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National Oceanography Centre

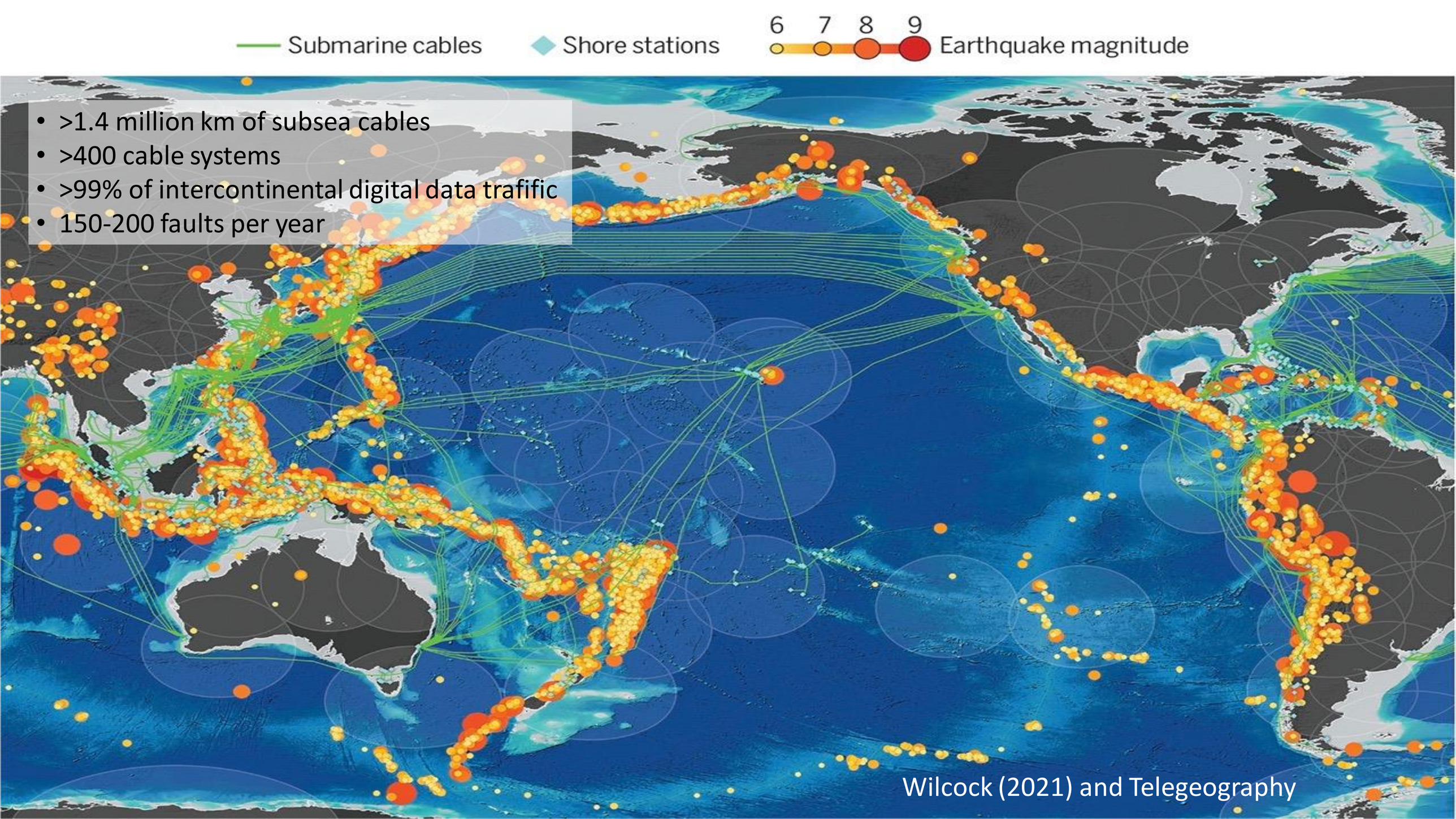
Volcanic Hazards & Subsea Cables:

Lessons from the 2022 eruption of Hunga volcano

Isobel Yeo & Michael Clare

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 | THE NIPPON FOUNDATION | NIWA Taihoro Nukurangi | University of Auckland Waipapa Taumata Rau New Zealand | Durham University | BGS British Geological Survey | AUT University Auckland, New Zealand | Tonga Geological Services MLNR Tonga | SUBCOM | Google | Tonga Cable Limited | SouthernCross Cable Network | 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

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The specific case of natural hazards

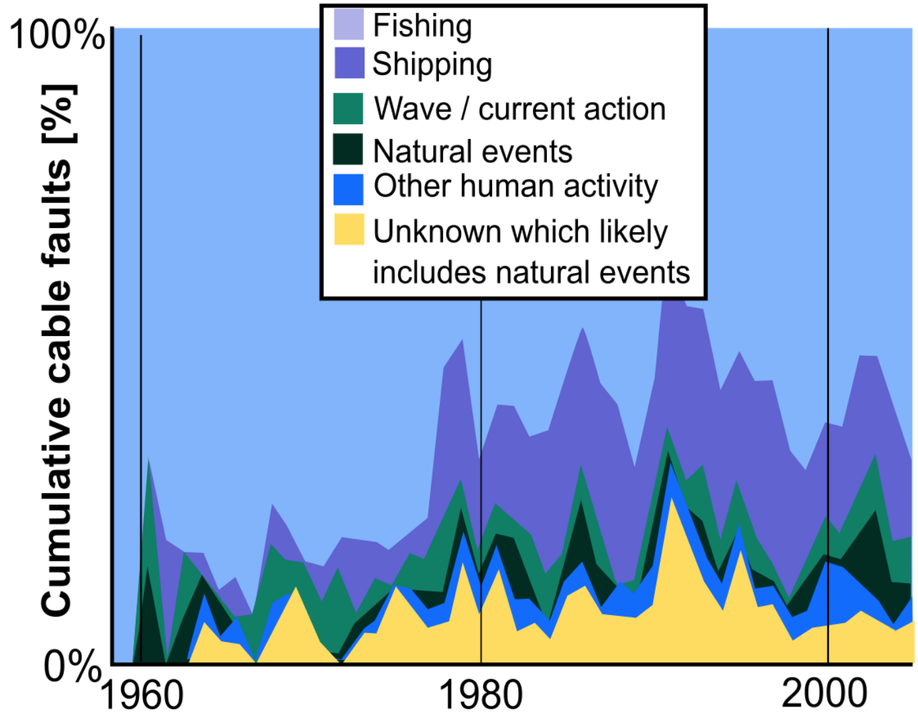
- Only 10-20% of subsea cable faults historically

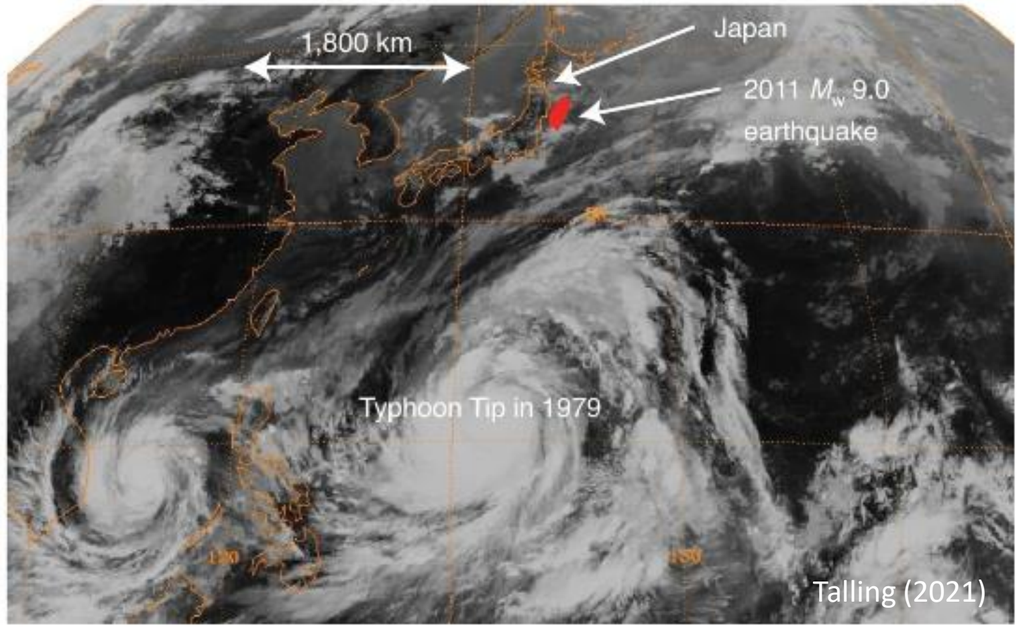
But....

- 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)





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THE TIMES | Today's sections | Past six days | Explore | Times Radio | Log in

Undersea avalanche snaps internet cables as cascade from Congo spews into Atlantic

Jane Flanagan, Cape Town

Tuesday June 08 2021, 5.00pm,

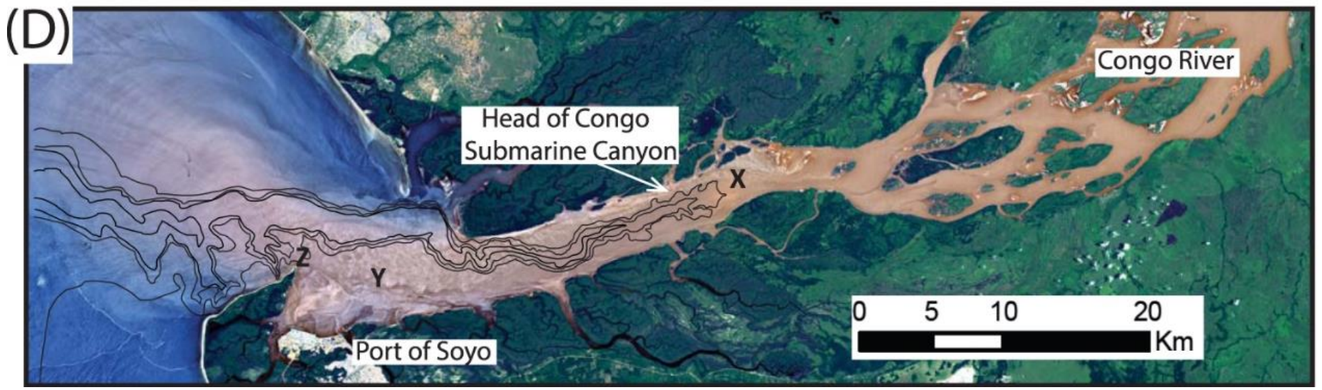
BUSINESS INSIDER SOUTH AFRICA

TECH

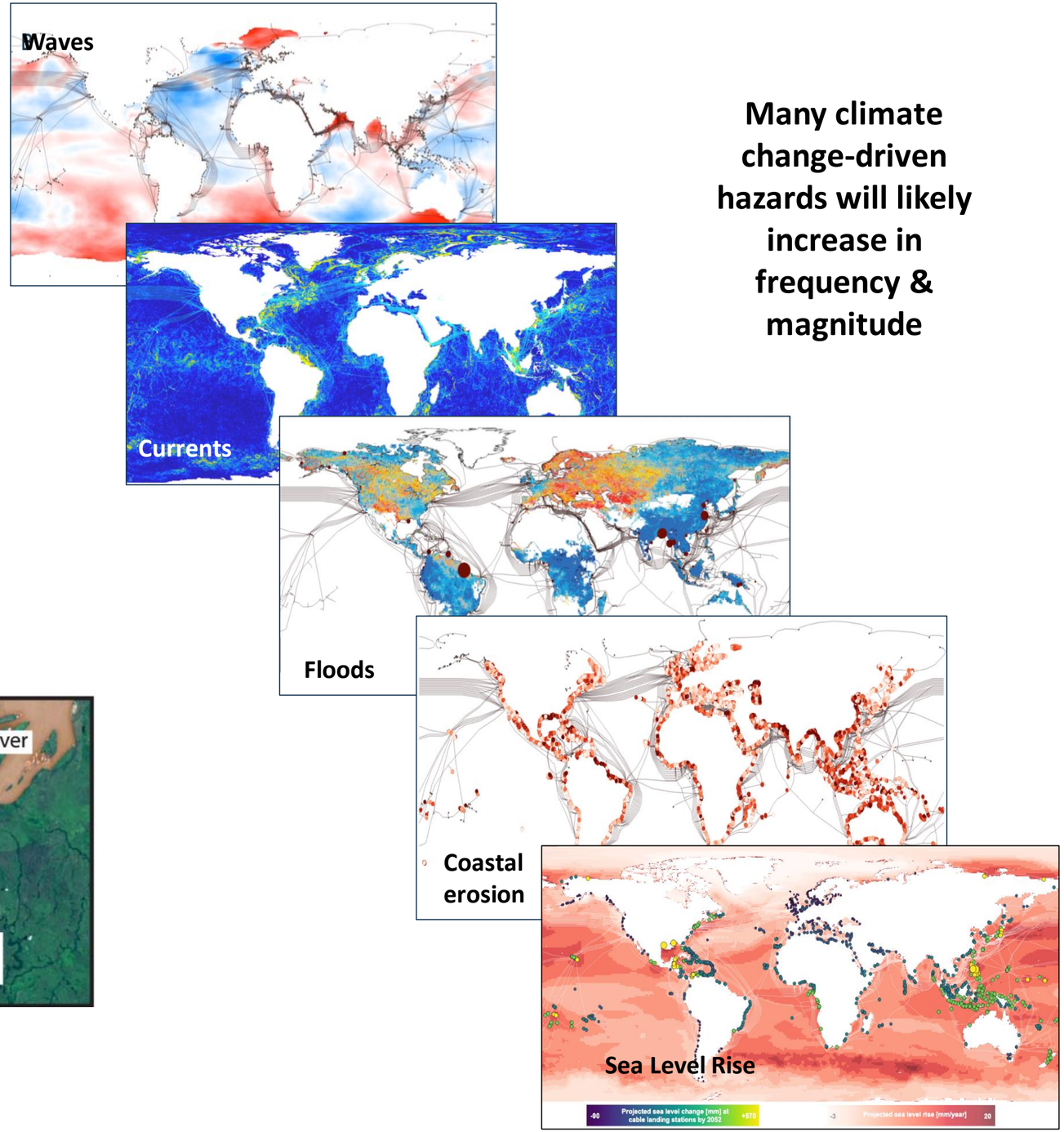
PICS: The burnt-out undersea cable that crippled SA's internet

Jay Caboz, Business Insider SA

07 Feb 2020



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)

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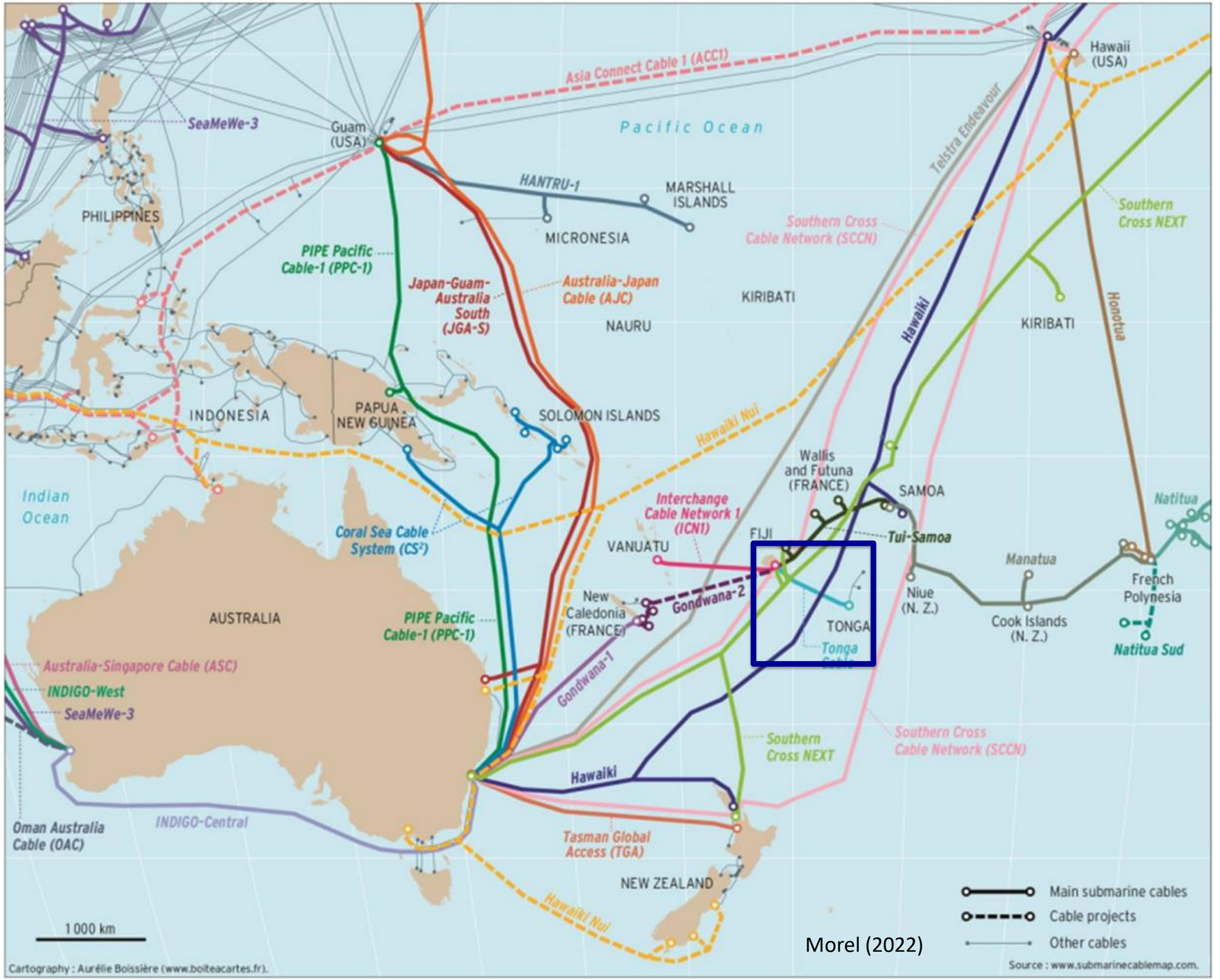
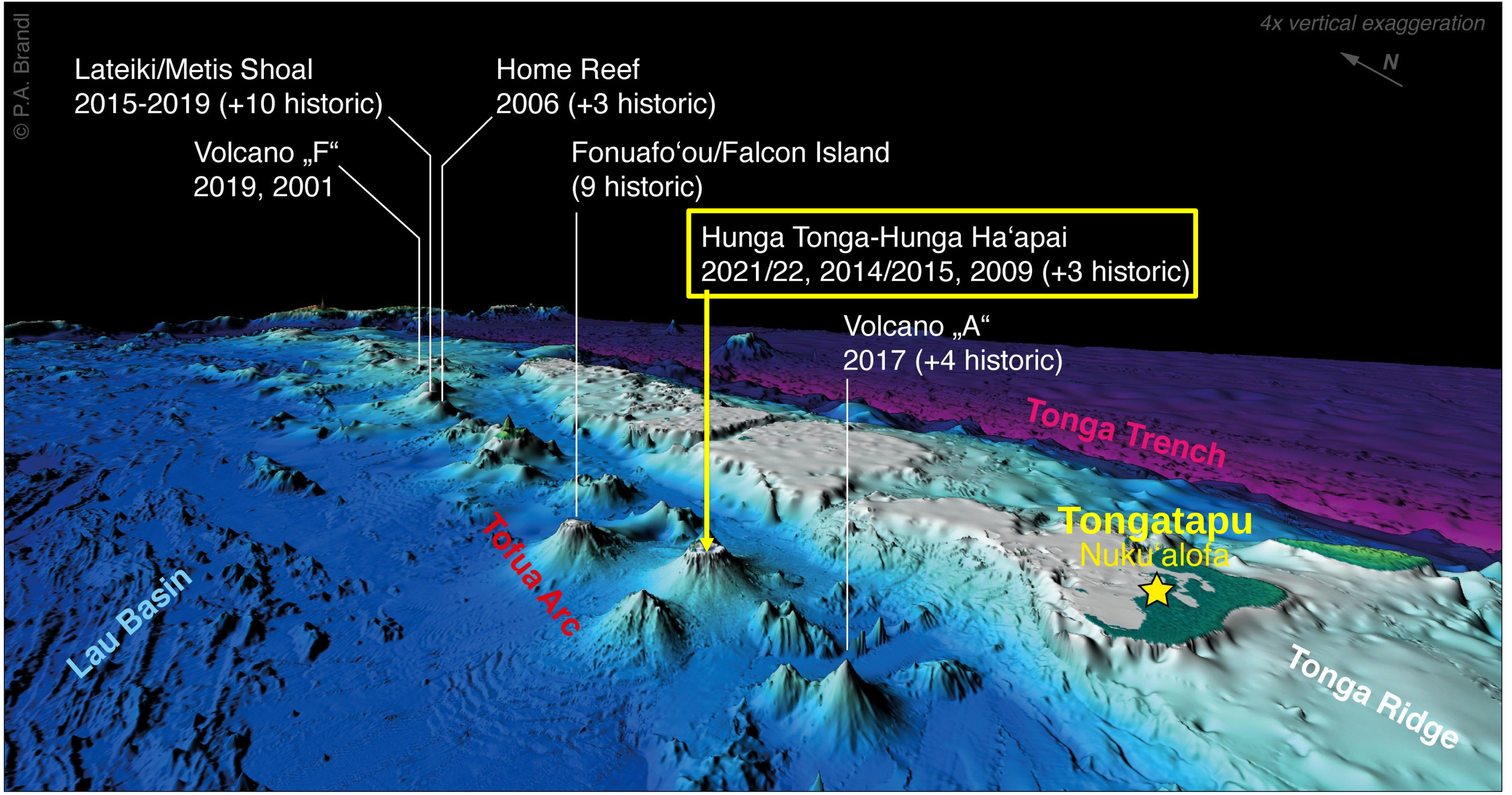
- Most regions are resilient due to:
  - Redundancy in the network
  - Ready access to repair ships
  - Sufficient replacement stocks

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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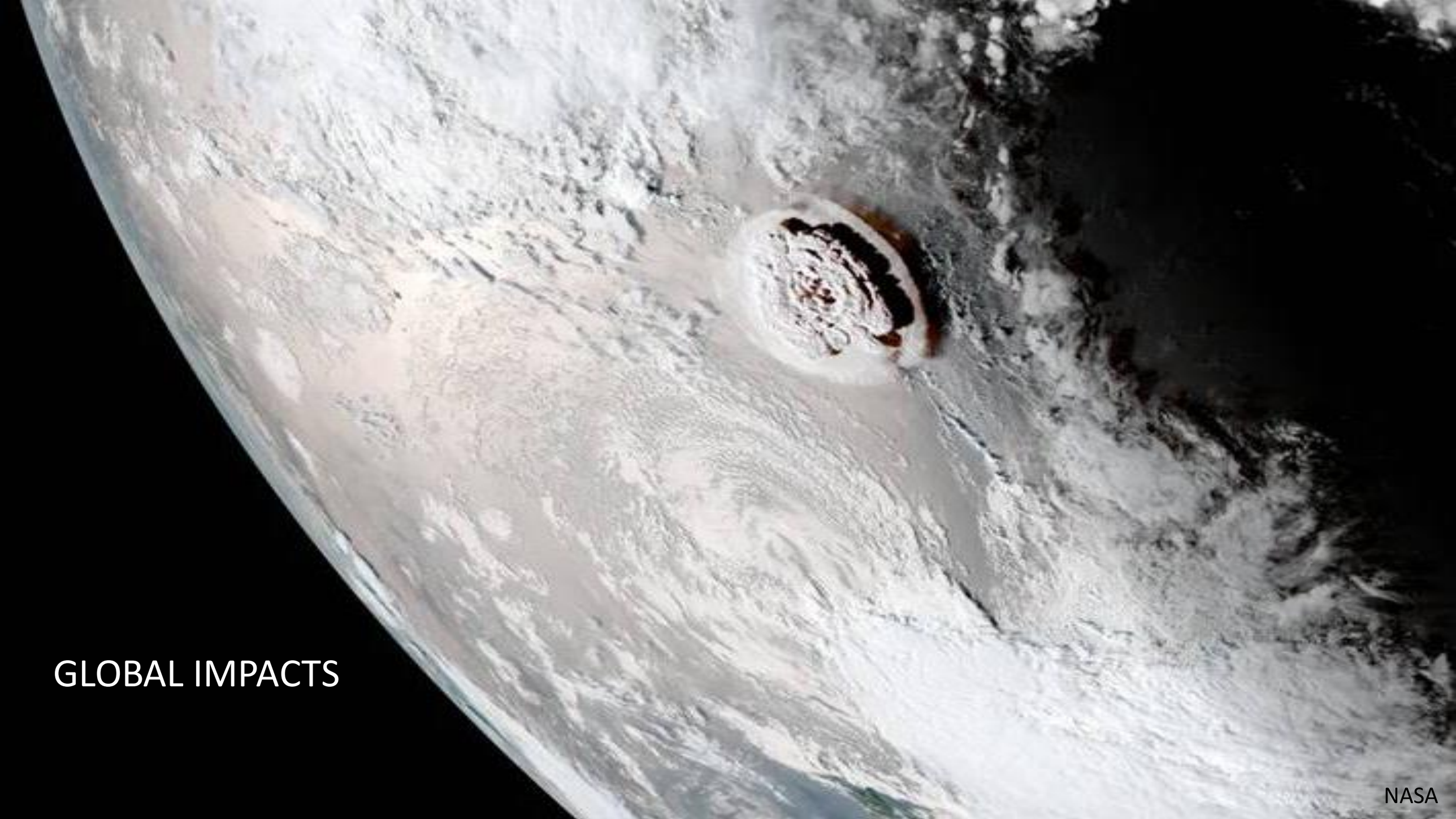
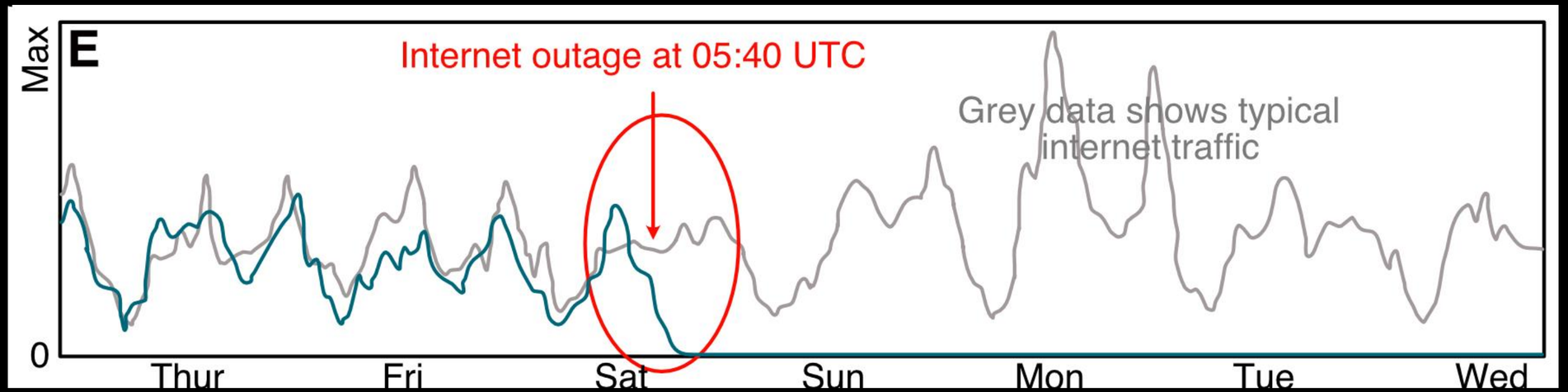


GLOBAL IMPACTS

NASA

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

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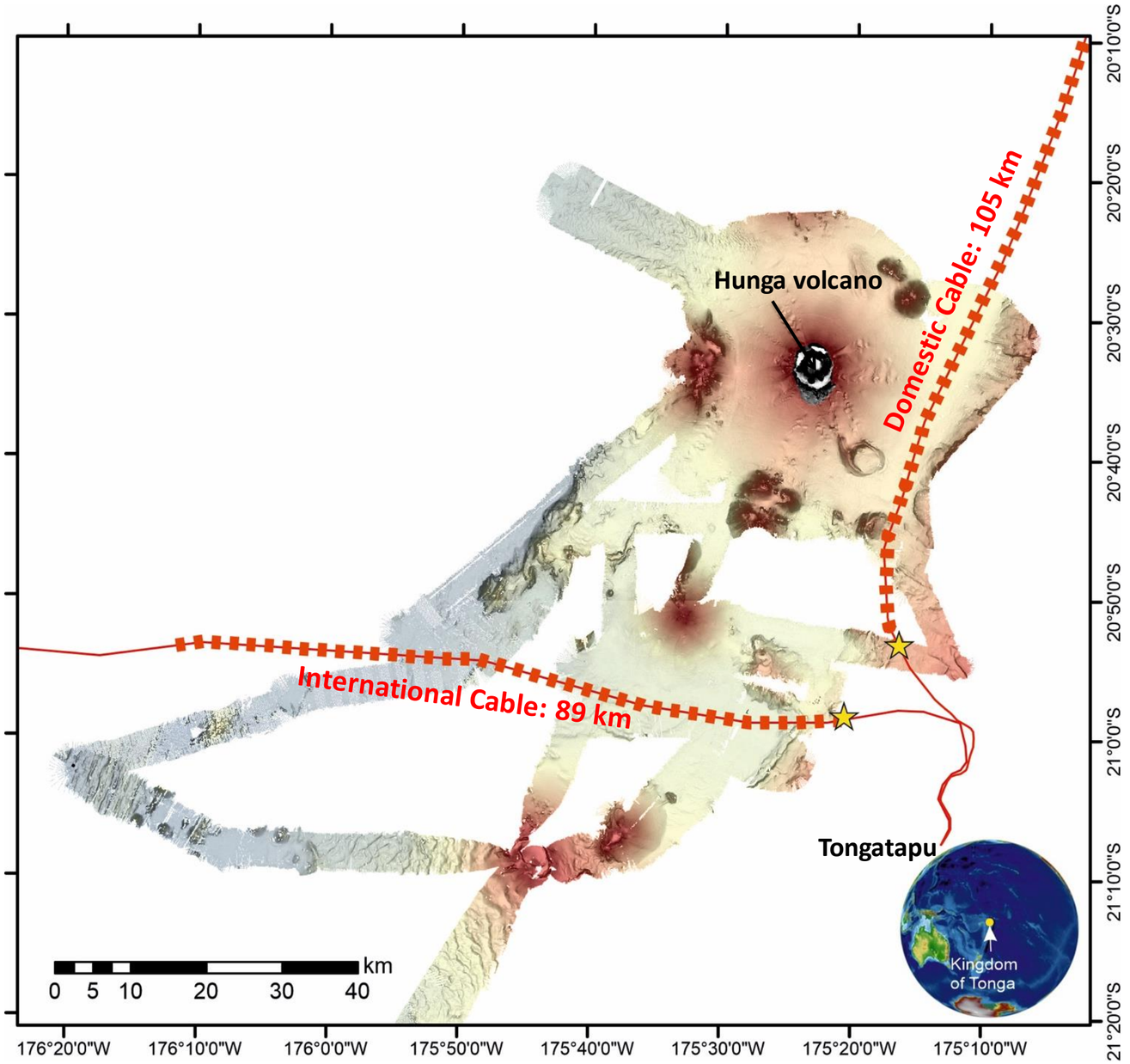
- Repair to international cable took 5 weeks
- Domestic cable repaired 1.5 years later…



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- Repair to international cable took 5 weeks
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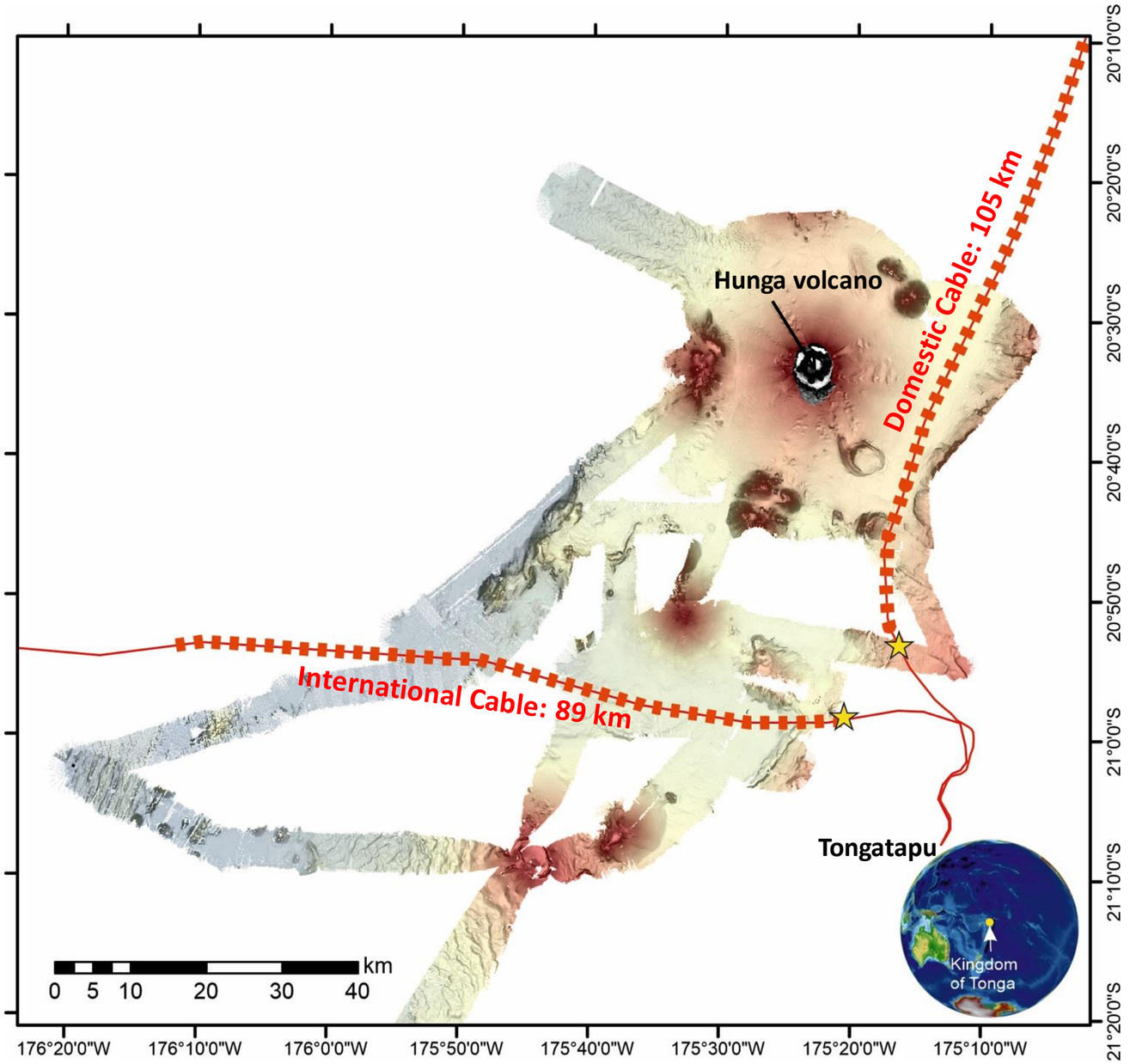

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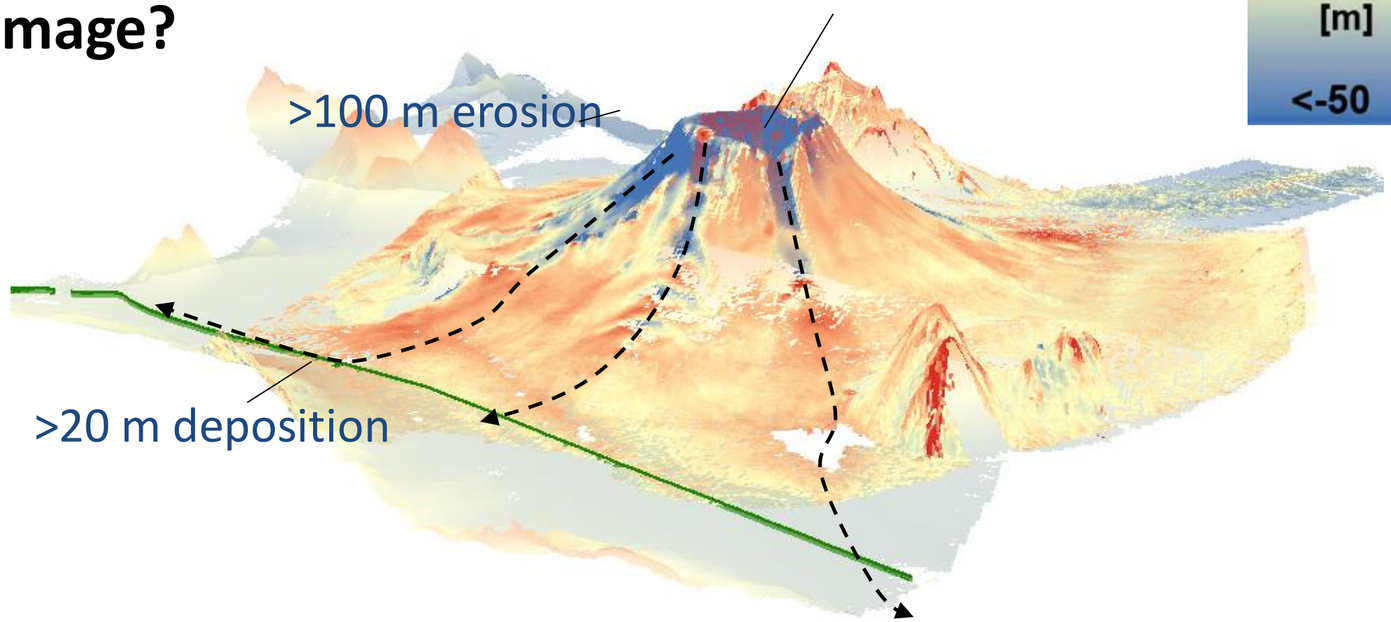
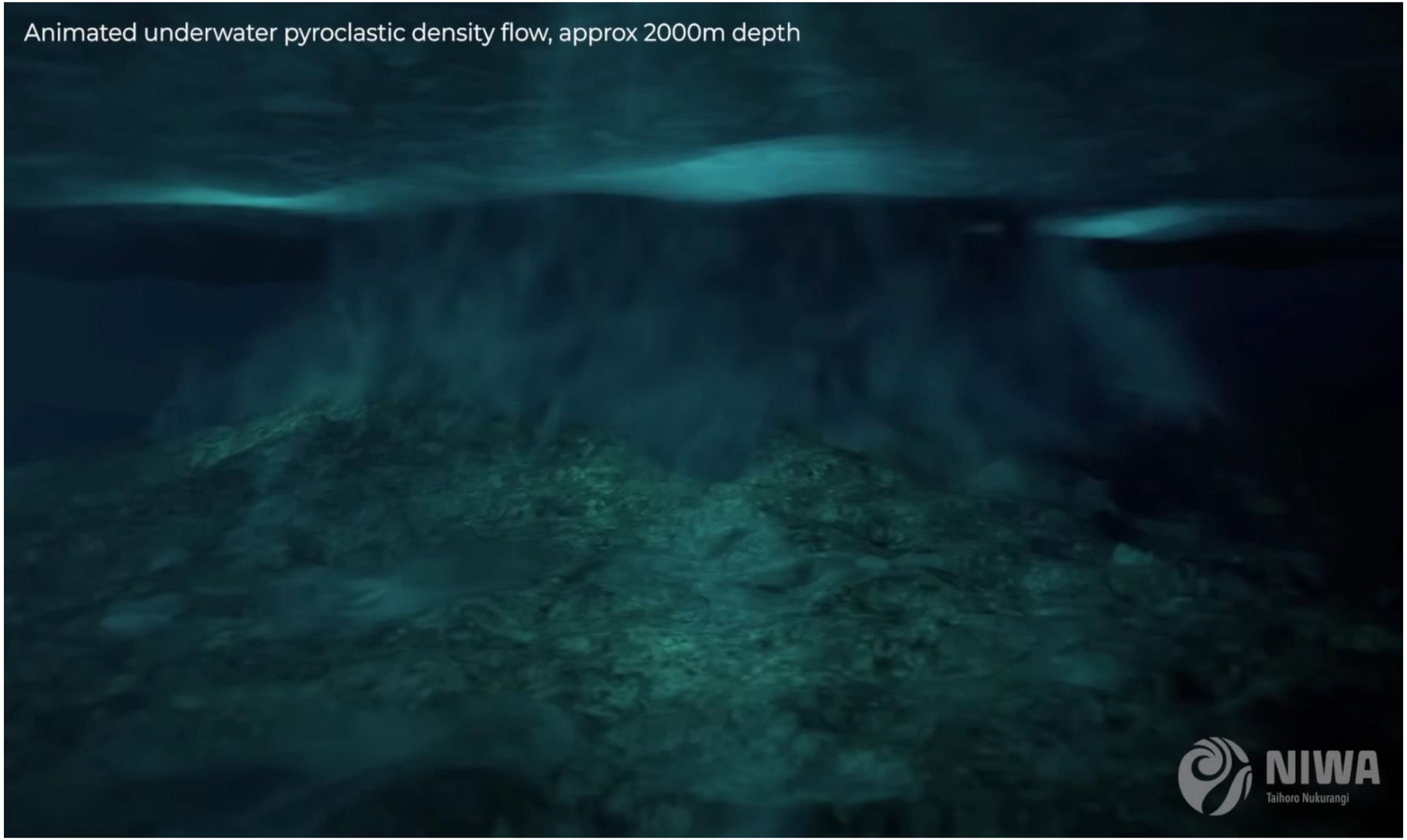
A very big hole!
900 m vertical change
>6 km^3 erupted volume

What caused the extensive damage?

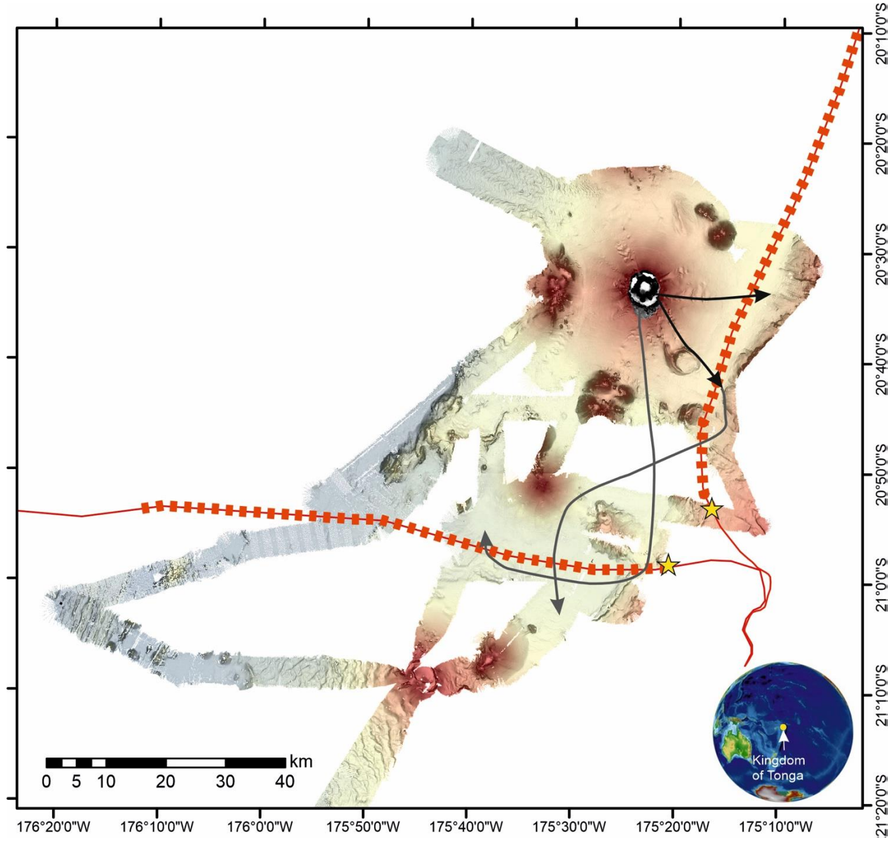
- Powerful and dense flows of volcanic material
- Identified from seafloor surveys performed within 3 months of the eruption

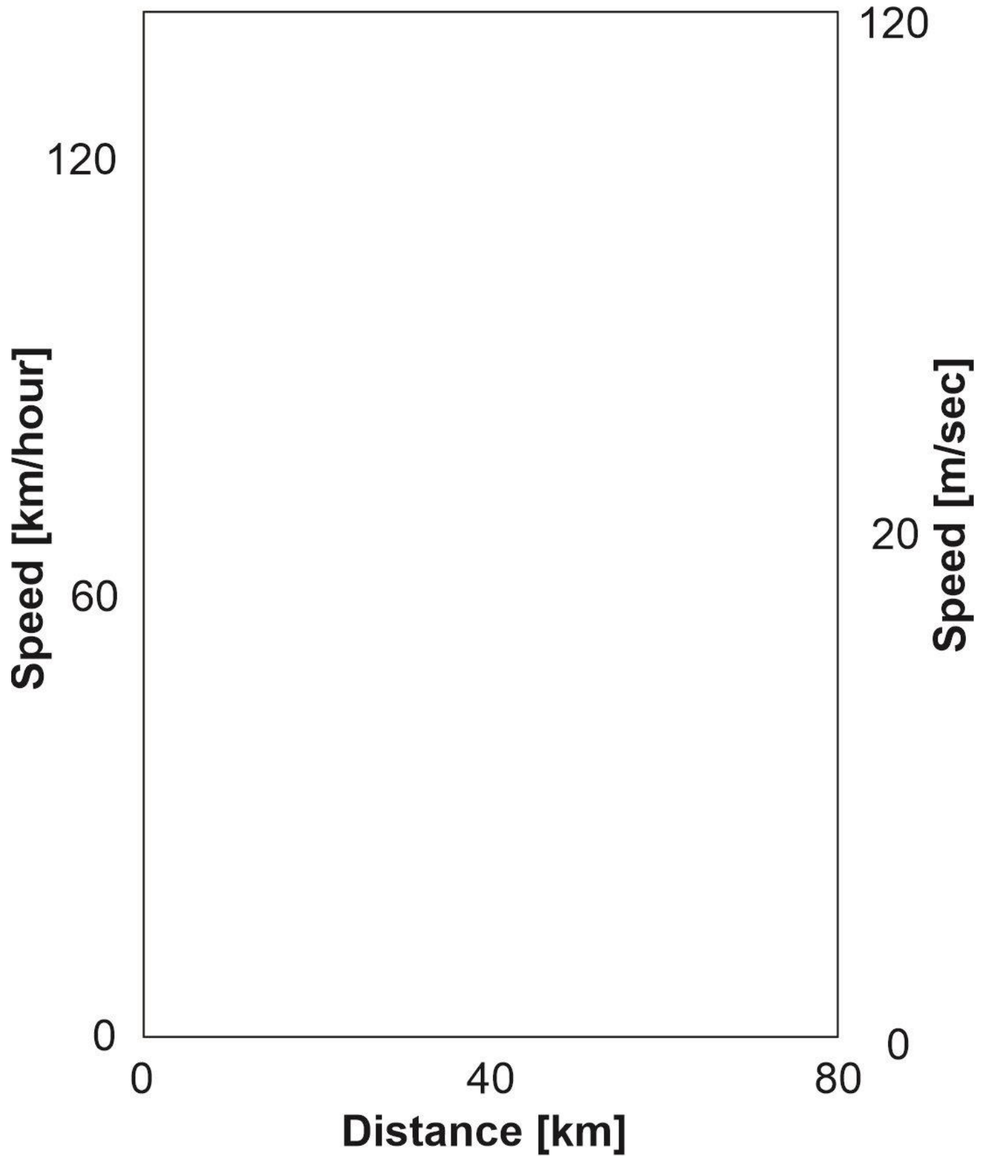


10 cm


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

UKNOF





The first underwater measurements of flows created by a volcanic eruption

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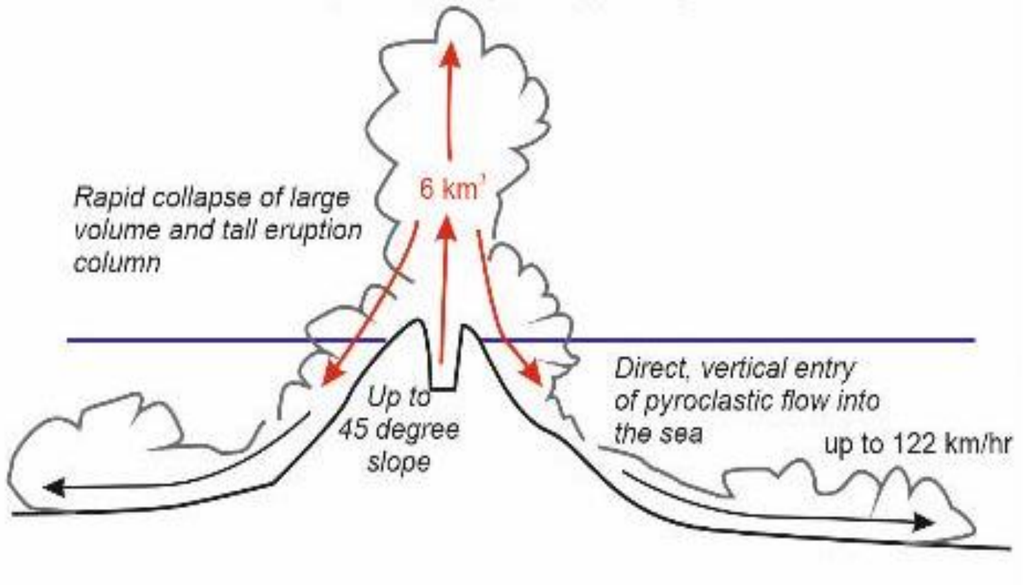
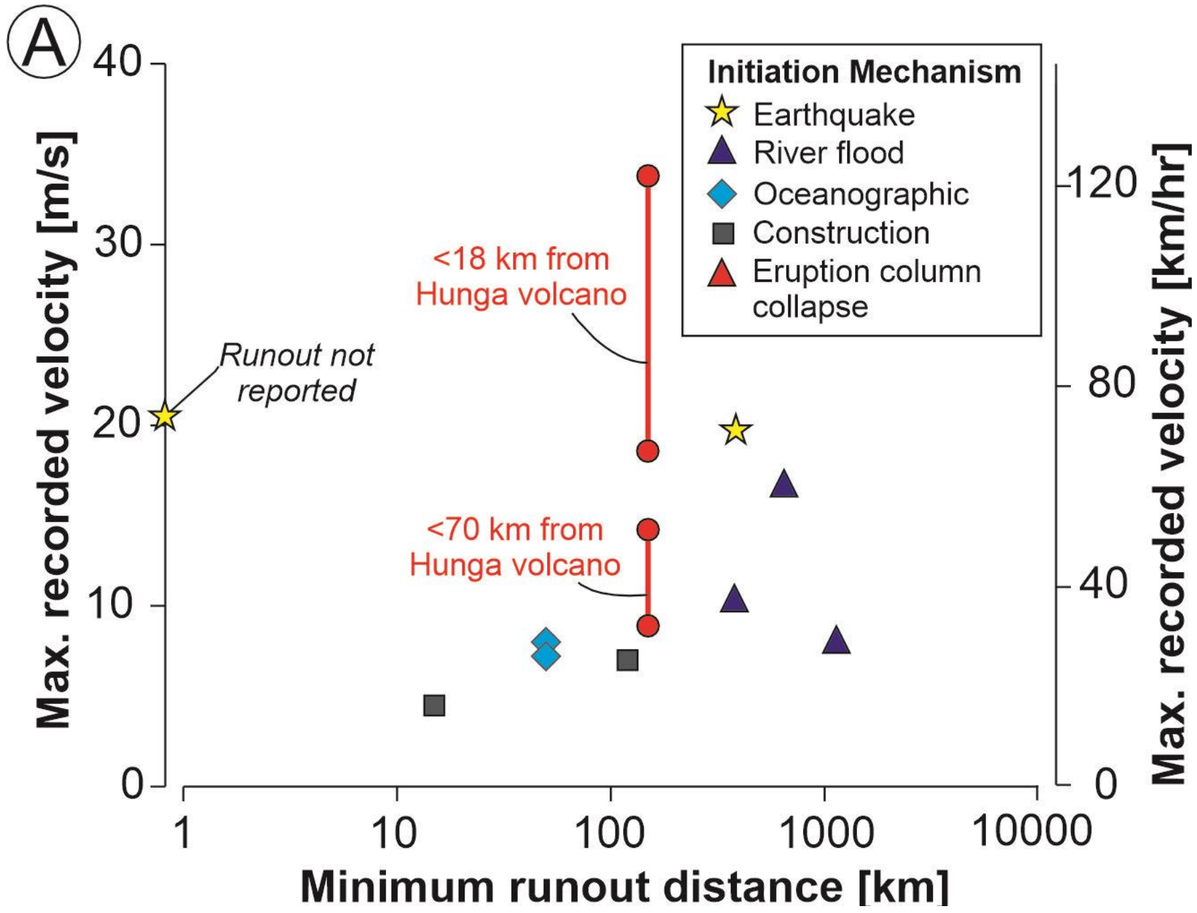
The fastest underwater flows on Earth



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

Setting a stand-off distance may not be appropriate…



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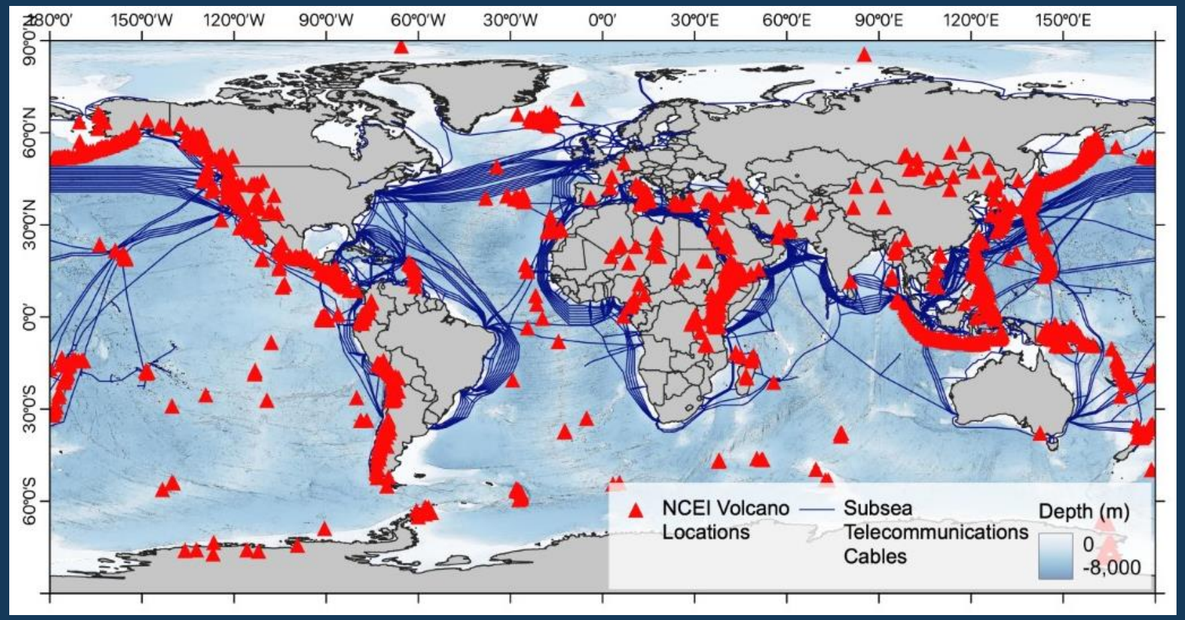
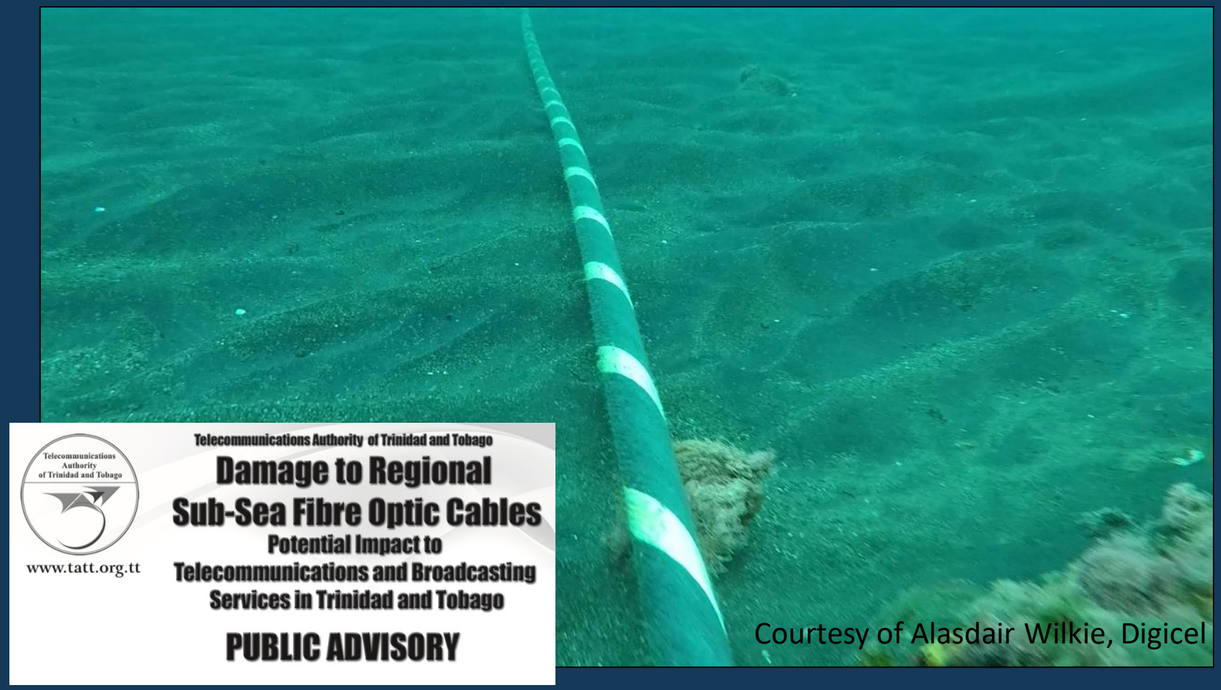
Small island states are particularly exposed…

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

Contact Us

https://www.noc.ac.uk

@isobelyeo @MikeAClare

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 communi- ties (*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

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Clare, Yeo et al. Science (2023)

Branko Sugar (15/01/2022)