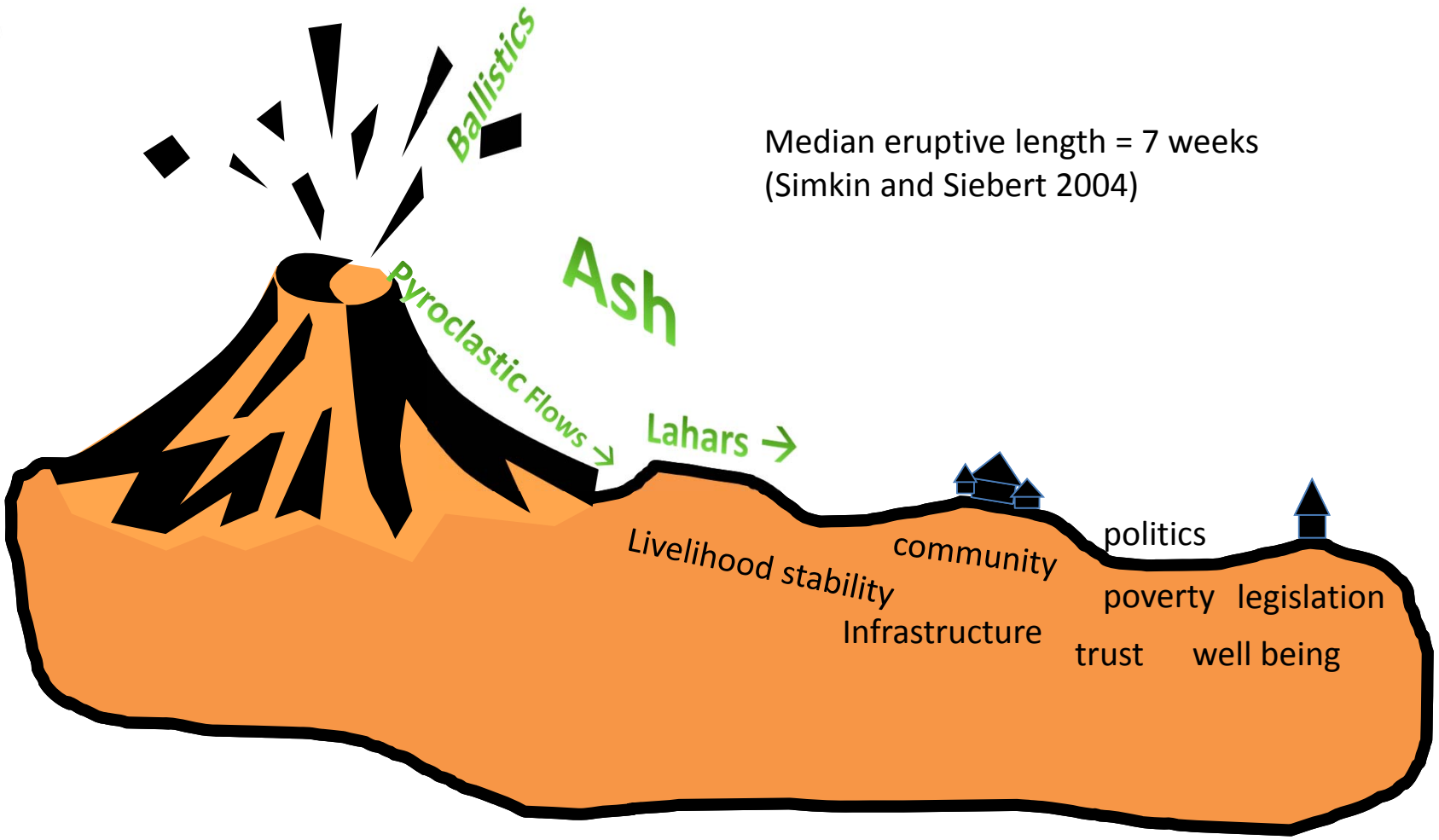
Jenni Barclay, School of Environmental Sciences, University of East Anglia
on behalf of STREVA TEAM

Dynamic Volcanic Risk: Challenges



Median eruptive length = 7 weeks
(Simkin and Siebert 2004)

What is ‘Risk’ ?

Define the RISK (analysis)

- Risk = probability event occurs times the loss (loss = people, property, efficacy)
- = hazard times vulnerability
- = (hazard times the vulnerability) times capacity to cope

DECIDING WHAT TO DO TO INCREASE RESILIENCE=>timescale + dynamics

Manage the RISK

- Avoid (via prediction of occurrence)
- Mitigate (via prediction of impact)
- Transfer (insure, govern away)
- Accept it (just get on with it)

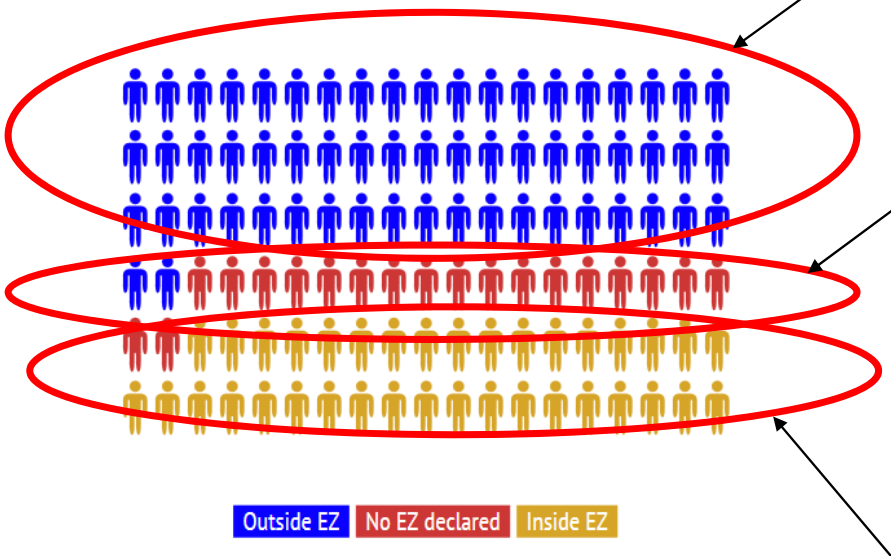
Risk and livelihoods: what is a livelihood (here)?

Livelihood

the means by which individual can provide themselves with the essentials for living and the capacity to secure those and other assets needed.

Also important: the social and cultural attachments that come with a particular place

Specific Volcanic Risk: insights from fatalities and immediate risk



Location of those killed relative to declared warnings

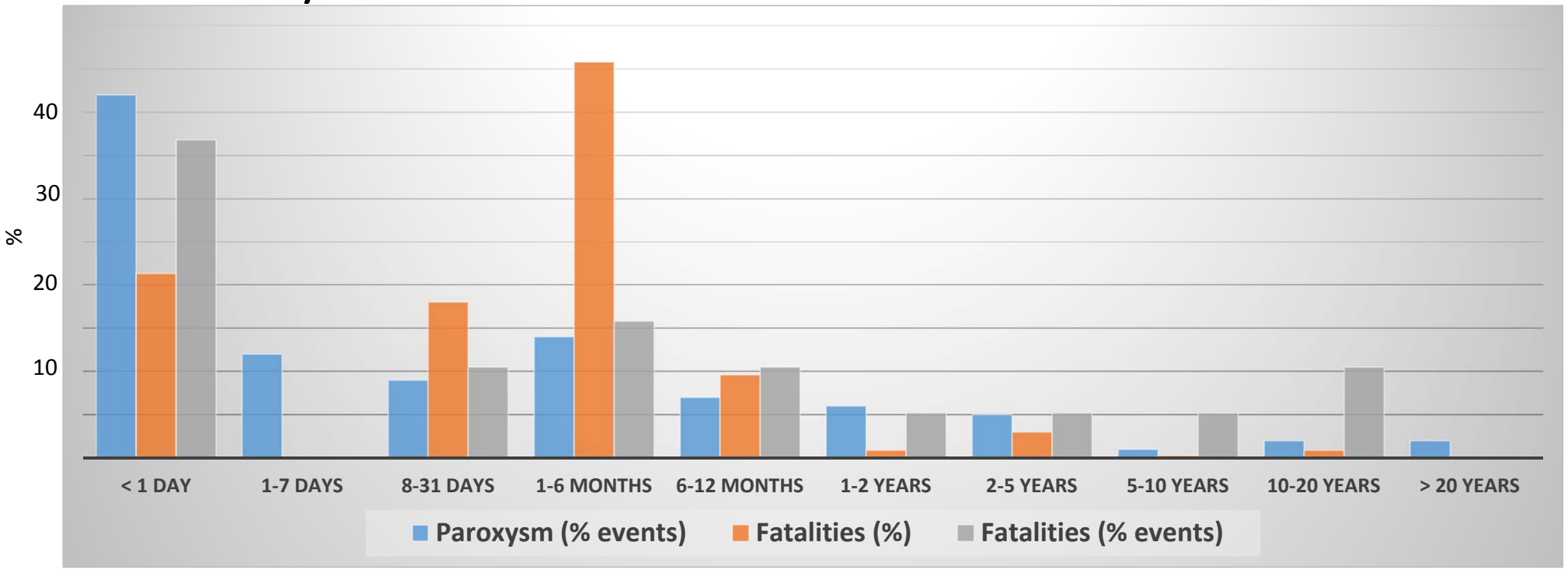
Incomplete understanding of volcanic impact (hazard impact and dynamics – hazard assessment)

Incomplete volcanic forecast cycle (warning to action)

Poorly anticipated Social processes

Barclay et al., in prep. Based on last 32 years of volcanic fatality data (not including Fuego)

Interval between start, ‘paroxysm’ and fatal activity.

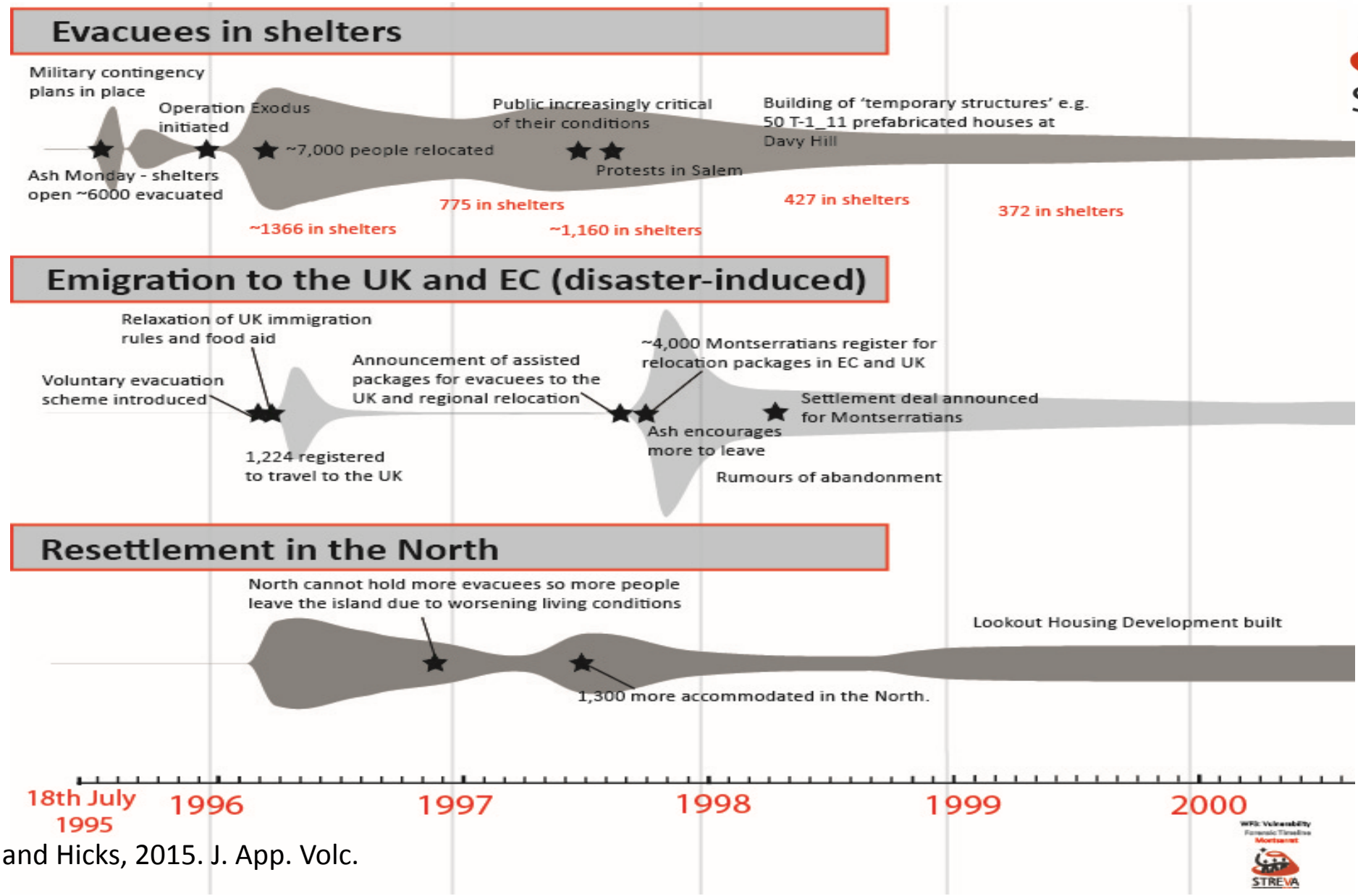


Data Sources:
Siebert et al., 2015 for n= 252 well documented eruptions with significant explosion (‘paroxysm’). Barclay et al., in prep for n = 19 eruptions with > 6 fatalities since 1985 (does not include recent activity at Fuego).

Our research challenges for volcanic eruptions

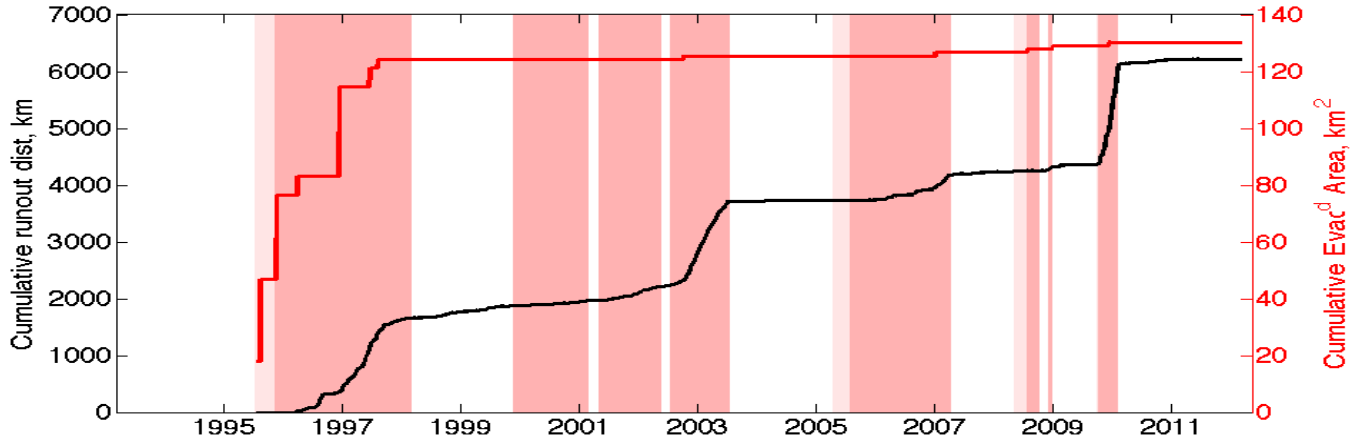
- More effective monitoring and translation of monitoring into warnings (prediction)
- Improved formulations for risk and *dynamic* risk (prediction and mitigation)
- Better understanding of mechanisms to promote uptake of volcanic risk advice to improve resilience (predict, mitigate, transfer, accept)

Drivers and outcomes of past events



Few and Hicks, 2015. J. App. Volc.

Soufriere Hills: relation between hazard and risk (outcomes)



Phillips et al., in prep

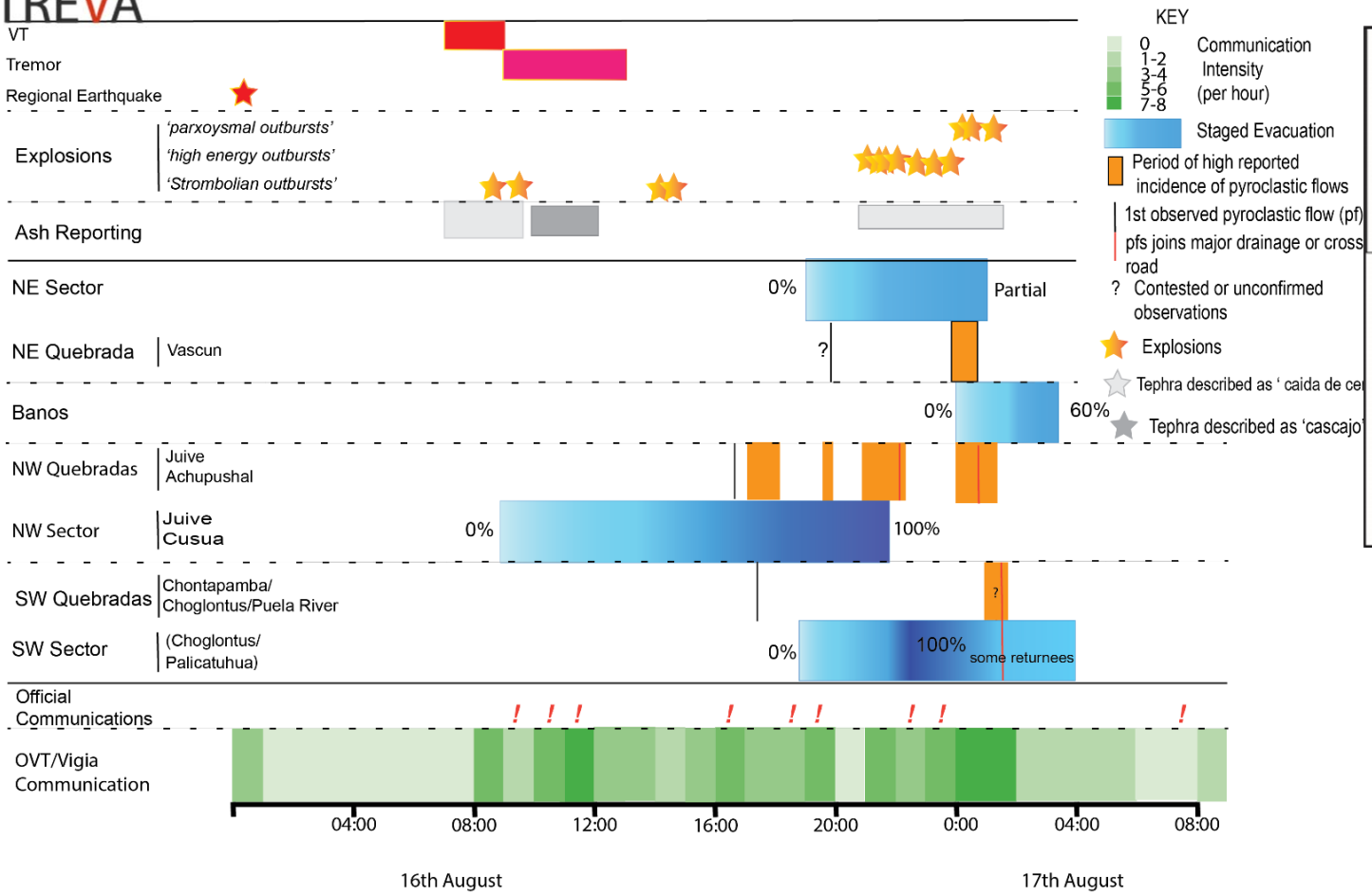
Hazard outcome = pyroclastic density current runout (impact) or seismic signal elevation (hazard forecast)

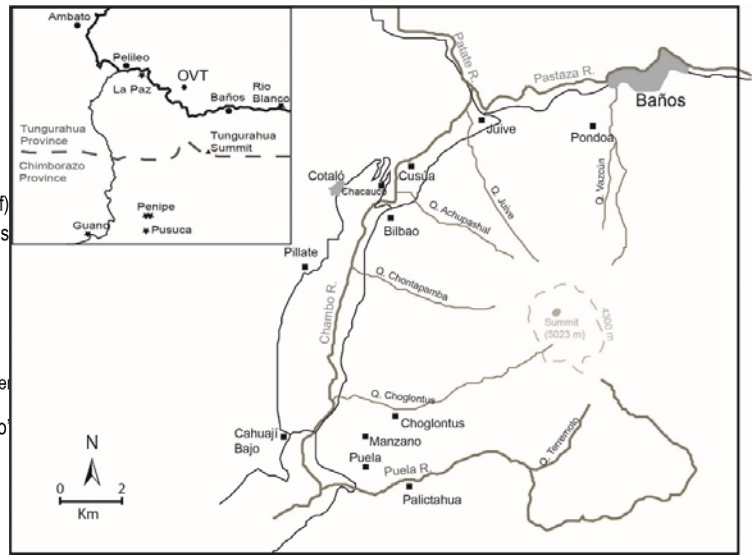
Risk outcome = decision to evacuate population

Correlations don't imply causation but can be compared with qualitative analysis

8 distinct periods → surface activity strong driver → geophysical signals more problematic

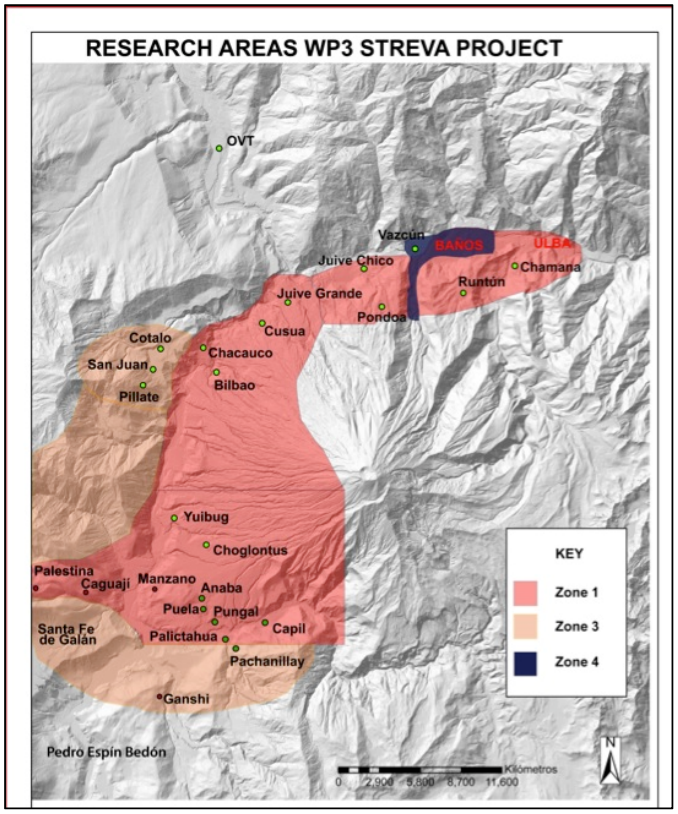
Tungurahua - 2006



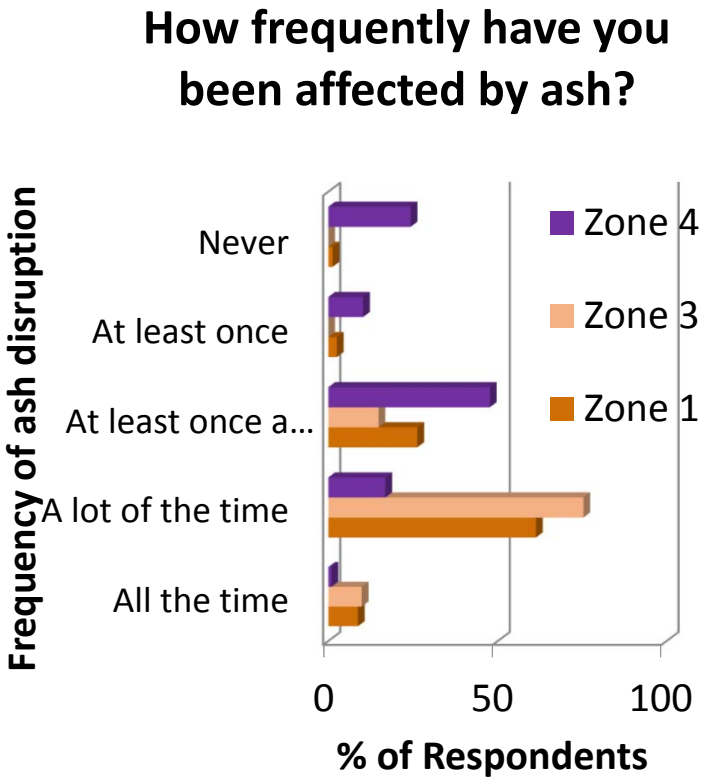


Armijos et al., 2017 Global Environmental Change

Representations of Risk



- Study areas divided by: degree of exposure to hazards and residency patterns



Armijos and Few, 2015; Few et al., 2017; Armijos et al., 2017.

A new approach: understanding risk from scratch

St. Vincent's Historical Eruptions

- **Start Date**
- 1979 Apr 13
- 1971 Oct 4
- 1902 May 6
- 1814 Jan 9
- 1812 Apr 27
- 1784 Mar
- 1718 Mar 26 (?)

The Approach

Past experiences

Personal/institutional experiences

Review of the monitoring data and hazard impacts

Anticipating the future

Group discussion how would this play out now?

Design and execution of tabletop scenarios

Identification of key ‘drivers’ of risk change during a crisis

Paired comparison exercise: risk ranking

Photos: David Pyle, Anna Hicks

Results: Identified ‘drivers’ of risk

- (Scientists knowledge of) the range and likelihood of hazards
- (Ability of scientists to interpret) Precursory behaviour
- Uncertainty and interpretation (judgement by scientists)
- Population awareness and understanding (good communication)
- Capacity to relocate,rehouse and help people recover
- Strong social cohesion and community relationships
- Good, flexible infrastructure in unaffected areas, including alternative land
- Ability to decide when eruption is over
- Participation in decision-making processes
- Changes in lifestyles (more to lose)

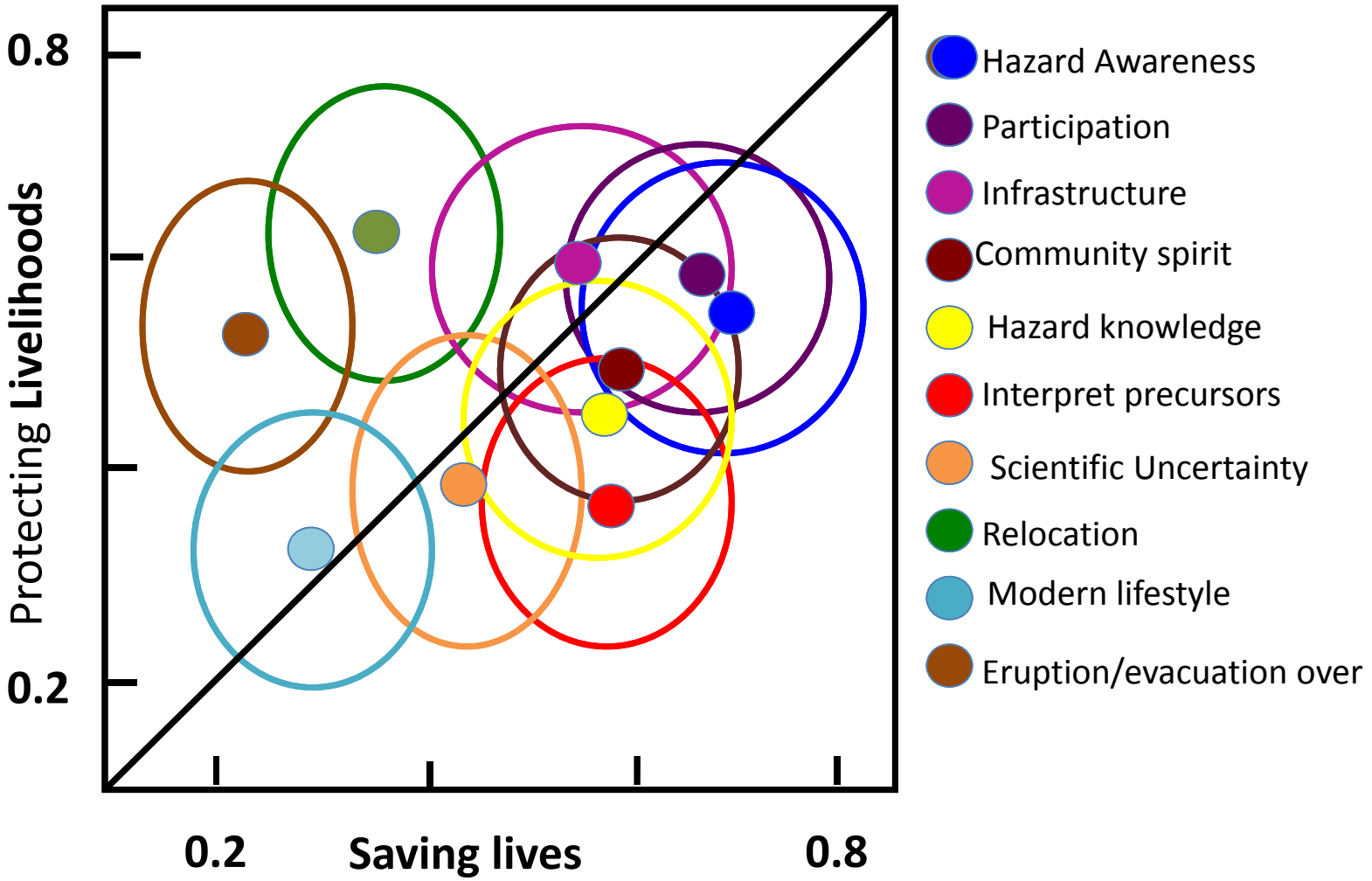
David Pyle

Aspect of Hazard Aspect of Vulnerability

Paired comparison (Ranking) Exercise

	tephra	ballistics	gas	lava flow	base surge	PDC	lahar	earthquake	rockfall/ landslide
tephra									
ballistics	=								
gas	>	>							
lava flow	=	<	<						
base surge									
PDC									
lahar									
earthquake									
rockfall/ landslide									

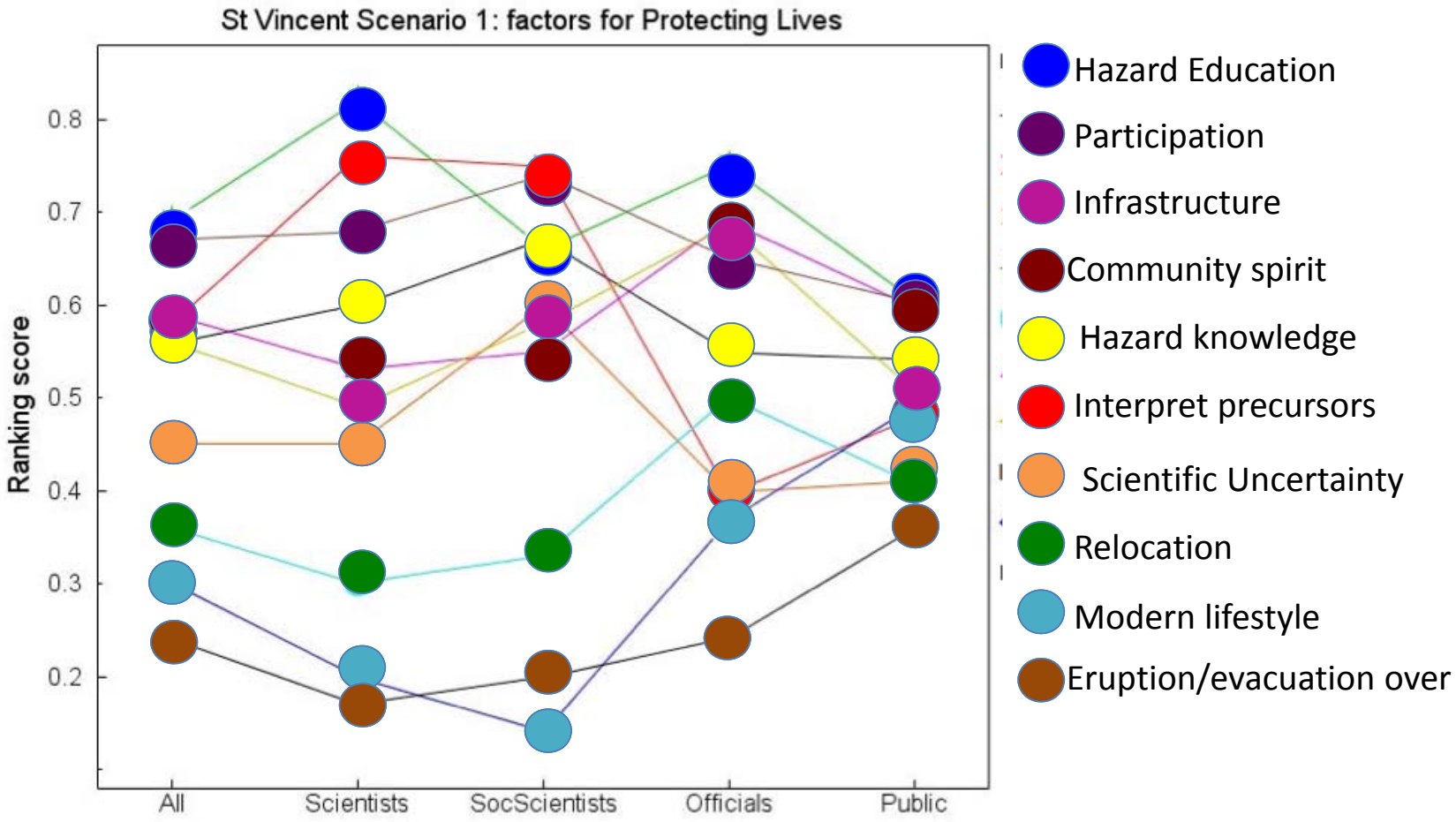
Results: the paired comparison



Main Points

- Communication around scientific information important
- For livelihoods: capacity to relocate and declare eruption end becomes more important
- Interesting insights into willingness to ‘own’ risk in this setting

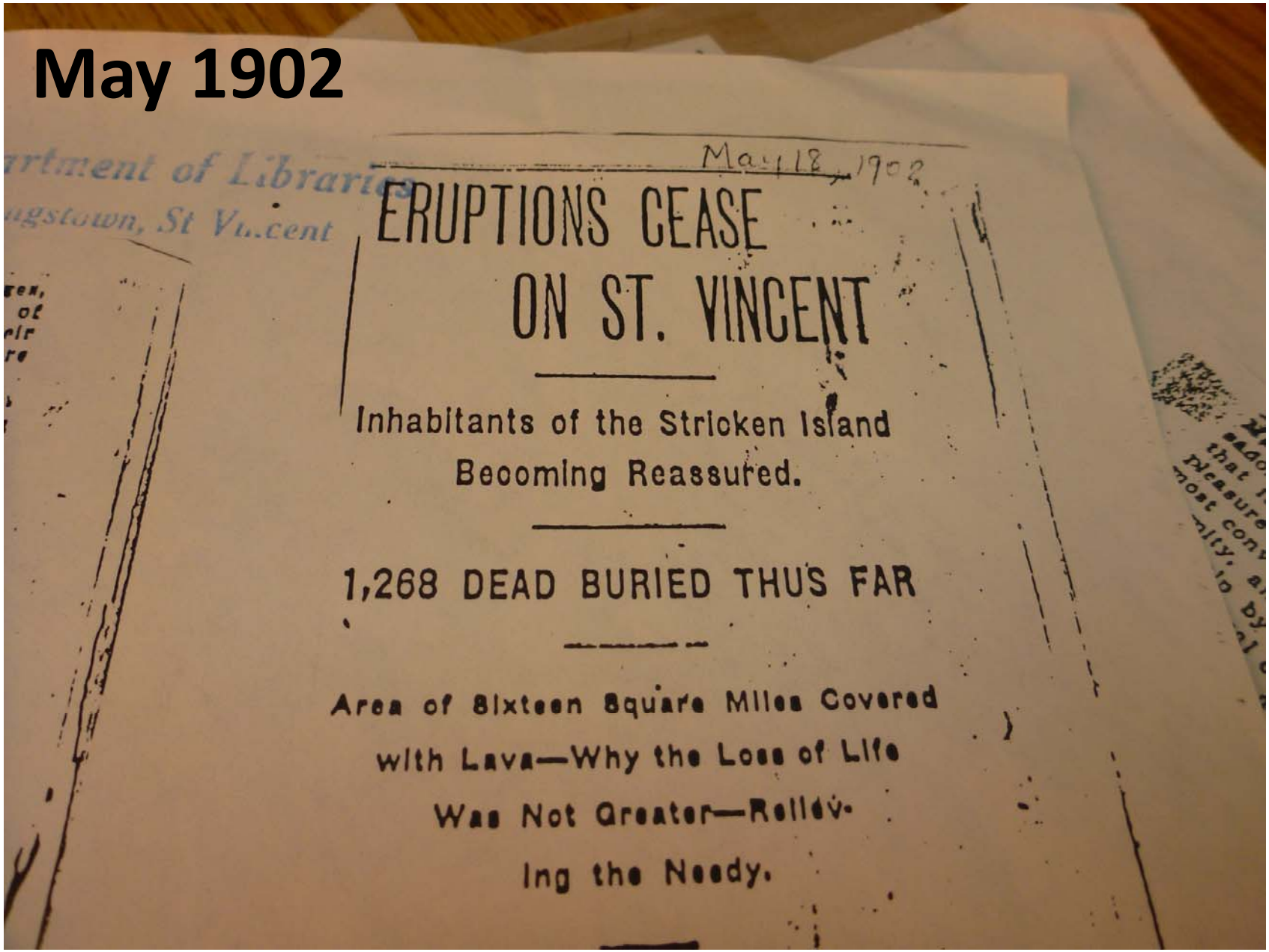
Heterogeneities!



Dynamic Scenario planning – how can it be useful?

- Communities **learn** from accumulated social memory of events
- Scientists and managers of risk **learn** what matters in a crisis, and likely response
- SP exercises **connect** groups
- SP inspires ownership of risk .
- SP **addresses uncertainty**.
- Time-stepped SP detects **thresholds for action and is appropriate for volcanic situations**

May 1902



May 18, 1902

ERUPTIONS CEASE ON ST. VINCENT

Inhabitants of the Stricken Island Becoming Reassured.

1,268 DEAD BURIED THUS FAR

Area of Sixteen Square Miles Covered with Lava—Why the Loss of Life Was Not Greater—Relieving the Needy.

SCENARIO 1

1) Earthquakes felt in all of the unsafe zone. These occur in something being described as cluster swarms. These become more intense through time.

END OF YEAR 1

1

Scenario 1: 3 months later

The seismic activity continues over most of the three months in 'swarms'

There are now lots of landslides and rockfalls in the crater; Seismic have looked at how the crater is deforming and say that it is moving upwards.

People who visit the crater notice that there are cracks in the ground where steam comes roaring out; the old dome seems to have a lot more fumaroles.

UPDATE: The LAST WEEK

Seismic have issued a bulletin to say that there has been no seismicity for a week.
It has been raining heavily all week. No-one has been able to visit the crater.

There has been a lot of debate about whether there has been rain clouds or steam from the volcano all this week.

2

Scenario 1: 1 day later

There has been an alert this day from seismic to say that there has been a change in the seismicity

There is a rumour from people working around Orange Hill that there was a rumbling coming from the volcano

There has been some flooding in the ghauts but it could be related to the bad weather. The Rabacca bridge is overtopped and has large trees and debris scattered across it in the morning.

3

Scenario 1: 3 days later

Day 1. In the middle of the night there was a very large explosion. It produced significant ash and a large cauliflower plume. Afterwards the scientists said it was 20 km high.

All windows within 10 km of the volcano were broken and fist-sized clasts (sufficient to kill people) fell within the high hazard zone on that day. There were a lot of pyroclastic flows.

Day 2: 1 cm of ash has fallen in Kingstown; and a lot elsewhere (map). Barbados airport is closed.

Day 3: there is a still activity and ash is falling everywhere. There has been rain generating lots of mudflows.

4

Scenario 1: 6 months later

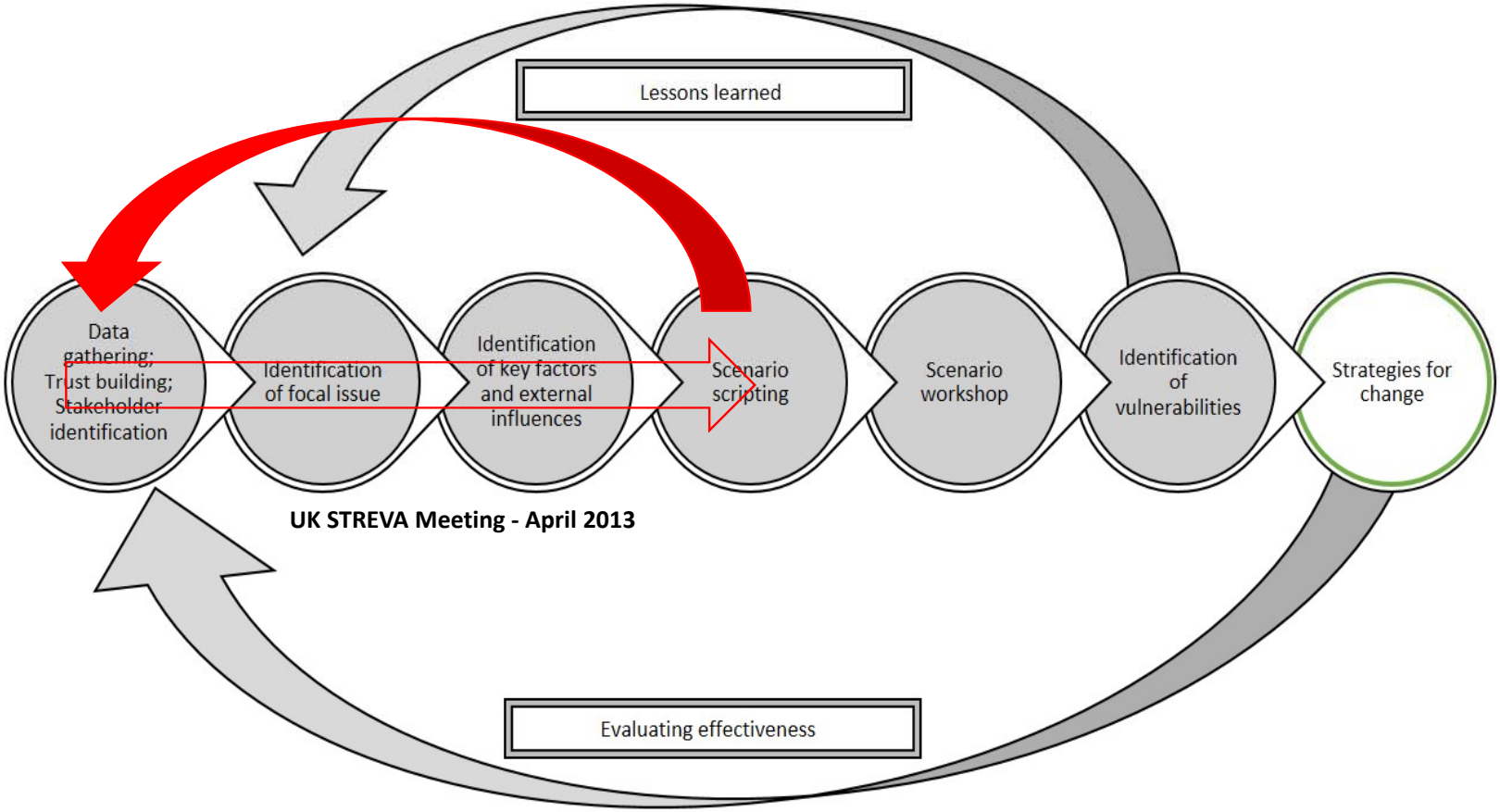
Activity quietened down but for all of these six months there have been large explosions every now and then – many without warning.

The biggest have made more flows in some of the valleys near the volcano

These only make a little ash in the south.

During Month 3 there was a hurricane that passed directly across St. Vincent.
There is an issue with water supply and this badly affects some of the shelters.

5



UK STREVA Meeting - April 2013

Scenario Exercise St Vincent, STREVA Forensic Workshop January 2014

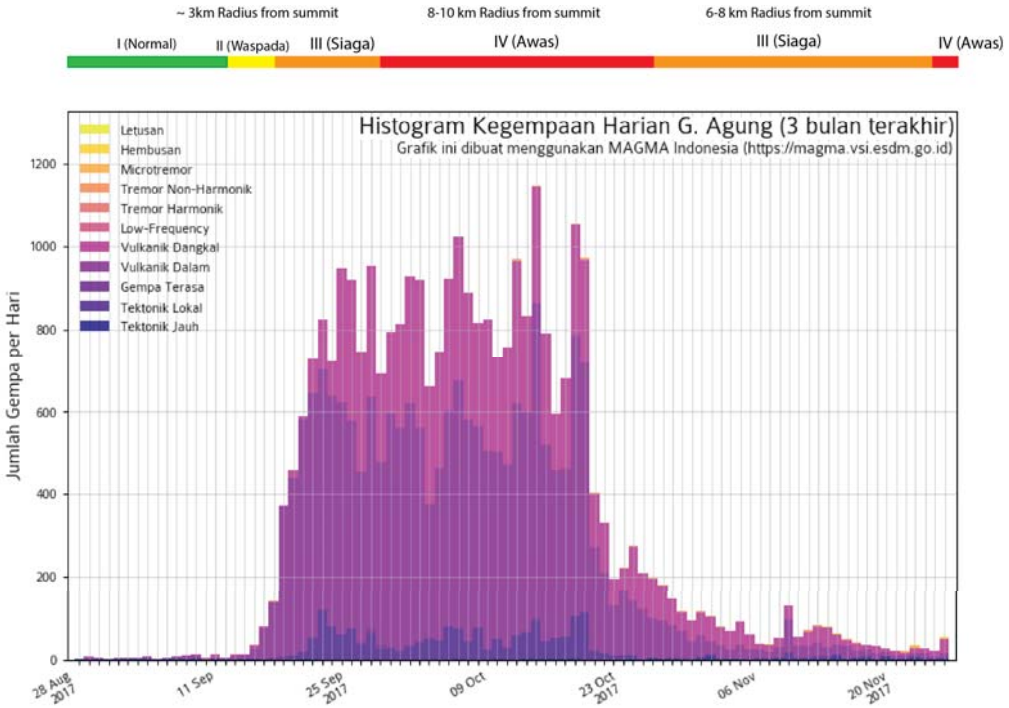
Inter and intra-setting learning

Scenario Exercise St Vincent, Caribbean Ash Hazards and Impacts (CaASHI) Workshop March 2015

Main findings: Forensic Workshop – Risk Implications?

1. Mismatch of expectations of NEMO's response times, support and capabilities (and international aid)
2. Desire to hear from scientists during a crisis
3. Need for an integrated communication plan (from NEMO)
4. Further hazard and risk information
5. Long-term impacts of ash
6. Need for personal preparedness plans (incl. school preparedness)
7. Need for transport plan for evacuation (no buses as per 1979 = individual vehicles = traffic = simulation exercise)
8. Need for multi-hazard shelters

AGUNG - Indonesia



Data compilation released MAGMA Indonesia in reports, + interpretation of reports September – December 2017