



LINX120

16th - 17th November 2023
Park Plaza, Victoria
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National
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Centre

Volcanic Hazards & Subsea Cables:

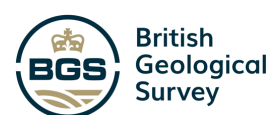
Lessons from the 2022 eruption of Hunga volcano

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

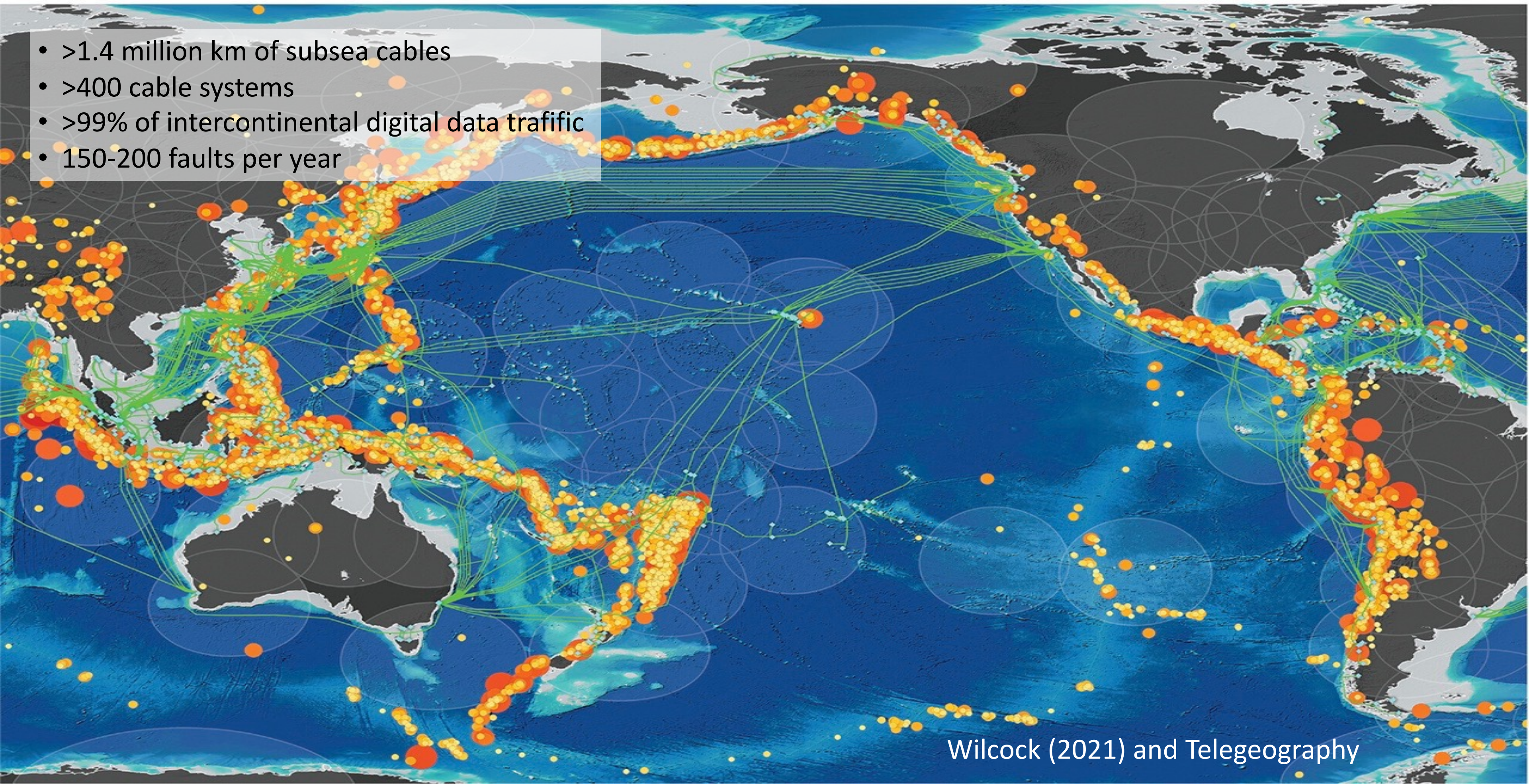


Tonga Cable Limited



— 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 traffic
- 150-200 faults per year



Wilcock (2021) and Telegeography

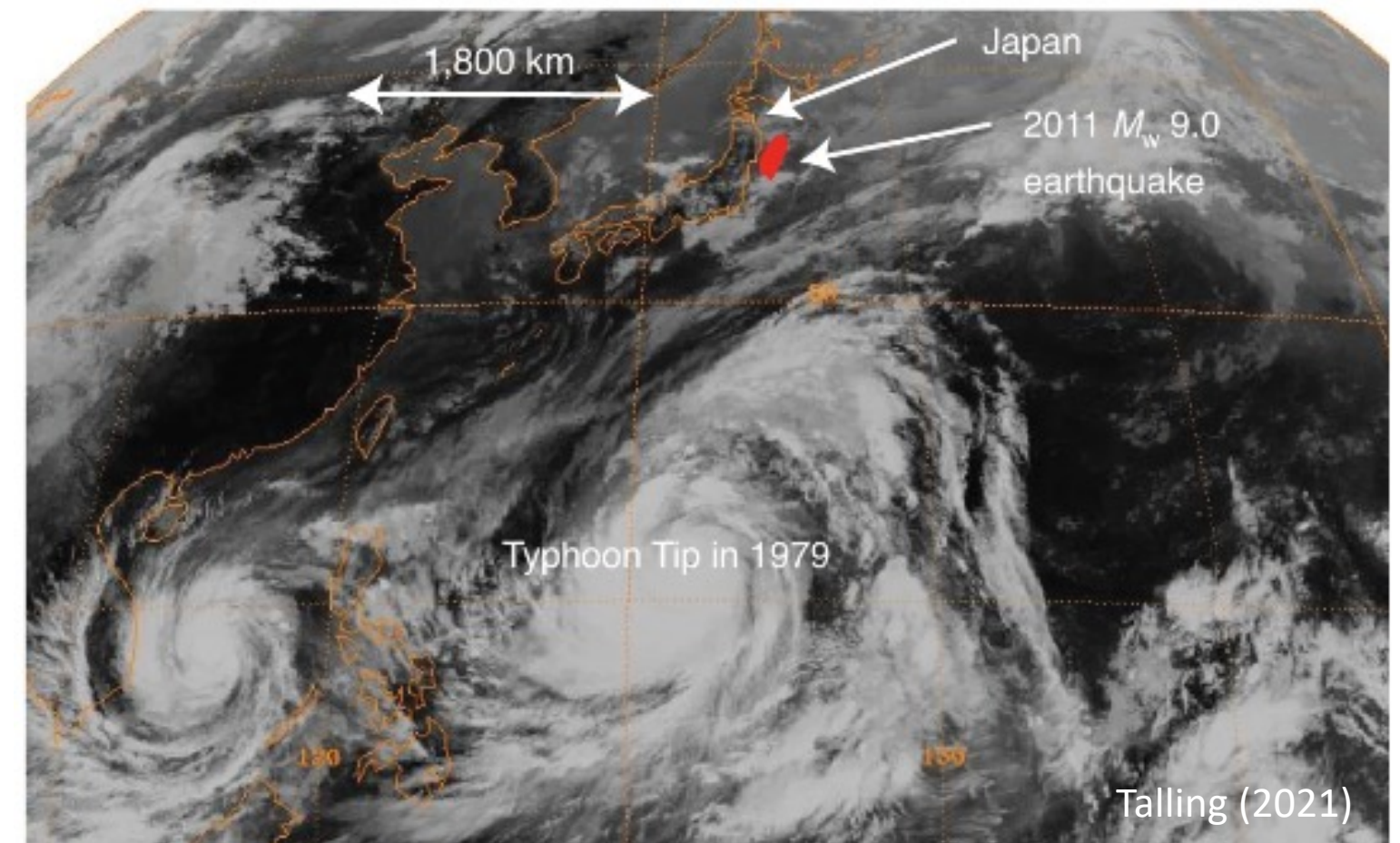
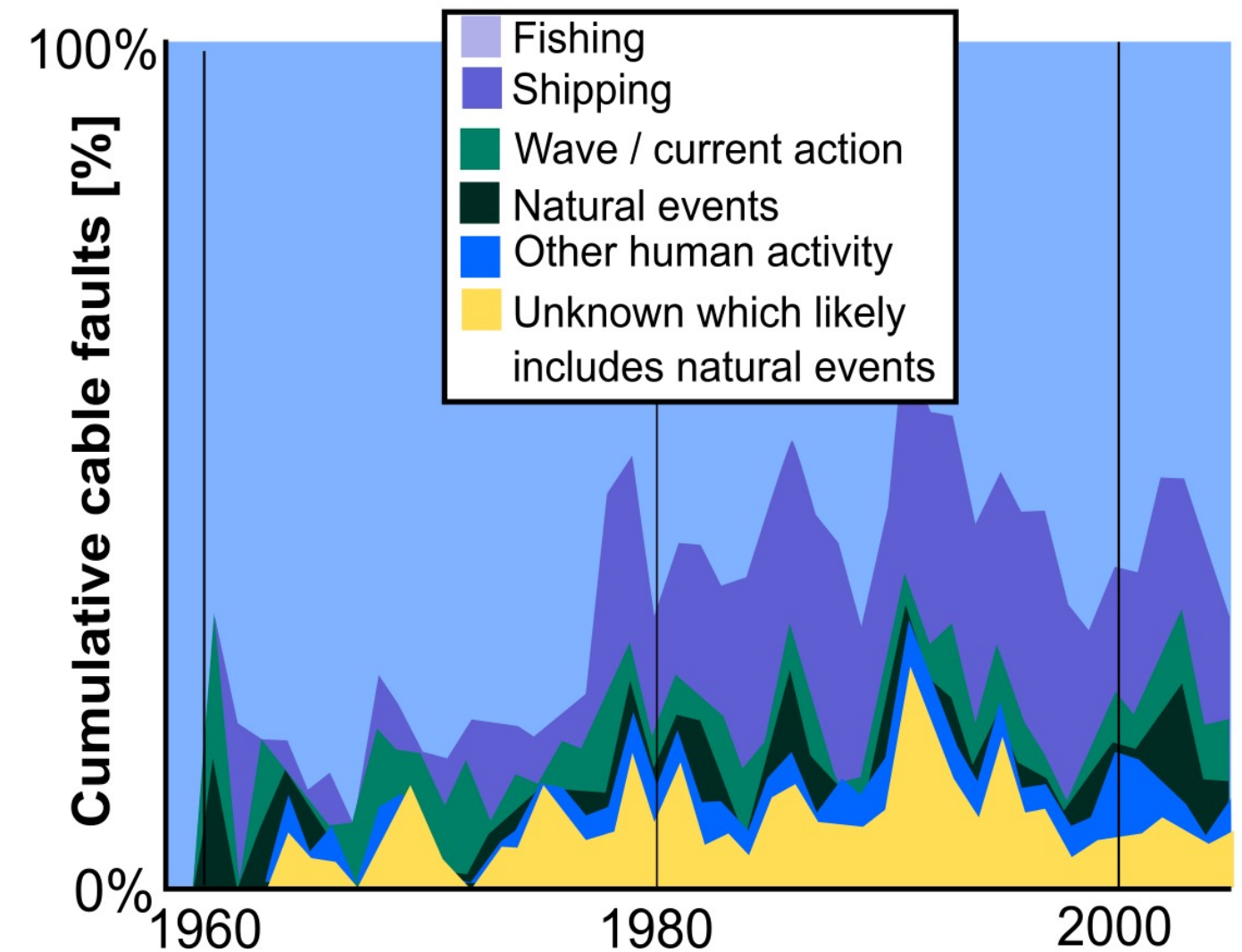
The specific case of natural hazards

- 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)



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

Jane Flanagan, Cape Town

Tuesday June 08 2021, 5.00pm,

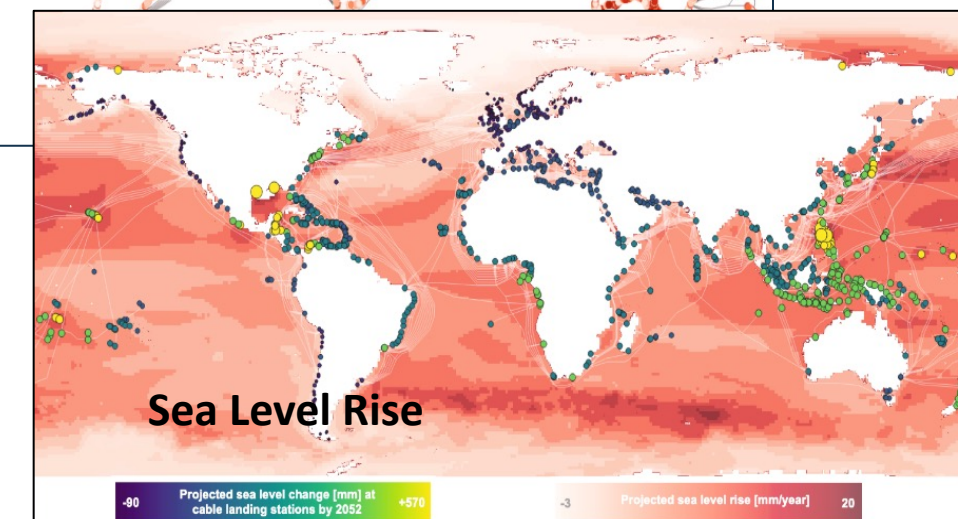
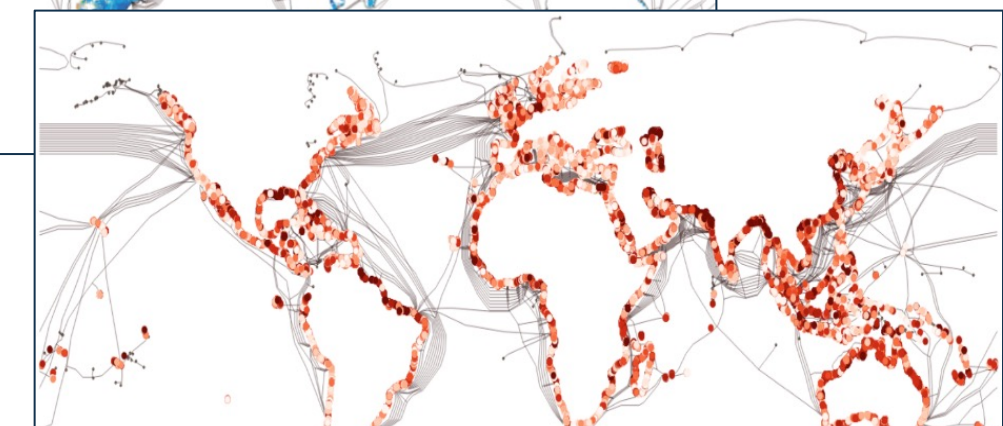
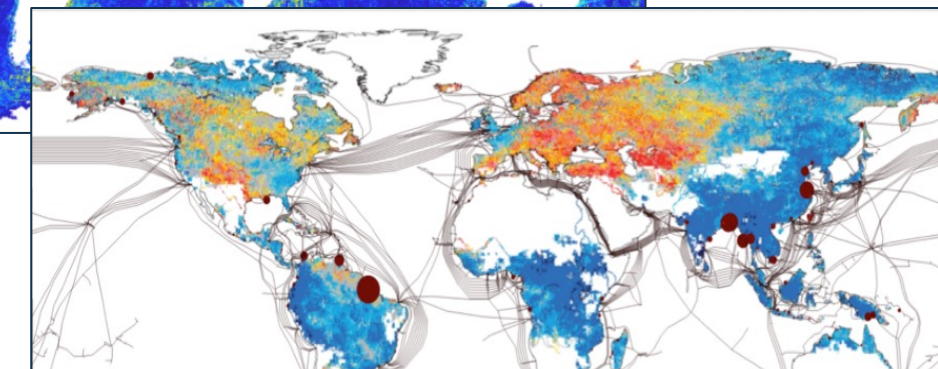
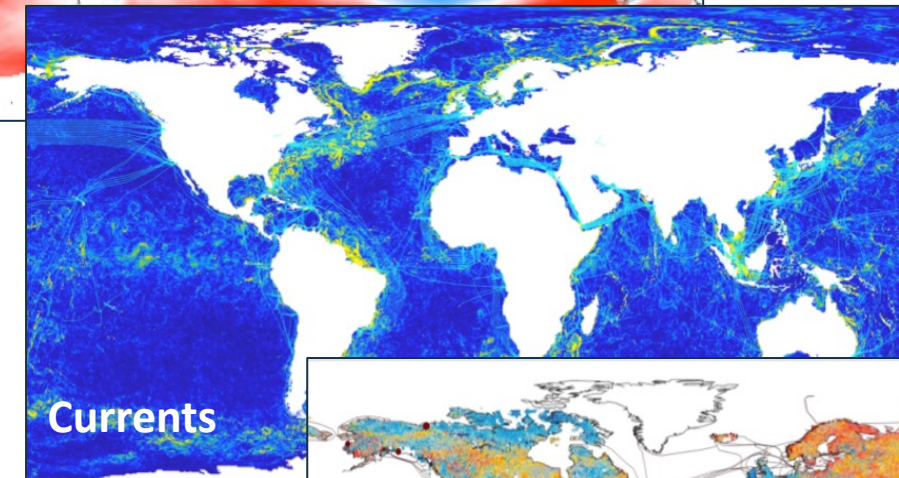
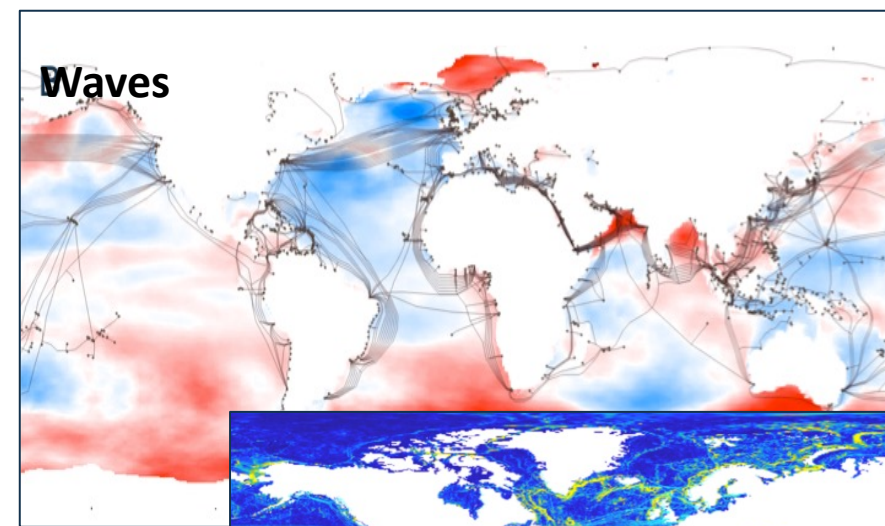
BUSINESS INSIDER SOUTH AFRICA

TECH

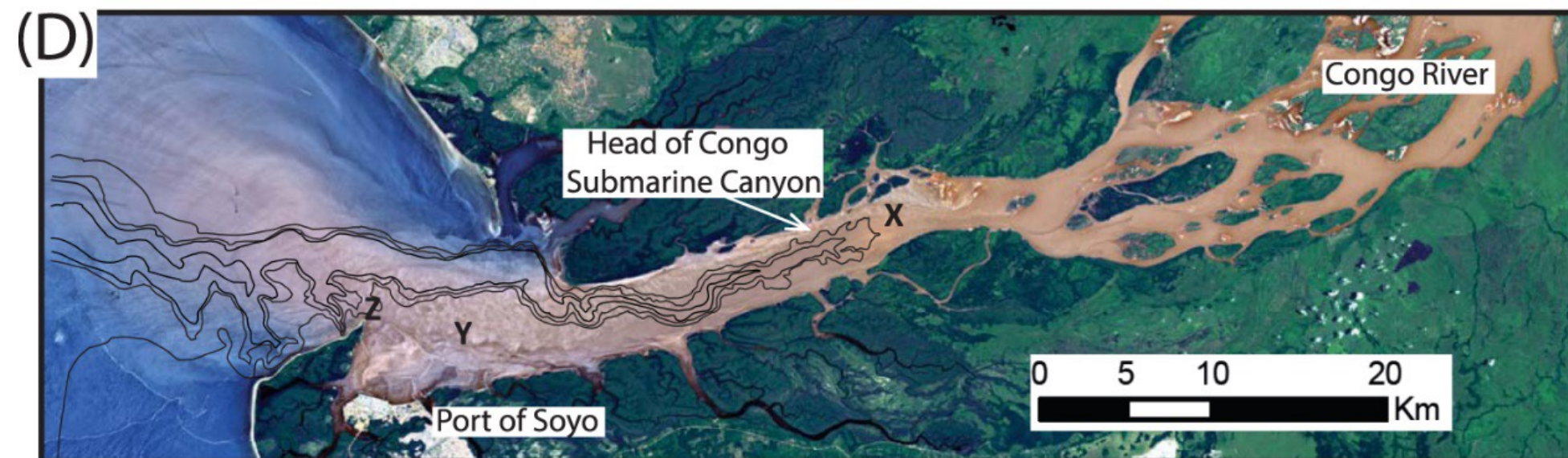
PICS: The burnt-out undersea cable that crippled SA's internet

Jay Caboz, Business Insider SA

07 Feb 2020

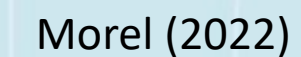


Many climate change-driven hazards will likely increase in frequency & magnitude



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

- # The South Pacific is an exception



4x vertical exaggeration



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)

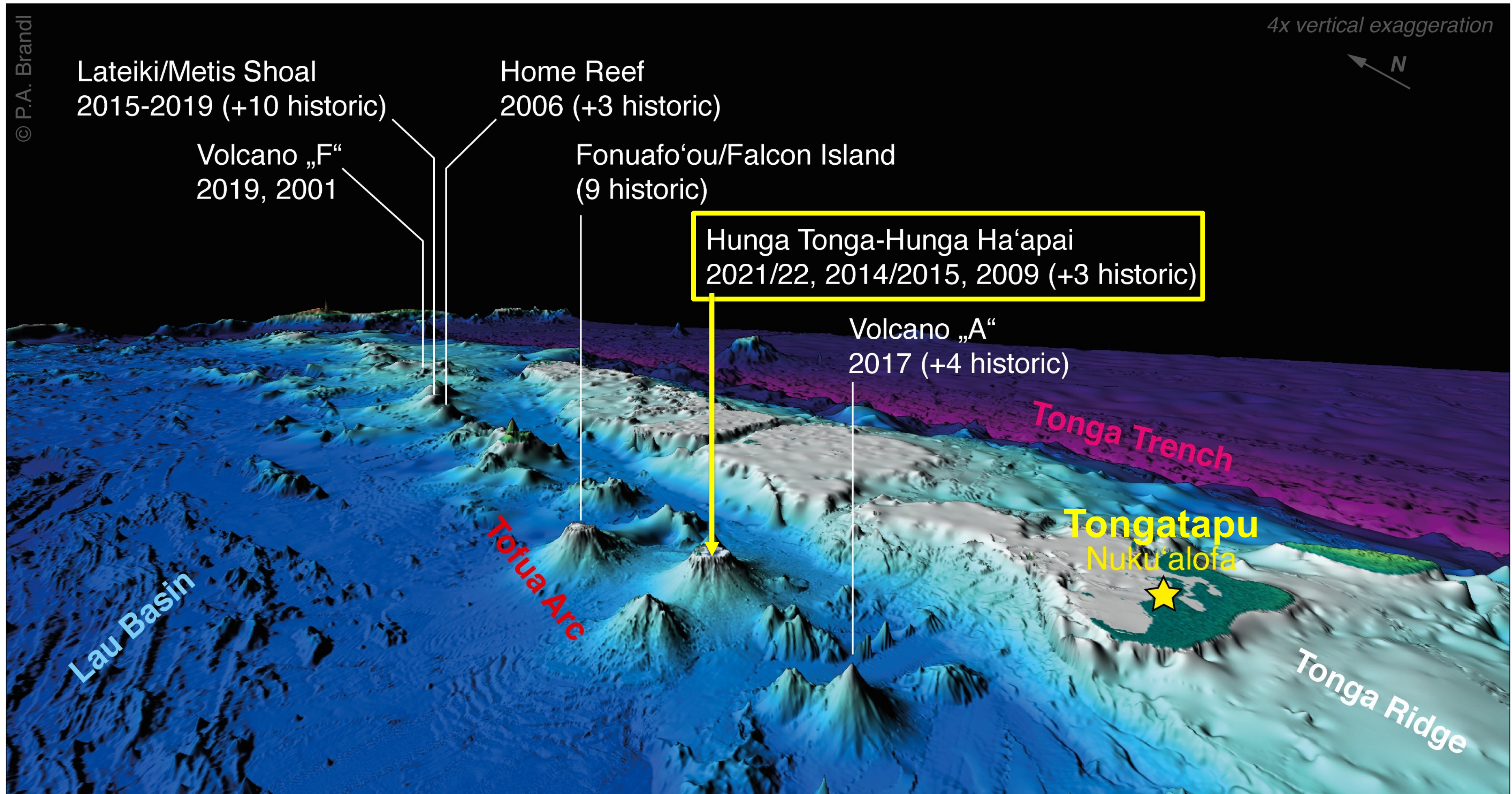
Tonga Trench

Tongatapu
Nuku‘alofa

Tonga Ridge

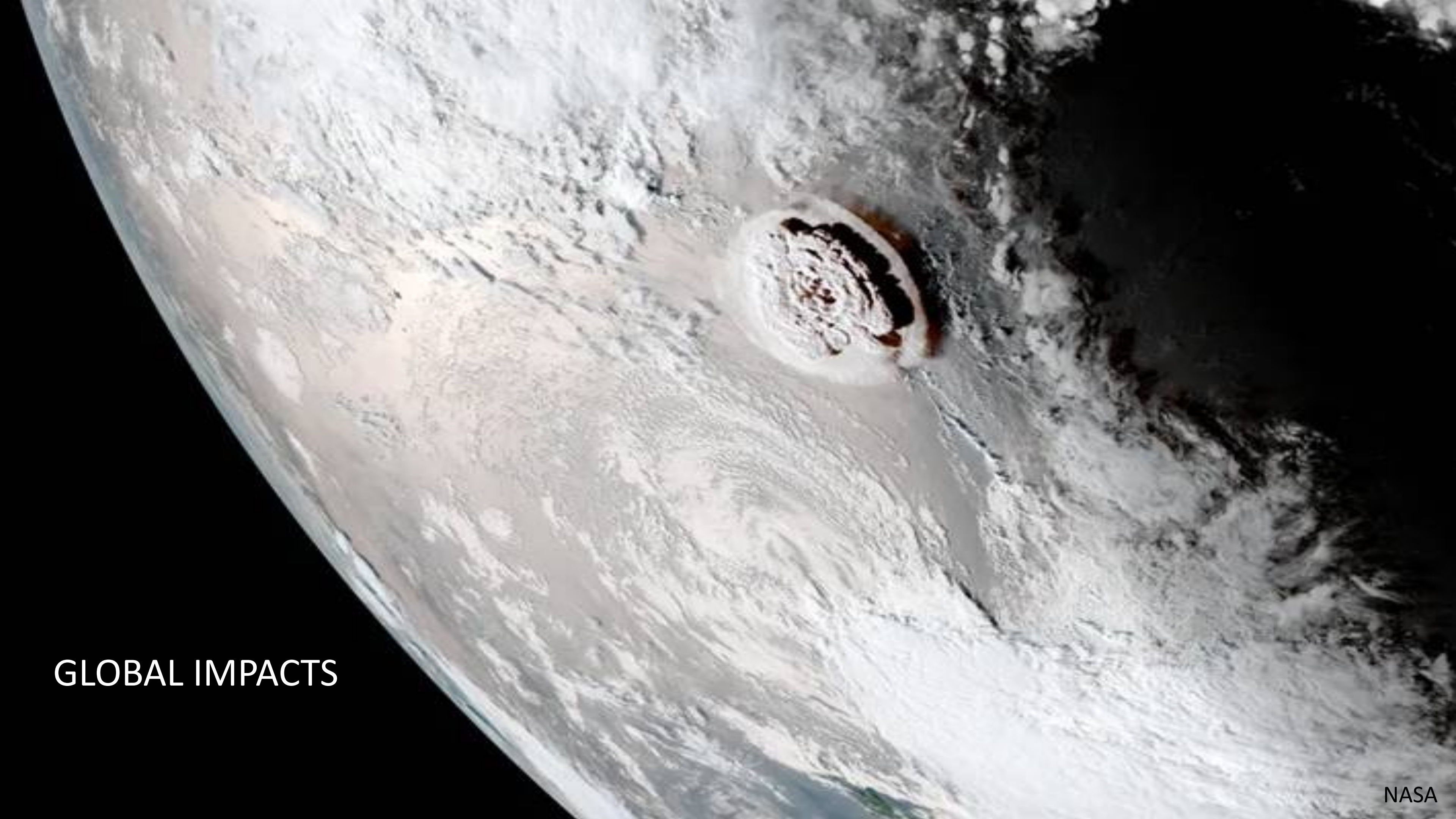
Lau Basin

Tofua Arc









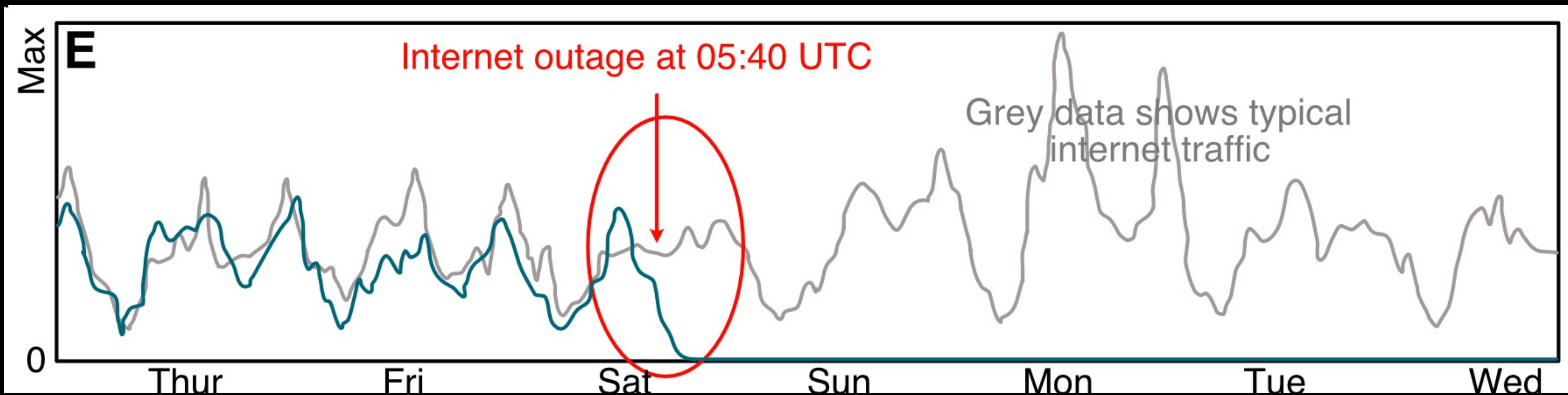
GLOBAL IMPACTS



Branko Sugar (15/01/2022)



and then, in the middle of a crisis....



Broken Cable Shuts Down Tonga's Internet

NFK EDITORS - JANUARY 27, 2019

Nuku'alofa, Tonga — [\(Map\)](#)



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The Pacific project
Tonga volcano

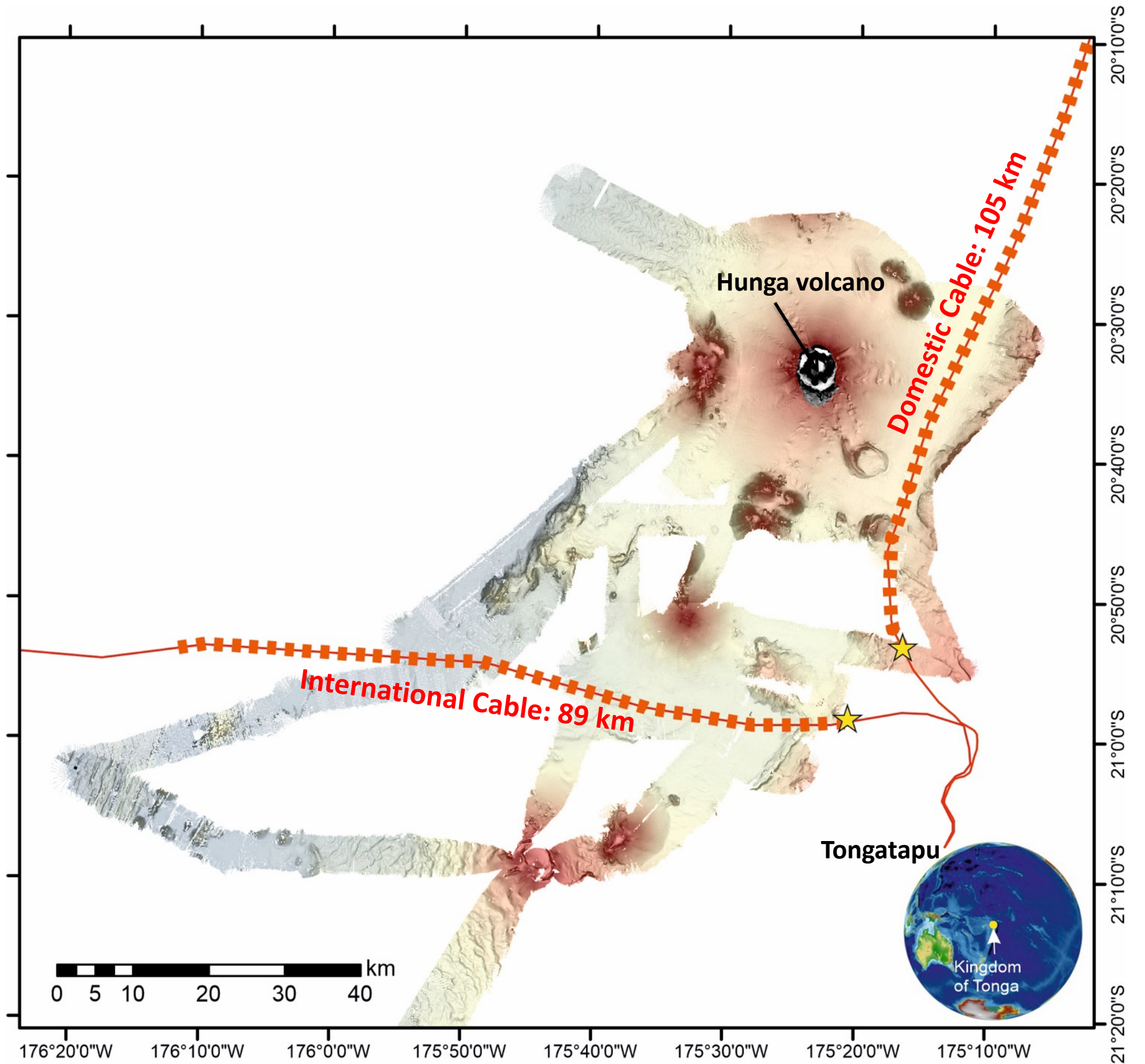
**'Not knowing is heartbreaking':
sleepless nights among Tongan
diaspora after contact with country
cut off**

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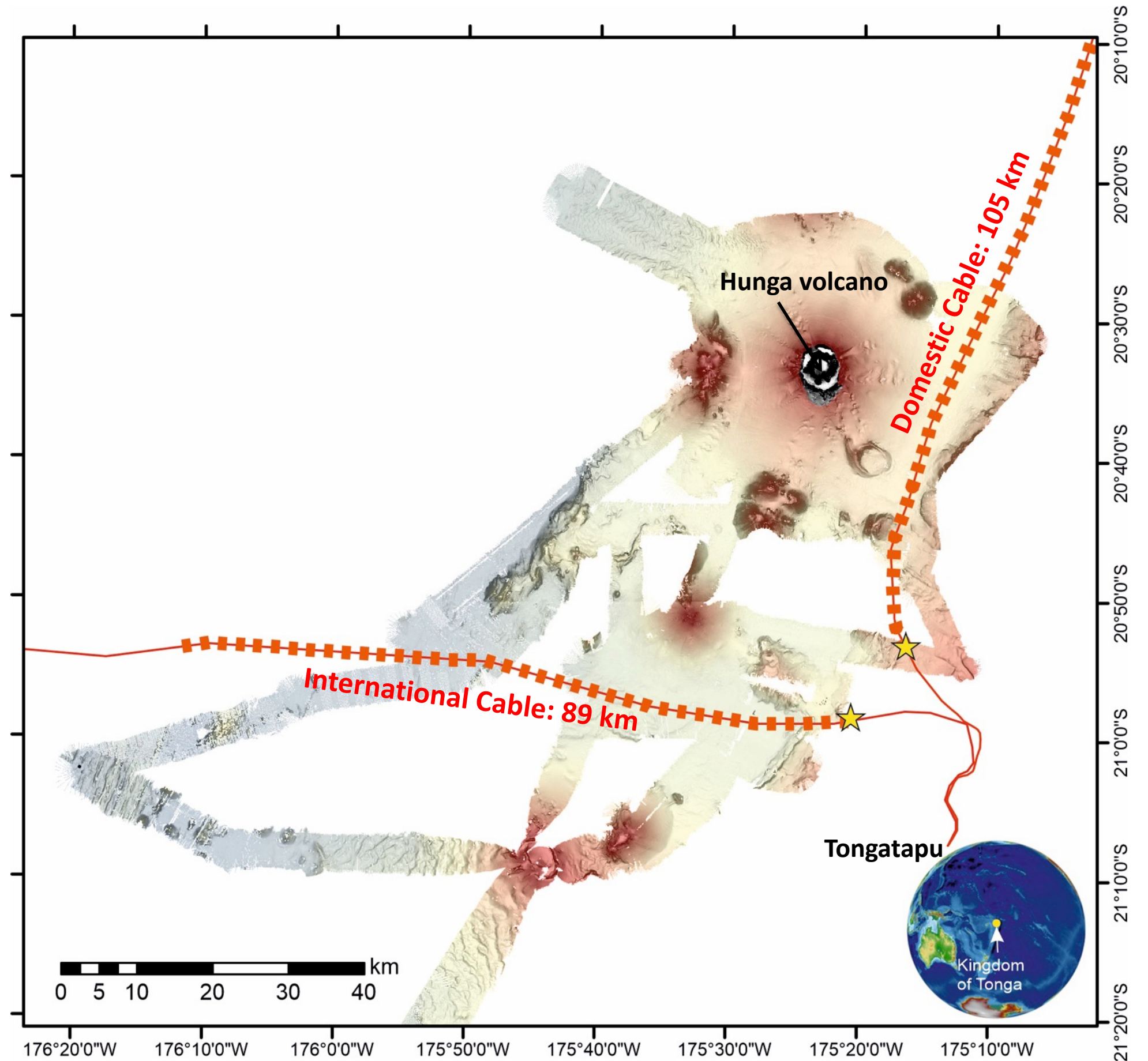
About this content
**Kate Lyons in Sydney and
Tess McClure in Auckland**
Mon 17 Jan 2022 04:17 GMT

f t e

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



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

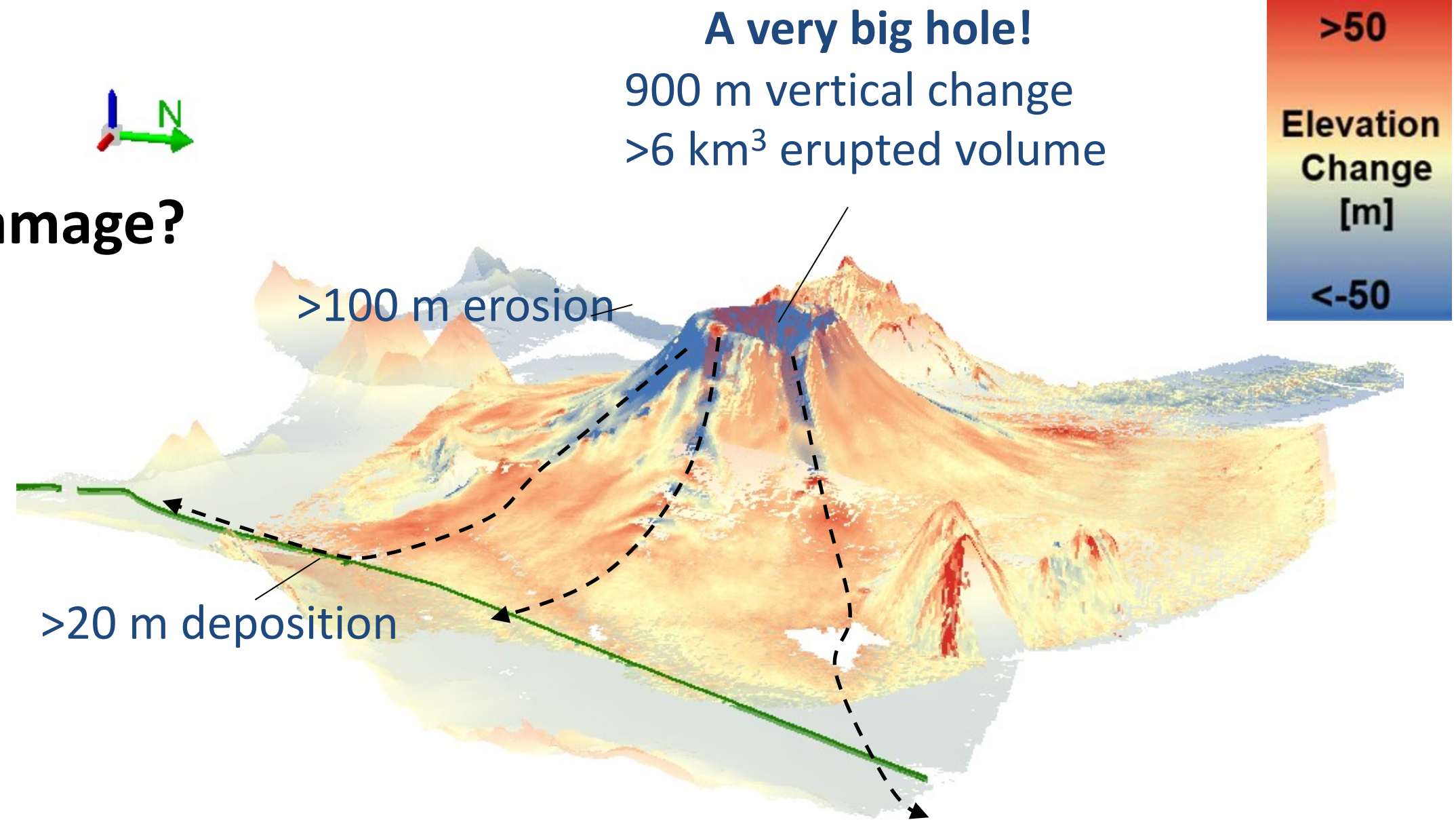




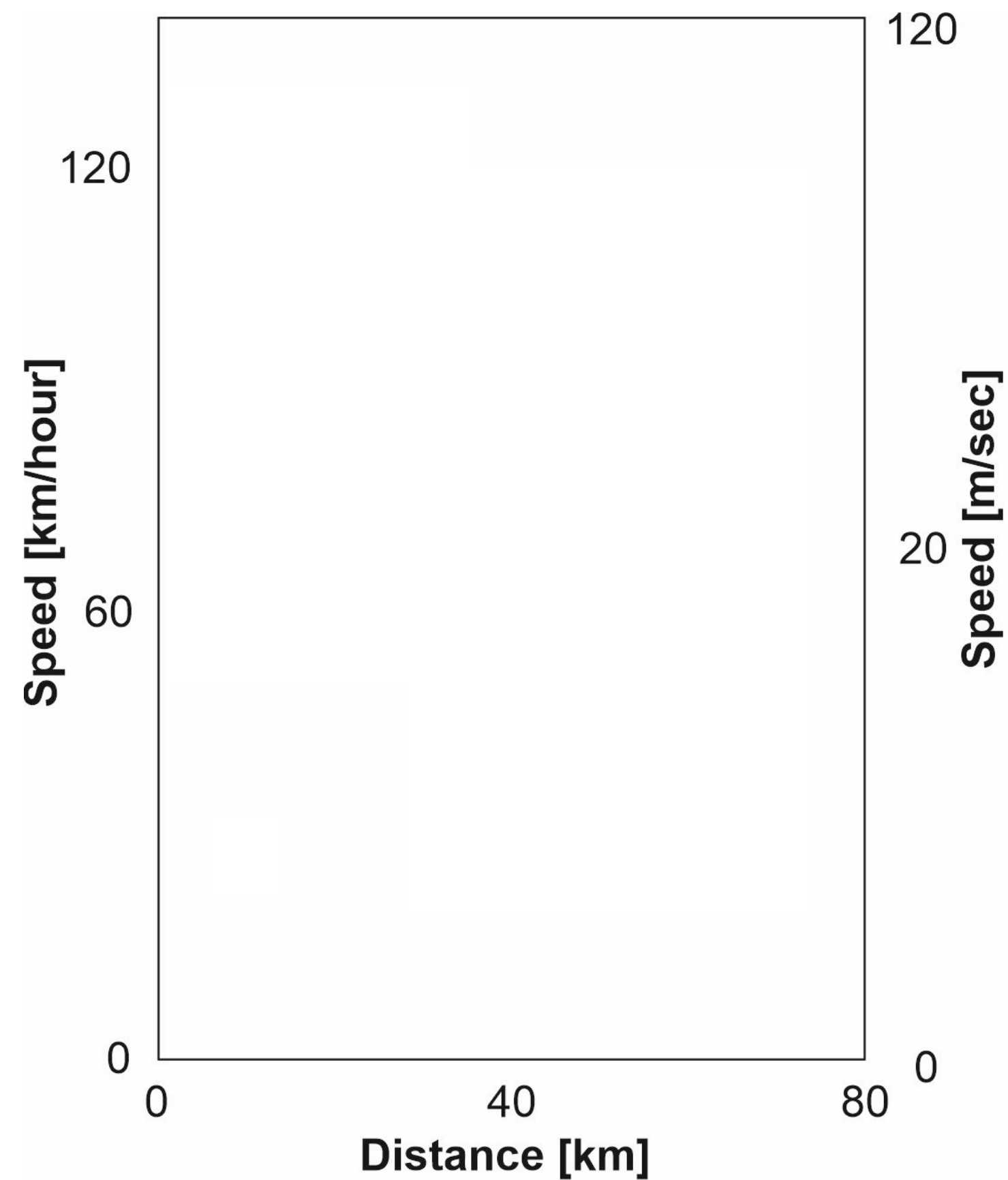
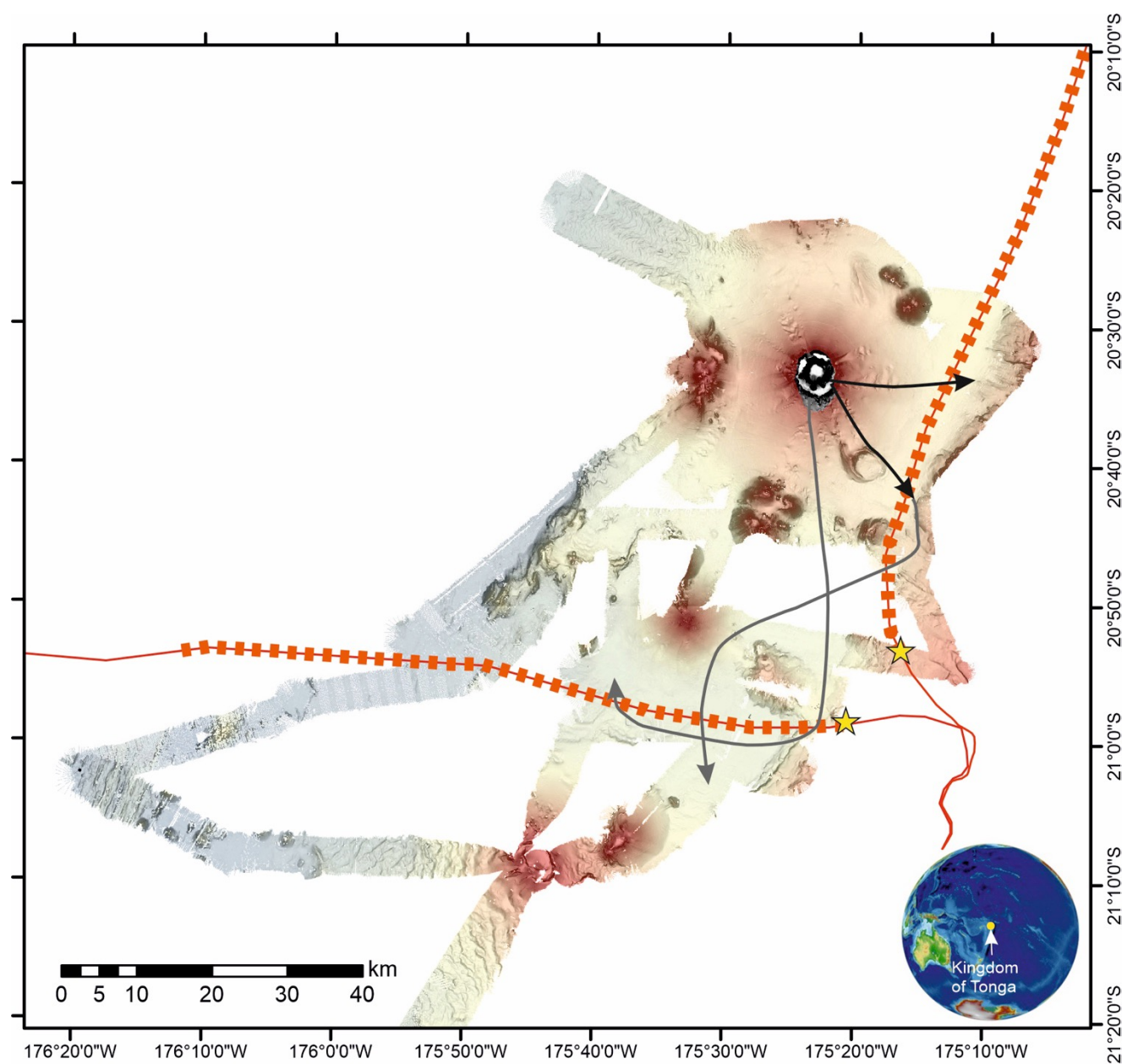
10 cm

What caused the extensive damage?

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

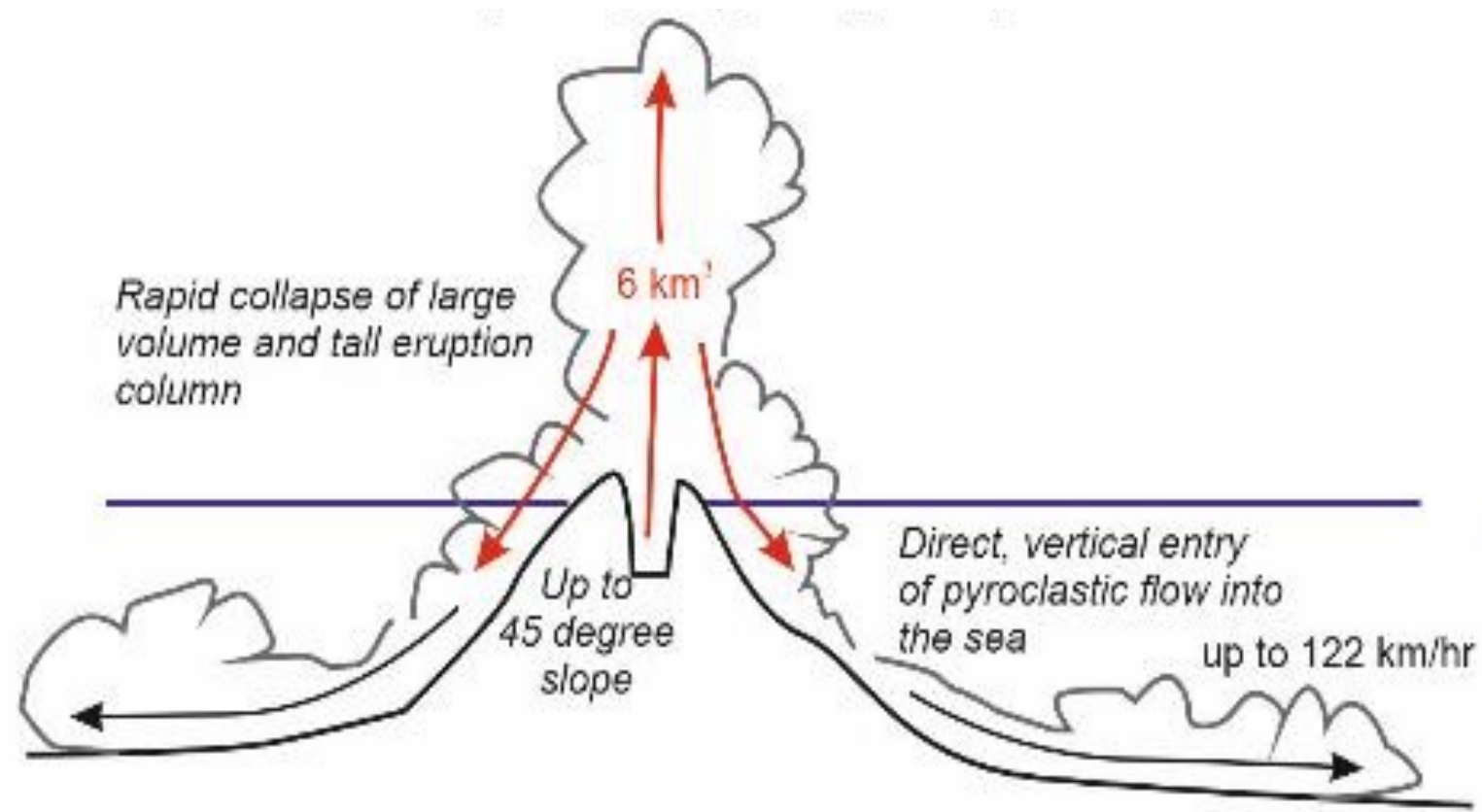


Animated underwater pyroclastic density flow, approx 2000m depth



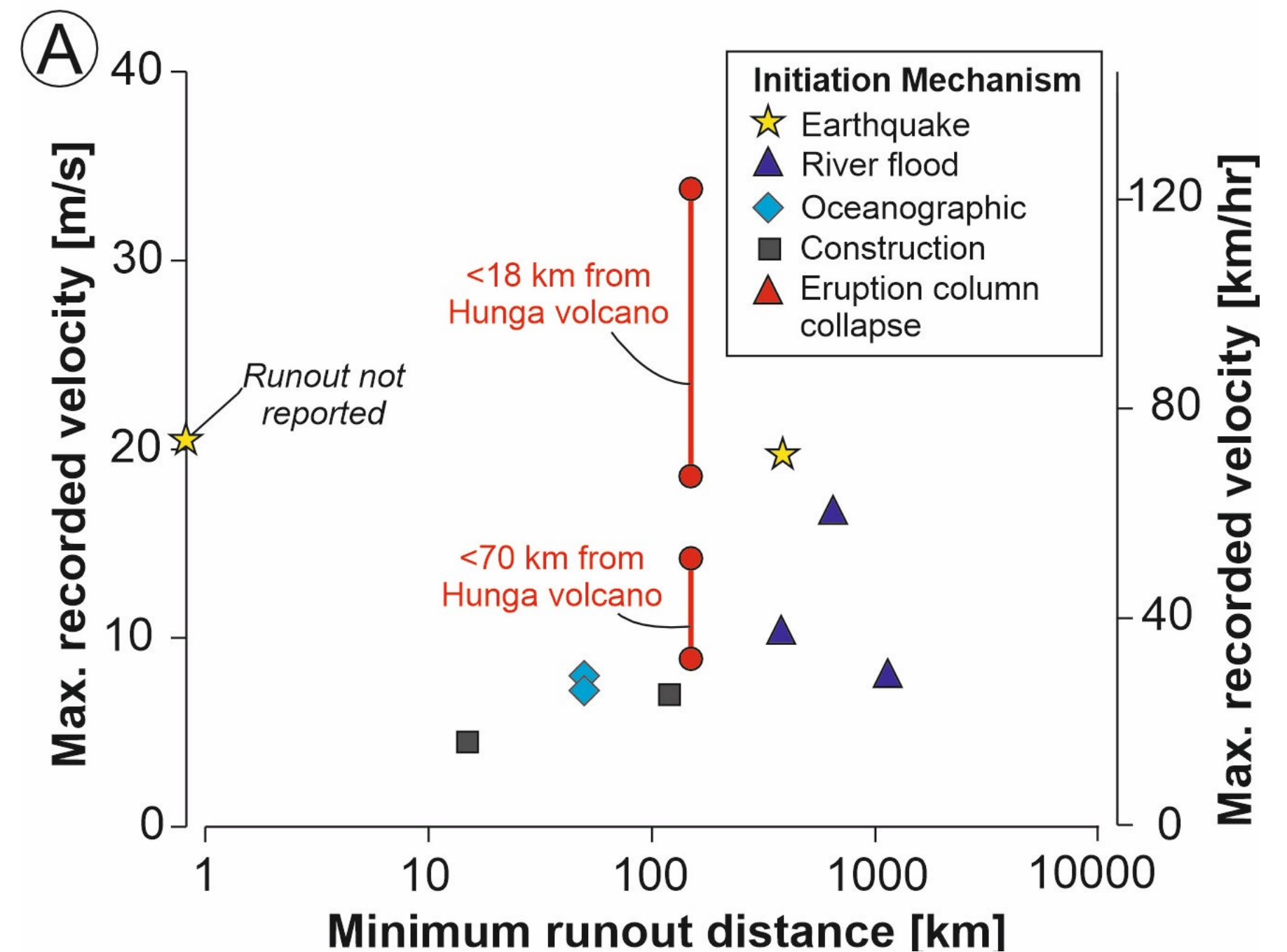
The first underwater measurements of flows created by a volcanic eruption

The fastest underwater flows on Earth



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

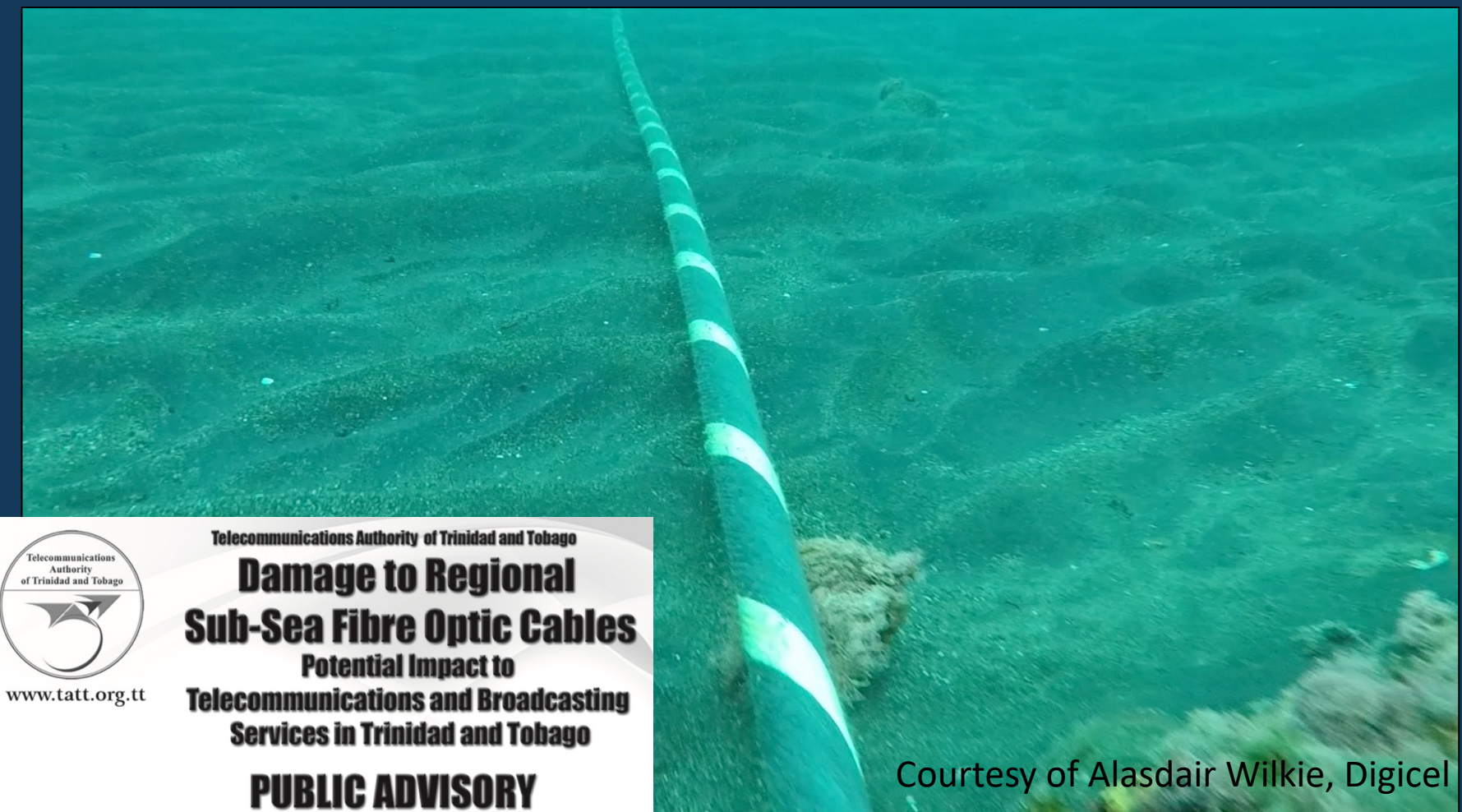
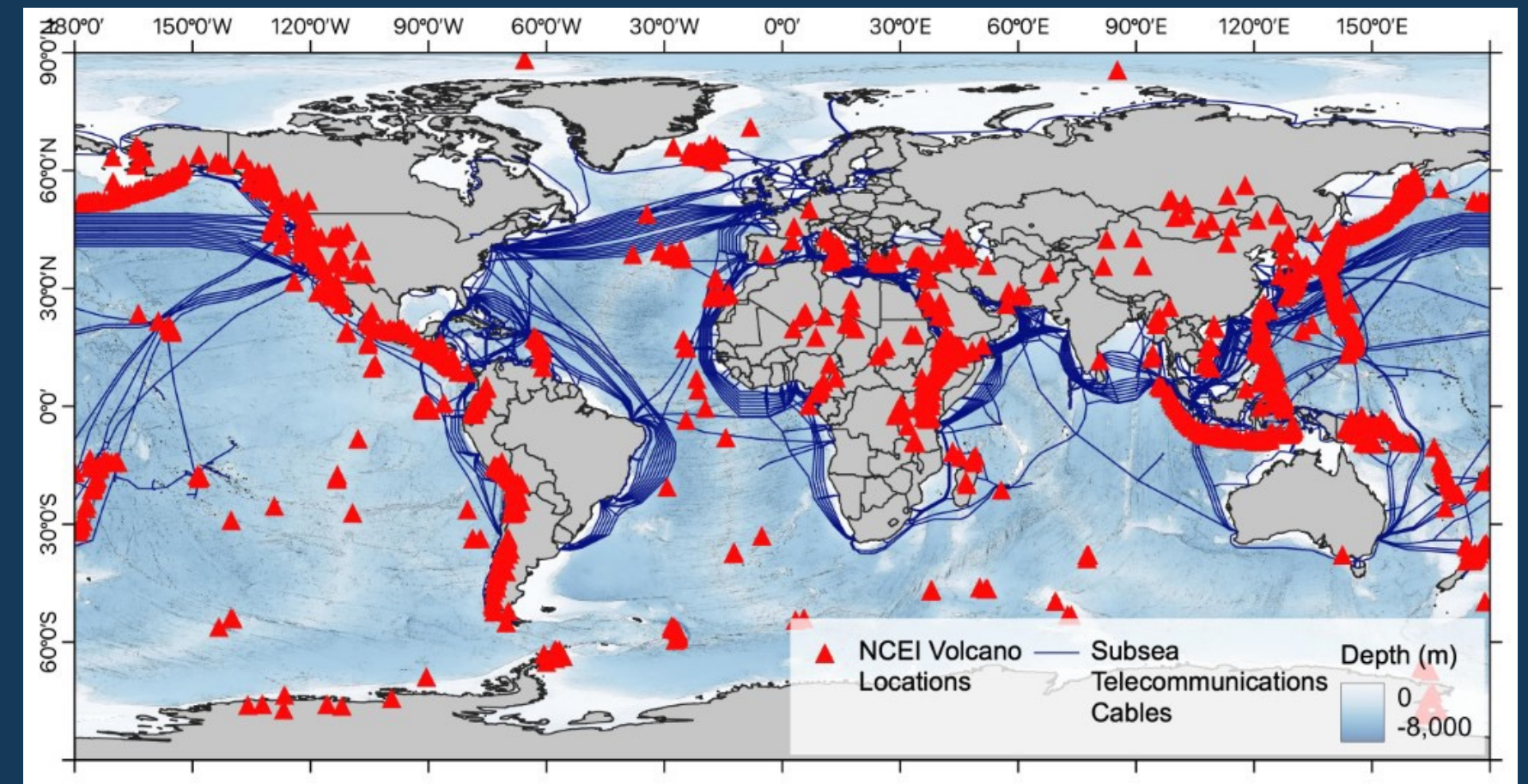
Setting a stand-off distance may not be appropriate...



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 low level satellite communications



Courtesy of Alasdair Wilkie, Digicel

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 @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 Watson², Richard Wysoczanski², Sarah Seabrook², Kevin Mackay², James E. Hunt¹, Emily Lane², Peter J. Talling³, Edward Pope³, Shane Cronin⁴, Marta Ribó⁵, Taaniela Kula⁶, David Tappin⁷, Stuart Henrys⁸, Cornel de Ronde⁸, Morelia Urlaub⁹, Stefan Kutterolf⁹, Samuiea Fonua¹⁰, Semisi Panuve¹⁰, Dean Veverka¹¹, Ronald Rapp¹², Valey Kamalov¹³, Michael Williams²

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-entrenched, scaled-down laboratory volcanoes to infer the behavior of large volcanoes (26, 27). Fields of mounds and scours, commonly found on the submerged flanks of volcanoes, may be diagnostic of catastrophic flank collapse. However, this hypothesis is weakened by the cause of a lack of repeatable behavior before and after a large eruption. These uncertainties severely limit the ability to infer behavior and associated hazards from ancient volcanoes.

We present observations of the caniclastic density current by the 15 January 2022 tsunami in the Kingdom of Tonga. The tsunami was the most explosive eruption in Tonga and had worldwide impact. The eruption plume entered the ocean (Fig. 1a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z, aa, ab, ac, ad, ae, af, ag, ah, ai, aj, ak, al, am, an, ao, ap, aq, ar, as, at, au, av, aw, ax, ay, az, ba, bb, bc, bd, be, bf, bg, bh, bi, bj, bk, bl, bm, bn, bo, bp, bq, br, bs, bt, bu, bv, bw, bx, by, bz, ca, cb, cc, cd, ce, cf, cg, ch, ci, cj, ck, cl, cm, cn, co, cp, cq, cr, cs, ct, cu, cv, cw, cx, cy, cz, da, db, dc, dd, de, df, dg, dh, di, dj, dk, dl, dm, dn, do, dp, dq, dr, ds, dt, du, dv, dw, dx, dy, dz, ea, eb, ec, ed, ee, ef, eg, eh, ei, ej, ek, el, em, en, eo, ep, eq, er, es, et, eu, ev, ew, ex, ey, ez, fa, fb, fc, fd, fe, ff, fg, fh, fi, fj, fk, fl, fm, fn, fo, fp, fq, fr, fs, ft, fu, fv, fw, fx, fy, fz, ga, gb, gc, gd, ge, gf, gg, gh, gi, gj, gk, gl, gm, gn, go, gp, gq, gr, gs, gt, gu, gv, gw, gx, gy, gz, ha, hb, hc, hd, he, hf, hg, hh, hi, hj, hk, hl, hm, hn, ho, hp, hq, hr, hs, ht, hu, hv, hw, hx, hy, hz, ia, ib, ic, id, ie, if, ig, ih, ii, ij, ik, il, im, in, io, ip, iq, ir, is, it, iu, iv, iw, ix, iy, iz, ja, jb, jc, jd, je, jf, jg, jh, ji, jj, jk, jl, jm, jn, jo, jp, jq, jr, js, jt, ju, jv, jw, jx, jy, jz, ka, kb, kc, kd, ke, kf, kg, kh, ki, kj, kk, kl, km, kn, ko, kp, kq, kr, ks, kt, ku, kv, kw, kx, ky, kz, la, lb, lc, ld, le, lf, lg, lh, li, lj, lk, ll, lm, ln, lo, lp, lq, lr, ls, lt, lu, lv, lw, lx, ly, lz, ma, mb, mc, md, me, mf, mg, mh, mi, mj, mk, ml, mm, mn, mo, mp, mq, mr, ms, mt, mu, mv, mw, mx, my, mz, na, nb, nc, nd, ne, nf, ng, nh, ni, nj, nk, nl, nm, nn, no, np, nq, nr, ns, nt, nu, nv, nw, nx, ny, nz, oa, ob, oc, od, oe, of, og, oh, oi, oj, ok, ol, om, on, oo, op, oq, or, os, ot, ou, ov, ow, ox, oy, oz, pa, pb, pc, pd, pe, pf, pg, ph, pi, pj, pk, pl, pm, pn, po, pp, pq, pr, ps, pt, pu, pv, pw, px, py, pz, qa, qb, qc, qd, qe, qf, qg, qh, qi, qj, qk, ql, qm, qn, qo, qp, qq, qr, qs, qt, qu, qv, qw, qx, qy, qz, ra, rb, rc, rd, re, rf, rg, rh, ri, rj, rk, rl, rm, rn, ro, rp, rq, rr, rs, rt, ru, rv, rw, rx, ry, rz, sa, sb, sc, sd, se, sf, sg, sh, si, sj, sk, sl, sm, sn, so, sp, sq, sr, ss, st, su, sv, sw, sx, sy, sz, ta, tb, tc, td, te, tf, tg, th, ti, tj, tk, tl, tm, tn, to, tp, tq, tr, ts, tt, tu, tv, tw, tx, ty, tz, ua, ub, uc, ud, ue, uf, ug, uh, ui, uj, uk, ul, um, un, uo, up, uq, ur, us, ut, uu, uv, uw, ux, uy, uz, va, vb, vc, vd, ve, vf, vg, vh, vi, vj, vk, vl, vm, vn, vo, vp, vq, vr, vs, vt, vu, vv, vw, vx, vy, vz, wa, wb, wc, wd, we, wf, wg, wh, wi, wj, wk, wl, wm, wn, wo, wp, wq, wr, ws, wt, wu, wv, ww, wx, wy, wz, xa, xb, xc, xd, xe, xf, xg, xh, xi, xj, xk, xl, xm, xn, xo, xp, xq, xr, xs, xt, xu, xv, xw, xx, xy, xz, ya, yb, yc, yd, ye, yf, yg, yh, yi, yj, yk, yl, ym, yn, yo, yp, yq, yr, ys, yt, yu, yv, yw, yx, yy, yz, za, zb, zc, zd, ze, zf, zg, zh, zi, zj, zk, zl, zm, zn, zo, zp, zq, zr, zs, zt, zu, zv, zw, zx, zy, zz).

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Science & Environment

Tonga volcano triggered seafloor debris stampede

🕒 8 September

 **Tonga eruption and tsunami**



Clare, Yeo et al. Science (2023)