

# **Volcanoes and Society**

Professor Steve Sparks Gresham College, 20 February 2019



#### **Global Volcanism**



551 historically active volcanoes (Sinabung 2010, Indonesia)

- ~ 1554 active volcanoes
- ~ 50 eruptions per year

~ 1 volcano erupts every 2 years with no historic eruption

Estimated historic fatalities > 250,000

**Economic and social costs high** 

Large eruptions effect global climate

Global vulnerability increasing (population growth, infrastructure)





# **Global Volcanism**

Most volcanoes are at plate boundaries



And I

### **Problems with Volcanoes: multiple hazards**



Pyroclastic flows

Volcanic ash

Tsunamis



Lahars



Explosions and volcanic gas



Lavas







#### 29,000 people die when political priorities take precedence over public concerns

# **Pyroclastic flows** Mt Pelée, Martinique 1902











Dans les studios de TF1, un débat entre scientifiques qui devait vite prendre l'allure d'un combat de boxe. De gauche à droite, Claude Allègre, directeur de l'IPG, l'arbitre Julien Besançon, et Haroun Tazieff.

....a volcanic crisis leads to a major evacuation, but the eruption is stillborn; scientists are embroiled in public controversy, severe criticism and recriminations.

In 2017 many people still do not trust the scientists and government





#### Lahar at Almero, Colombia 1985: 23,000 deaths



# https://vimeo.com/volfilm/videos





#### **Merapi Eruption 2010**

#### 350 killed & 400,000 evacuated Pyroclastic flow went twice as far as expected















#### Galeras, Colombia Relocation controversy





















# **K**Location



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# Soufrière Hills Volcano Eruption, July 1995 to 2010

#### 1997 Map of pyroclastic flow deposits























#### Soufriere Hills Volcano Montserrat



9,000 relocated 20 deaths > 1 billion \$ losses ~ £30 million per yr UK HMG £600 million Governor Frank Savage







#### BRISTOL

### Galways Wall Crisis



















#### Living with an erupting volcano: hazard zones for crisis micro-management











# "...this island is exactly the wrong size for an eruption..."



# Map simplified in July 1997 and has remained much the same ever since





#### **Risk Assessment Panel formed December 1997**

- Assess the hazards and risks at the volcano every 6 months
- Use of observations, models and expert elicitation
- Output: report and risk charts expressed as probabilities
- Risk reported in terms of Chief Medical Officers scale and analogies familiar to public

Scientific Advisory Committee (SAC) formed July 2003

• Under UK guidelines for SAC (Sir Robert May CSA)

**Advice given to Governments of UK and Montserrat** 





#### **MVO structured elicitation procedure for scientific advice**



**Pooled estimates and opinions:** 

- What is the chance a major explosion in next 6 months?
- What is the chance that a village 6 km NW of the volcano will be inundated by a pyroclastic flow?

#### **Central estimate and bounds**







An optimal decision on any question of interest can be obtained from the weighted sum of the opinions of a group of experts:





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50% 95%

5%

#### ELICITATION WEIGHTS FOR INDIVIDUAL SCIENTISTS



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#### Comparative societal risk exposure







#### **Risk Assessment July 2003**





# 12 July 2003

# What happened?

Largest historic dome collapse (210 million cubic metres) on 12th July 2003

13th July 2003 Risk reduced!



#### **Iceland summer 2010**

- 30 active volcanoes
- 205 historic eruptions
- 1 eruption every 5 years since 900 AD
- Each volcano different
- Three eruptions of 10 km<sup>3</sup> in 930, 1362, 1783
- Eyjafallajokull 0.1 km<sup>3</sup>
- Laki 1783 6 months of sustained pollution









#### • 8-20 March 2010

Small eruption on flanks. Little ash and little interest except locally and to scientists

#### •14-17 April 2010

New summit vents much more explosive eruptions. Lots of ash

#### • 18 April -23 May 2010

Weaker explosive eruptions



### Eyjafjallajokull

- four known eruptions in 520, 932, 1612 and 1821-23
- all explosive
- three followed by Katla in a year
- last Katla eruption in 1918





# **Iceland ash emergency 2010**



















### Chilbolton Observatory (Met Office)









- Grounded aircraft flying into and out of Europe for 6 days
- Cost '\$200M' a day (> 1 bn €)
- Significant political fallout
- Travel disruption and insurance claims





#### **Volcanic Ash Advisory Centres**

CURRENT STATUS OF ICAO VOLCANIC ASH ADVISORY CENTRES (VAAC) - AREAS OF RESPONSIBILITY SITUATION ACTUELLE DES CENTRES OACI D'AVIS DE CENDRES VOLCANIQUES (VAAC) - ZONES DE RESPONSABILITÉ ESTADD ACTUAL DE LOS CENTROS DE AVISOS DE CENZAS VOLCÀNICAS (VAAC) DE LA OACI - AREAS DE RESPONSABILIDAD CYLLECTBYIOLLEE DES CENTRES DE AVISOS DE CENZAS VOLCÀNICAS (VAAC) DE LA OACI - AREAS DE RESPONSABILIDAD CYLLECTBYIOLLEE DE AVISOS DE AVISOS DE CENZAS VOLCÀNICAS (VAAC) DE LA OACI - AREAS DE RESPONSABILIDAD CYLLECTBYIOLLEE DE CANTRES DE AVISOS DE CENZAS VOLCÀNICAS (VAAC) DE LA OACI - AREAS DE RESPONSABILIDAD







# Response

- Zero tolerance for 20 years (worked well)
- "visible ash" was criteria in most VAACs
- Iceland ash challenged international practice
- Operational response protocols change in a weekend
- VAAC tools not designed for new thresholds
- Lack of transparency and evidence on new criteria (2 mg/m<sup>3</sup>)
- Not joined up





# Governance

- Complex decision-making process
  - Decision driven primarily by NAME model output
  - UK Govt. (Dept. for Transport), CAA and European partners
  - SAGE advisory, CAA advisory, NATs,ICAO, airlines, engine manufacturers

Lessons learnt with much better response in 2011 Volcanoes on National Risk Register





# Any questions?

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