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LINX120

16th - 17th November 2023

Park Plaza, Victoria

London

National Oceanography Centre

Volcanic Hazards & Subsea Cables:

Lessons from the 2022 eruption of Hunga volcano

Michael Clare & Isobel Yeo

Sally Watson, Richard Wysoczanski, Sarah Seabrook, Kevin Mackay, James Hunt, Emily Lane, Peter Talling, Edward Pope, Shane Cronin, Marta Ribó Gene, Taaniela Kula, David Tappin, Stuart Henrys, Cornel de Ronde, Morelia Urlaub, Steffan Kutterolf, Mike Williams

Natural Environment Research Council

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Tonga Geological Services MLNR Tonga

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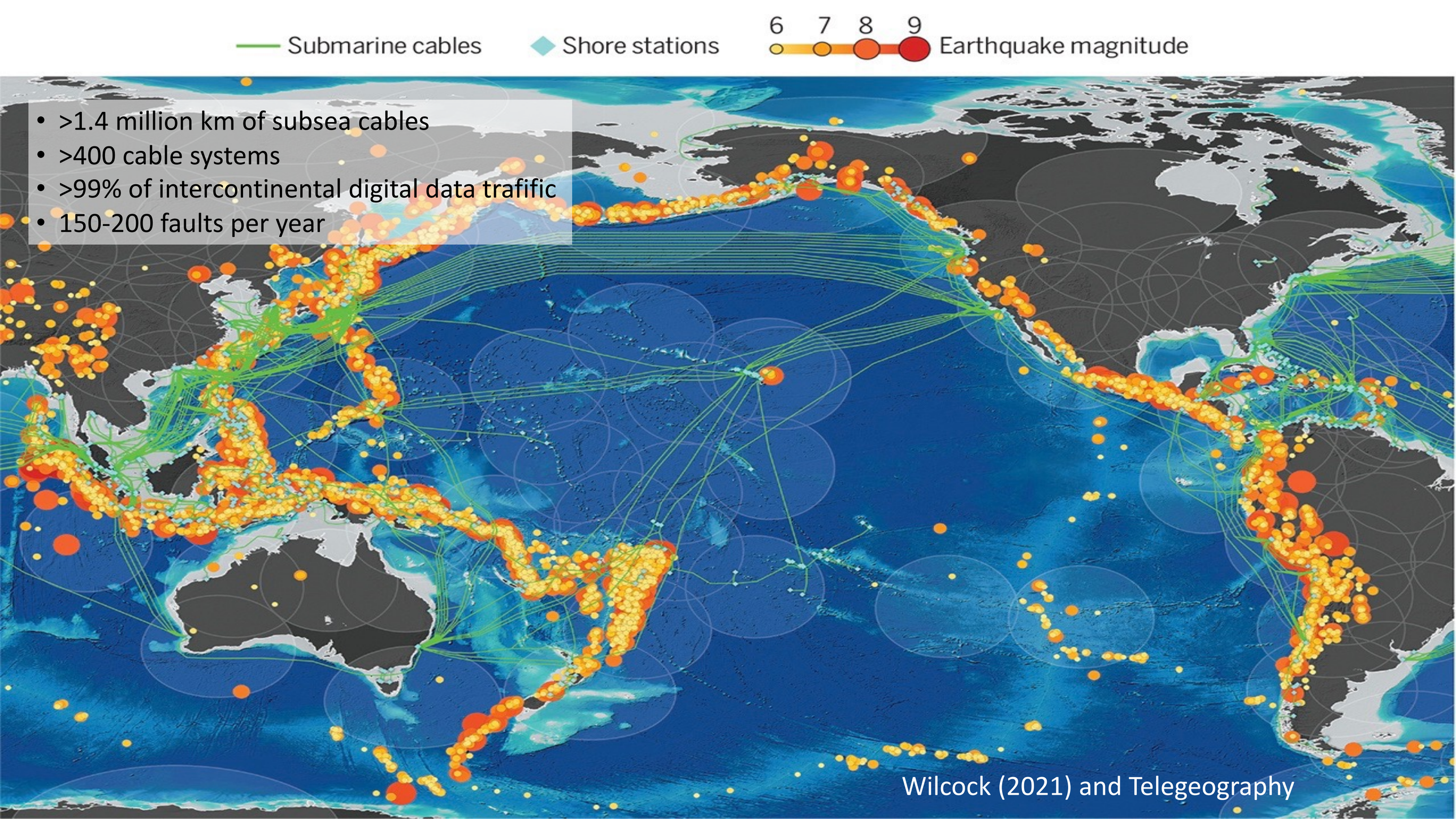
SouthernCross Cable Network

Tonga Cable Limited

International Cable Protection Committee


Submarine cables
Shore stations
6 7 8 9
Earthquake magnitude
• >1.4 million km of subsea cables
• >400 cable systems
• >99% of intercontinental digital data trafific
• 150-200 faults per year
Wilcock (2021) and Telegeography

The specific case of natural hazards

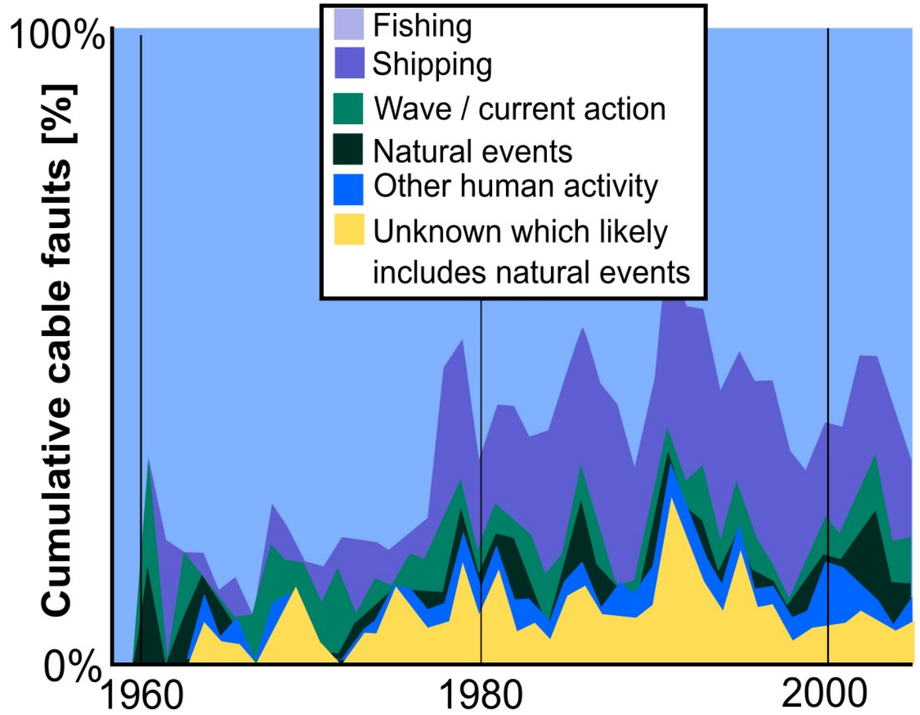
- Only 10-20% of subsea cable faults historically

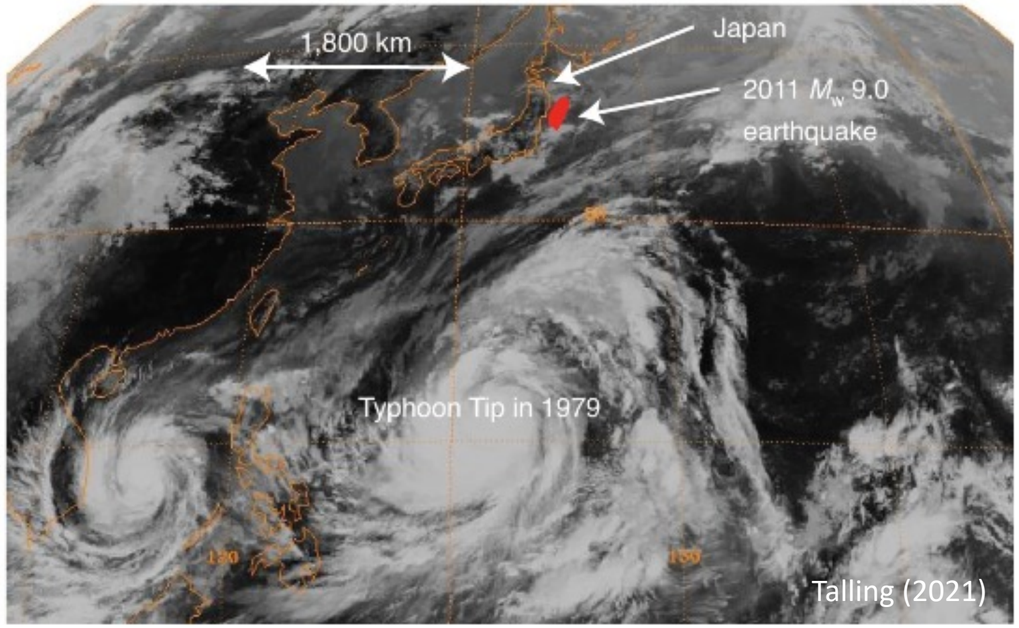
But....

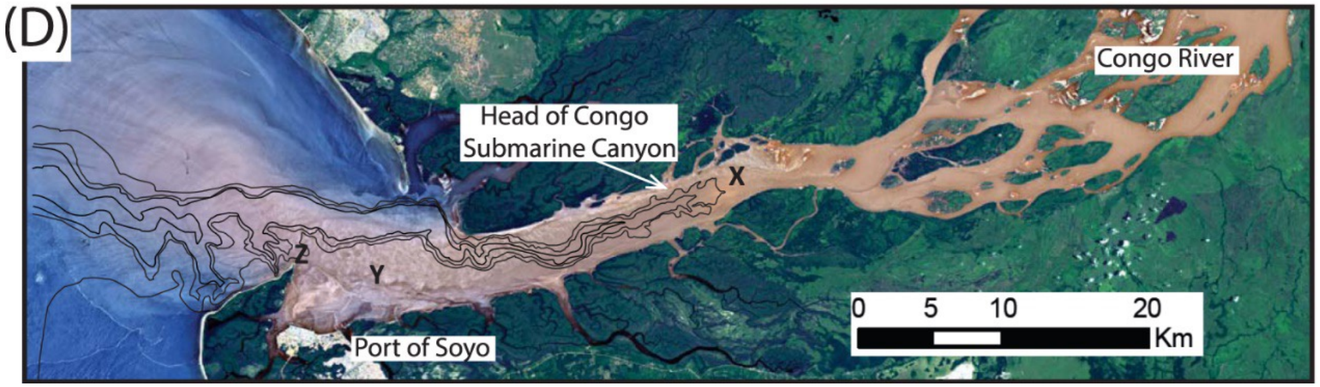
- Affect cables in all water depths
  - >30% of faults in deep water

- Can affect multiple systems synchronously over large areas leading to $100Ms repair and bigger knock on effects

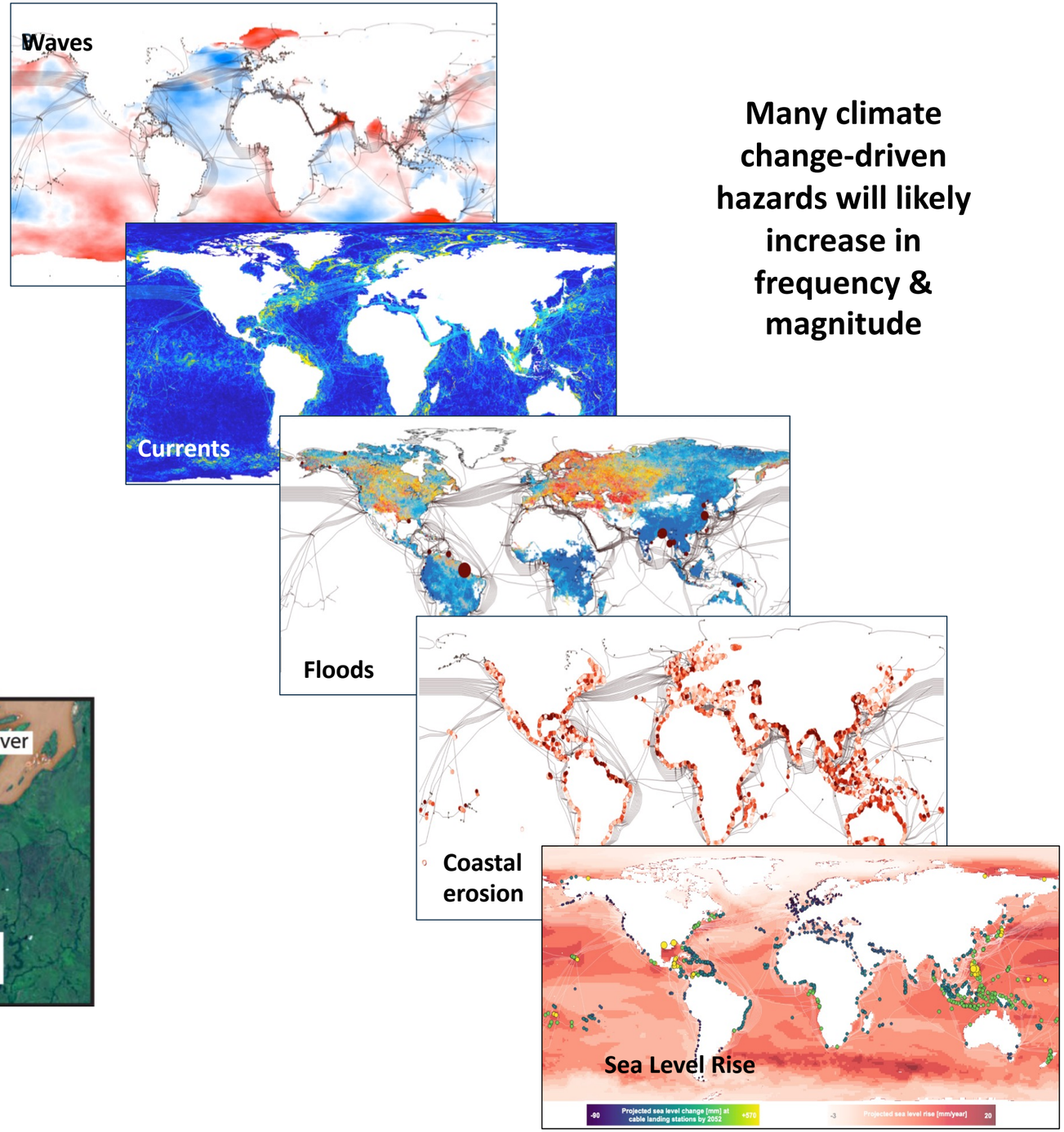
Clare et al. (2022) after Kordahi et al. (2019)







Flood triggered cable-damaging flows ran out >1200 km into the deep sea during first COVID-19 lockdown

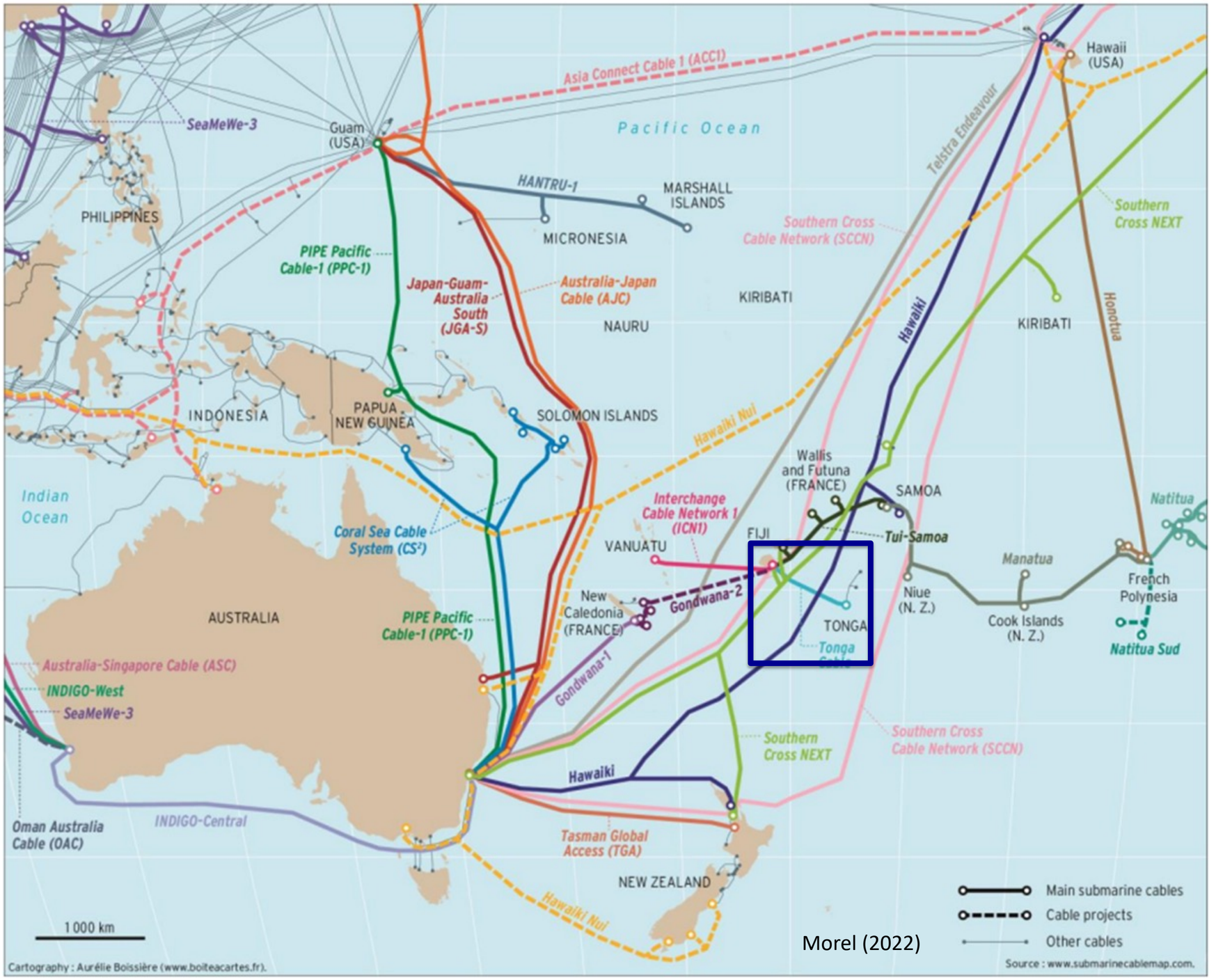


Many climate change-driven hazards will likely increase in frequency & magnitude

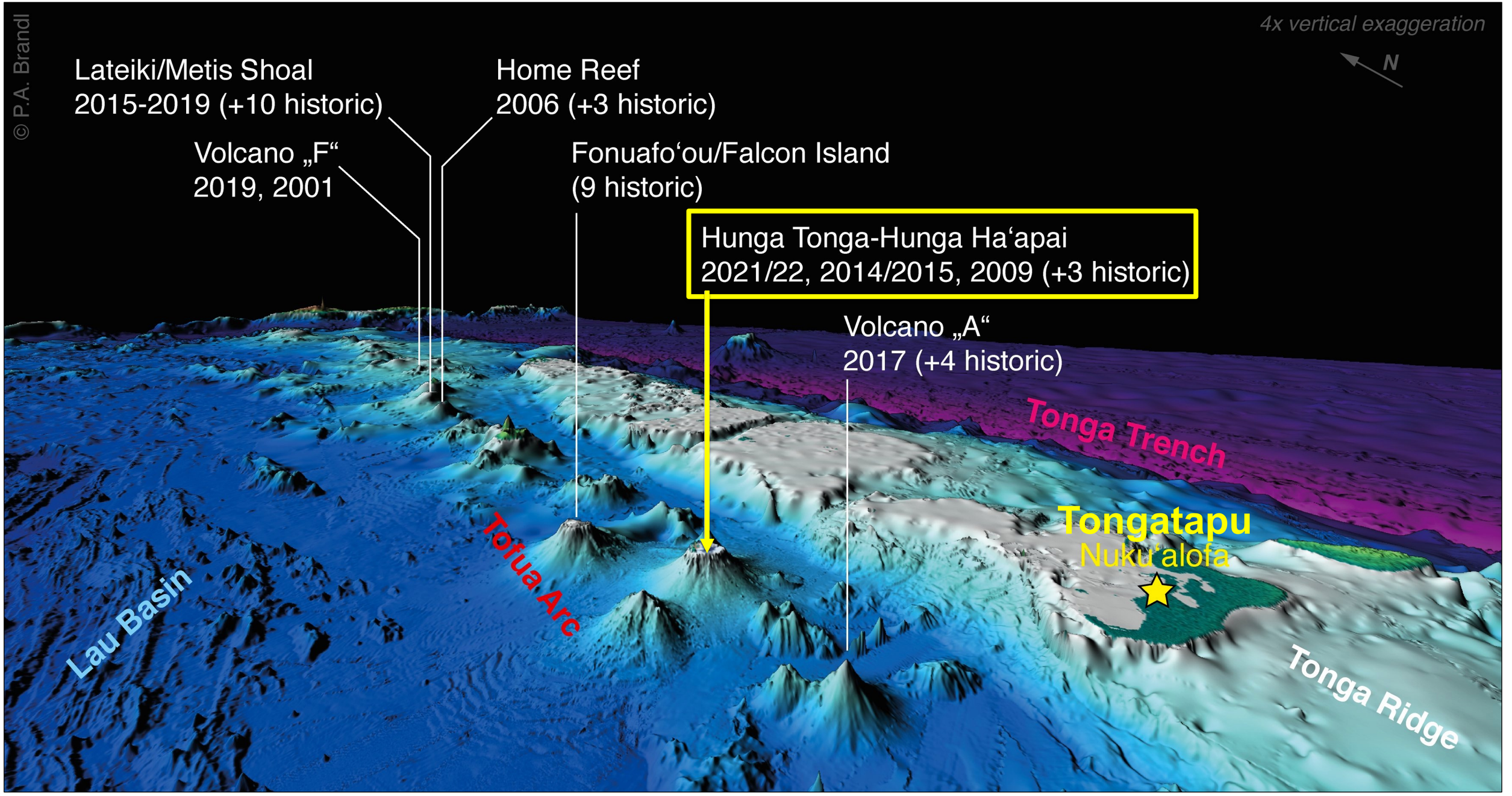
Clare et al. (2022)

- Most regions are resilient due to:
  - Redundancy in the network
  - Ready access to repair ships
  - Sufficient replacement stocks

The South Pacific is an exception



Morel (2022)


© P.A. Brandl
4x vertical exaggeration
N
Lateiki/Metis Shoal
2015-2019 (+10 historic)
Home Reef
2006 (+3 historic)
Volcano „F“
2019, 2001
Fonuafo‘ou/Falcon Island
(9 historic)
Hunga Tonga-Hunga Ha‘apai
2021/22, 2014/2015, 2009 (+3 historic)
Volcano „A“
2017 (+4 historic)
Tonga Trench
Tongatapu
Nuku‘alofa
Tofua Arc
Lau Basin
Tonga Ridge


Pununu Tukuafu - Tonga Geological Services


November 17 2021
A
Planet Earth
January 3 2022
B
Planet Earth
January 7 2022
C
Planet Earth
January 15 2022; 15:25 TOT
D
Planet Earth
TONGA GEOLOGICAL SERVICES
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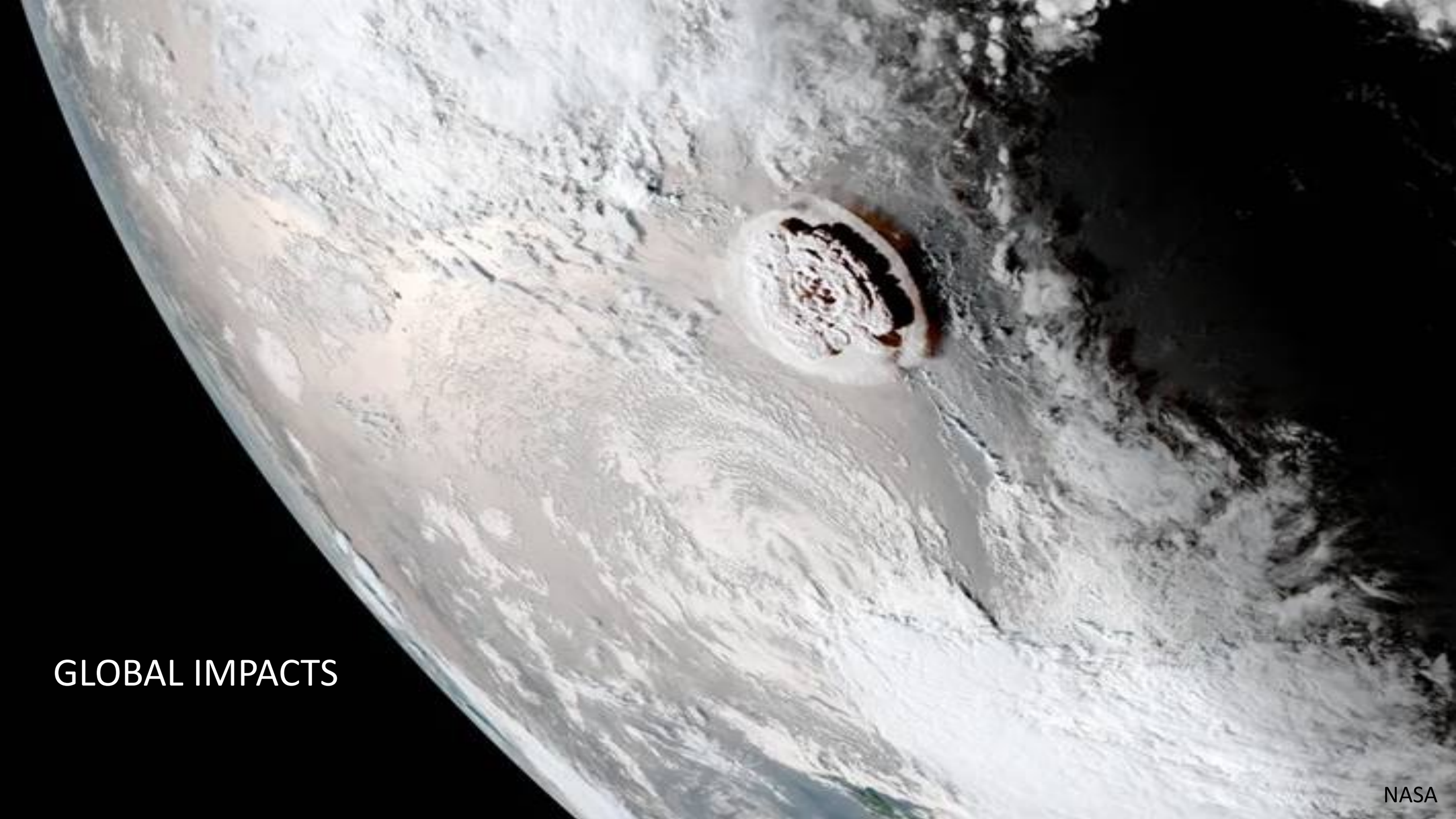


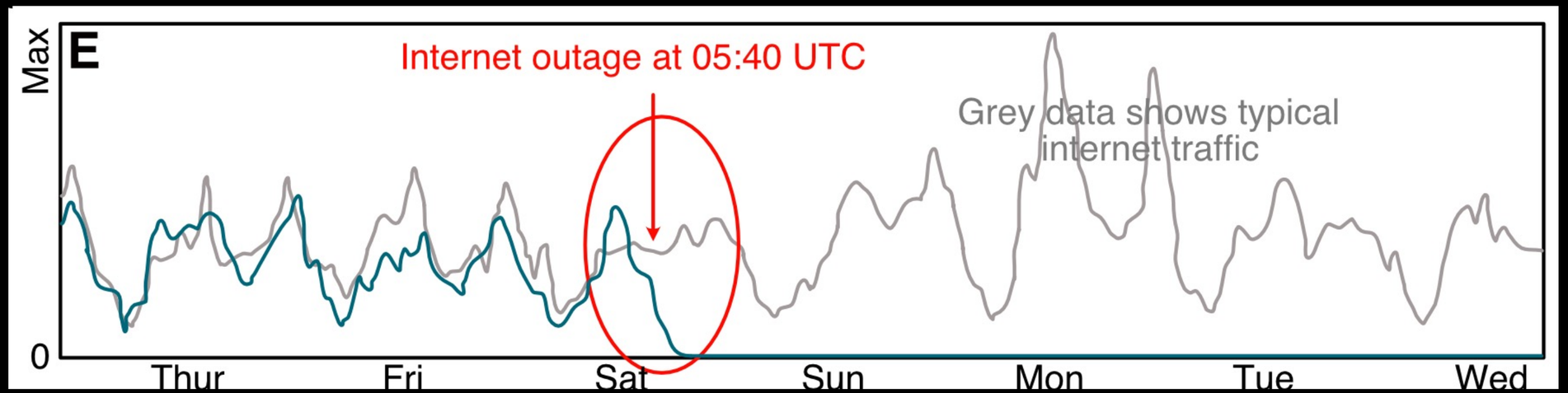
GLOBAL IMPACTS

NASA

Branko Sugar (15/01/2022)

Dr Faka’iloatonga Taumoefolau (15/01/22)

and then, in the middle of a crisis….



Broken Cable Shuts Down Tonga's Internet

NFK EDITORS - JANUARY 27, 2019

Nuku'alofa, Tonga —(Map)

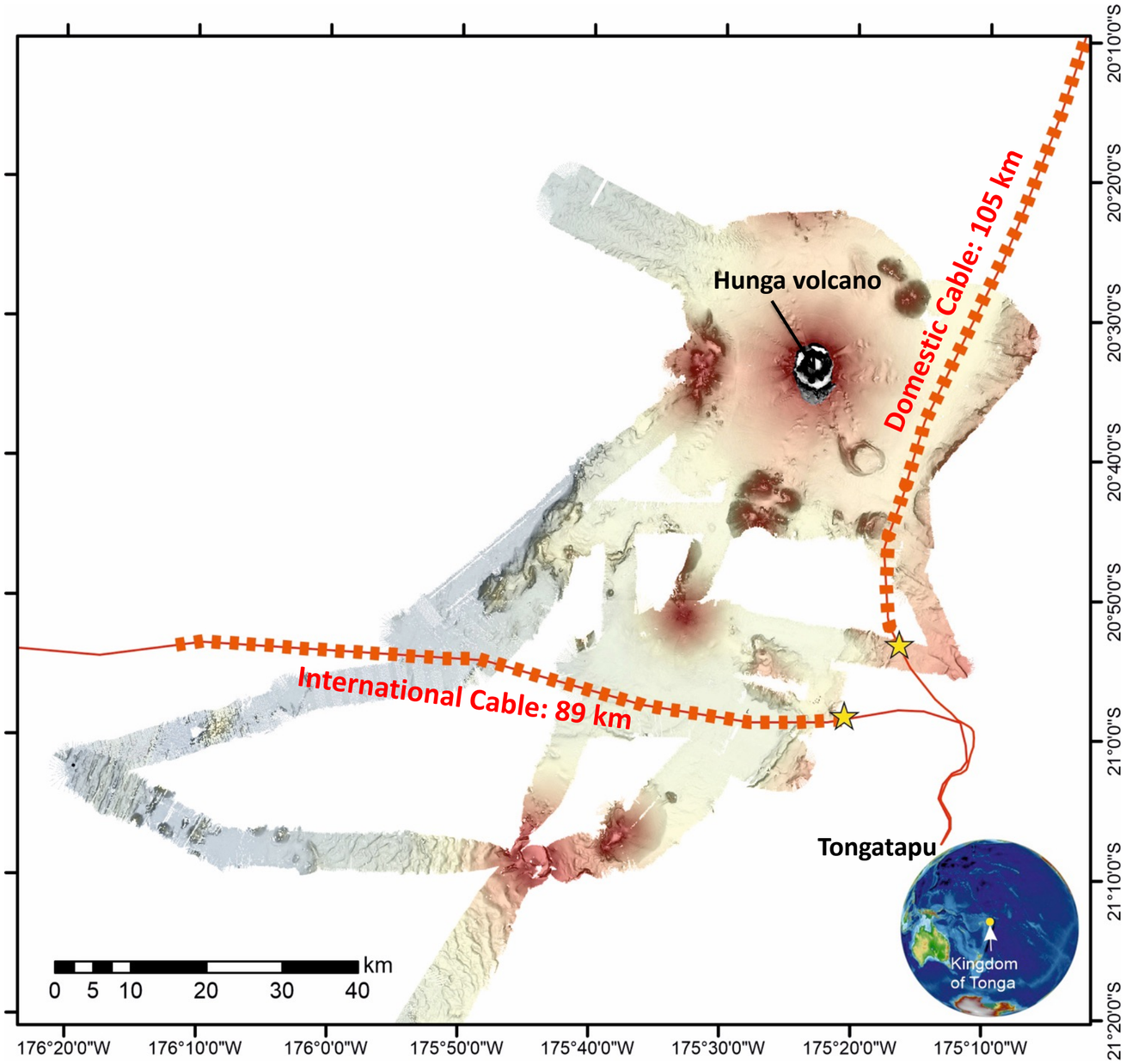
The Pacific project
Tonga volcano

'Not knowing is heartbreaking': sleepless nights among Tongan diaspora after contact with country cut off

Kate Lyons *in Sydney and* Tess McClure *in Auckland*

Mon 17 Jan 2022 04.17 GMT

- Repair to international cable took 5 weeks
- Domestic cable repaired 1.5 years later…



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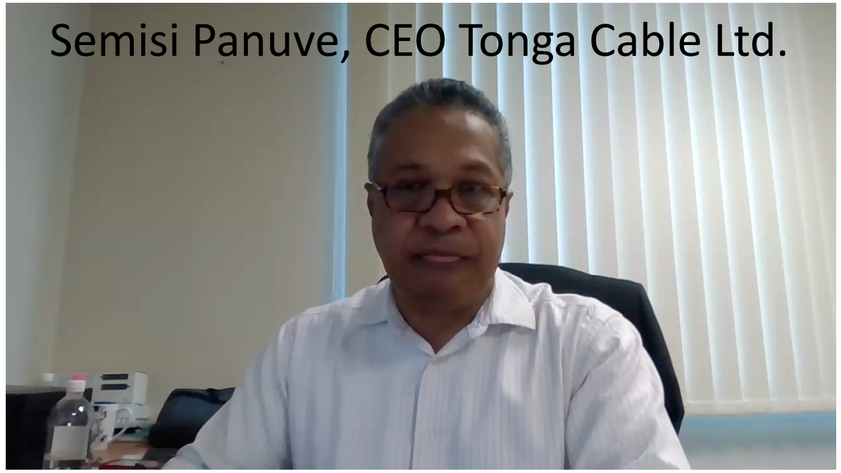
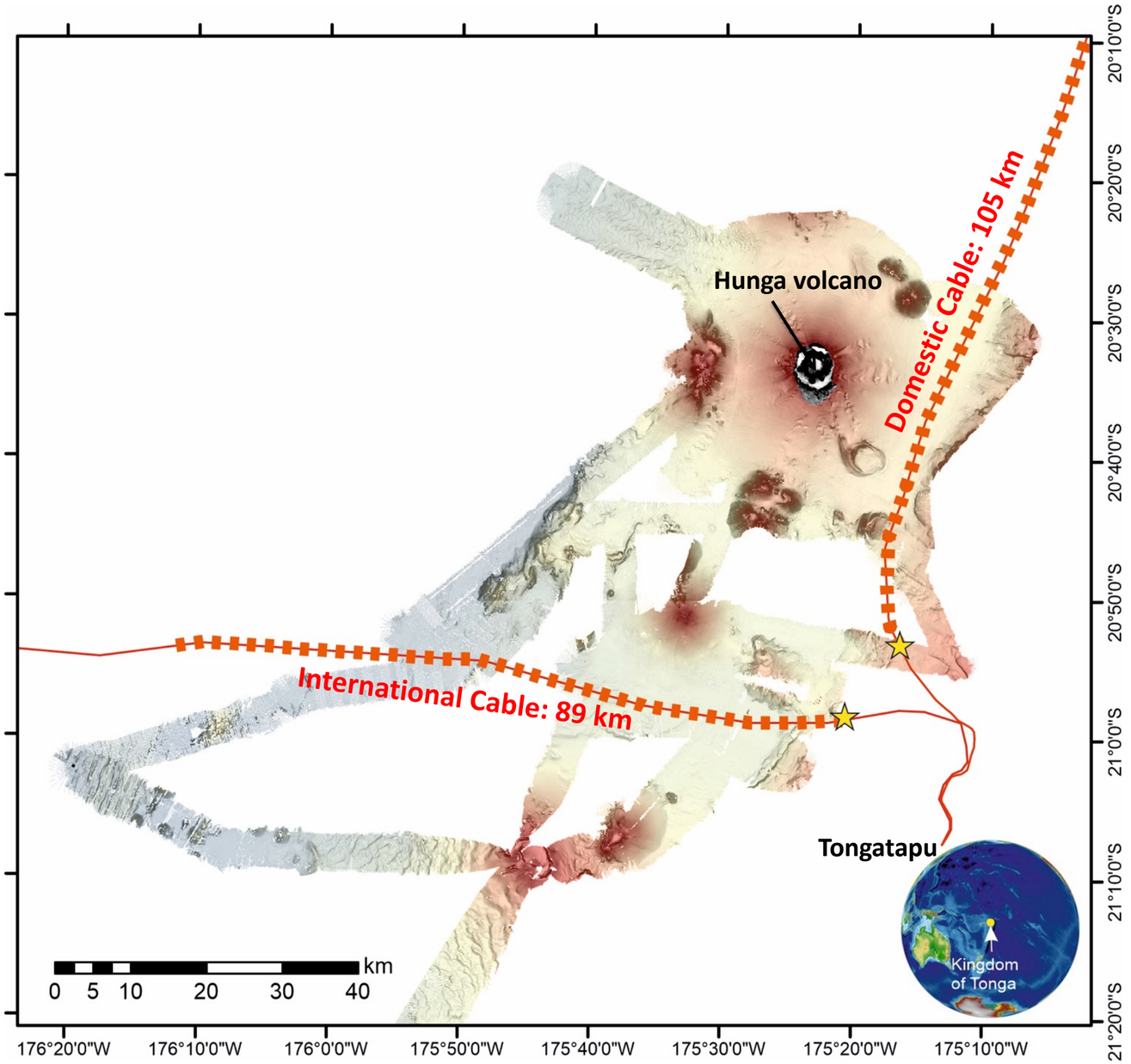
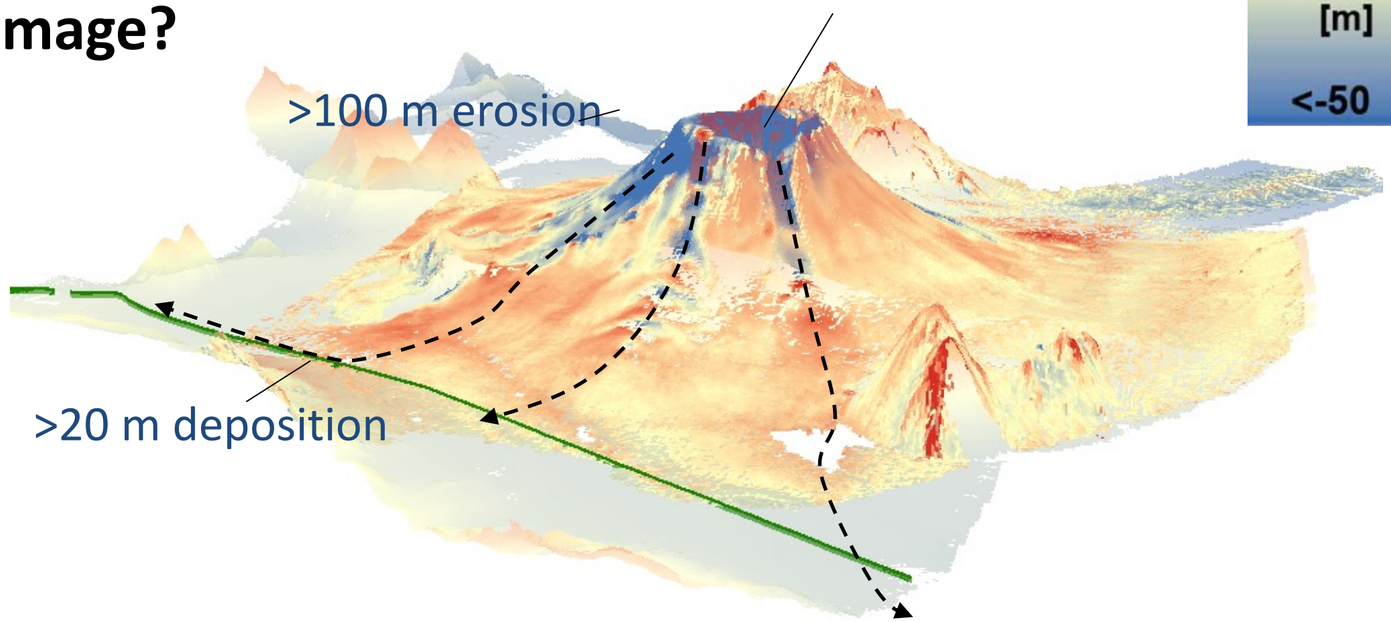


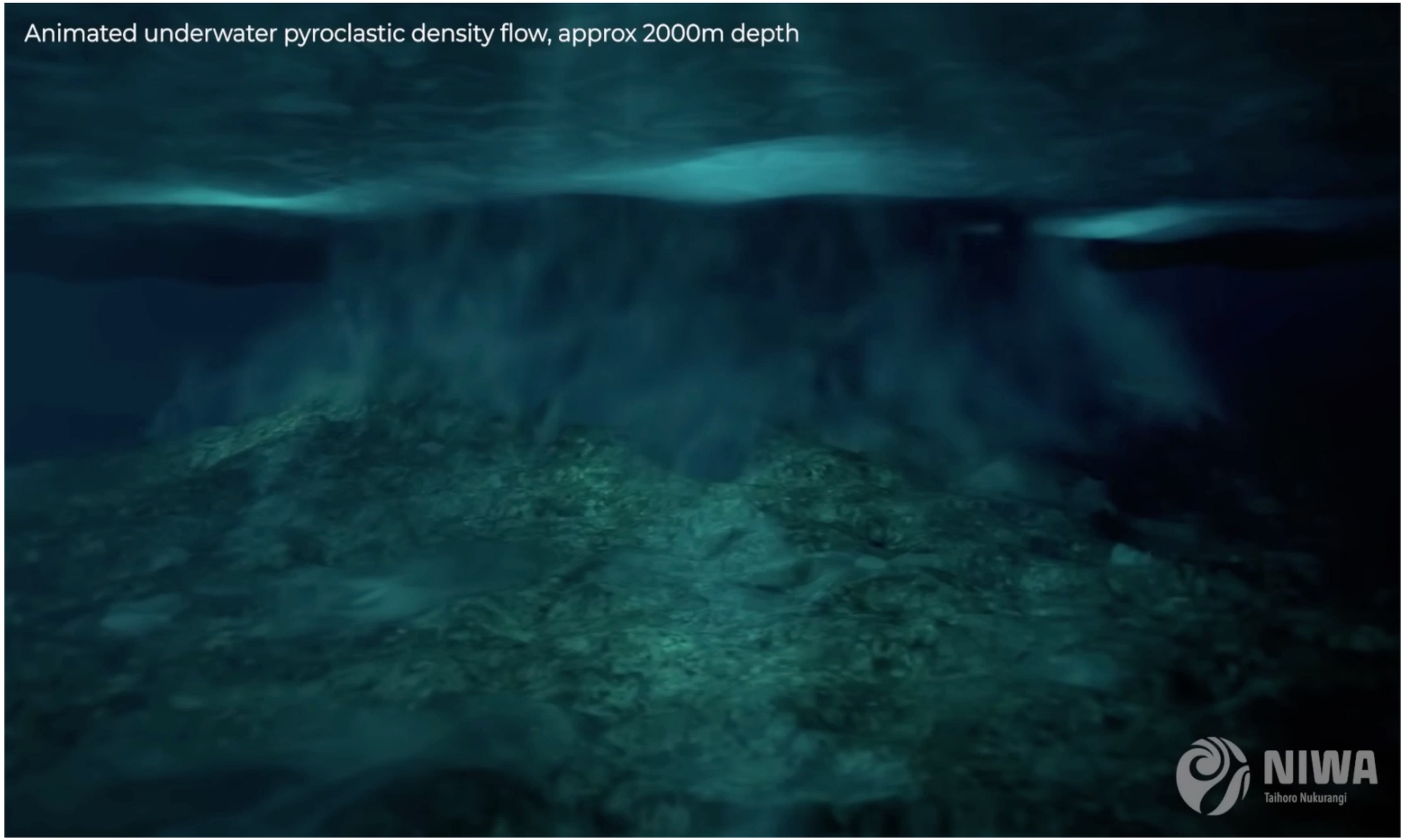


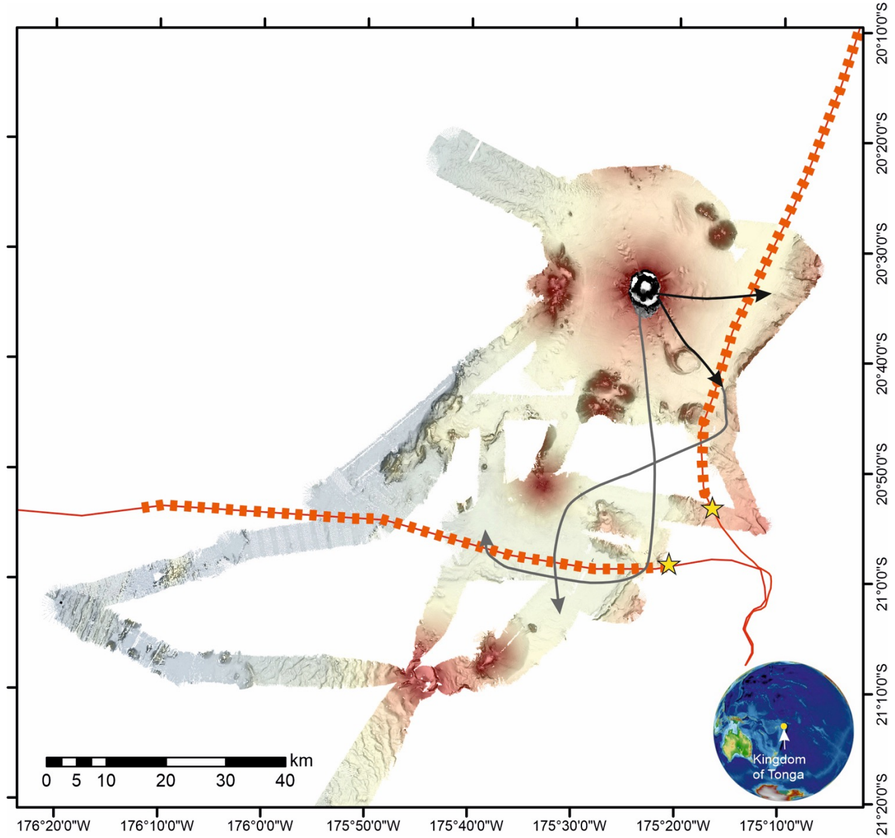
What caused the extensive damage?

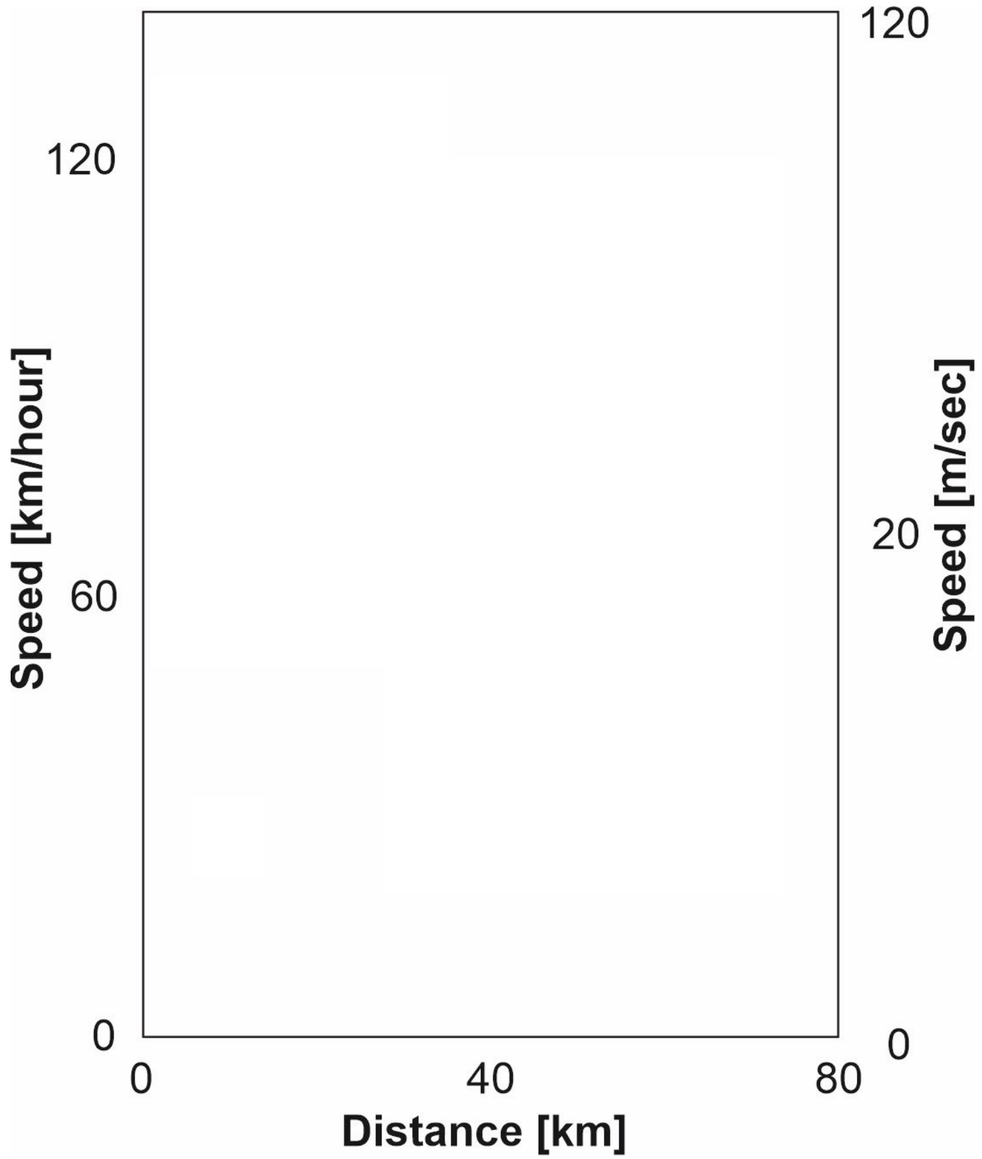
- Powerful and dense flows of volcanic material
- Identified from seafloor surveys performed within 3 months of the eruption

A very big hole!
900 m vertical change
>6 km^3 erupted volume



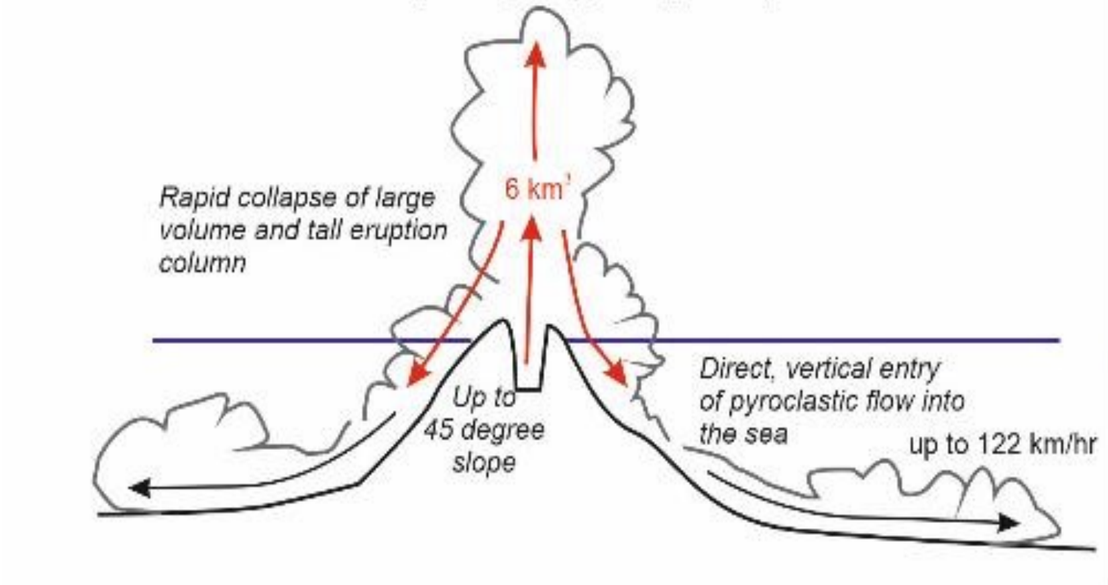

Animated underwater pyroclastic density flow, approx 2000m depth
NIWA
Taihoro Nukurangi





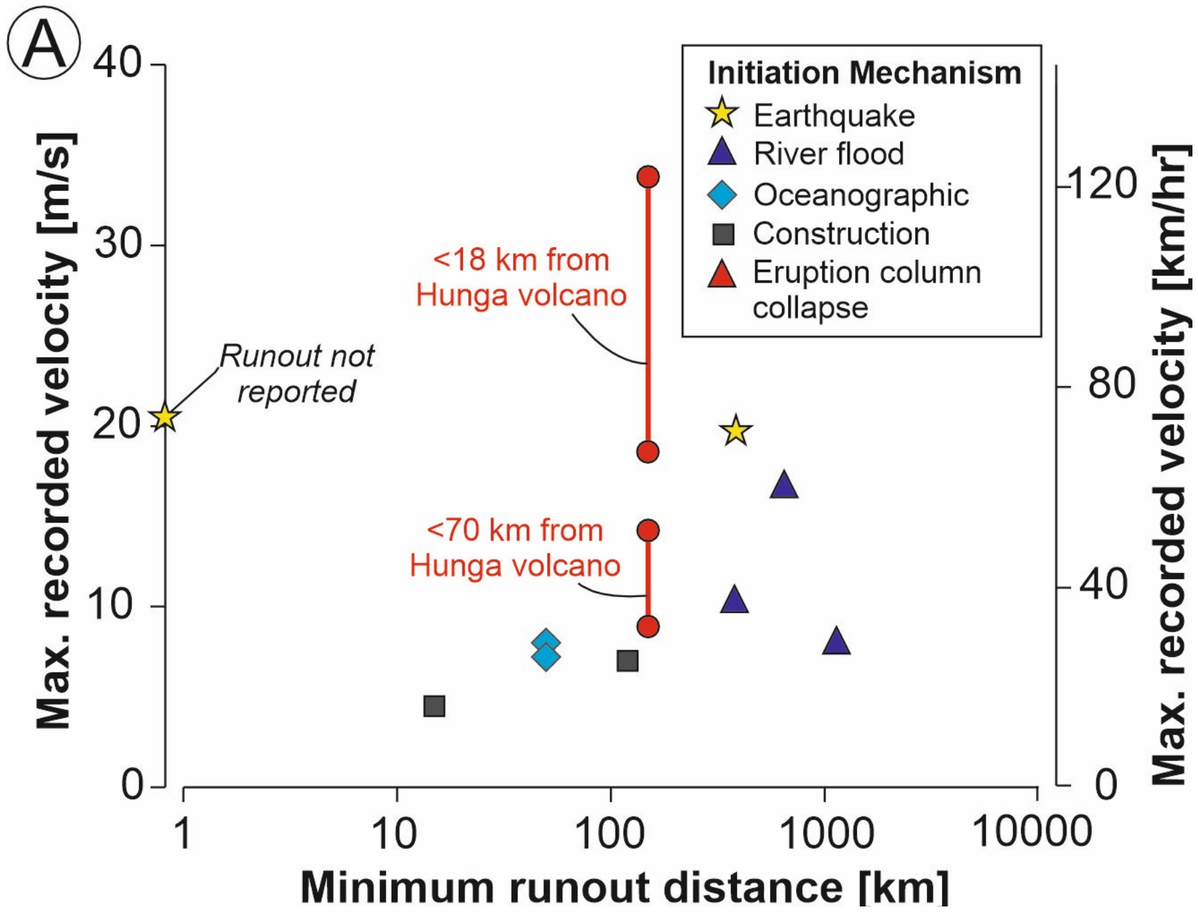
The first underwater measurements of flows created by a volcanic eruption

The fastest underwater flows on Earth



Dense and fast flows can travel at fast speed for >100 km

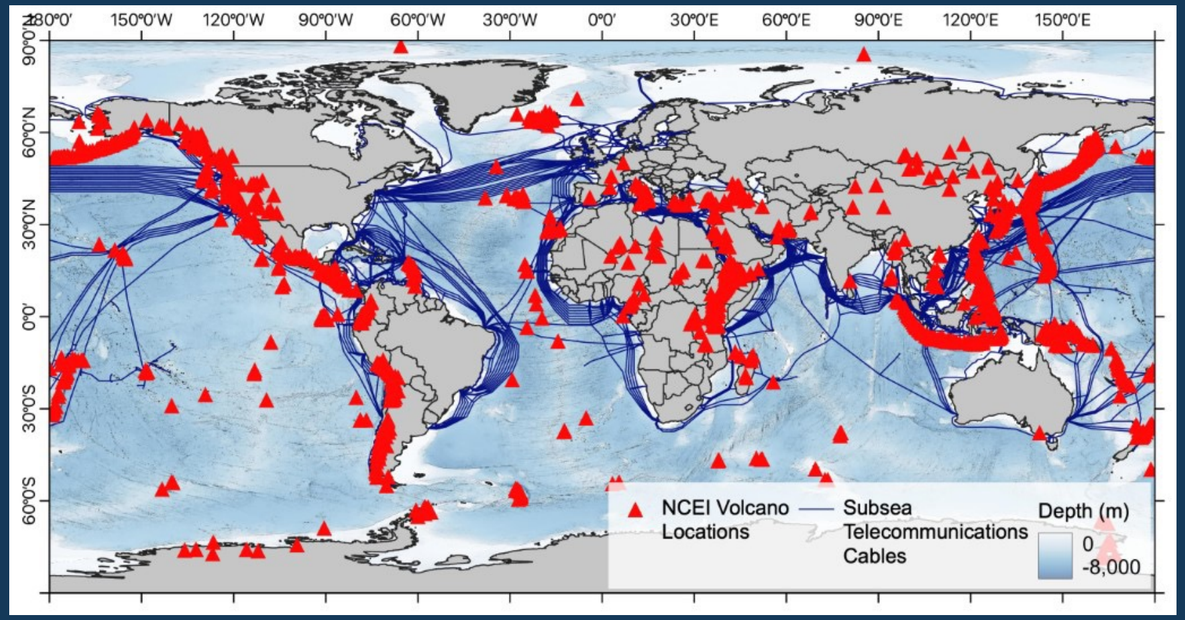
Setting a stand-off distance may not be appropriate…

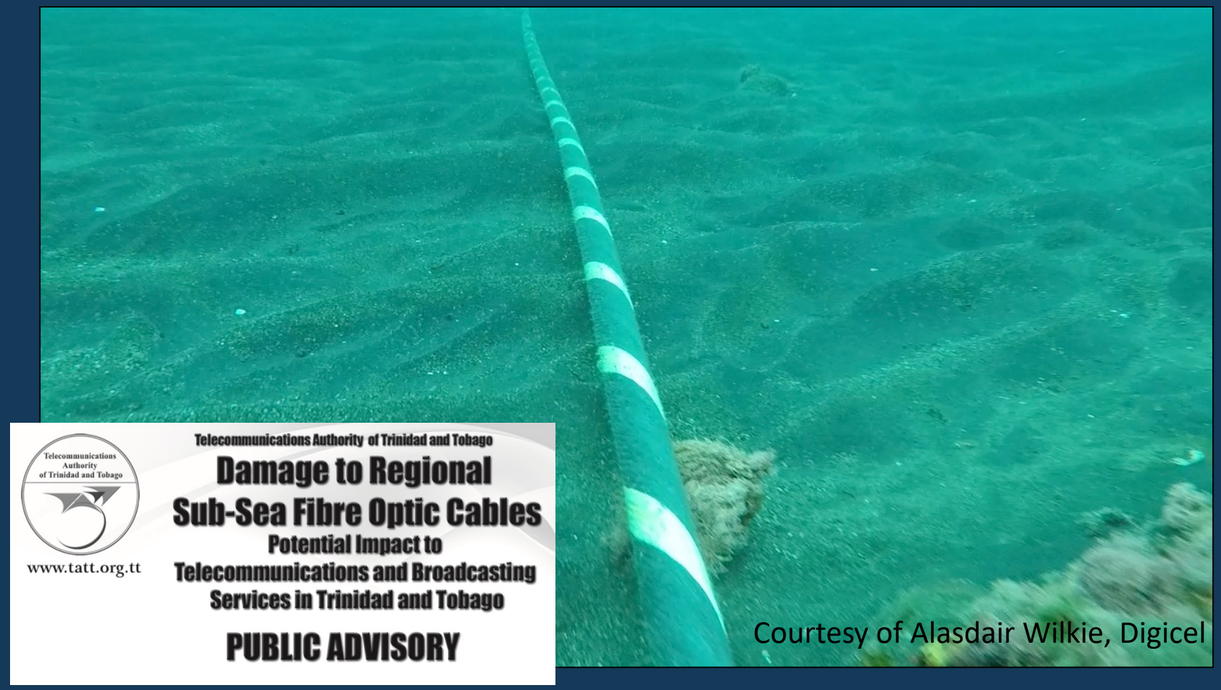


Small island states are particularly exposed…

What should we do?

- Better mapping incl. repeat surveys
- Regional monitoring incl. use of fibre-optic sensing along cables
- More and diverse routes and landing points
- Local stocks of cable
- Increased investment in back-up ow level satellite communications





Courtesy of Alasdair Wilkie, Digicel

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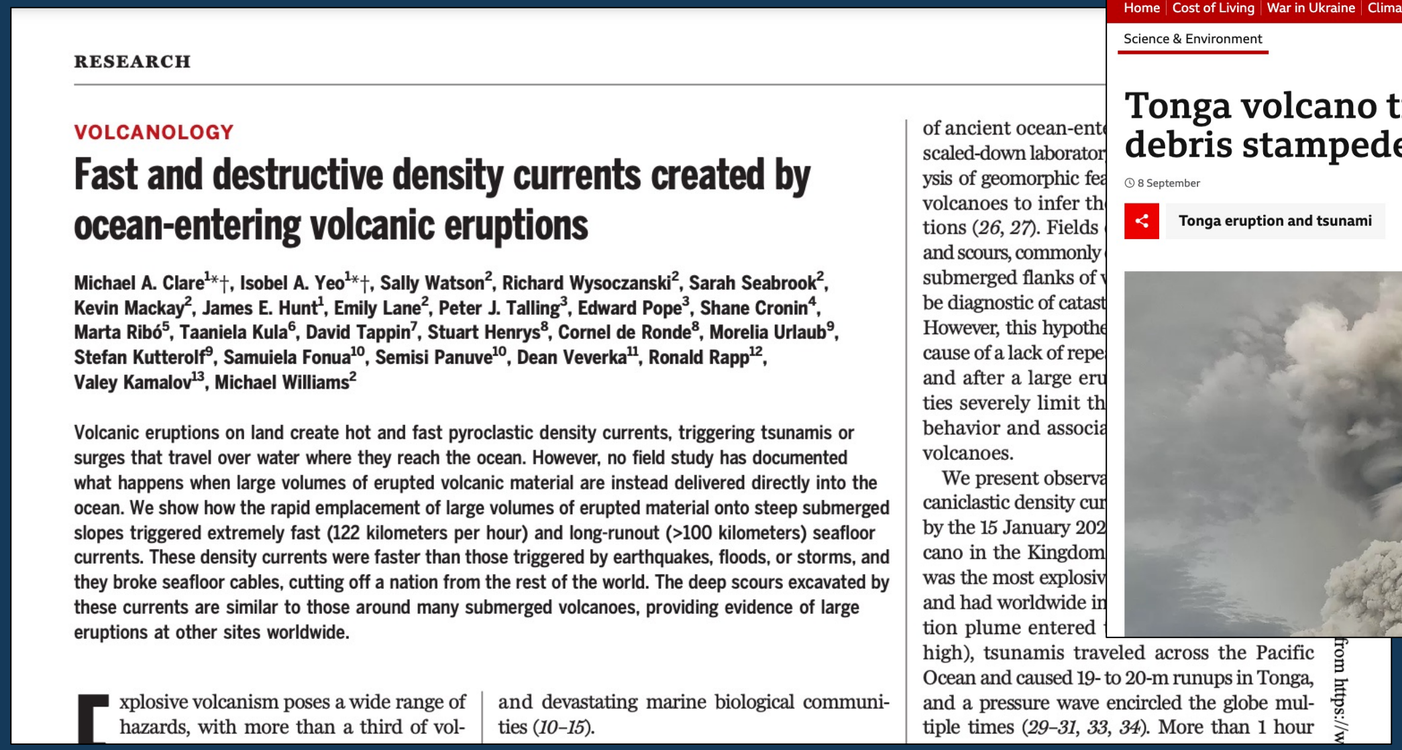
Read more…



RESEARCH

VOLCANOLOGY

Fast and destructive density currents created by ocean-entering volcanic eruptions

Michael A. Clare[1]*†, Isobel A. Yeo[1]*†, Sally Watson[2], Richard Wysoczanski[2], Sarah Seabrook[2], Kevin Mackay[2], James E. Hunt[1], Emily Lane[2], Peter J. Talling[3], Edward Pope[3], Shane Cronin[4], Marta Ribó[5], Taaniela Kula[6], David Tappin[7], Stuart Henrys[8], Cornel de Ronde[8], Morelia Urlaub[9], Stefan Kutterolf[9], Samuiela Fonua[10], Semisi Panuve[10], Dean Veverka[11], Ronald Rapp[12], Valey Kamalov[13], Michael Williams[2]

Volcanic eruptions on land create hot and fast pyroclastic density currents, triggering tsunamis or surges that travel over water where they reach the ocean. However, no field study has documented what happens when large volumes of erupted volcanic material are instead delivered directly into the ocean. We show how the rapid emplacement of large volumes of erupted material onto steep submerged slopes triggered extremely fast (122 kilometers per hour) and long-runout (>100 kilometers) seafloor currents. These density currents were faster than those triggered by earthquakes, floods, or storms, and they broke seafloor cables, cutting off a nation from the rest of the world. The deep scours excavated by these currents are similar to those around many submerged volcanoes, providing evidence of large eruptions at other sites worldwide.

Explosive volcanism poses a wide range of hazards, with more than a third of vol- and devastating marine biological communities (*10*–*15*).

of ancient ocean-ente
scaled-down laborator
ysis of geomorphic fea
volcanoes to infer th
tions (*26*, *27*). Fields
and scours, commonly
submerged flanks of v
be diagnostic of catast
However, this hypothe
cause of a lack of repe
and after a large eru
ties severely limit th
behavior and associa
volcanoes.

We present observa
caniclastic density cur
by the 15 January 202
cano in the Kingdom
was the most explosiv
and had worldwide in
tion plume entered
high), tsunamis traveled across the Pacific Ocean and caused 19- to 20-m runups in Tonga, and a pressure wave encircled the globe multiple times (*29*–*31*, *33*, *34*). More than 1 hour

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Science & Environment

Tonga volcano triggered seafloor debris stampede

8 September

Tonga eruption and tsunami

Clare, Yeo et al. Science (2023)