Vulnerability assessment across volcanic hazards

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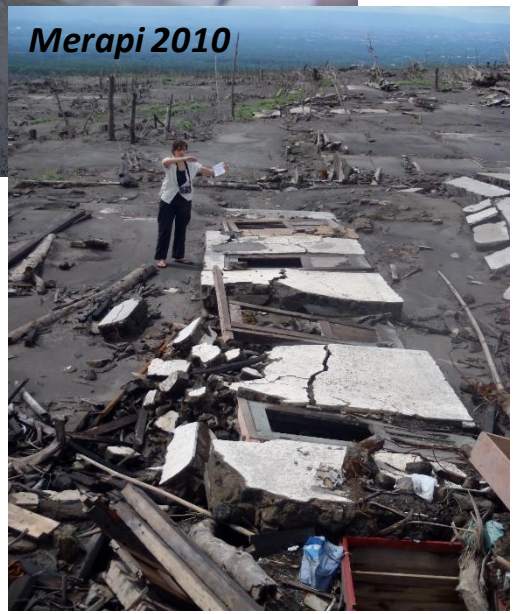
Volcanic vulnerability assessment…

- Pre-eruption

(linked with exposure assessments)

- Post-eruption

(impact assessment)



- Syn-eruption =

(Exposure + impact assessment?)

Volcanic vulnerability assessment…

- Pre-eruption

(linked with exposure assessments)

- Critically important for risk assessment
- Time-consuming - small area of focus
- Reliant on post-eruption data

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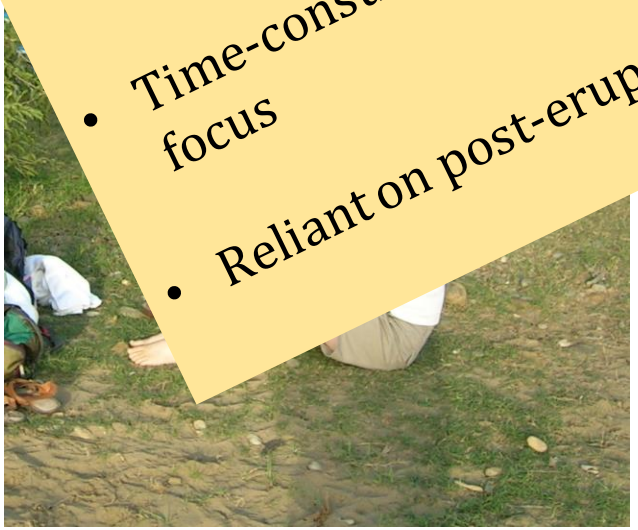

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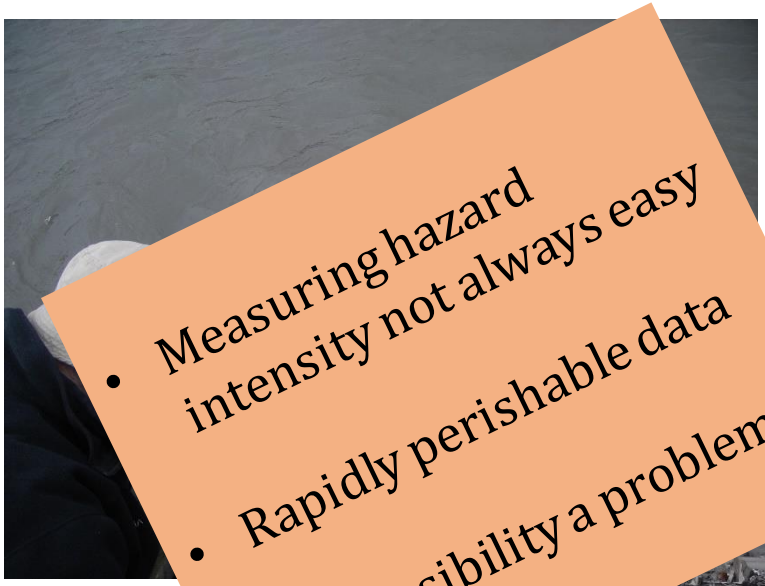


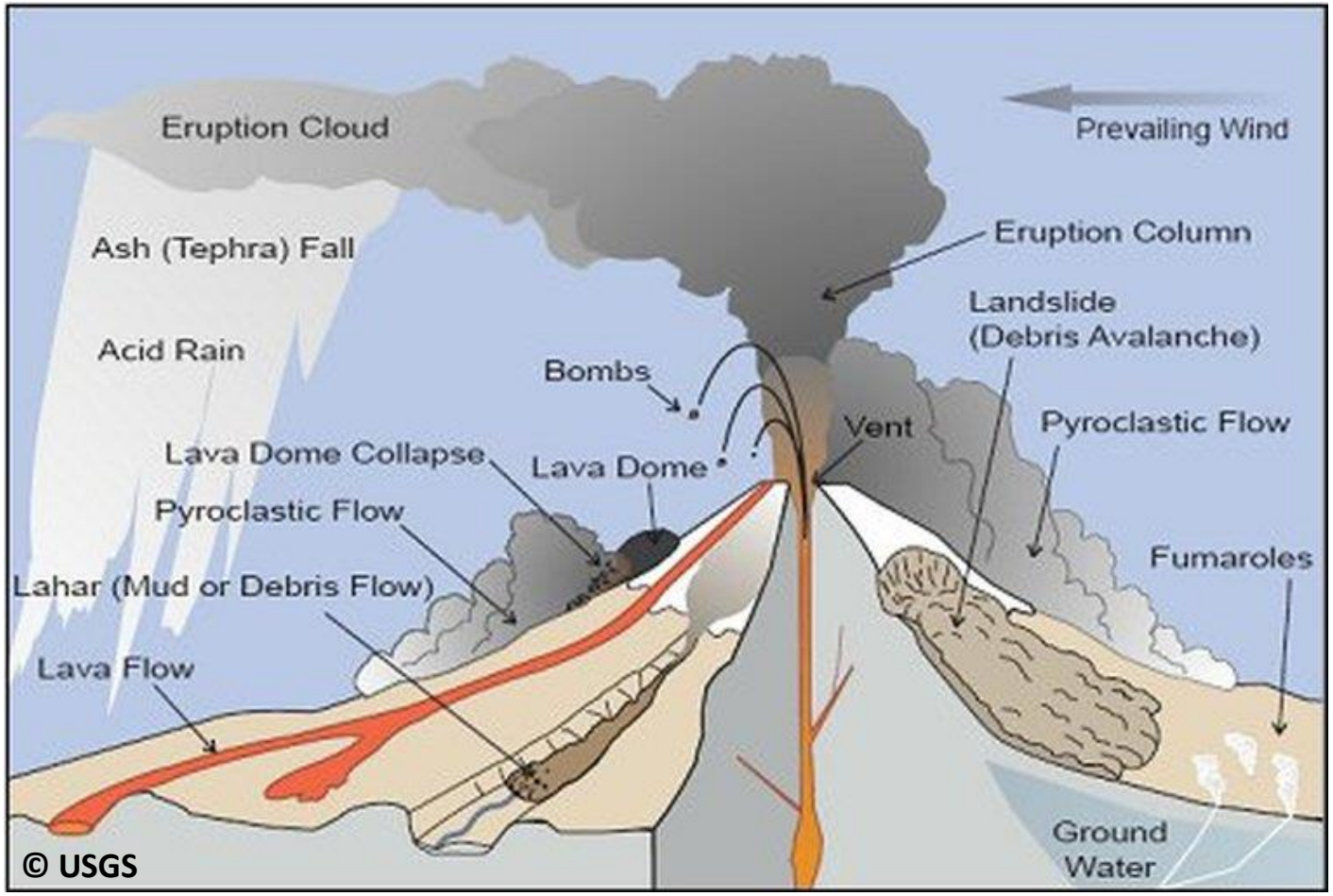
- Measuring hazard intensity not always easy
- Rapidly perishable data
- Accessibility a problem

- Syn-eruption =

(Exposure + impact assessment?)

The many facets of volcanic vulnerability…

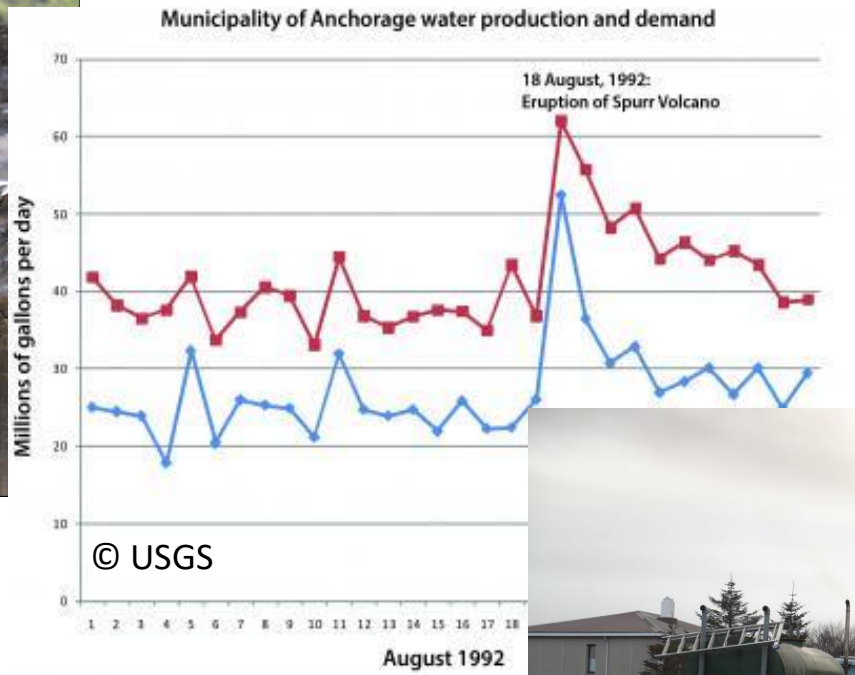
Multiple hazards, sometimes interacting



The many facets…

Multiple hazards, sometimes interacting

Multiple assets, sometimes interacting



The many facets…

Multiple hazards, sometimes interacting

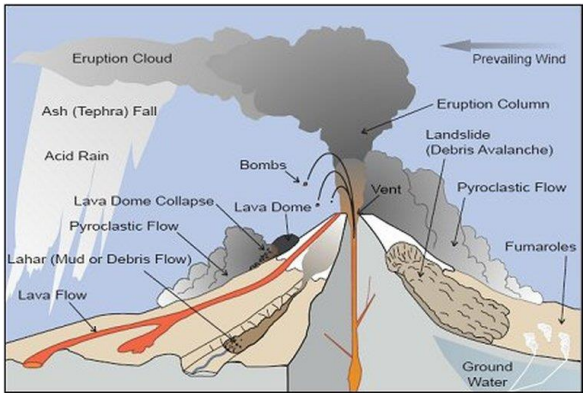
Multiple assets, sometimes interacting

Multiple vulnerabilities, sometimes interacting

- Physical (human, buildings, agriculture, infrastructure, aviation, …)
- Societal (mental trauma, loss of livelihoods, homes, community, education, …)
- Economic (loss relative to wealth, non-insured, insured, long-term, …)
- Institutional
- Political
- Systemic
- …

The many facets…

Multiple hazards, sometimes interacting



Multiple assets, sometimes interacting

Multiple vulnerabilities, sometimes interacting

And multiple motivations (sometimes interacting!)

- Operational, research, institutional, economic, …

The many facets…

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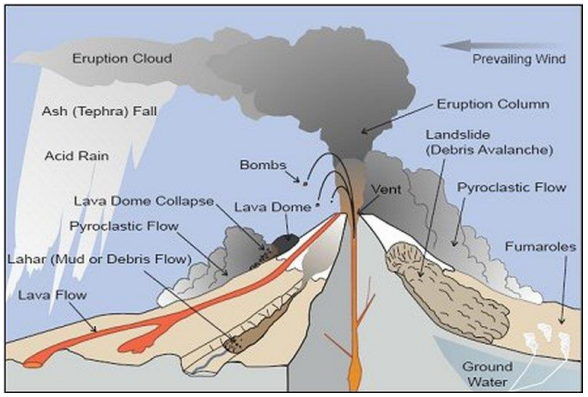

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And all of these are dynamic…

Thus far dominated by tephra fall

Table 4. Existing critical infrastructure fragility and vulnerability functions developed for different volcanic hazards. We found no published peer-reviewed fragility functions for water supply, communication networks or lava flows. See Supplementary material 1 for a review of these functions.

	Tephra fall	PDC	Lahar
Electrical supply	a		
Wastewater networks	b		
Transportation networks	b		
Buildings	b, c, d	d, e, f	e
Critical components	g		

Which is understandable given the far reach and wide-ranging impacts…

a Wardman et al. (2012c).
b Kaye (2007).
c Spence et al. (2005).
d Zuccaro et al. (2008).
e Zuccaro and De Gregorio (2013).
f Spence et al. (2007).
g Wilson et al. (2012a).

Wilson et al., 2014. JVGR

Knowledge = power

- But we have very few data…
- And only some knowledge
- Data sources:
  - Empirical

Rabaul, 1994 © E. Endo

Blong and McKee, 1995; Blong, 2003

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Table 8. Resistance of Openings as Derived from Loading Experiments

Opening types	Collapse load (kPa)	Maximum displacement (mm)
Aluminum window, good condition	3	25
Aluminum window, bad condition	1.5	61
Old wooden window	5	41.5
Old wooden door	3.5	26

Spence et al., 2004. Nat Haz Review

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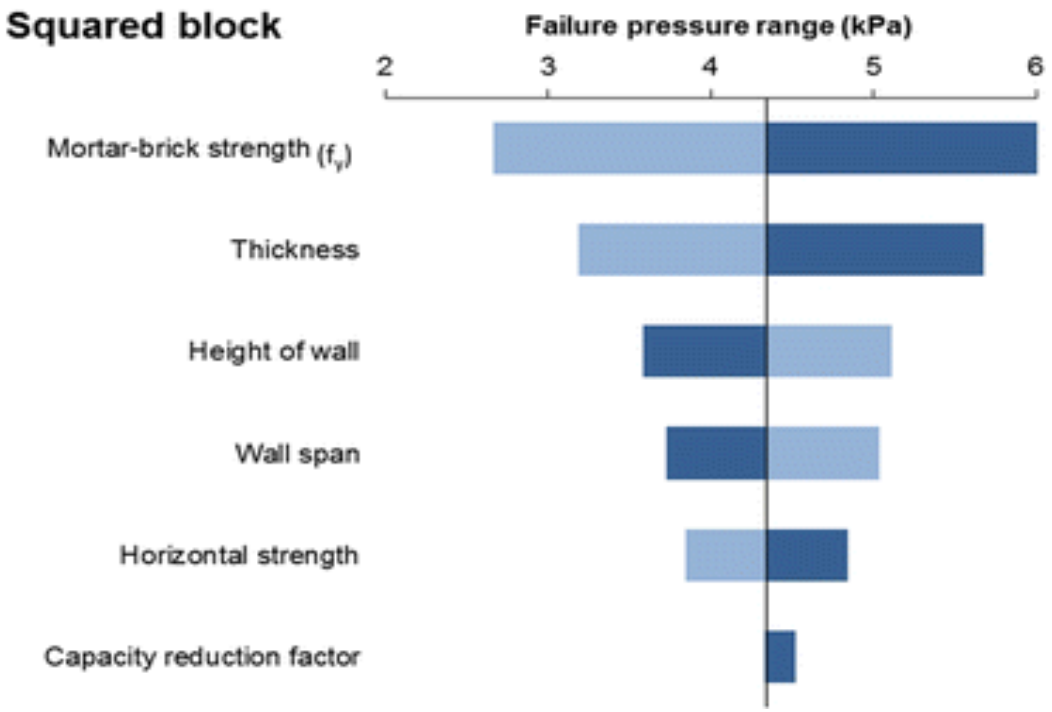
  - Theoretical

$$w = 6m / \left[\left(\frac{1.5\,\beta - \beta^2}{2\,\beta + (\mu\alpha^2/K)} \right) \cdot \alpha^2 \cdot L^2 \right]$$

where m is the moment/unit length normal to the bed joint (N/mm^2). In turn, m is a function of the wall thickness (t) in millimetre and the strength of the bond between mortar and brick vertically (f_y), i.e. along the joins perpendicular to the floor; $m = f_y \cdot t^2/3500$ where the numerical coefficient is a combination of unit conversion factors and a design factor that accounts for existing buildings of uncertain construction, age and condition. The design factor can be adjusted where more information regarding construction quality and building condition are available; here, the standard value of 3.5 is used (following BS 5628-1 2005). μ is the ratio between the moment per unit length parallel to the bed joint and m, L the span of the wall (m), α the ratio of wall height to wall span, K the ratio of the horizontal to vertical elastic moduli and β a constant that gives the location of the point where the fracture meets the top edge of the wall and is a function of the wall height and span.



Jenkins et al., 2015. Bull Volc

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  - Remotely sourced data – increasing source (brief foray into Fuego)

Fuego eruption 2018

- 110 killed; 197 missing (17 June2018); Estimated dead: 2,000 from census
- From an impact perspective, there are striking similarities with Merapi 2010 (from media images and Peter Baxter's current medical ground-truthing)

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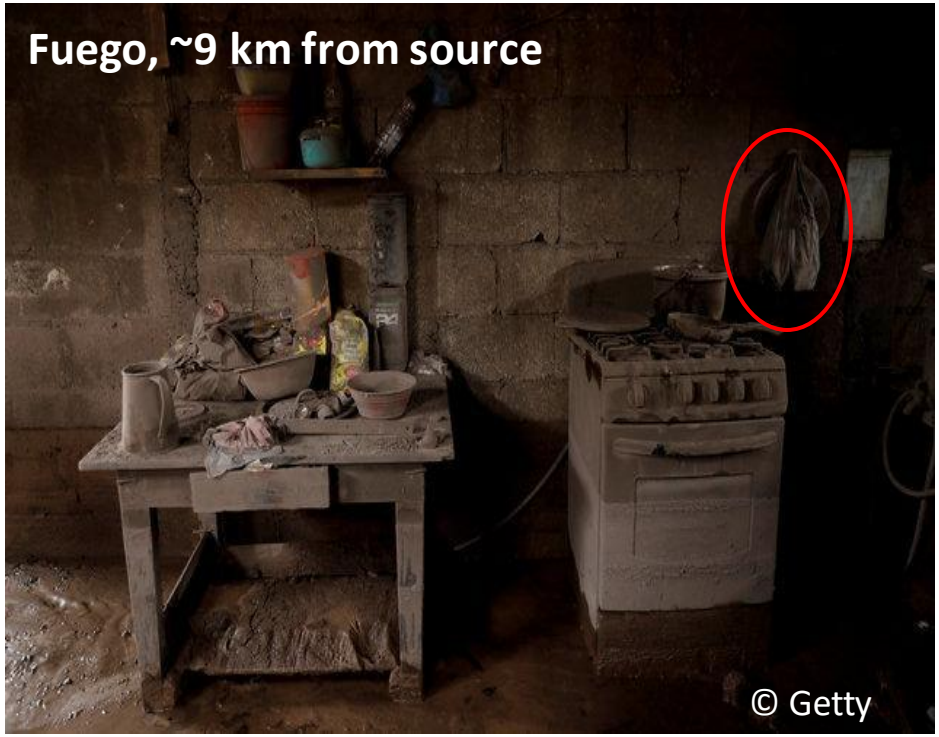

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- **But ideally we ground-truth**

Non-traditional data sources (e.g. social and professional media images, remote sensing), *and* increasing exposure datasets, e.g. HOT, GEM, have the potential to provide an additional quantitative source for empirical data…

Thoughts

- Learn to walk well in one key area before we run across all?
- Standardise, categorise, and agree on data collection guidelines?
- Need to communicate our uncertainties better? So that external partners appreciate how poor the estimates are when applying them to calculate damage, casualties and/or loss…
- Ethics of collaborating – how do we best feed the data back to our local partners? Can we do it better?

CAN ANYONE TRULY CLAIM TO BE AN

?