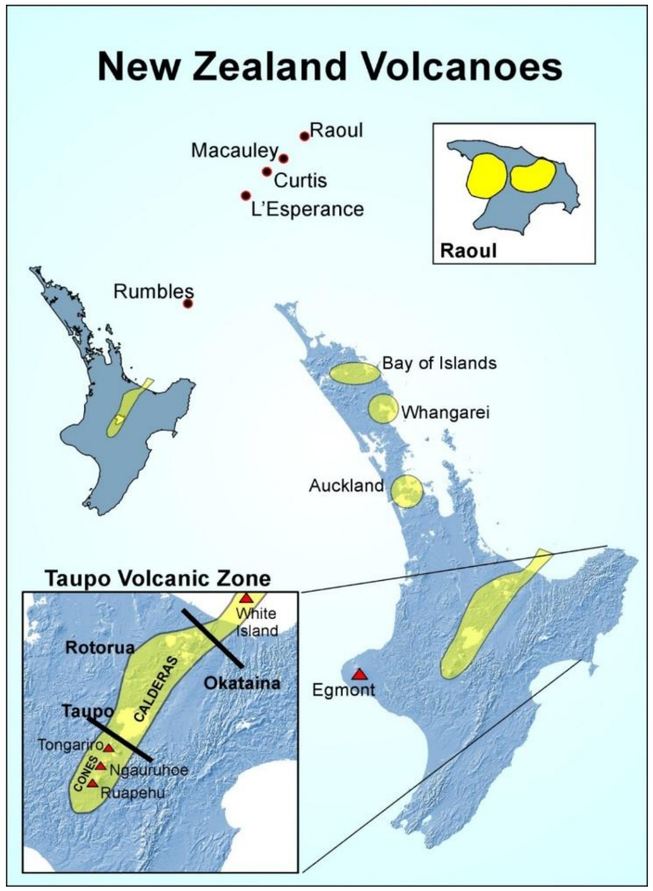
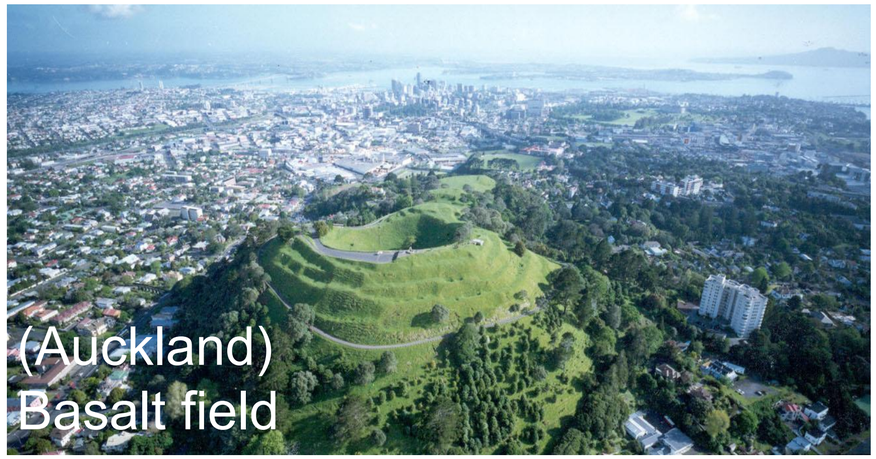
Pre-event risk communication and behavioural change: Whakaari / White Island, Aotearoa New Zealand

Nico Fournier and **Volcano Monitoring Group**
Earth Sciences New Zealand (*formerly Te Pū Ao - GNS Science*), Aotearoa New Zealand

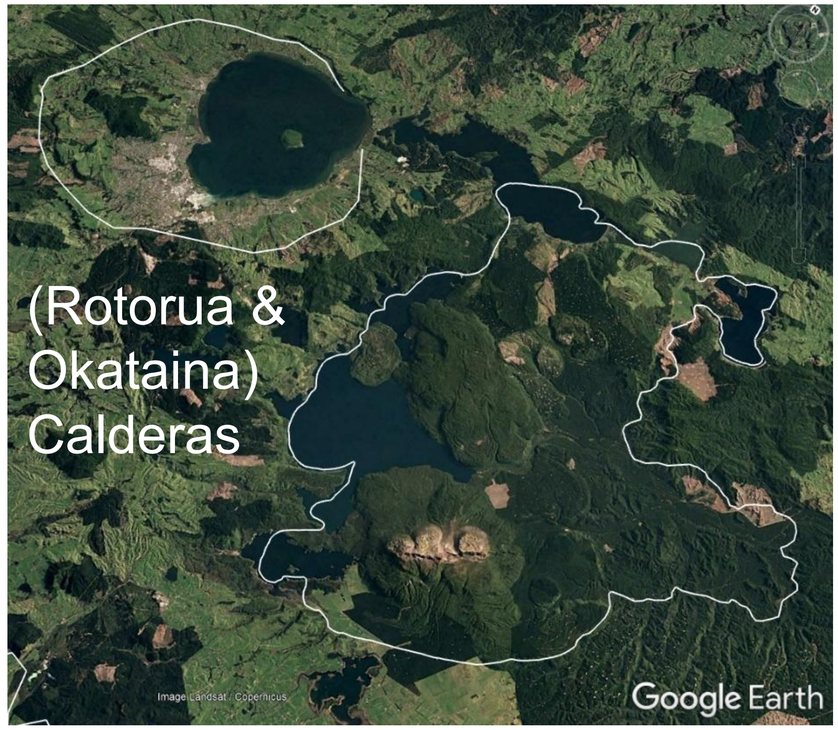
formerly


New Zealand Volcanoes
Raoul
Macauley
Curtis
L'Esperance
Raoul
Rumbles
Bay of Islands
Whangarei
Auckland
Taupo Volcanic Zone
White Island
Rotorua
CALDERAS
Okataina
Egmont
Taupo
Tongariro
CONES
Ngauruhoe
Ruapehu


(Auckland)
Basalt field


(Taranaki)
Stratovolcano/domes


(Ruapehu & Tongariro)
Strato-volcano

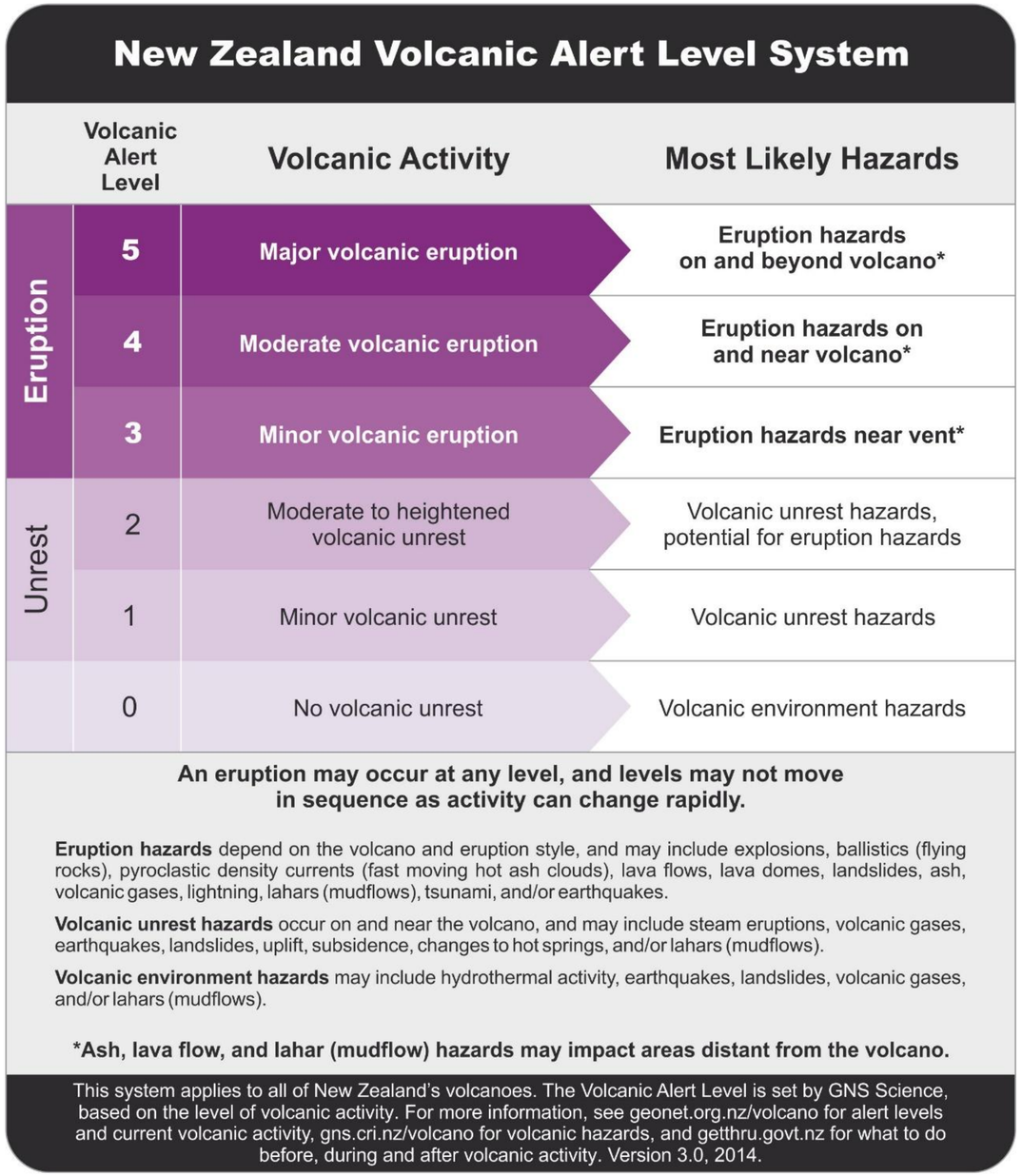

(Rotorua &
Okataina)
Calderas
Image Landsat / Copernicus
Google Earth


(Whakaari)
Stratovolcano
GNS SCIENCE


(Taupo)
Caldera

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*
Eruption	4	Moderate volcanic eruption	Eruption hazards on and near volcano*
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Unrest	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.

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

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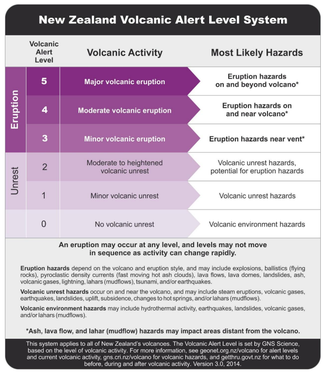
Volcanic Activity Bulletins
a.k.a. what is happening at our volcanoes and the “so what?”



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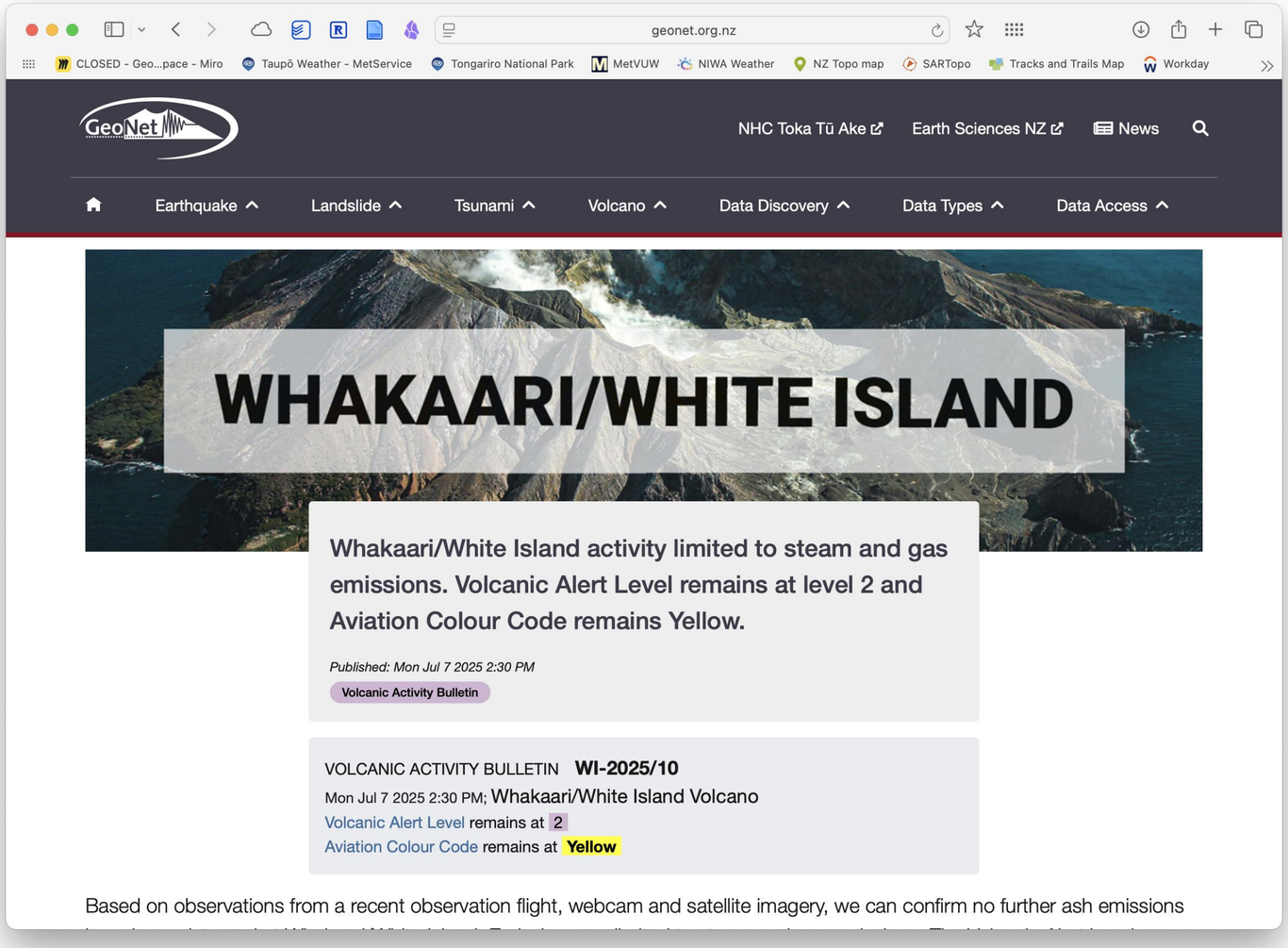
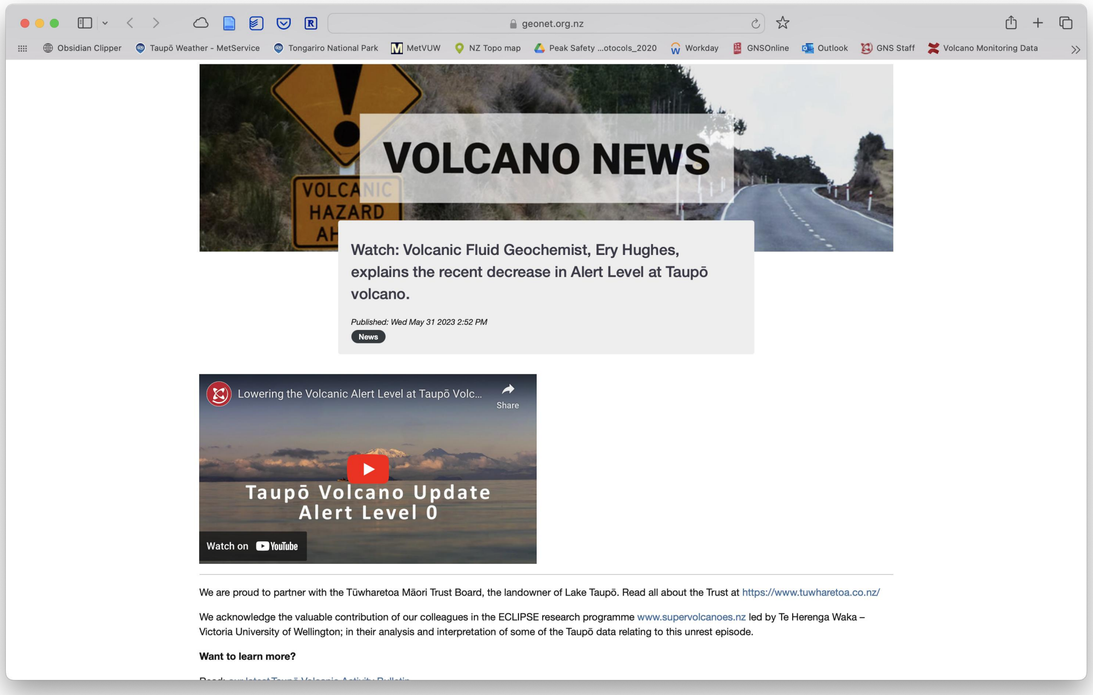
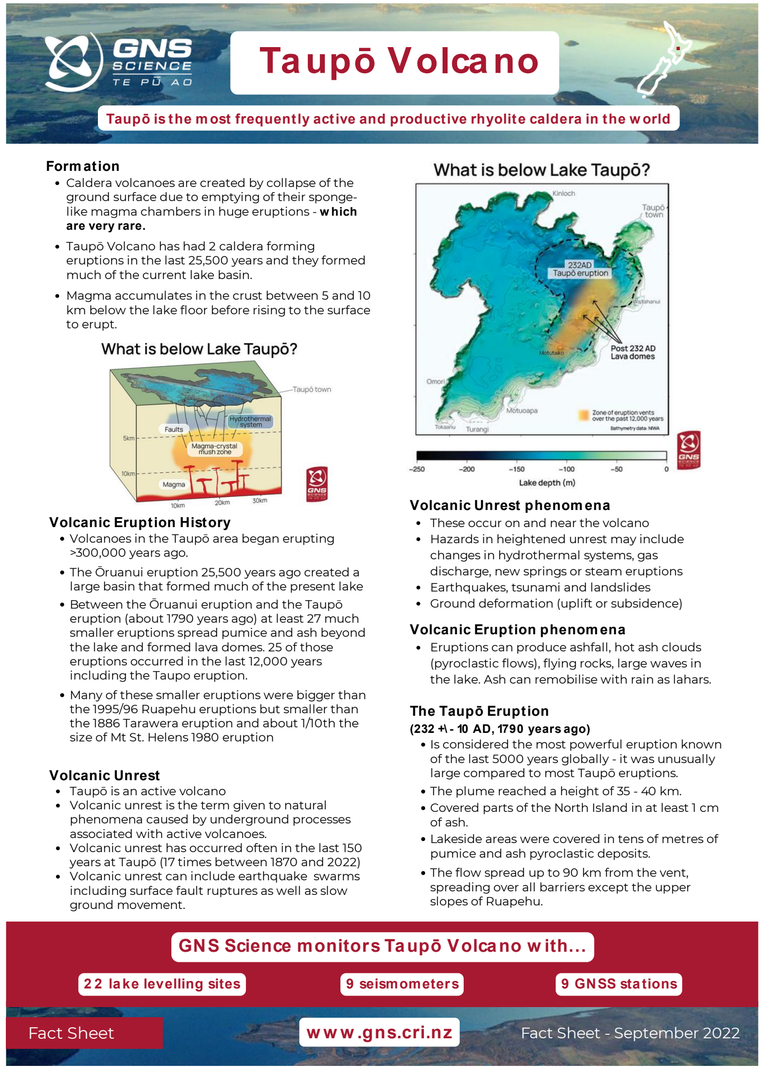


Communication products

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





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 S17710E
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

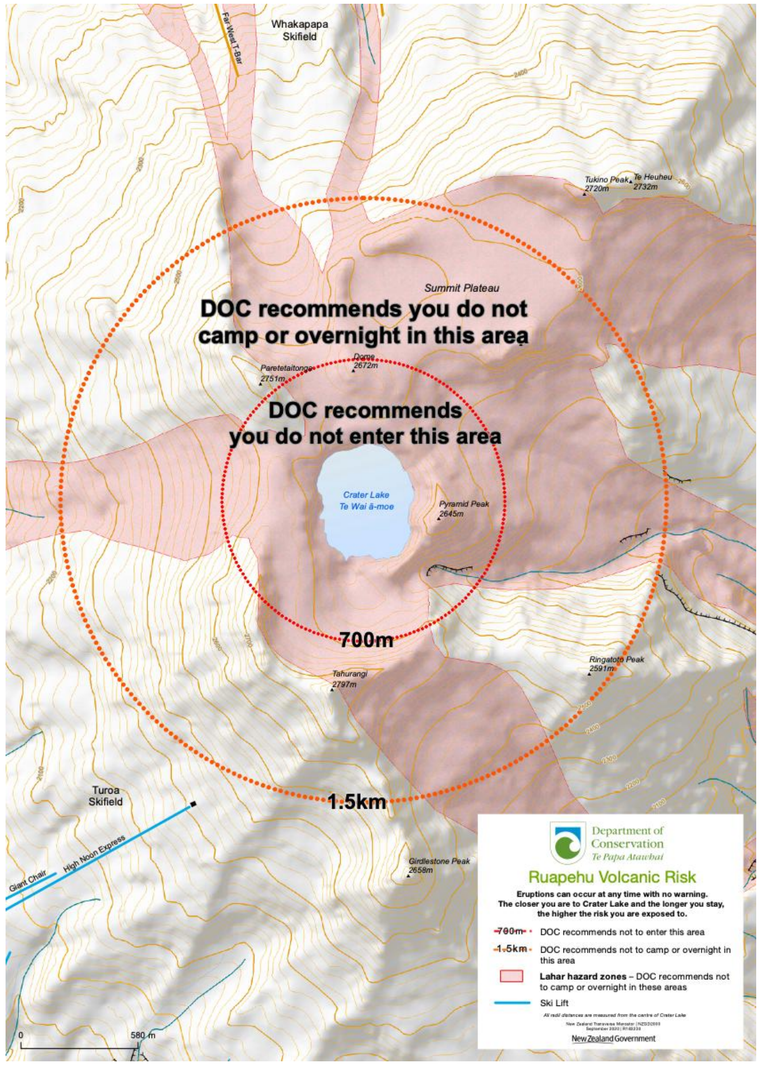
Taupō Volcano Scenarios

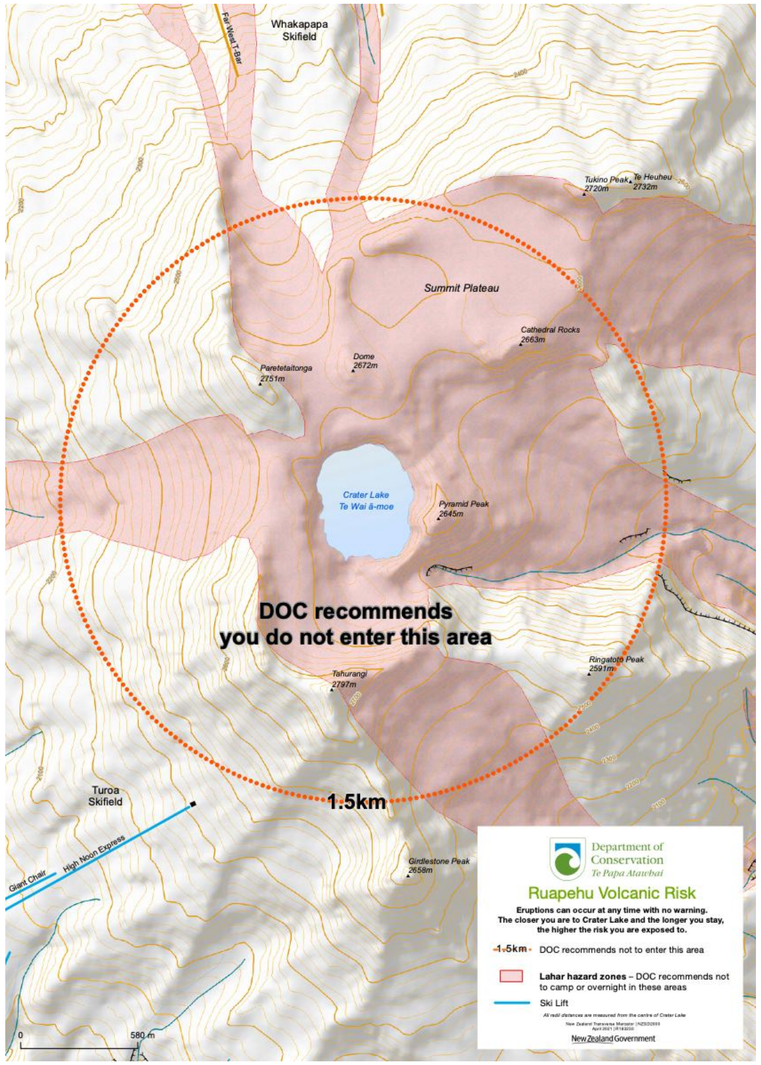
Version: 1.03
20 January 2023

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.

	Scenario	Examples	Potential hazards	Likelihood of scenarios occurring within the next 3 months (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.	• 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.	• **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.	• **Earthquakes:** Notable increase in size and/or number of located earthquakes (up to about M7), may trigger **landslides** • **Ground deformation:** may become visible and disrupt shallow underground infrastructure, particularly in the case of fault rupture • **Other:** 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





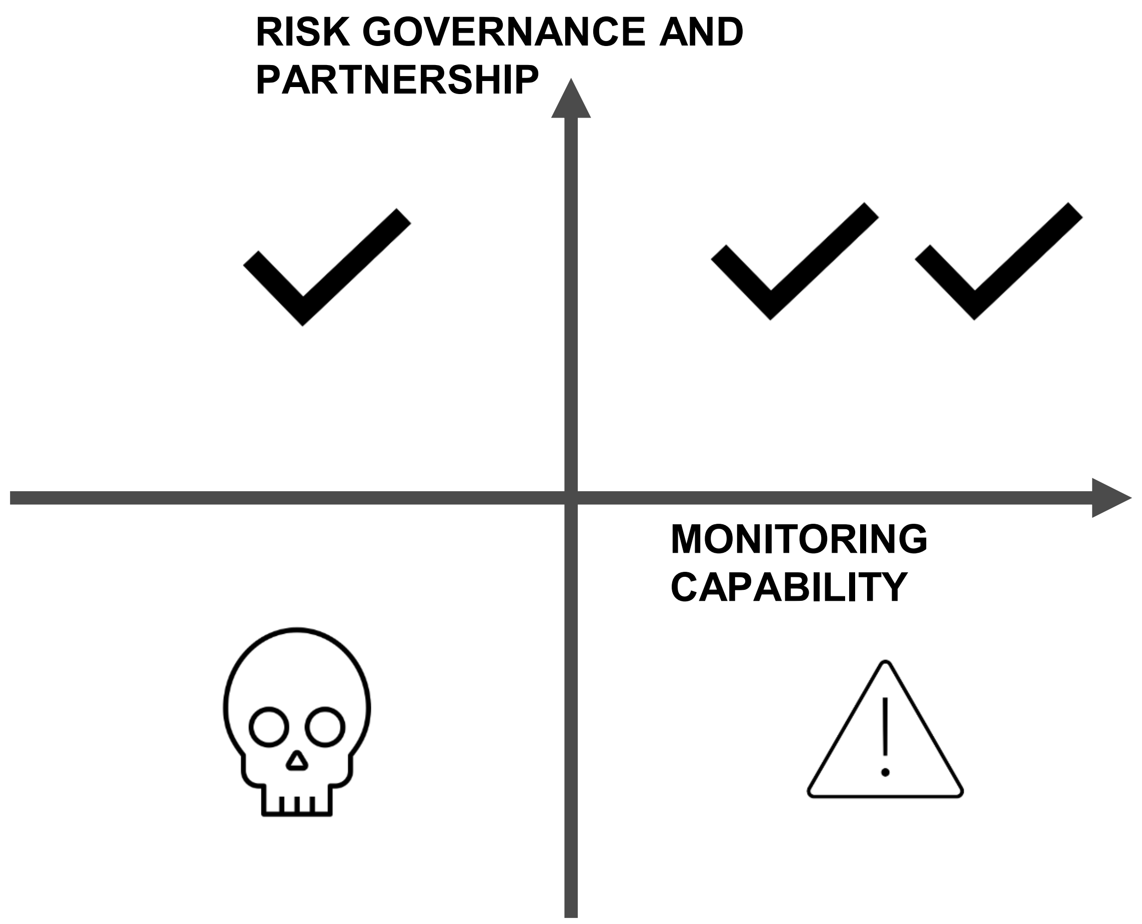
Volcanic risk management for visitors at Tongariro post 2012 eruption

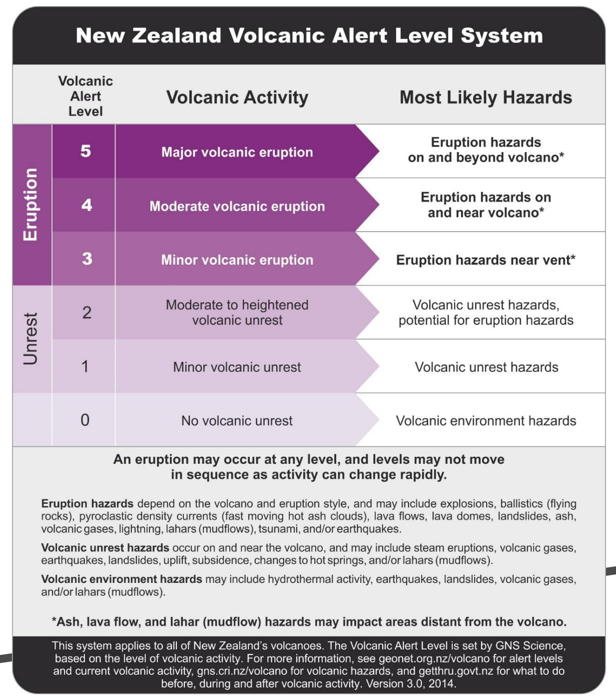
	Fatalities per year estimated	Fatality risk per visit
Falls	0.2	2.8×10^{-6}
Hypothermia	0.33	4.6×10^{-6}
Heart attack	1	1.4×10^{-5}
Avalanche (extrapolated from Ruapehu)	0.05	7.0×10^{-7}
Car accident in vicinity	1	1.4×10^{-5}
Volcanic eruption (Jolly and Taig 2012)	0.08	1.1×10^{-6}
Volcanic eruption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

Jolly and Tait, 2012

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 to 7.5×10^{-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





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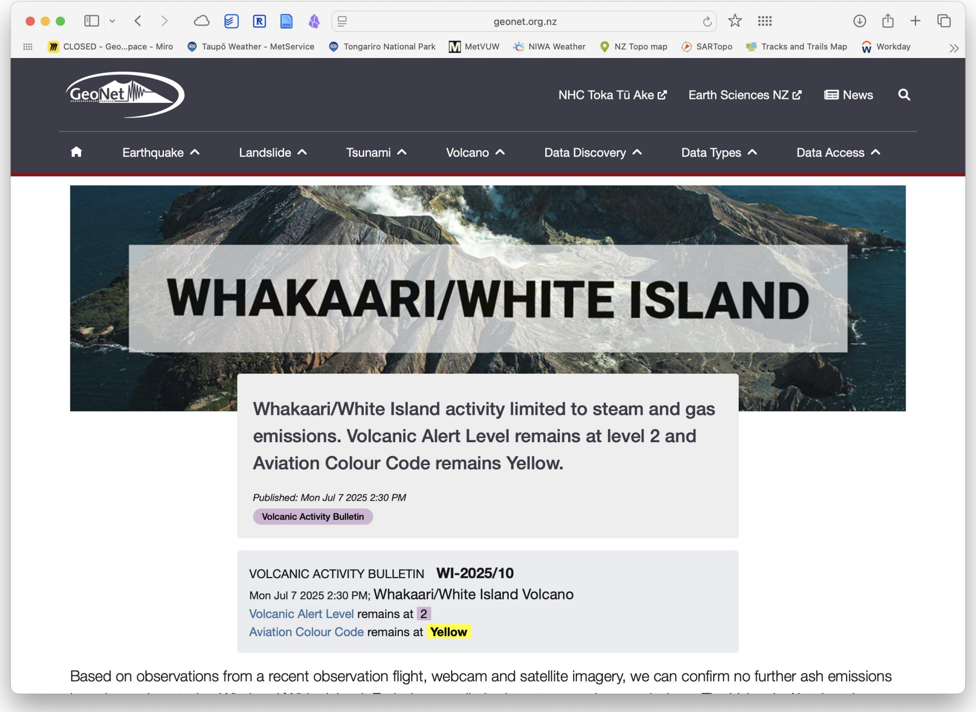

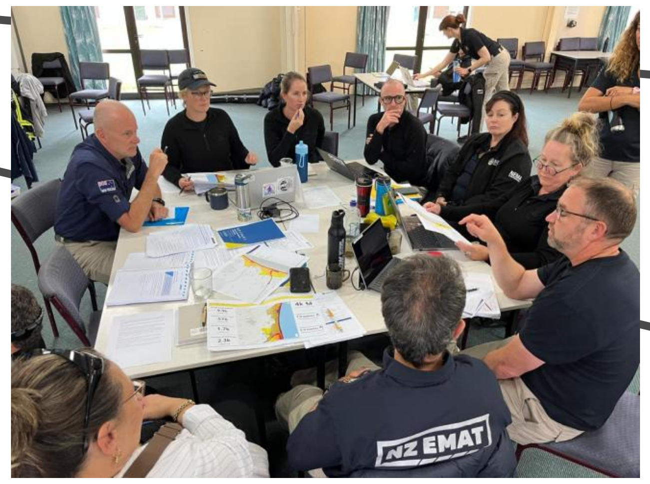

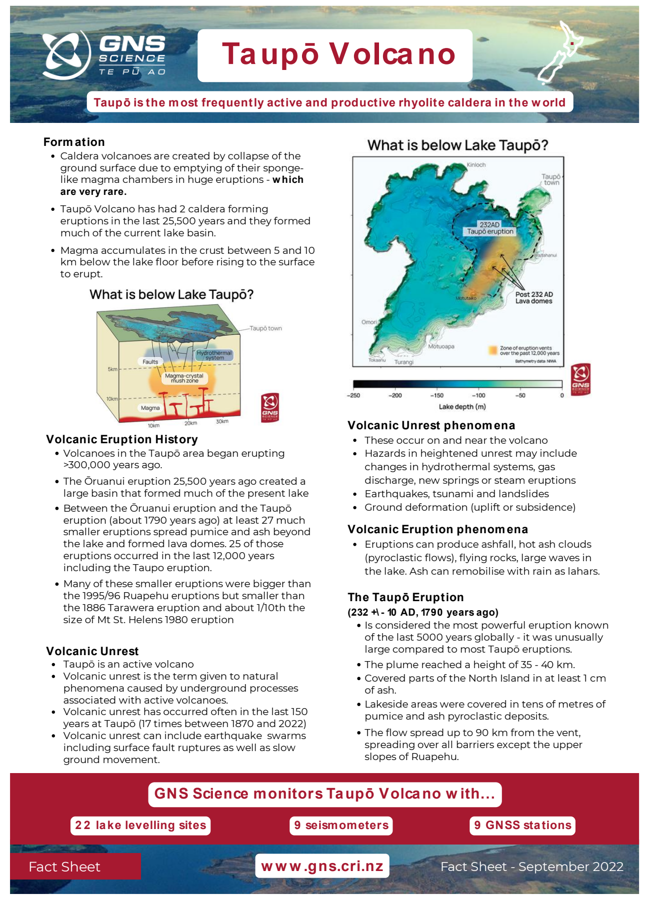

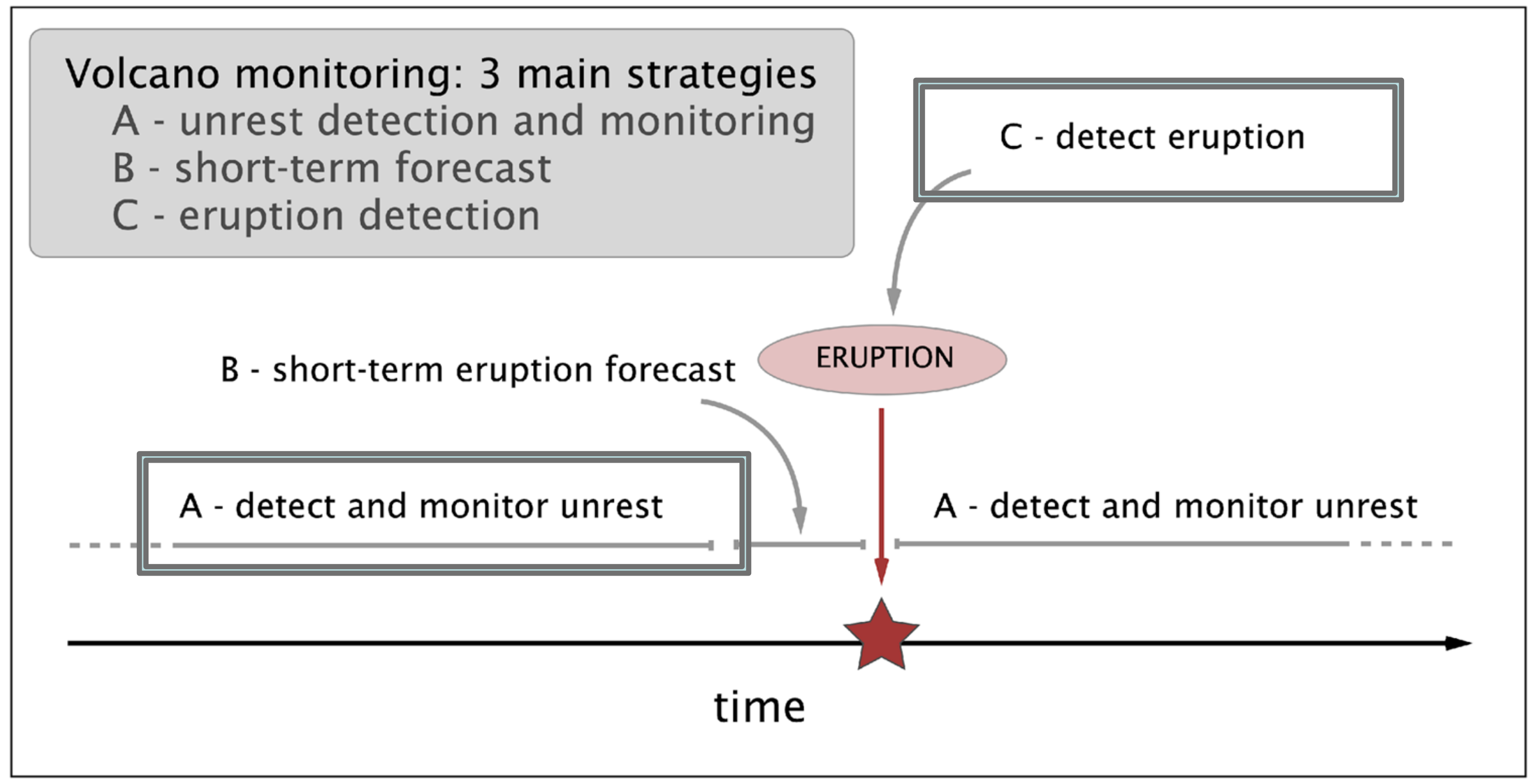

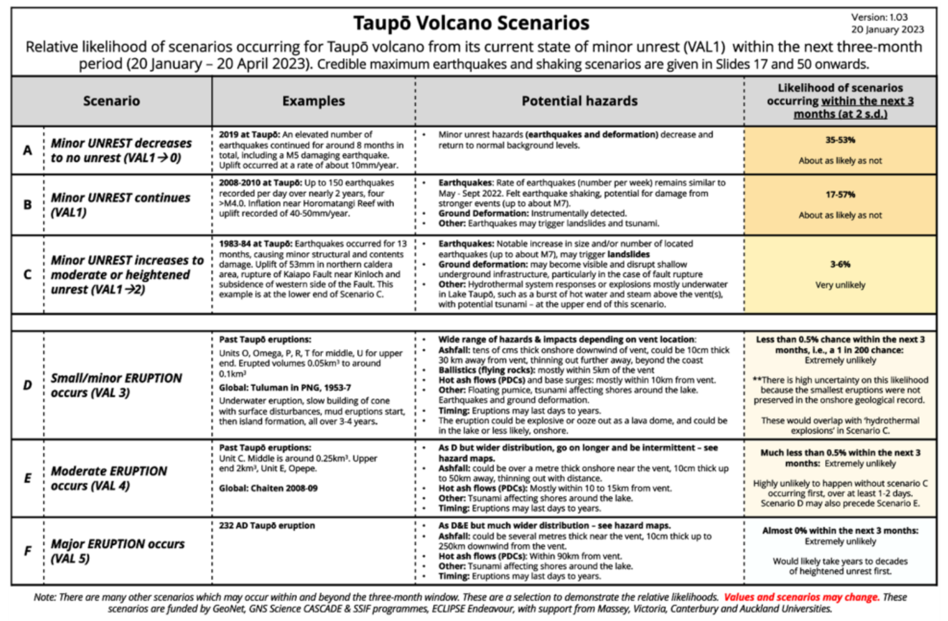

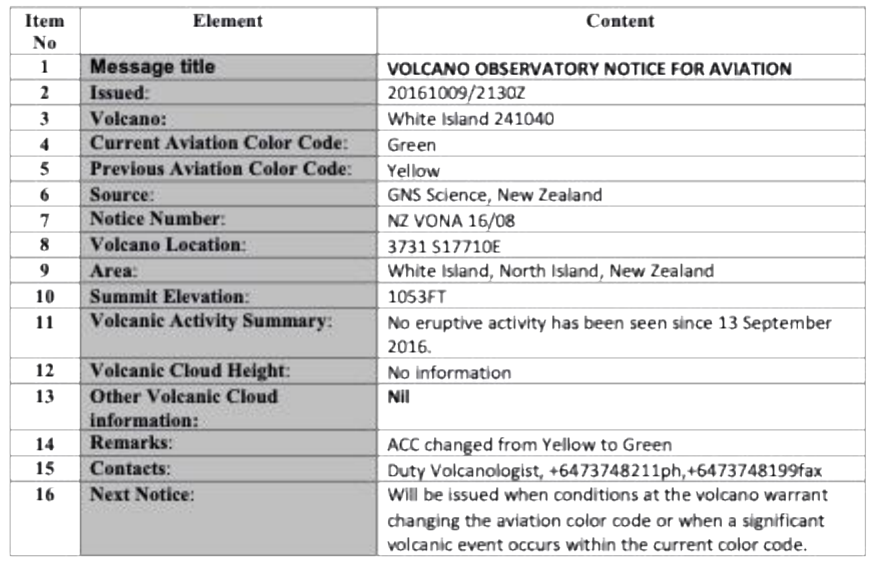

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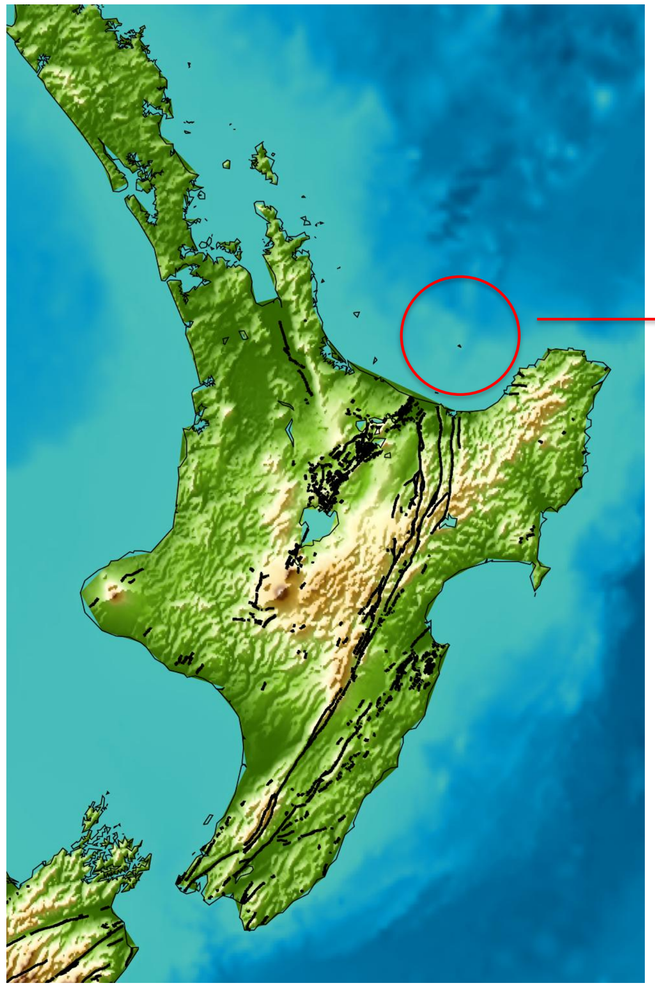
or is it…?

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.

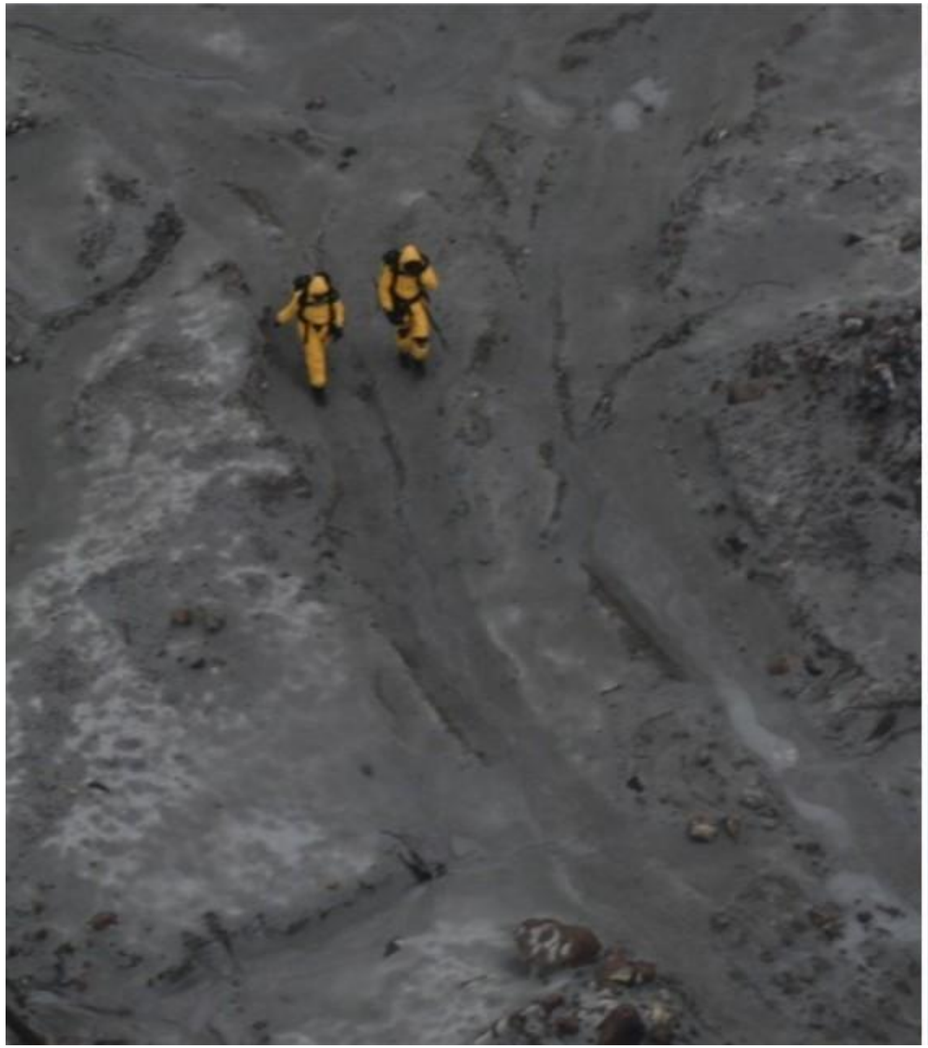
By 5pm, no signs of survivors.

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 (pleaded 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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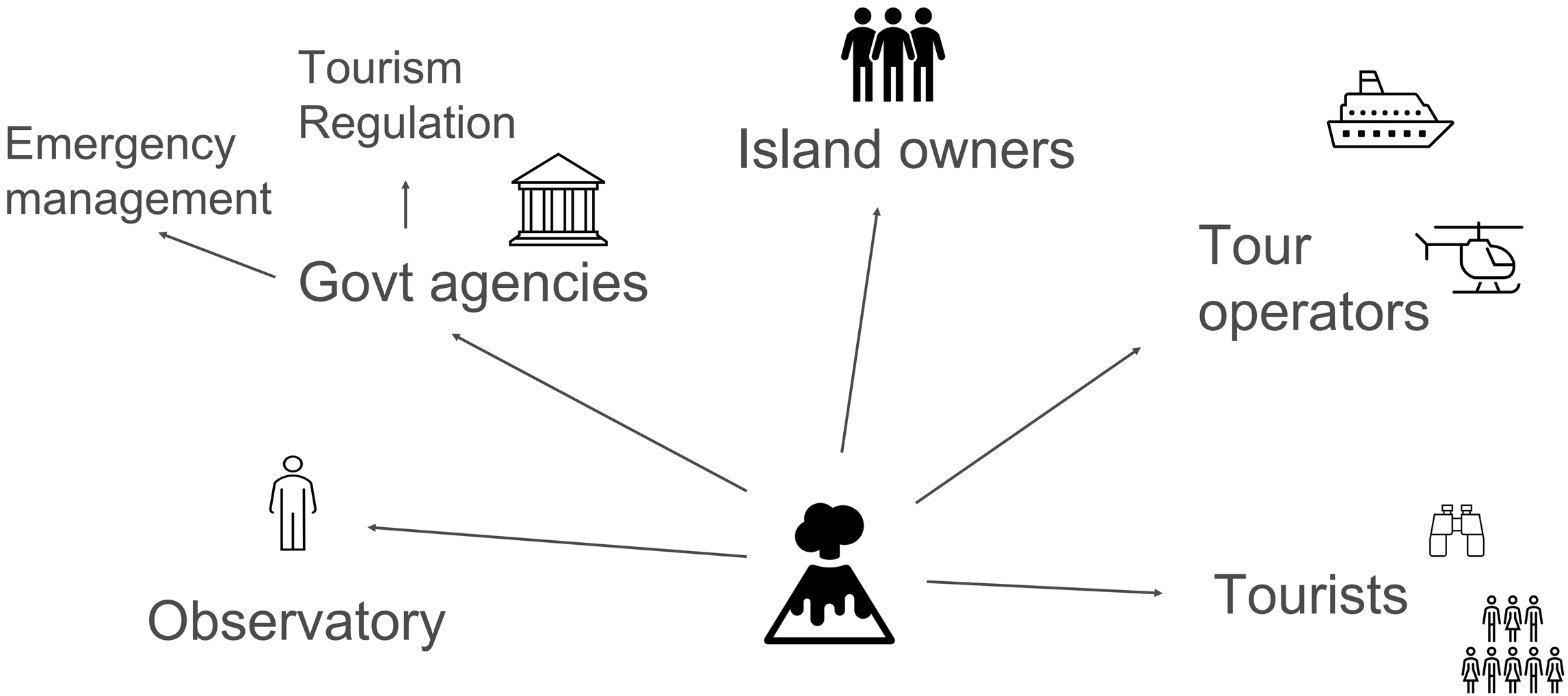
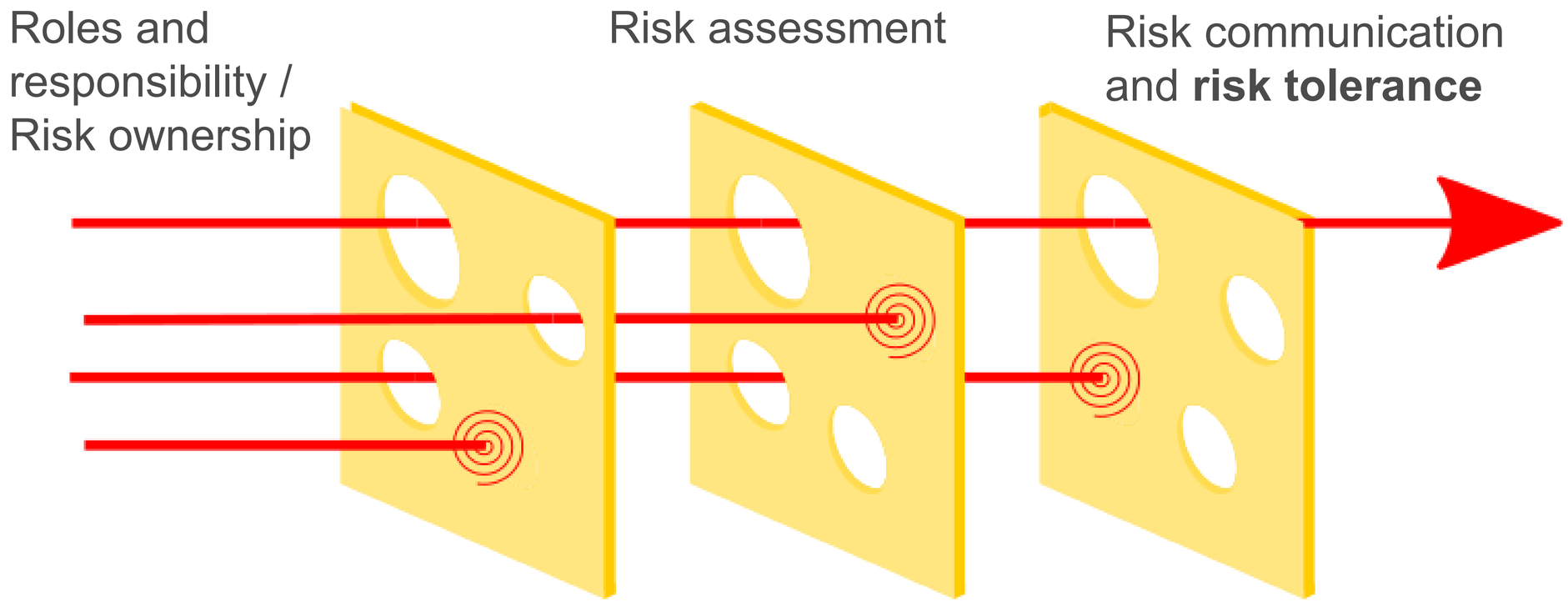
Who owns the risk? Who is the decision maker?



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

n.fournier@gns.cri.nz

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