

Pre-event risk communication and behavioural change: Whakaari / White Island, Aotearoa New Zealand



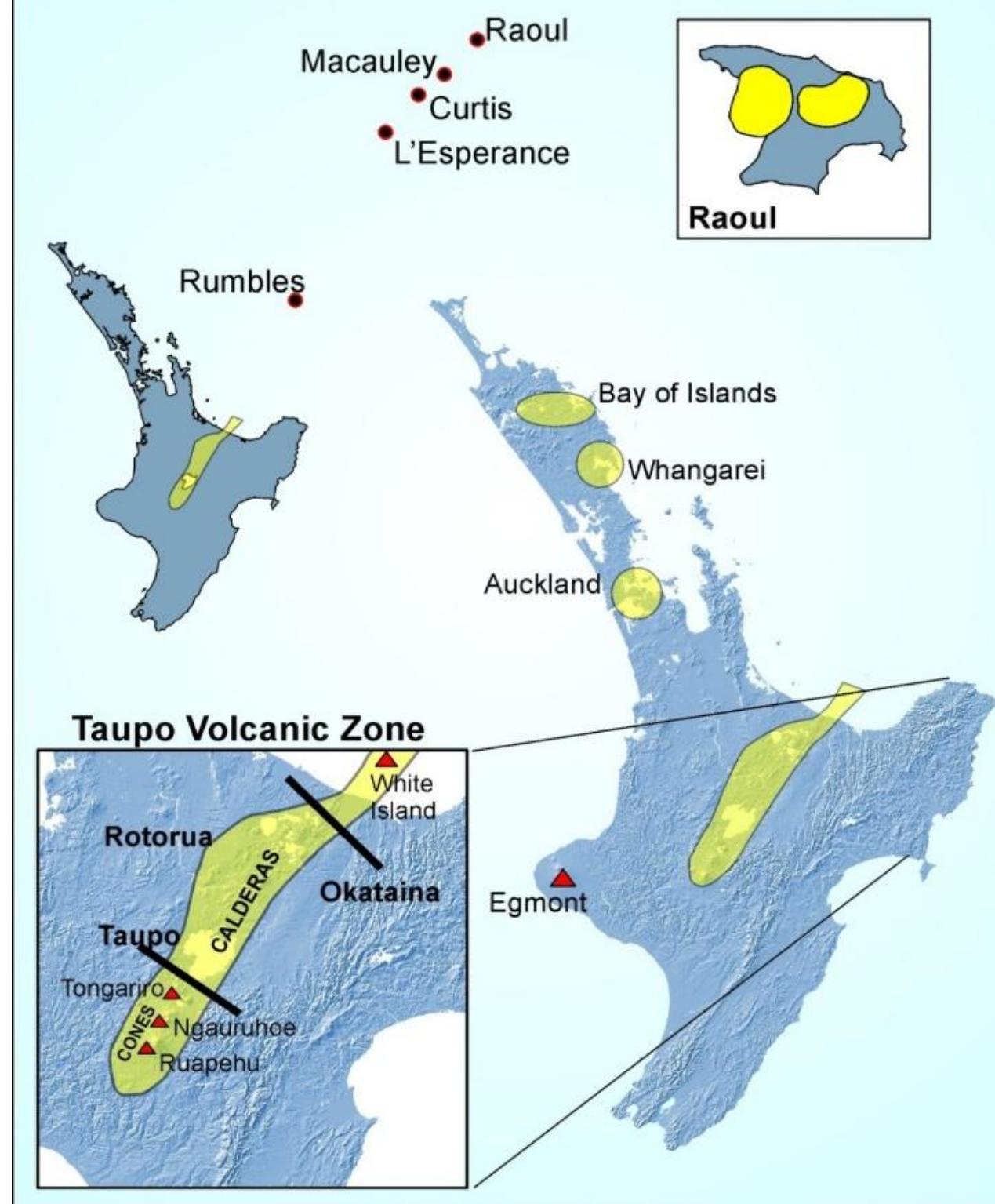
Nico Fournier and Volcano Monitoring Group

Earth Sciences New Zealand (formerly Te Pū Ao - GNS Science), Aotearoa New Zealand



formerly

New Zealand Volcanoes



6 Volcanic Alert Levels in NZ a.k.a. our patients “status”

We set the VAL by voting in the
GeoNet Volcano Monitoring Group

New Zealand Volcanic Alert Level System			
	Volcanic Alert Level	Volcanic Activity	Most Likely Hazards
Eruption	5	Major volcanic eruption	Eruption hazards on and beyond volcano*
	4	Moderate volcanic eruption	Eruption hazards on and near volcano*
	3	Minor volcanic eruption	Eruption hazards near vent*
Unrest	2	Moderate to heightened volcanic unrest	Volcanic unrest hazards, potential for eruption hazards
	1	Minor volcanic unrest	Volcanic unrest hazards
	0	No volcanic unrest	Volcanic environment hazards
An eruption may occur at any level, and levels may not move in sequence as activity can change rapidly.			
Eruption hazards depend on the volcano and eruption style, and may include explosions, ballistics (flying rocks), pyroclastic density currents (fast moving hot ash clouds), lava flows, lava domes, landslides, ash, volcanic gases, lightning, lahars (mudflows), tsunami, and/or earthquakes.			
Volcanic unrest hazards occur on and near the volcano, and may include steam eruptions, volcanic gases, earthquakes, landslides, uplift, subsidence, changes to hot springs, and/or lahars (mudflows).			
Volcanic environment hazards may include hydrothermal activity, earthquakes, landslides, volcanic gases, and/or lahars (mudflows).			
*Ash, lava flow, and lahar (mudflow) hazards may impact areas distant from the volcano.			
This system applies to all of New Zealand's volcanoes. The Volcanic Alert Level is set by GNS Science, based on the level of volcanic activity. For more information, see geonet.org.nz/volcano for alert levels and current volcanic activity, gns.cri.nz/volcano for volcanic hazards, and getthru.govt.nz for what to do before, during and after volcanic activity. Version 3.0, 2014.			

Volcanic Activity Bulletins

a.k.a. what is happening at our volcanoes and the “so what?”

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This system applies to all of New Zealand's volcanoes. The Volcanic Alert Level is set by GNS Science, based on the level of volcanic unrest. For more information, visit [gns.cri.nz/volcanoes/](http://www.gns.cri.nz/volcanoes/) or [gns.cri.nz/volcanoes/volcanic-hazards/](http://www.gns.cri.nz/volcanoes/volcanic-hazards/) before, during and after volcanic activity. Version 3.0, 2014.

*Ash, lava flow, and lahar (mudflow) hazards may impact areas distant from the volcano.

The screenshot shows the GeoNet.org.nz website interface. The top navigation bar includes links for NHC Toka Tū Ake, Earth Sciences NZ, News, and a search icon. Below the navigation is a main menu with categories: Home, Earthquake, Landslide, Tsunami, Volcano, Data Discovery, Data Types, and Data Access. A large banner image of Whakaari/White Island is prominently displayed. Overlaid on the banner is a large, bold text box containing the text: "WHAKAARI/WHITE ISLAND". Below this, a callout box contains the following text: "Whakaari/White Island activity limited to steam and gas emissions. Volcanic Alert Level remains at level 2 and Aviation Colour Code remains Yellow." At the bottom of this box, it says "Published: Mon Jul 7 2025 2:30 PM" and "Volcanic Activity Bulletin". Another callout box below it displays the "VOLCANIC ACTIVITY BULLETIN WI-2025/10" for "Mon Jul 7 2025 2:30 PM; Whakaari/White Island Volcano". It states "Volcanic Alert Level remains at 2" and "Aviation Colour Code remains at Yellow". At the very bottom of the page, a note says: "Based on observations from a recent observation flight, webcam and satellite imagery, we can confirm no further ash emissions".

Communication products

Bulletins, videos, news items,
social media (X/Twitter, Facebook),
fact sheets

geonet.org.nz

Obsidian Clipper Taupō Weather - MetService Tongariro National Park MetVUW NZ Topo map Peak Safety ...otocols_2020 Workday GNSOnline Outlook GNS Staff Volcano Monitoring Data



VOLCANO NEWS

Watch: Volcanic Fluid Geochemist, Ery Hughes, explains the recent decrease in Alert Level at Taupō volcano.

Published: Wed May 31 2023 2:52 PM

News



Lowering the Volcanic Alert Level at Taupō Volc... Share

Taupō Volcano Update Alert Level 0

Watch on YouTube

We are proud to partner with the Tūwharetoa Māori Trust Board, the landowner of Lake Taupō. Read all about the Trust at <https://www.tuwharetoa.co.nz/>

We acknowledge the valuable contribution of our colleagues in the ECLIPSE research programme www.supervolcanoes.nz led by Te Herenga Waka – Victoria University of Wellington; in their analysis and interpretation of some of the Taupō data relating to this unrest episode.

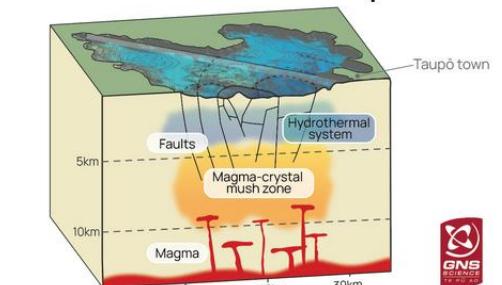
Want to learn more?



Formation

- Caldera volcanoes are created by collapse of the ground surface due to emptying of their sponge-like magma chambers in huge eruptions - **which are very rare.**
- Taupō Volcano has had 2 caldera forming eruptions in the last 25,500 years and they formed much of the current lake basin.
- Magma accumulates in the crust between 5 and 10 km below the lake floor before rising to the surface to erupt.

What is below Lake Taupō?



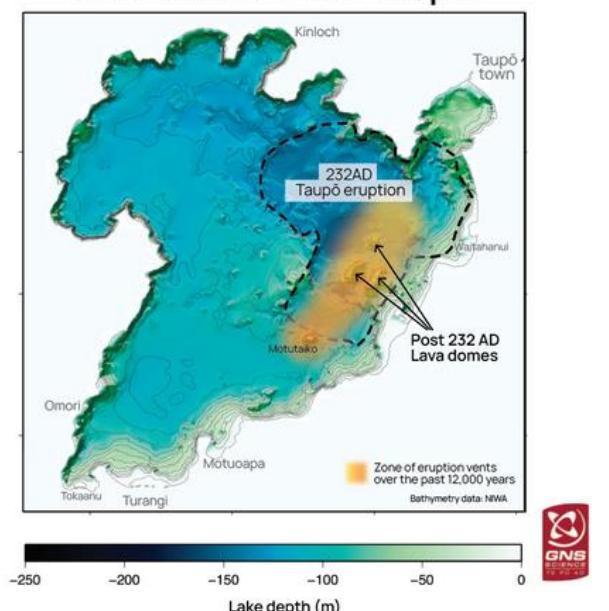
Volcanic Eruption History

- Volcanoes in the Taupō area began erupting >300,000 years ago.
- The Ōruanui eruption 25,500 years ago created a large basin that formed much of the present lake
- Between the Ōruanui eruption and the Taupō eruption (about 1790 years ago) at least 27 much smaller eruptions spread pumice and ash beyond the lake and formed lava domes. 25 of those eruptions occurred in the last 12,000 years including the Taupo eruption.
- Many of these smaller eruptions were bigger than the 1995/96 Ruapehu eruptions but smaller than the 1886 Tarawera eruption and about 1/10th the size of Mt St. Helens 1980 eruption

Volcanic Unrest

- Taupō is an active volcano
- Volcanic unrest is the term given to natural phenomena caused by underground processes associated with active volcanoes.
- Volcanic unrest has occurred often in the last 150 years at Taupō (17 times between 1870 and 2022)
- Volcanic unrest can include earthquake swarms including surface fault ruptures as well as slow ground movement.

What is below Lake Taupō?



Volcanic Unrest phenomena

- These occur on and near the volcano
- Hazards in heightened unrest may include changes in hydrothermal systems, gas discharge, new springs or steam eruptions
- Earthquakes, tsunami and landslides
- Ground deformation (uplift or subsidence)

Volcanic Eruption phenomena

- Eruptions can produce ashfall, hot ash clouds (pyroclastic flows), flying rocks, large waves in the lake. Ash can remobilise with rain as lahars.

The Taupō Eruption

(232 ± 10 AD, 1790 years ago)

- Is considered the most powerful eruption known of the last 5000 years globally - it was unusually large compared to most Taupō eruptions.
- The plume reached a height of 35 - 40 km.
- Covered parts of the North Island in at least 1 cm of ash.
- Lakeside areas were covered in tens of metres of pumice and ash pyroclastic deposits.
- The flow spread up to 90 km from the vent, spreading over all barriers except the upper slopes of Ruapohu.

GNS Science monitors Taupō Volcano with

22 lake levelling sites

9 seismometers

9 GNSS stations

Fact Sheet

www.gns.cri.nz

Fact Sheet - September 2022

Our science advisory feeds into risk management

VAAC / Aviation-facing

VOLCANO OBSERVATORY NOTICE FOR AVIATION (VONA)

Item No	Element	Content
1	Message title	VOLCANO OBSERVATORY NOTICE FOR AVIATION
2	Issued:	20161009/2130Z
3	Volcano:	White Island 241040
4	Current Aviation Color Code:	Green
5	Previous Aviation Color Code:	Yellow
6	Source:	GNS Science, New Zealand
7	Notice Number:	NZ VONA 16/08
8	Volcano Location:	3731 S 17710E
9	Area:	White Island, North Island, New Zealand
10	Summit Elevation:	1053FT
11	Volcanic Activity Summary:	No eruptive activity has been seen since 13 September 2016.
12	Volcanic Cloud Height:	No information
13	Other Volcanic Cloud information:	NIL
14	Remarks:	ACC changed from Yellow to Green
15	Contacts:	Duty Volcanologist, +6473748211ph, +6473748199fax
16	Next Notice:	Will be issued when conditions at the volcano warrant changing the aviation color code or when a significant volcanic event occurs within the current color code.

Two-way relationship with VAAC:

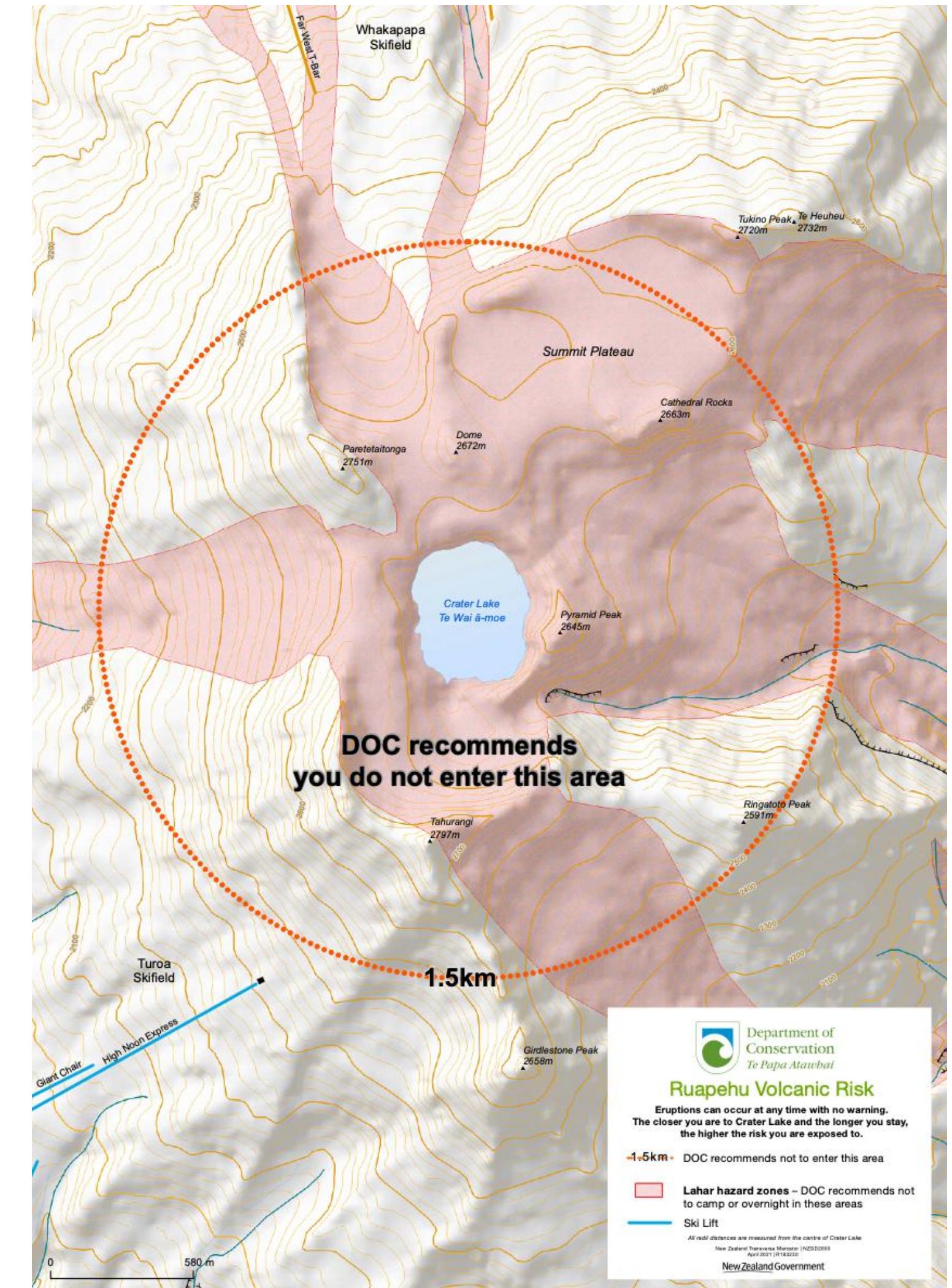
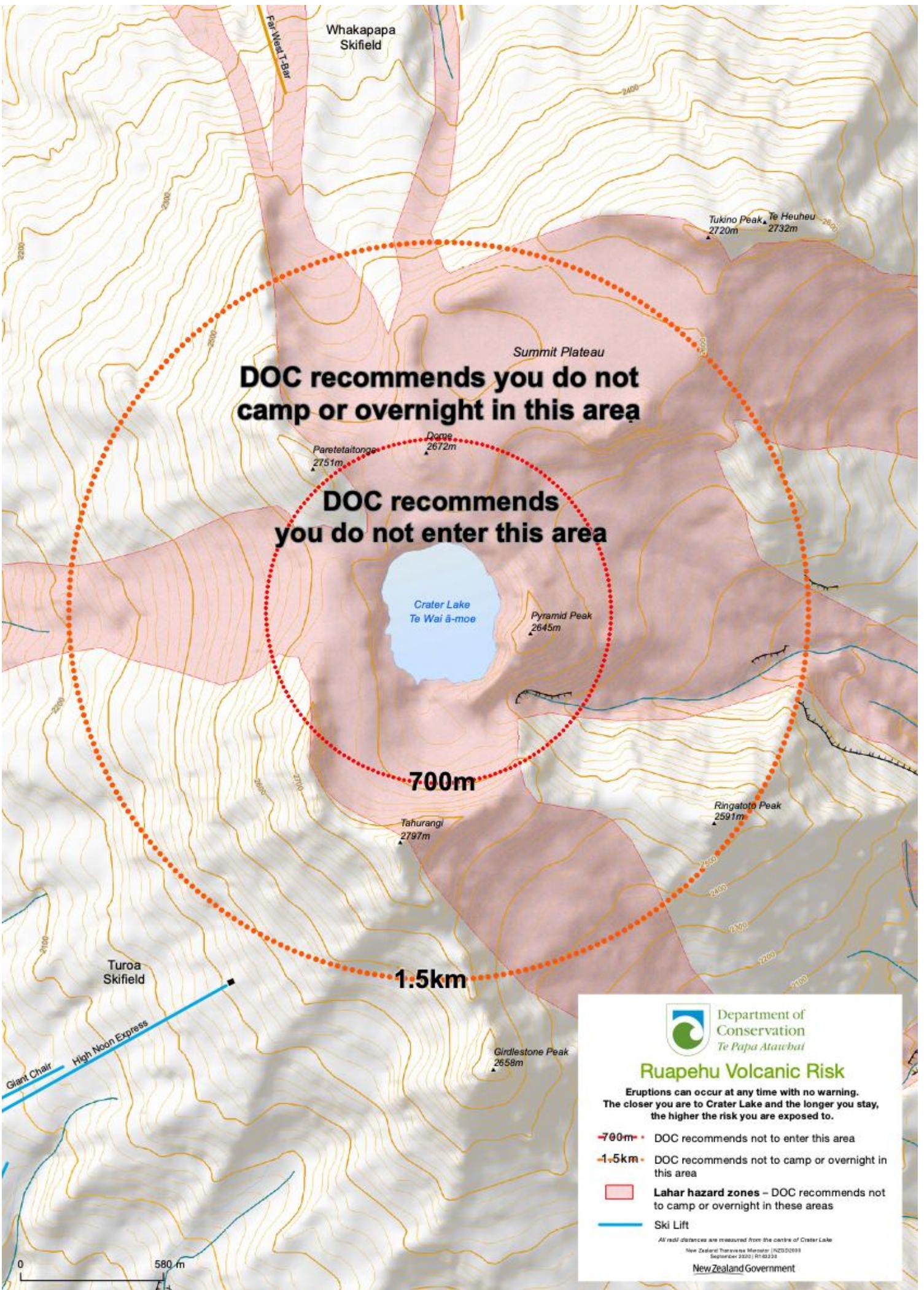
VO > VAAC (VONA, eruption info for models)

VO < VAAC (Eruption detection / confirmation)

For local and national authorities: scenarios with respective likelihood

Taupō Volcano Scenarios				
Relative likelihood of scenarios occurring for Taupō volcano from its current state of minor unrest (VAL1) within the next three-month period (20 January – 20 April 2023). Credible maximum earthquakes and shaking scenarios are given in Slides 17 and 50 onwards.			Version: 1.03 20 January 2023	
Scenario		Examples	Potential hazards	Likelihood of scenarios occurring <u>within the next 3 months</u> (at 2 s.d.)
A	Minor UNREST decreases to no unrest (VAL1 → 0)	2019 at Taupō: An elevated number of earthquakes continued for around 8 months in total, including a M5 damaging earthquake. Uplift occurred at a rate of about 10mm/year.	<ul style="list-style-type: none">Minor unrest hazards (earthquakes and deformation) decrease and return to normal background levels.	35-53% About as likely as not
B	Minor UNREST continues (VAL1)	2008-2010 at Taupō: Up to 150 earthquakes recorded per day over nearly 2 years, four >M4.0. Inflation near Horomatangi Reef with uplift recorded of 40-50mm/year.	<ul style="list-style-type: none">Earthquakes: Rate of earthquakes (number per week) remains similar to May - Sept 2022. Felt earthquake shaking, potential for damage from stronger events (up to about M7).Ground Deformation: Instrumentally detected.Other: Earthquakes may trigger landslides and tsunami.	17-57% About as likely as not
C	Minor UNREST increases to moderate or heightened unrest (VAL1 → 2)	1983-84 at Taupō: Earthquakes occurred for 13 months, causing minor structural and contents damage. Uplift of 53mm in northern caldera area, rupture of Kaiapo Fault near Kinloch and subsidence of western side of the Fault. This example is at the lower end of Scenario C.	<ul style="list-style-type: none">Earthquakes: Notable increase in size and/or number of located earthquakes (up to about M7), may trigger landslidesGround deformation: may become visible and disrupt shallow underground infrastructure, particularly in the case of fault ruptureOther: Hydrothermal system responses or explosions mostly underwater in Lake Taupō, such as a burst of hot water and steam above the vent(s), with potential tsunami – at the upper end of this scenario.	3-6% Very unlikely

Volcanic risk management for visitors at Ruapehu



Volcanic risk management for visitors at Tongariro post 2012 eruption

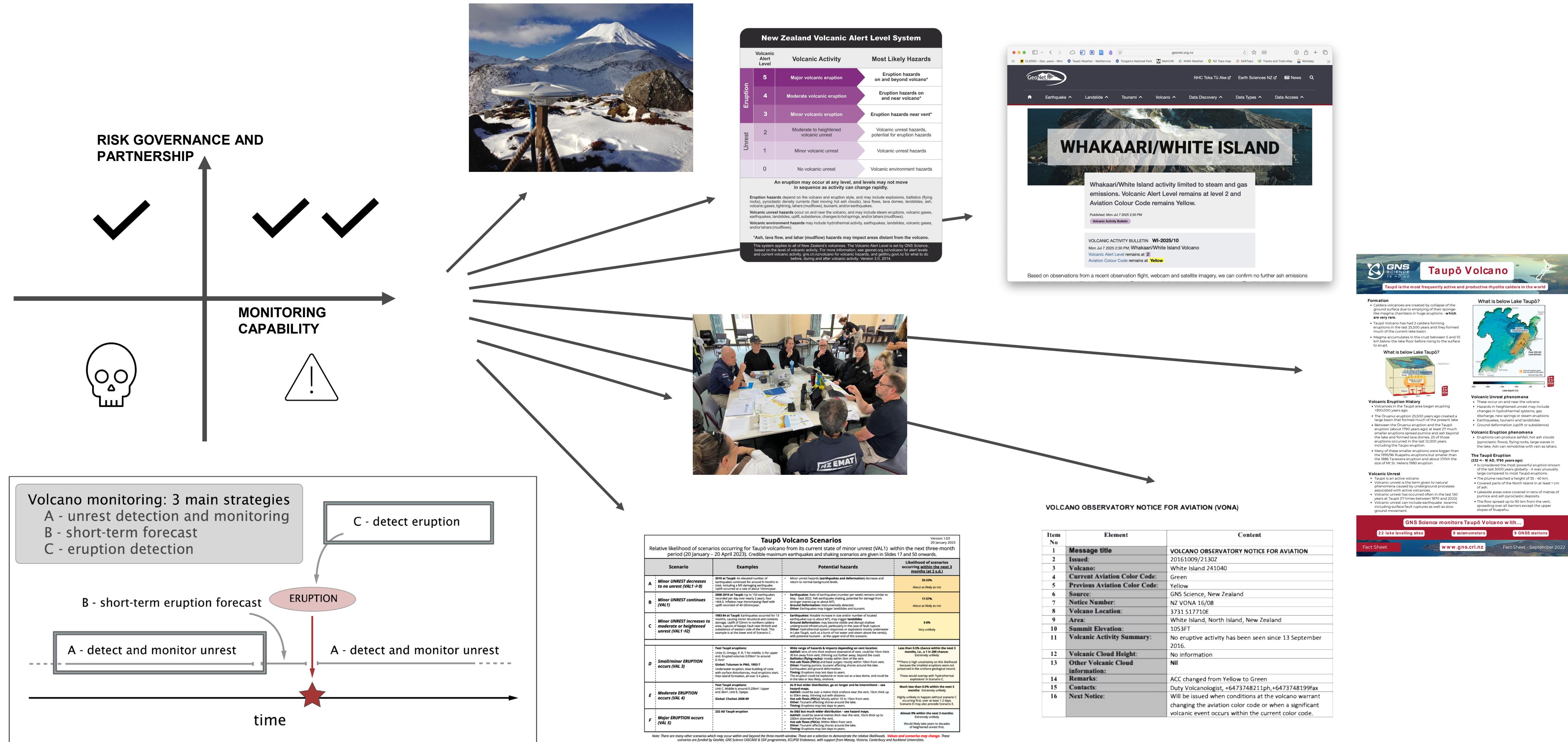


Jolly and Tait, 2012

	Fatalities per year estimated	Fatality risk per visit
Falls	0.2	2.8×10^{-6}
Hypothermia	0.33	4.6×10^{-6}
Heart attack	1	1.4×10^{-5}
Avalanche (extrapolated from Ruapehu)	0.05	7.0×10^{-7}
Car accident in vicinity	1	1.4×10^{-5}
Volcanic eruption (Jolly and Tait 2012)	0.08	1.1×10^{-6}
Volcanic eruption estimate range (this report)	0.9-5.3	$1.3-7.5 \times 10^{-5}$

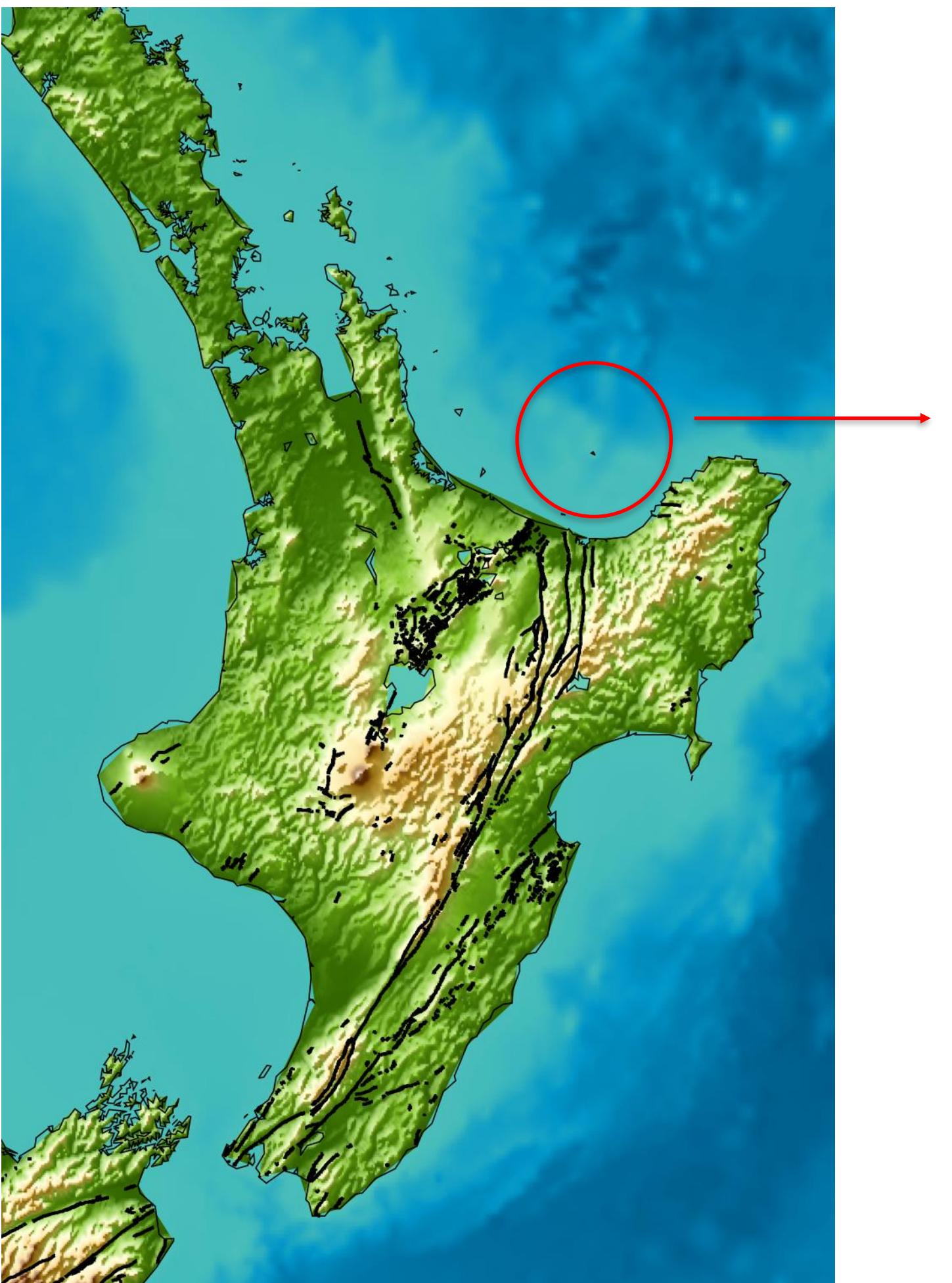
Activity	Hazard	Location	Individual fatality risk	Risk per...	Basis	Source
Tramping on TAC	Volcanic eruption	Near Ketetahi	1.1×10^{-6}	Walk	As described above	Jolly and Taig (2012)
Tramping on TAC	Volcanic eruption	Near Ketetahi	$1.3 \text{ to } 7.5 \times 10^{-5}$	Walk	As described above	This report
Downhill skiing and boarding	All	US, Australian and Italian ski resorts	6.7×10^{-7} to 2.9×10^{-6}	Day of skiing or boarding	Range quoted from lowest to highest from ski areas	Windsor et al. 2009 Postgrad Med Journal 85 pp 316-321
Walking and scrambling	All accidents	Mt Snowdon	2.6×10^{-6} to 4.1×10^{-5}	Single walk along track	Averaged from 2006 to 2010	Private communication to Tony Taig from Snowdon National Park Authority
Climbing	All accidents	Mt Cook	1.3×10^{-4} to 6.5×10^{-3}	Day of climbing	Range quoted from lowest to highest based on nights spent in huts	Malcolm 2001. NZ Med Journal 114 pp78-80

Volcanic risk management in New Zealand is rather comprehensive

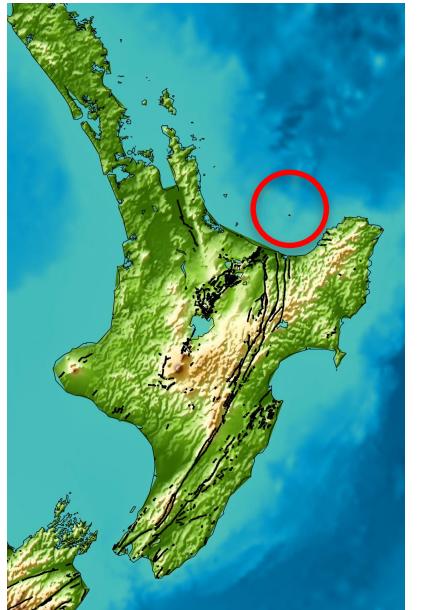


or is it...?

Whakaari / White Island



Hundreds of visitors daily



Photographs: Chuck Marshall (lifeinmichigan.com)



Hundreds of visitors daily



Chuck Marshall (lifeinmichigan.com)



Volcanic Air Safari

Eruption on 9 December 2019 at 14:11



Michael Schade, twitter

Rapid onset eruption without immediate warning, but in period of heightened unrest

A relatively small eruption

Major impacts because
tourists were right at the vent.

47 people on the island



White Island Flights / NZ Herald

Most of the crater floor affected by surge and pyroclastic flows



Auckland Rescue Helicopter Trust



Instagram/The Helicopter Page

Some tour operators still offshore near the island



RNZ / Michael Schade



AFP photo / Michael Schade

Rescue operations

Initial rescues in the first few hours. 47 people on island at time of eruption. ~ 20 fatalities. Survivors evacuated by boats and helicopters. Main injuries were burns.

By 5pm, no signs of survivors.

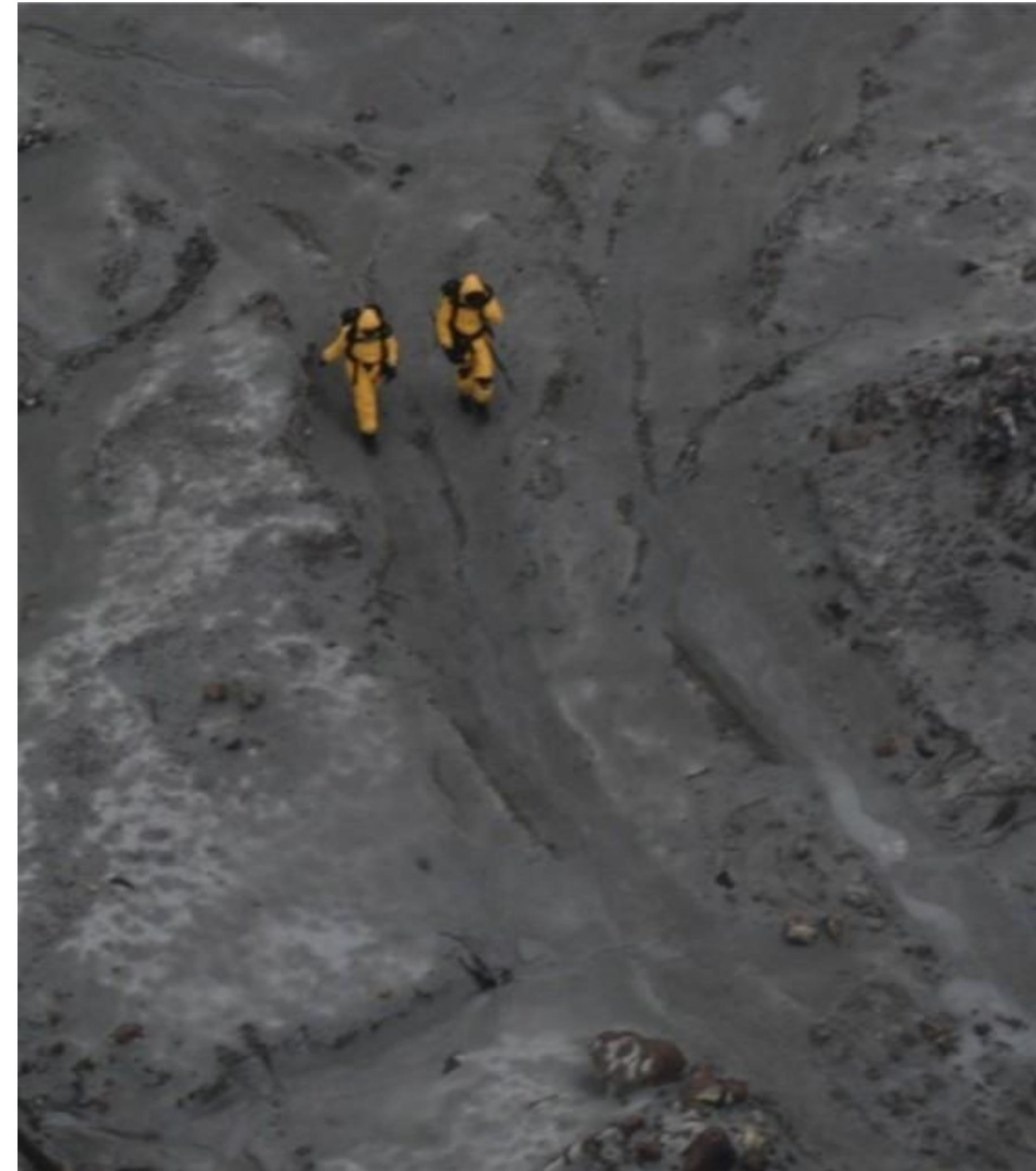
Rescue and recovery operations halted due to potential risk of another eruption

Focus on recovering the 8 missing persons



RNZ / Dom Thomas

Whakaari recovery operations – Friday 13 December 2019



The aftermath



Two Government inquiries

Worksafe NZ inquiry

Lens = safety at work

Scope = period preceding the eruption, up to the eruption itself

Two initial charges against GNS / the VO:

1. **Failure to ensure the safety of visitors** on the day of the eruption (our “workplace”) (dropped)
2. **Failure to communicate the risk** to our heli providers (pledged guilty to lesser charge)

Coronial inquiry (ongoing)

Lens = wider volcanic risk management system

Scope = before, during and after the eruption. **Systemic issues impacting the outcome of such eruption**

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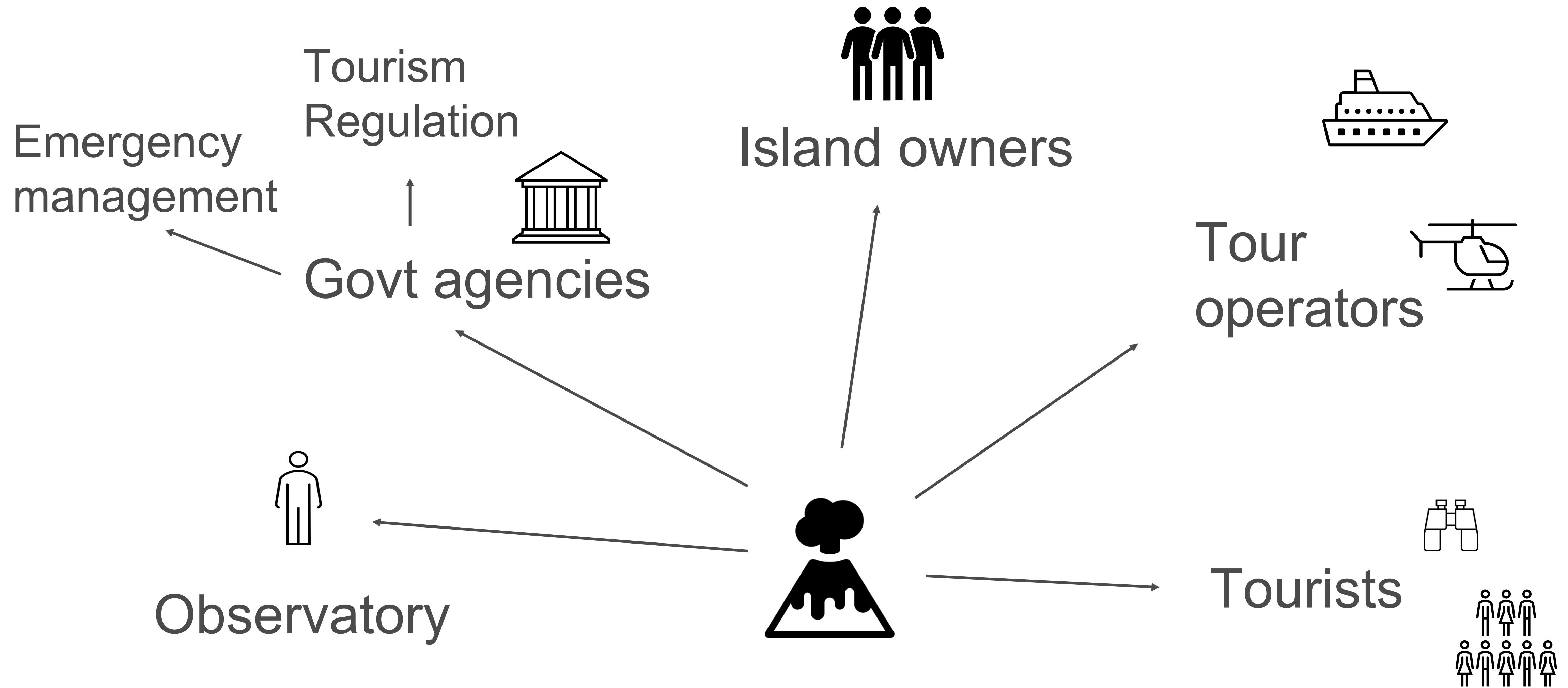
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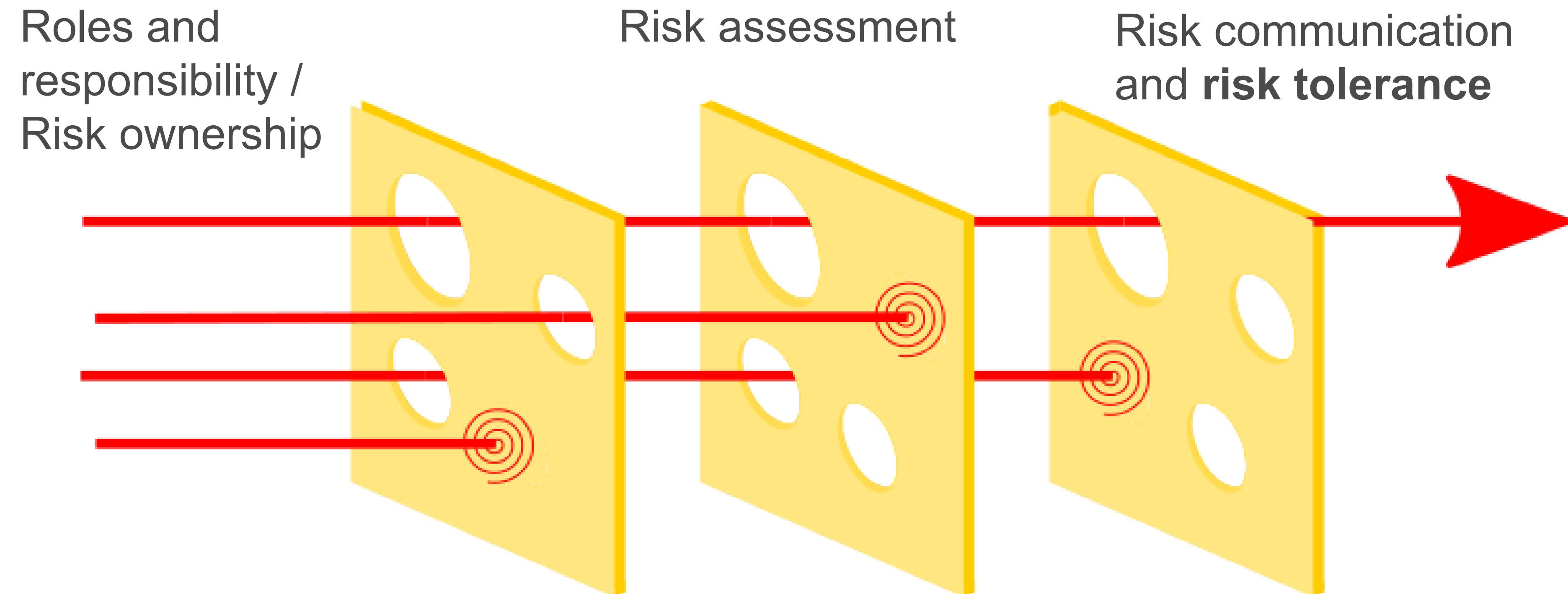
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Who owns the risk? Who is the decision maker?



There are always vulnerabilities



Some takeaway points from an EW4All perspective

Difference between monitoring capability and efficiency.
Some volcanoes just don't cooperate

EW4All needs to fit the local legislative framework, incl. roles and responsibilities

Risk assessment is only the first step

Risk communication is crucial

Risk tolerance discussions are often missing





How do we introduce essential conversations about risk tolerance in EW4All?