 12 km across and thus the small settlements on the island lie entirely within the 100 km radius. Mt. Halla volcano lies off the coast to the south, exposing the island of Jeju Do (Cheju Do) in its entirety, as well as small islands closer to the mainland, with the 100 km radius extending to the southern tip of the mainland. Two airports and a port are exposed here. In the north, Ch'uga-ryong borders the DPRK, and the 100 km radius encompasses much of the northern Republic of Korea and southern DPRK. Seoul, the capital of the Republic of Korea, lies less than 90 km from this volcano, therefore considerable critical infrastructure is exposed.

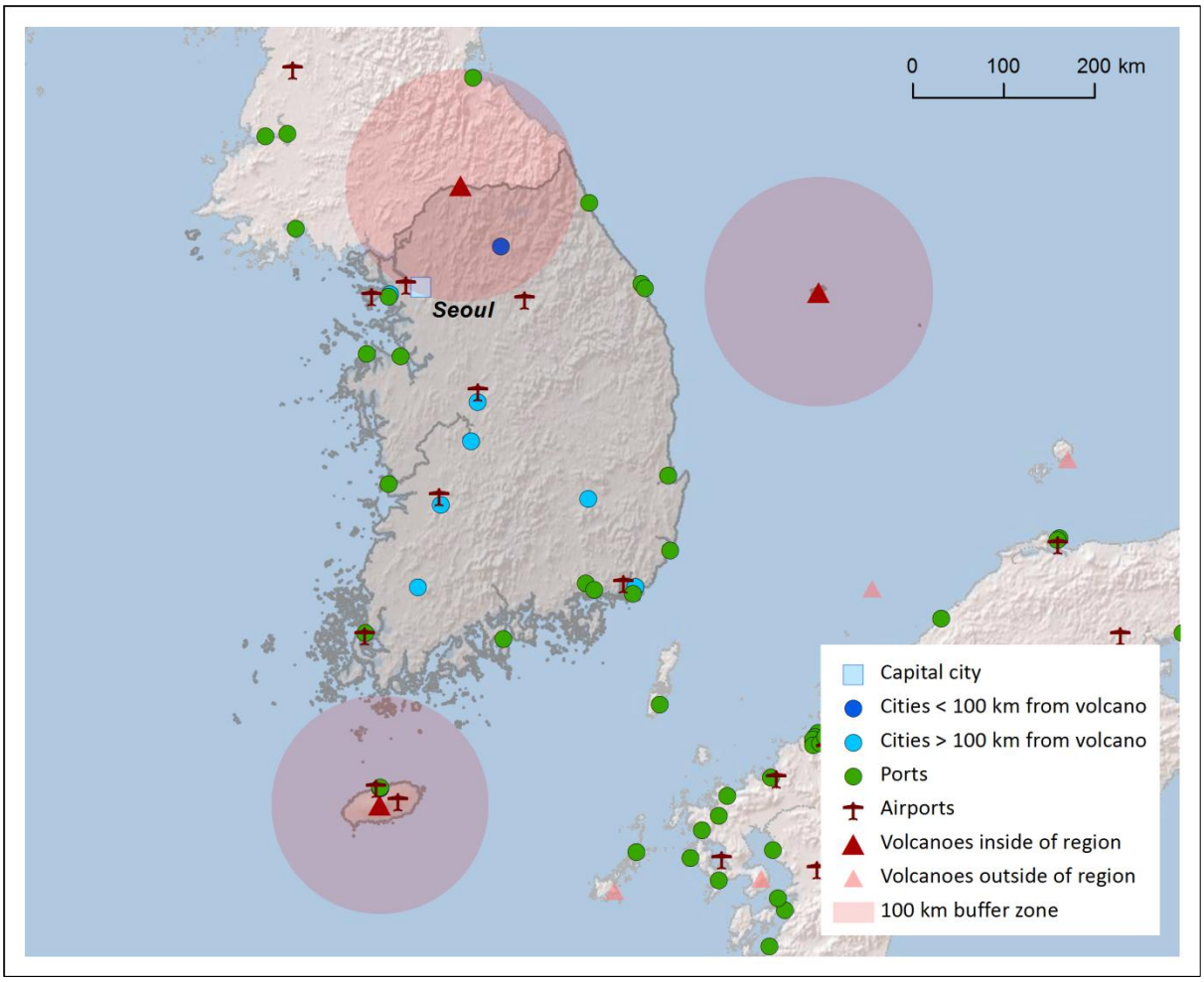

Figure 10.14 The location of the volcanoes in the Republic of Korea and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

The eruption records for the volcanoes in the Republic of Korea are not sufficiently extensive for hazard assessment through the calculation of the VHI without large associated uncertainties, with just one eruption having an attributed VEI here. These volcanoes are therefore unclassified. Ulreung and Halla have seven Holocene eruptions between them, however Ch'uga-ryong has no confirmed Holocene events.

The PEI is moderate to high in the Republic of Korea, ranging from 3 to 5. Risk levels are not classified here due to the absence of hazard information.

CLASSIFIED	**Hazard III**							
	Hazard II							
	Hazard I							
UNCLASSIFIED	**U – HHR**							
	U- HR			Ulreung	Halla			
	U- NHHR					Ch'uga-ryong		
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 10.14 Identity of the Republic of Korea'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 the Republic of Korea have recorded historical eruptions. However the Jeju Volcanological Institute operates two seismometers and deformation instrumentation at Mt. Halla volcano, which has a Holocene record of activity from the 11th Century.

Russia

Note that we include Elbrus volcano from Region 1 here. See Region 9 for description of the Kuril Islands and Russian volcanoes here.

Description

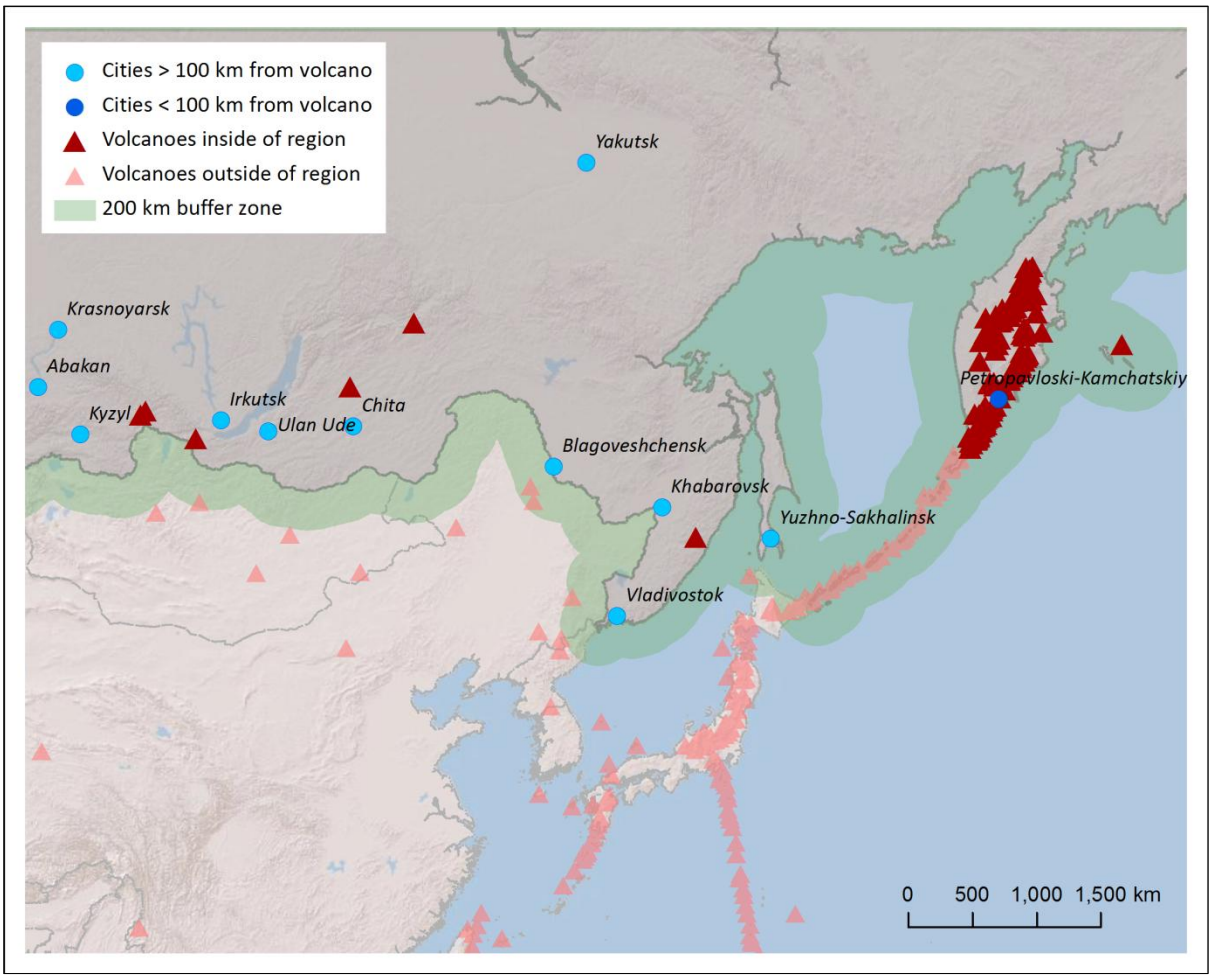

Figure 10.15 Location of Russia's volcanoes, the capital and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect Russia.

Volcanic activity in Russia is concentrated in the country's easternmost region on the Kamchatka peninsula and the Kurile island arc which stretches from Kamchatka in the north to Japan in the south. The activity arises due to the subduction of the Pacific Plate and forms part of the Pacific Ring of Fire. In addition, volcanism caused by tectonic rifting has occurred in the mainland part of Russia but is small and infrequent in comparison to the Kurile-Kamchatka volcanic arc. According to IVS volcano observatory, 3 to 5 volcanoes on the Kurile-Kamchatka arc are erupting on a daily basis.

Over half of the erupted material on the Kurile-Kamchatka volcanic arc is produced by the Central Kamchatka Depression on the Kamchatka peninsula. Here we find one of the largest volcanic centres in the world which includes the Klyuchevskoy volcano group and Sheveluch volcano. Frequent and

vigorous volcanic activity continues SSE along the Eastern Volcanic Belt which is 850 km long and 50 - 100 km wide.

Highly active volcanism in Kamchatka has been ongoing for the past 2 to 2.5 million years. Holocene activity has been dominated by formation of large and spectacular stratovolcanoes. The largest of them, Klyuchevskoy, reaches 4750 m a.s.l. and is the tallest volcano in Eurasia. The number of active volcanoes is 29, where active is defined as having erupted since the 17th century, although several additional volcanoes are included based on other evidence of activity.

Kurile island arc has both on-land and submarine volcanoes. Volcanoes on land include 37 active and potentially active volcanoes. The number of submarine volcanoes is estimated to be around 100. The largest recent eruption in the Kuriles was in 2009 at Sarychev volcano (VEI 4).

The volcanoes in this region are capable of producing large explosive eruptions with ash-rich plumes, pyroclastic flows, direct blasts and deposits of ballistic material. Long-duration effusive eruptions can produce extensive lava flows, such as demonstrated by the eruption of Plosky Tolbachik 2012 - 2013. However, due to the sparse population of the region, the greatest volcanic hazard is ash on aviation routes. The tectonic nature of the region may also cause large earthquakes.

In Kamchatka, populated centres are located at over 30 km distance from volcanic centres. There have been 3 casualties in 3 separate eruptions of Klyuchevskoy since 1960 where scientists were killed near the summit. The largest eruptions over the last century, such as Bezymianny in 1956 (eruption column of 40 km a.s.l. and directed blast of 25 - 30 km, VEI 5) have not caused casualties or significant damage to infrastructure.

Regular monitoring of Kamchatkan volcanoes began in 1935 when the Kamchatka Volcanological Station was founded in Kliuchi. This is now the Institute of Volcanology and Seismology (IVS). The Kamchatka Volcanic Eruption Response Team (KVERT) was established in 1993. KVERT is responsible for issuing alerts (including aviation colour codes) for Kamchatka and Northern Kurile volcanoes.

See also:

Kamchatka Volcanic Eruption Response Team (KVERT): www.kscnet.ru/ivs/kvert/index_eng.php

Institute of Volcanology and Seismology: www.kscnet.ru/ivs/eng/

Volcano Facts

Number of Holocene volcanoes	154
Number of Pleistocene volcanoes with M≥4 eruptions	20
Number of volcanoes generating pyroclastic flows	28
Number of volcanoes generating lahars	17
Number of volcanoes generating lava flows	54

Number of fatalities caused by volcanic eruptions	6
Tectonic setting	147 subduction zone, 2 intra-plate, 4 rift-zone, 1 unknown.
Largest recorded Pleistocene eruption	The M7.6 eruption of the Golygin Ignimbrite from Diky Greben at 443 ka.
Largest recorded Holocene eruption	The KO eruption of Kurile Lake, at M7.2 in 8387 BP.
Number of Holocene eruptions	891 confirmed eruptions. 32 uncertain eruptions and 8 discredited eruptions.
Recorded Holocene VEI range	0 – 7 and unknown
Number of historically active volcanoes	25
Number of historical eruptions	330

Number of volcanoes	Primary volcano type	Dominant rock type
10	Caldera(s)	Andesitic (5), Basaltic (4), Dacitic (1)
71	Large cone(s)	Andesitic (36), Basaltic (31), Dacitic (3), Unknown (1)
4	Lava dome(s)	Andesitic (1), Basaltic (2), Dacitic (1)
44	Shield(s)	Andesitic (2), Basaltic (42)
20	Small cone(s)	Andesitic (4), Basaltic (13), Unknown (3)
5	Submarine	Dacitic (1), Unknown (4)

Table 10.15 The number of volcanoes in Russia, their volcano type classification and dominant rock type according to VOTW4.0.

Socio-Economic Facts

Total population (2012)	143,021,000
Gross Domestic Product (GDP) per capita (2005 PPP $)	14,808
Gross National Income (GNI) per capita (2005 PPP $)	14,461
Human Development Index (HDI) (2012)	0.788 (High)

Population Exposure

Capital city	Moscow

Distance from capital city to nearest Holocene volcano	1423.5 km
Total population (2011)	138,739,892
Number (percentage) of people living within 10 km of a Holocene volcano	4,718 (<1%)
Number (percentage) of people living within 30 km of a Holocene volcano	84,639 (<1%)
Number (percentage) of people living within 100 km of a Holocene volcano	2,369,815 (1.7%)

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

Moscow	10,381,222
Novosibirsk	1,419,007
Ekaterinburg	1,287,573
Nizny Novgorod	1,284,164
Samara	1,134,730
Omsk	1,129,281
Kazan'	1,104,738
Rostov-on-Don	1,074,482
Chelyabinsk	1,062,919
Ufa	1,033,338

Infrastructure Exposure

Number of airports within 100 km of a volcano	1
Number of ports within 100 km of a volcano	2
Total length of roads within 100 km of a volcano (km)	3,042
Total length of railroads within 100 km of a volcano (km)	863

Volcanoes in Russia are distributed between two main groups: those on the Kamchatka Peninsula and those inland, north of Mongolia. Volcanoes in the Kuril Islands are discussed in the separate Kuril Island profile. The concentration of volcanoes in the Kamchatka Peninsula means this is exposed in its entirety, however being sparsely populated the exposed population is small. This does however mean that all critical infrastructure here is exposed, including that in the largest city, Petropavlovsk-Kamchatsky.

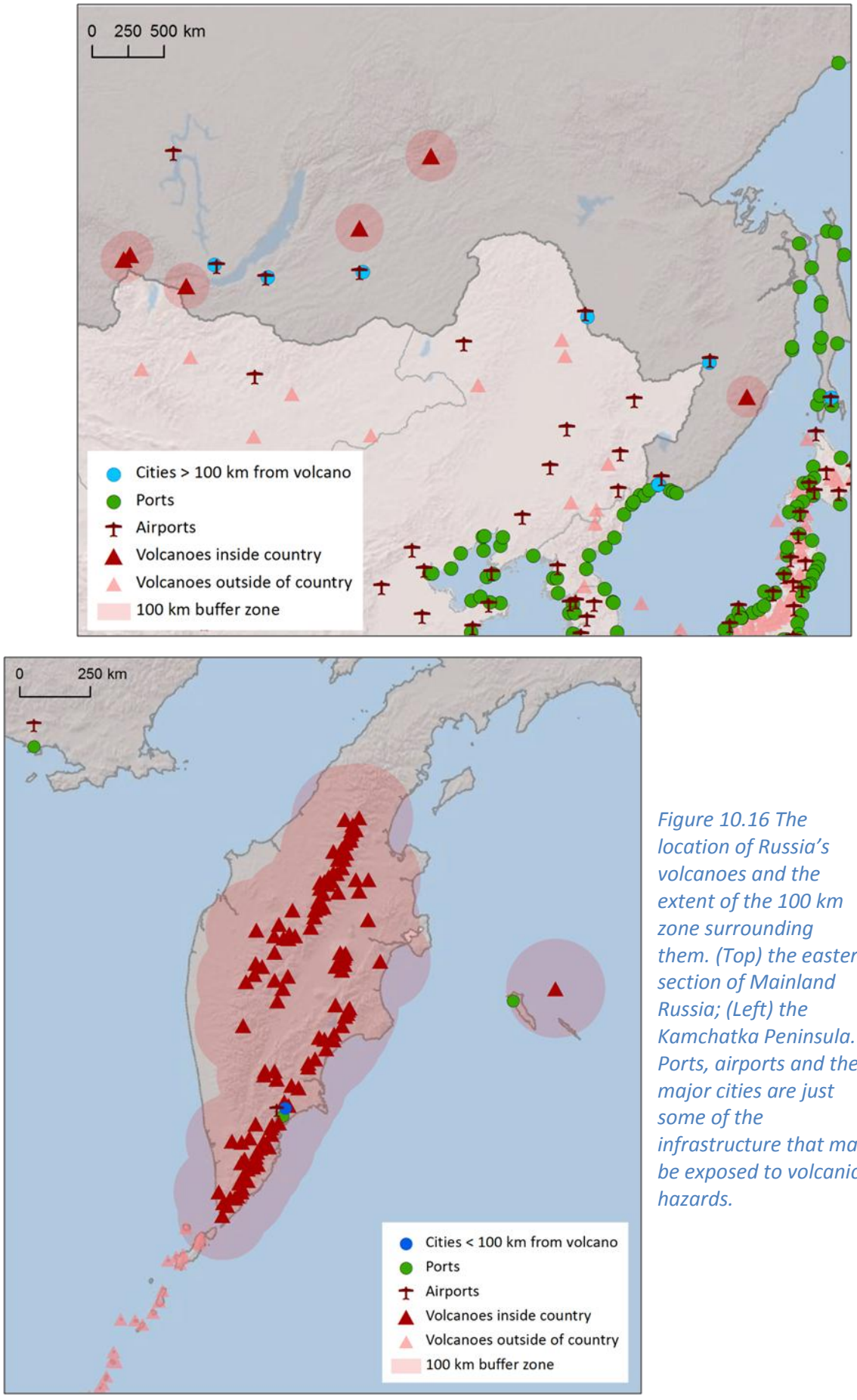

Figure 10.16 The location of Russia's volcanoes and the extent of the 100 km zone surrounding them. (Top) the eastern section of Mainland Russia; (Left) the Kamchatka Peninsula. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

The volcanoes of Russia have varying levels of data available in the eruption record. Just 12% of volcanoes have appropriate eruptive histories to define the hazard. These volcanoes are classified across all three hazard levels, and all but three have erupted since 1900 AD. Of the classified volcanoes, just Kostakan has no historical record.

Most volcanoes in Russia lack a sufficiently extensive eruption record to determine the hazard through calculation of the VHI without large associated uncertainties, and these are therefore unclassified. Indeed, 61 of these volcanoes have no confirmed eruptions during the Holocene. Of these, one, Asacha, has experienced unrest since 1900 AD. Of the remaining unclassified volcanoes with Holocene eruptions, 12 have records of historical activity, including eruptions since 1900 AD at six volcanoes. Thirteen of the unclassified volcanoes have Holocene records of large explosive VEI ≥4 eruptions.

Most volcanoes in Russia have a low local population, categorising these as PEI 2 volcanoes. In combination with the hazard levels this makes most classified volcanoes Risk Level I with just four classed at Risk Level II.

Volcano	Population Exposure Index	Risk Level
Avachinsky	3	II
Koryaksky	3	II
Bezymianny	2	II
Shiveluch	2	II
Gorely	2	I
Karymsky	2	I
Kikhpinych	2	I
Kliuchevskoi	2	I
Kostakan	2	I
Krasheninnikov	2	I
Maly Semiachik	2	I
Mutnovsky	2	I
Tolbachik	2	I
Zhupanovsky	2	I

Table 10.16 Classified volcanoes of Russia ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given. Risk Level I – 10 volcanoes; Risk Level II – 4 volcanoes; Risk Level III – 0 volcanoes.

CLASSIFIED	**Hazard III**		Bezymianny; Shiveluch	Koryaksky; Avachinsky				
	Hazard II		Karymsky; Maly Semiachik; Kikhpinych; Krasheninnikov; Tolbachik; Kliuchevskoi					
	Hazard I		Mutnovsky; Gorely; Zhupanovsky; Kostakan					
UNCLASSIFIED	**U – HHR**		Koshelev; **Ilyinsky**; **Zheltovsky**; **Ksudach**; Opala; **Akademia Nauk**; **Kronotsky**; **Kizimen**; Ushkovsky; Khangar; **Ichinsky**; Alney-Chashakondzha					
	U- HR		Kambalny; Yavinsky; Diky Greben; Kurile Lake; Khodutka; Tolmachev Dol; Vilyuchik; Barkhatnaya Sopka; Veer; Bakening; Zavaritsky; Bolshoi Semiachik; Taunshits; **Uzon**; Gamchen; Komarov; Vysoky; Piip; Cherpuk Group; Bolshoi-Kekuknaysky; Shisheika; Terpuk; Sedankinsky; Gorny Institute; Kinenin; Bliznetsy; Titila; Elovsky; Nylgimelkin; Spokoiny; Ostry; Severny; Udokan Plateau					
	U-NHHR		Mashkovtsev; Kell; Belenkaya; Ozernoy; Olkoviy Volcanic Group; Plosky; Piratkovsky; Ostanets; Otdelniy; Golaya; **Asacha**; Visokiy; Unnamed; Bely; Bolshe-Bannaya; Dzenzursky; Schmidt; Unnamed; Udina; Zimina; Kamen; Maly Payalpan; Bolshoi Payalpan; Akhtang; Kozyrevsky; Romanovka; Uksichan; Kulkev; Geodesistoy; Anaun; Krainy; Kekurny; Eggella; Cherny; Unnamed; Verkhovoy; Pogranychny; Zaozerny; Bliznets; Kebeney; Uka; Fedotych; Leutongey; Tuzovsky; Mezhdusopochny; Shishel; Alngey; Kaileney; Plosky; Snezhniy; Iktunup; Snegovoy; Iettunup; Voyampolsky; Vitim Plateau; Tunkin Depression; Oka Plateau; Azas Plateau			Unnamed; Unnamed; Sikhote-Alin		
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 10.17 Identity of Russia'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.*

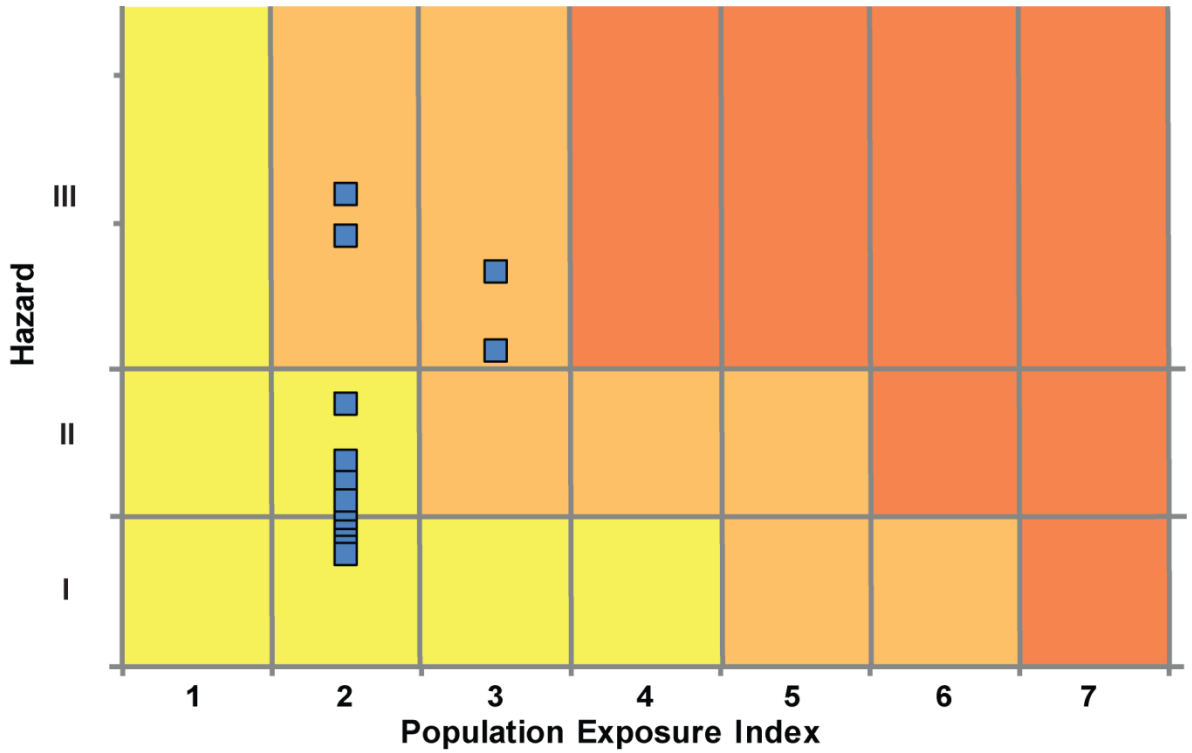

Figure 10.17 Distribution of Russia's classified volcanoes across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

The Institute of Volcanology and Seismology (IVS FEB RAS) and Kamchatka Volcanic Eruption Response Team (KVERT) are responsible for monitoring volcanoes and providing aviation alerts. Twenty-five Russian volcanoes are recorded as having historical activity. Of these fourteen have no continuous monitoring. The remaining have dedicated seismic monitoring, from three or fewer stations at five volcanoes, to networks of seven or more stations. At least three volcanoes have additional deformation monitoring (Karymsky, Kliuchevskoi and Bezymianny).

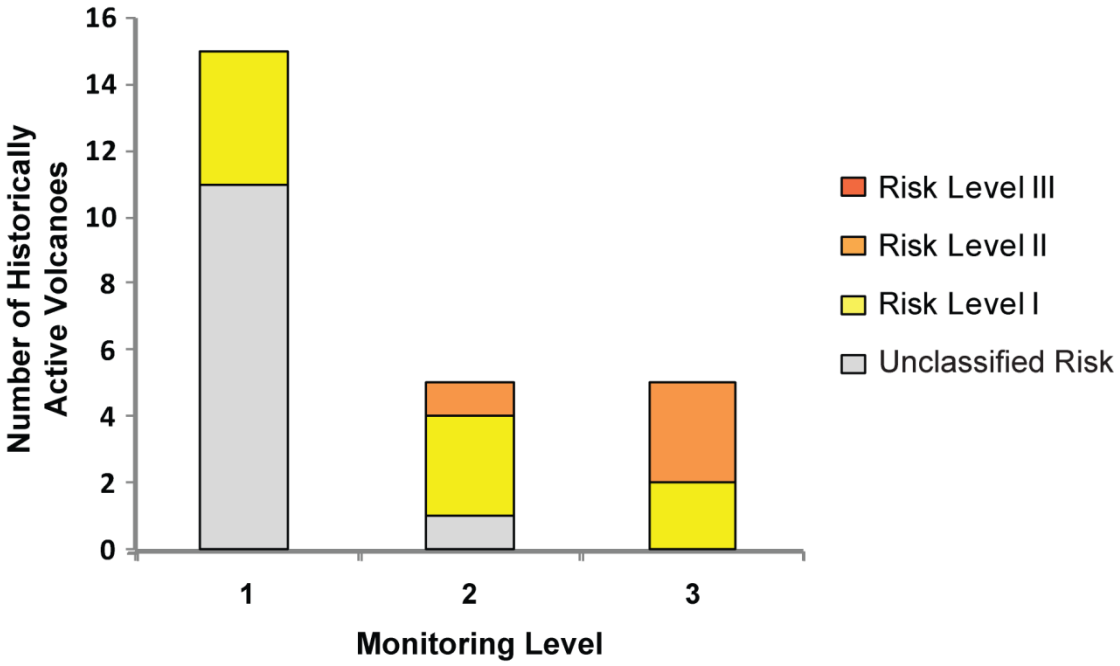

Figure 10.18 The monitoring and risk levels of the historically active volcanoes in Russia. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.