Appendix B – Region 11

Country and regional profiles of volcanic hazard and risk:

Alaska

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This download comprises the profiles for Region 11: Alaska 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 11: Alaska

Here volcanism in the U.S. state of Alaska is discussed. See Region 4 for American Samoa, Region 8 for the U.S. Marianas Islands, Region 12 for the contiguous states of the U.S.A. and Region 13 for Hawaii.

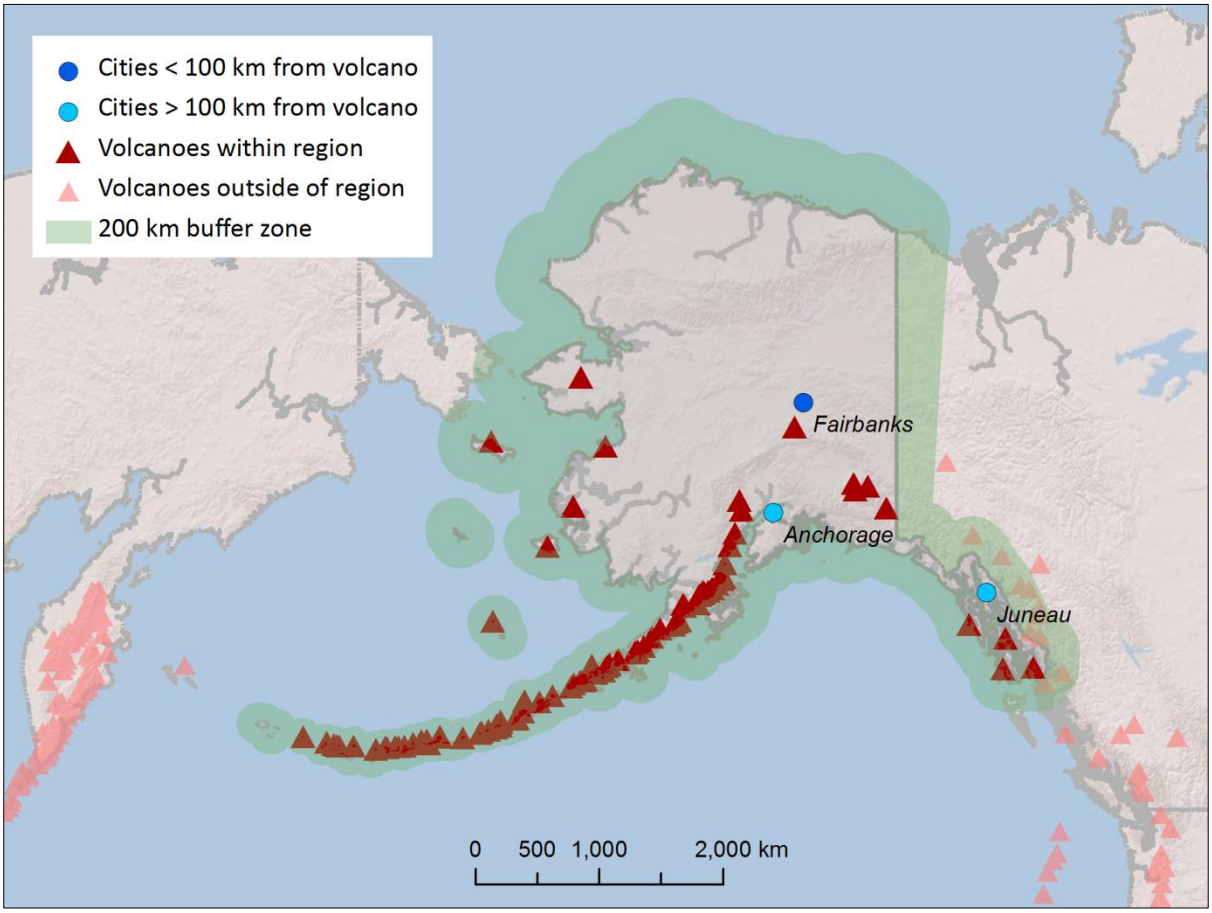

Figure 11.1 Location of Alaska's volcanoes, the capital and largest cities. A zone extending 200 km beyond the country's borders shows other volcanoes whose eruptions may directly affect Alaska

Description

This region comprises the American state of Alaska and the Aleutian Islands. Ninety-two Holocene volcanoes are located here, dominantly through the 2,500 km Aleutian Arc, which extends towards Kamchatka forming the northern section of the Ring of Fire. Further volcanoes are situated in the interior of Alaska, south on the border with Canada and to the most northerly of Alaska's volcanoes – Imuruk Lake on the Seward Peninsula. Volcanism in Alaska and the Aleutians is dominantly due to the subduction of the Pacific Plate beneath the North American Plate, however eleven volcanoes are due to intra-plate processes. Volcanoes of Alaska are dominantly andesitic in composition and most are stratovolcanoes.

During the Holocene 526 eruptions of VEI 0 – 6 are recorded in Alaska from 59 volcanoes. The remaining volcanoes are suspected of having eruptions of Holocene age. 44 of these volcanoes have

records of 333 historical eruptions, of which 13 were large explosive eruptions of VEI 4 to 6. The VEI 6 1912 eruption of Katmai/Novarupta was the largest in the 20th Century anywhere in the world, producing voluminous air fall and ash flow. With a record of such explosive events, many have produced pyroclastic flows and lahars, yet due to the sparse population in Alaska only three eruptions have resulted in fatalities. Indeed, fewer than 20,000 people live within 30 km of volcanoes throughout the state.

The Alaska Volcano Observatory (AVO) list Akutan, Pavlof and Shishaldin as the most frequently active volcanoes historically, though emphasise that even today, there may not be a complete catalogue of activity as many of Alaska's volcanoes are remote and visual observations may be hampered by inclement weather. The historic records indicate about 2 eruptions per year here.

The AVO monitors volcanoes throughout Alaska and is a partnership of the U.S. Geological Survey, the Geophysical Institute of the University of Alaska Fairbanks and the Alaska Division of Geological and Geophysical Surveys. The AVO was set up in 1988 to monitor and study volcanism in Alaska. The AVO relies on federal, state and university resources.

The volcanoes in Alaska are potentially hazardous to aircraft, with more than 80,000 large aircraft per year over and possibly downwind of volcanoes here (Schaefer and Nye, 2008). A passenger aircraft with 231 people on board lost all power after encountering the ash cloud from Redoubt Volcano in 1989. Fortunately, the engines restarted after free-falling about 3,000 metres (Casadevall, 1994 in Schaefer and Nye, 2008). Schaefer and Nye (2008) describe eruptions here during 1989 to 1990 as the second-most costly eruptions in the history of the United States, having impacted on the aviation and oil industries. The AVO notifies the public and Volcanic Ash Advisory Centres (VAAC's) of Volcano Alert Levels (Normal, Advisory, Watch, and Warning), and separate Aviation Color Codes are issued – Green to Red. See Chapter 14.

The AVO conducts monitoring activities and scientific research, produces hazard assessments and is involved in hazard mitigation. Monitoring activities are widespread, with networks of seismometers and deformation instrumentation, in addition to satellite observations and deployment of other monitoring systems. About 30 volcanoes are monitored in Alaska and the Aleutians, including eighteen historically active volcanoes which have regular dedicated ground-based monitoring systems in place.

In the event of unrest or eruption, the AVO informs the public and emergency managers. The AVO communicates activity information to the Federal Aviation Administration, the National Weather Service, local military, civil authorities and the Alaska Department of Emergency Services and the Governor's Office of the State of Alaska. Information is released in line with the NVEWS method: VAN (Volcano Activity Notice) are important announcements of volcanic activity, change in activity, aviation colour code or alert levels; VONA (Volcano Observatory Notice for Aviation) focuses on ash cloud hazards; Daily Status Reports provide short statements on the activity of volcanoes at an elevated alert level; Weekly Summaries describe the week's activity and activity status of monitored volcanoes; and Information Statements provide further information on a variety of background topics.

See also:

Shaefer, J. and Nye, C. (2008) Monitoring the Active Volcanoes of Alaska, Alaska GeoSurvey News, Vol. II., No. 1. www.avo.alaska.edu/pdfs/cit4443.pdf

Alaska Volcano Observatory website: www.avo.alaska.edu/volcanoes/about.php

Volcano facts

Number of Holocene volcanoes	92
Number of Pleistocene volcanoes with M≥4 eruptions	7
Number of volcanoes generating pyroclastic flows	40
Number of volcanoes generating lahars	41
Number of volcanoes generating lava flows	90
Number of eruptions with fatalities	3
Number of fatalities attributed to eruptions	4
Tectonic setting	81 subduction zone, 11 intra-plate
Largest recorded Pleistocene eruption	The Old Crow Tephra eruption of Emmons Lake in Alaska is the largest Quaternary eruption recorded at M7.5. This eruption occurred at 96 ka.
Largest recorded Holocene eruption	Nine VEI 6 eruptions are recorded during the Holocene, with the most recent at Novarupta in 1912 AD.
Number of Holocene eruptions	526 confirmed Holocene eruptions.
Recorded Holocene VEI range	0 – 6 and unknown
Number of historically active volcanoes	44
Number of historical eruptions	333

Number of volcanoes	Primary volcano type	Dominant rock type
3	Caldera(s)	Andesitic (2), Rhyolitic (1)
67	Large cone(s)	Andesitic (43), Basaltic (13), Dacitic (3), Rhyolitic (2), Unknown (6)
3	Lava dome(s)	Andesitic (1), Dacitic (1), Unknown (1)
9	Shield(s)	Andesitic (3), Basaltic (6)
9	Small cone(s)	Andesitic (2), Basaltic (7)
1	Submarine	Andesitic (1)

Table 11.1 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)	30

Table 11.2 Average recurrence interval (years between eruptions) for small and large eruptions in Alaska.

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 30 years.

Eruption Size

Eruptions are recorded throughout Alaska and the Aleutian Islands of VEI 0 to 6, representing a range of eruption styles from mild events to large explosive eruptions. VEI 2 events dominate the record, with about 45% of all Holocene eruptions of a known size classed as such, and nearly 90% are small to moderate at VEI 0 to 3. Over 11% of eruptions are large explosive events at VEI ≥4.

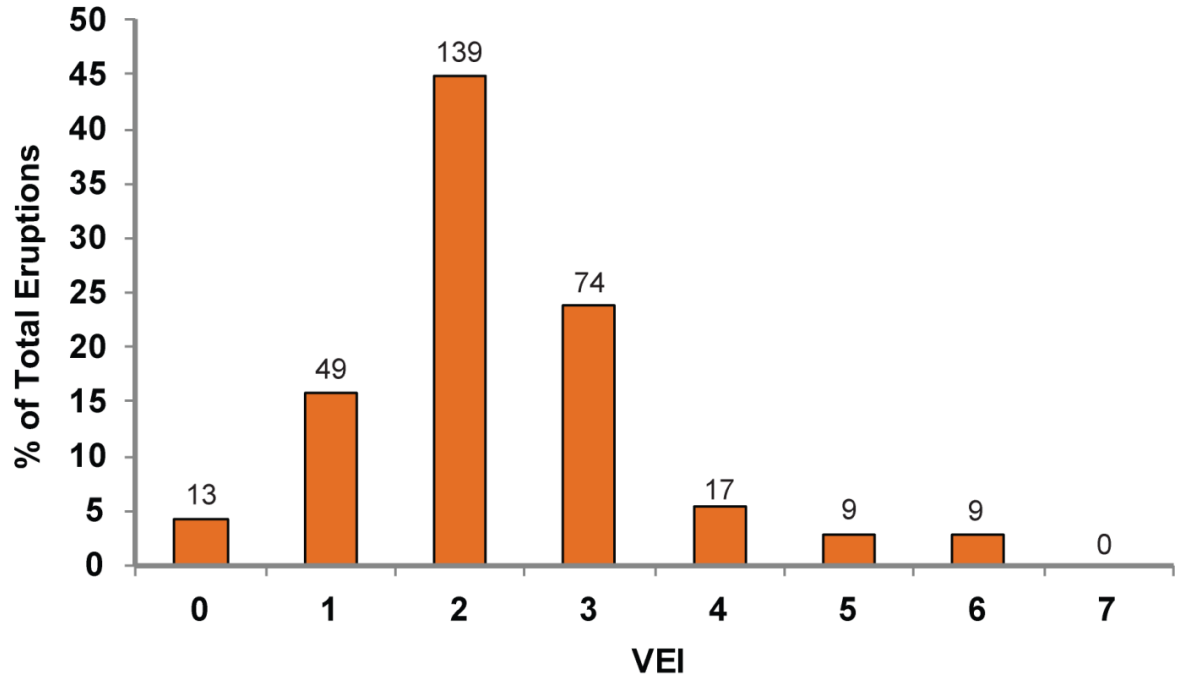

Figure 11.2 Percentage of eruptions in this region recorded at each VEI level; the number of eruptions is also shown. The percentage is of total eruptions with recorded VEI (310 events). A further 216 eruptions were recorded with unknown VEI.

Population Exposure

Capital city (of the State)	Juneau
Distance from capital city to nearest Holocene volcano	161 km
Total Population (2013)	735,132 (US Census Bureau)
Number (percentage) of people living within 10 km of a Holocene volcano	<2,000
Number (percentage of people living within 30 km of a Holocene volcano	<20,000
Number (percentage of people living within 100 km of a Holocene volcano	<230,000

Largest cities as measured by population and their population size (from 2010 United States Census):

Anchorage	291,826
Fairbanks	31,535
Juneau	30,711

Infrastructure exposure

Number of airports within 100 km of a volcano	6
Number of ports within 100 km of a volcano	80
Total length of roads within 100 km of a volcano (km)	6,431
Total length of railroads within 100 km of a volcano (km)	0

The volcanoes of Alaska and the Aleutian Islands are concentrated in the south and west of Alaska. Of the largest cities, only Fairbanks lies within 100 km of a volcano (Buzzard Creek), while the capital, Juneau, lies over 160 km away from a Holocene volcano. With the volcanoes primarily located on islands and along the coastline of southern Alaska, 80 ports are situated within 100 km of these. Six airports and an extensive road network also lie within 100 km of Alaskan volcanoes, and numerous small settlements, with no towns besides the three largest described here having a population higher than 10,000.

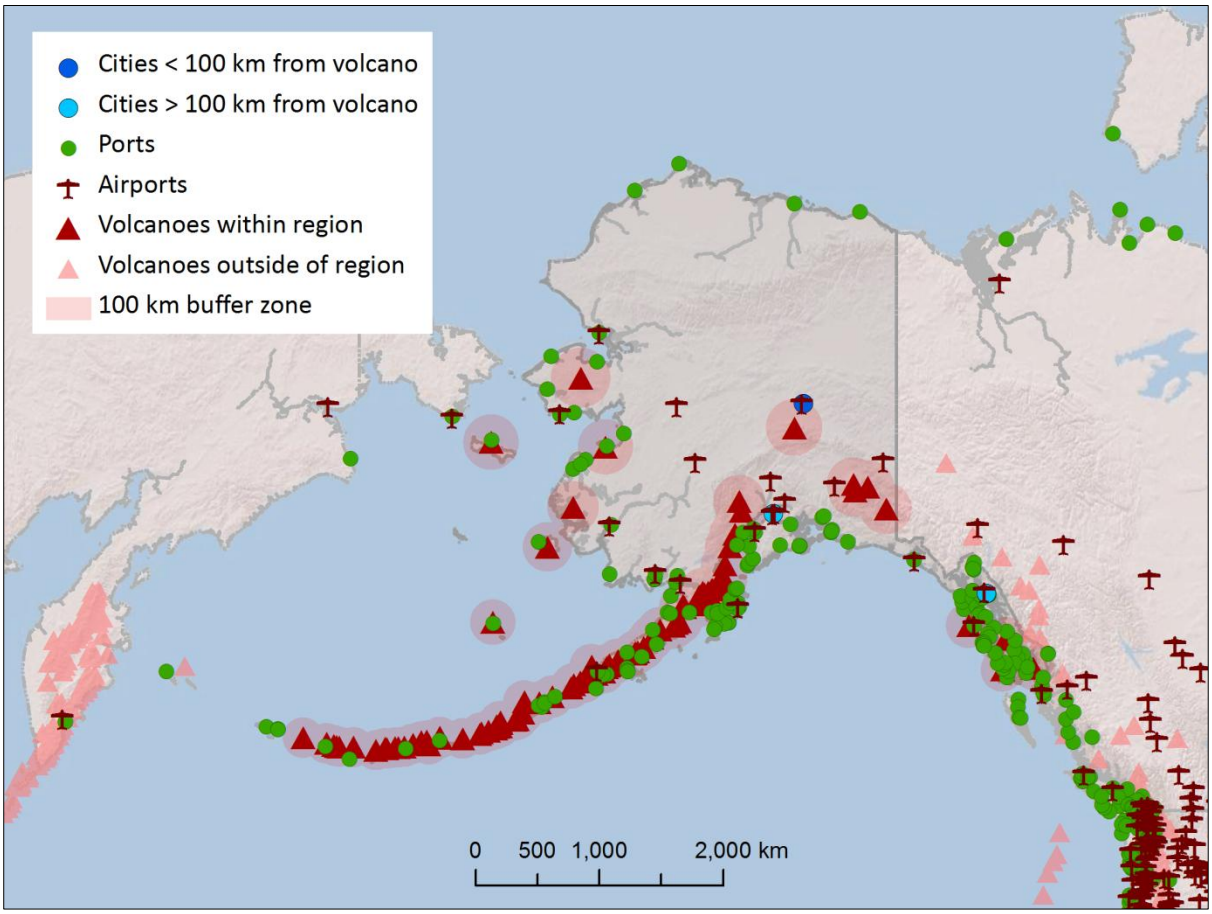

Figure 11.3 The location of Alaska's volcanoes and the extent of the 100 km zone surrounding them. Ports, airports and the major cities are just some of the infrastructure that may be exposed to volcanic hazards.

Hazard, Uncertainty and Exposure Assessments

Of the 92 volcanoes in Alaska, just 22 have an assigned hazard level based on their eruptive history. These volcanoes classify across all three hazard levels, with most at Hazard Level II. Just four volcanoes are classed at Hazard Level III – Fisher, Augustine, Iliamna and Redoubt. These four volcanoes all have records of explosive, pyroclastic flow producing eruptions.

Of the unclassified volcanoes, 33 have no confirmed eruptions during the Holocene, though Kukak, Douglas, Dutton and Emmons Lake all have periods of unrest above background levels since 1900. 22 unclassified volcanoes have confirmed historical (post-1500 AD) eruptions, and of these 15 have erupted since 1900 AD. Eleven unclassified volcanoes have Holocene records of large explosive (VEI ≥4) eruptions.

The small population in Alaska, particularly in proximity to the volcanoes, is evidenced by the classification of all volcanoes here at PEI 1 and 2. Of the classified volcanoes, all but the three Hazard Level III volcanoes are classed at Risk Level I.

CLASSIFIED	**Hazard III**	Fisher	Augustine; Iliamna; Redoubt					
	Hazard II	Seguam; Cleveland; Okmok; Trident	Bogoslof; Akutan; Westdahl; Shishaldin; Pavlof; Veniaminof					
	Hazard I	Kiska; Gareloi; Kanaga; Great Sitkin; Amukta	Korovin; Makushin; Wrangell					
UNCLASSIFIED	**U – HHR**	**Little Sitkin**; **Semisopochnoi**; **Tanaga**; Takawangha; **Yunaska**; Carlisle; **Kagamil**; Vsevidof; **Chiginagak**; Ugashik-Peulik; **Katmai**; **Fourpeaked**	**Kasatochi**; **Atka**; Amak; **Kupreanof**; **Aniakchak**; **Ukinrek Maars**; **Martin**; **Novarupta**; Snowy Mountain; **Spurr**					
	U- HR	Moffett; Koniuji; Yantarni; Kaguyak; Hayes; Imuruk Lake; Churchill	Roundtop; Dana; Black Peak; Mageik; Griggs; St. Paul Island; Buzzard Creek; Edgecumbe					
	U-NHHR	Buldir; Segula; Davidof; Bobrof; Chagulak; Herbert; Tana; Uliaga; Recheschnoi; Kialagvik; Unnamed; Denison; Steller; **Kukak**; **Douglas**	Sergief; Isanotski; Frosty; **Dutton**; **Emmons Lake**; Pavlof Sister; Stepovak Bay 2; Stepovak Bay 3; Stepovak Bay 4; Nunivak Island; Ingakslugwat Hills; St. Michael; Kookooligit Mountains; Sanford; Gordon; Duncan Canal; Tlevak Strait-Suemez Is.; Behm Canal-Rudyerd Bay					
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 11.3 Identity of Alaska'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.*

Population Exposure Index

Number of Volcanoes	Population Exposure Index
0	7
0	6
0	5
0	4
0	3
48	2
44	1

Table 11.4 The number of volcanoes in Alaska classed in each PEI category.

Risk Levels

Volcano	Population Exposure Index	Risk Level
Augustine	2	II
Fisher	1	I
Iliamna	2	II
Redoubt	2	II
Akutan	2	I
Bogoslof	2	I
Cleveland	1	I
Korovin	2	I
Makushin	2	I
Okmok	1	I
Pavlof	2	I
Shishaldin	2	I
Trident	1	I
Veniaminof	2	I
Westdahl	2	I
Wrangell	2	I
Amukta	1	I
Gareloi	1	I
Great Sitkin	1	I
Kanaga	1	I
Kiska	1	I
Seguam	1	I

Table 11.5 Classified volcanoes of Alaska ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given.

Number of Volcanoes	Risk Level
0	III
3	II
19	I
70	Unclassified

Table 11.6 The number of volcanoes in the Alaska region classified at each Risk Level.

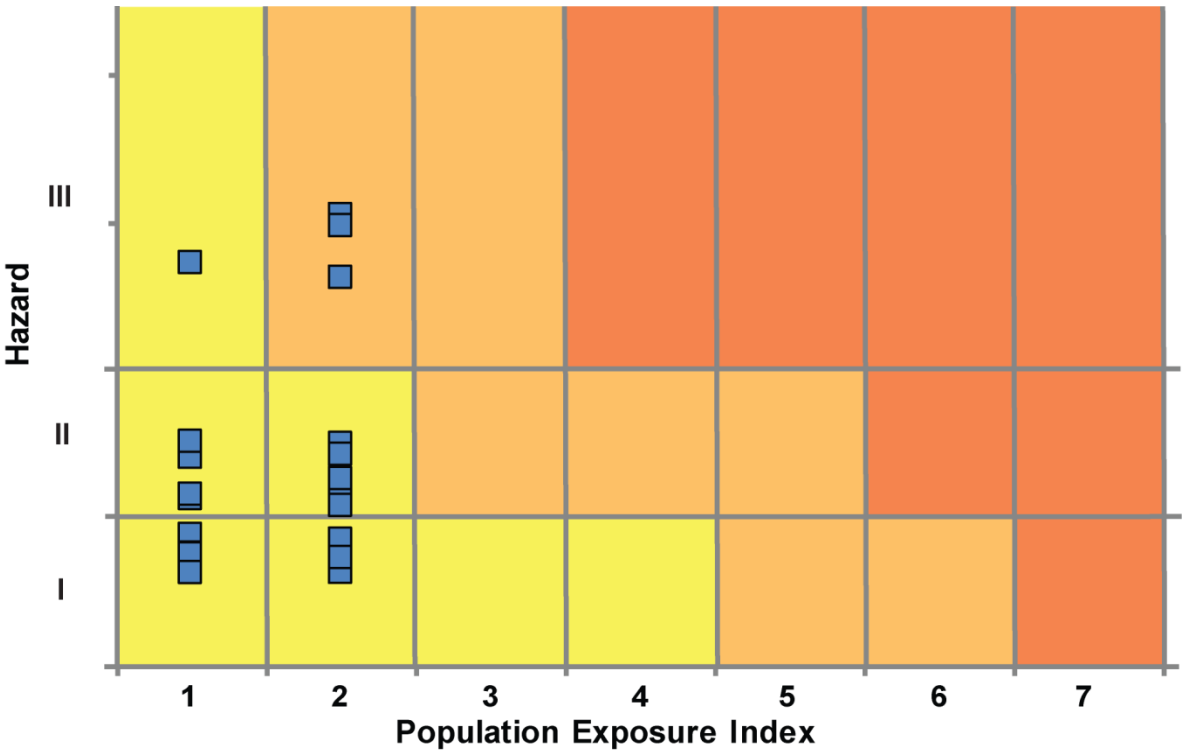

Figure 11.4 Distribution of the classified volcanoes of Alaska across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

Forty-four volcanoes in Alaska have records of historical activity in VOTW4.22. These volcanoes are mainly Unclassified and Risk Level I, with just three at Risk Level II – Augustine, Ilimna and Redoubt. The AVO classes at least another six volcanoes as having historical activity. The AVO provides a list of volcanoes which have dedicated seismic monitoring. Twenty-one historically active volcanoes in Alaska do not have dedicated seismic monitoring, however, five of these have 3 or more seismometers located within 20 km according to the AVO map of monitoring stations. Eighteen volcanoes (10 Risk Level I, 3 Risk Level II, 5 unclassified) are monitored by the AVO with dedicated seismic networks and some with additional deformation networks.

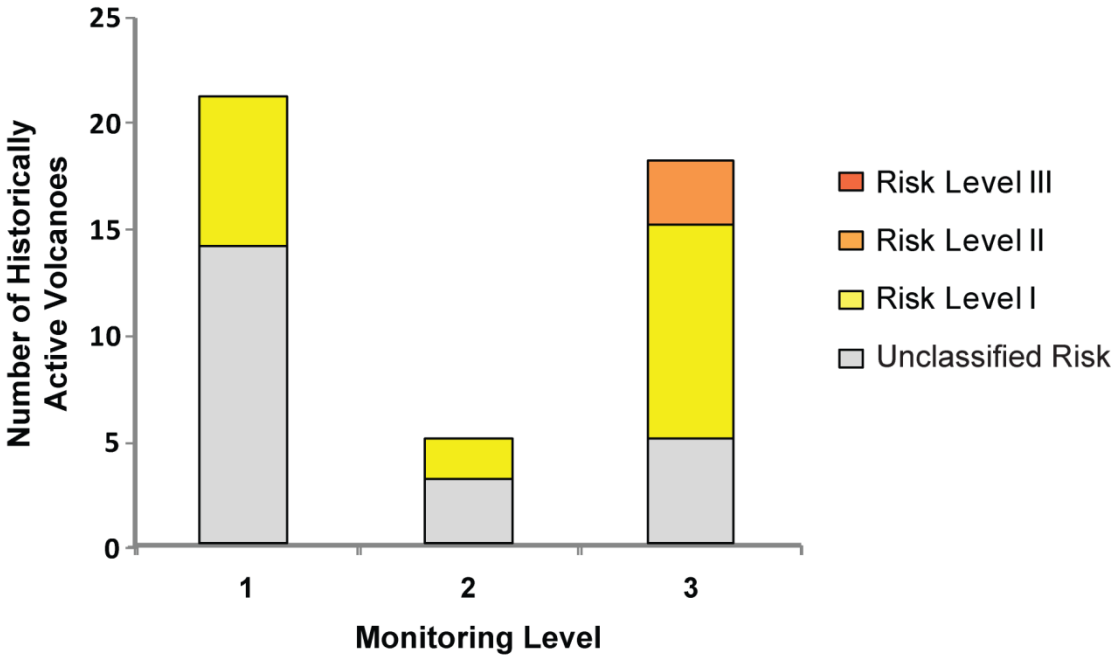

Figure 11.5 The monitoring and risk levels of the historically active volcanoes in Alaska. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.