The Abdus Salam
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United Nations
Educational, Scientific and
Cultural Organization

IAEA
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Advanced Workshop on Evaluating, Monitoring and Communicating Volcanic and Seismic Hazards in East Africa

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The assessment of volcanic hazards, vulnerability, risk and uncertainty

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Assessment of volcanic hazards, vulnerability, risk and uncertainty

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ICTP Workshop, Triest, 20 August, 2009

Hazard

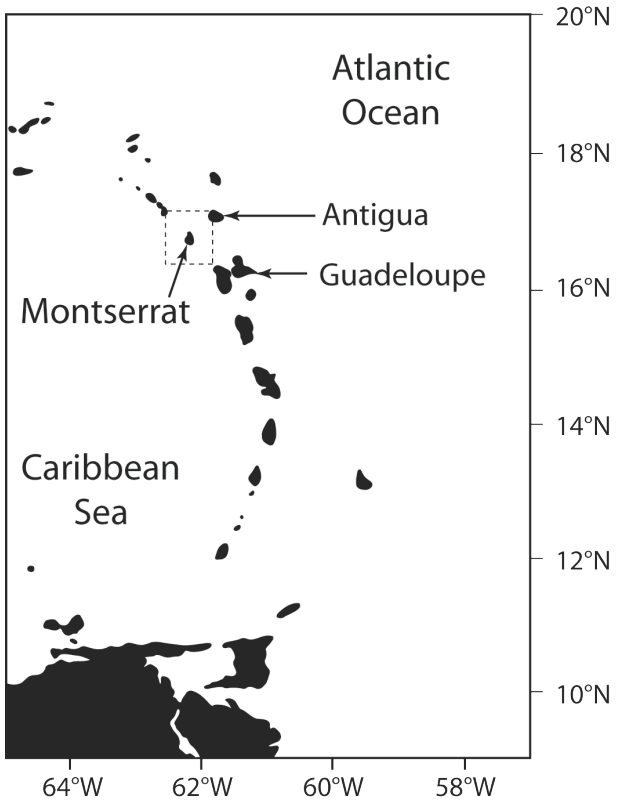
A volcanic hazard is any volcano-related phenomenon that threatens communities around a volcano

Pyroclastic flow

Lahar

Volcanic hazards are described by the physical characteristics of the phenomenon, by the areas that they are expected to effect, by their magnitude and return period

Location


Atlantic Ocean
Antigua
Guadeloupe
Montserrat
Caribbean Sea
20°N
18°N
16°N
14°N
12°N
10°N
64°W
62°W
60°W
58°W

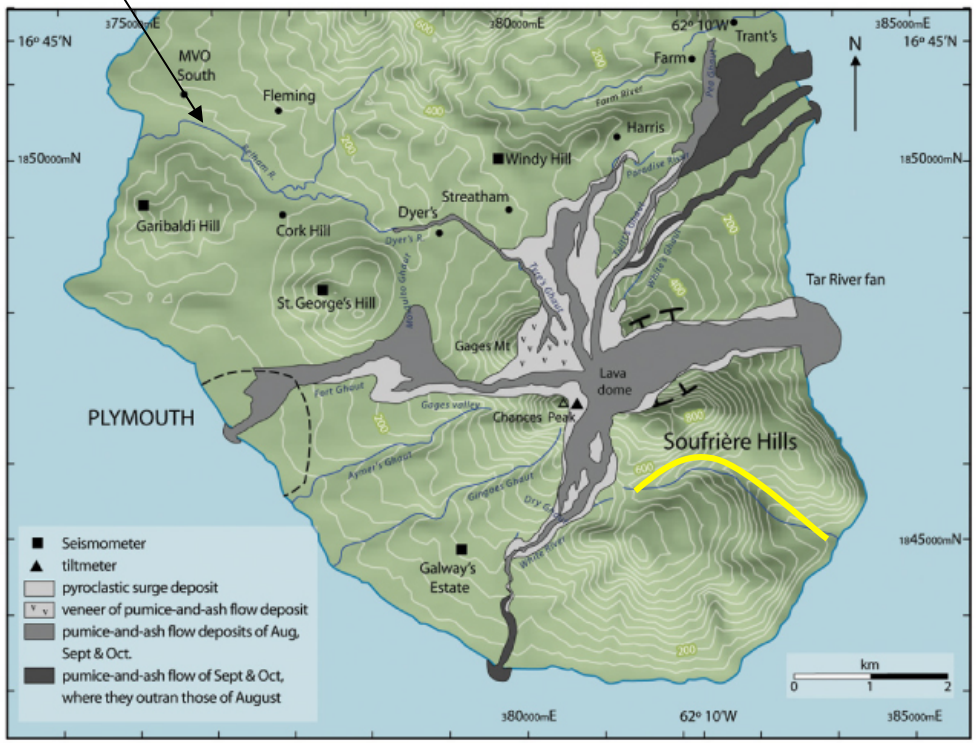

North West Bluff
MAR DEI CARAIBI
Yellow Hole
St John's
18°5'
Cudjoehead
Woodlands Bay
Trant's Bay
Blackburne Airport
CENTRE HILLS
Salem
Bethel
Harris
Cork Hill
SOUFRIÈRE HILLS
Chances Peak 914m
PLYMOUTH
Kinsale
18°45'
Germans Bay
Morris
Landing Bay
Old Fort Point
Shoe Rock
62°10'

Destruction of Plymouth

Hazards maps are determined by mapping of past volcanic events and by modelling of the natural processes

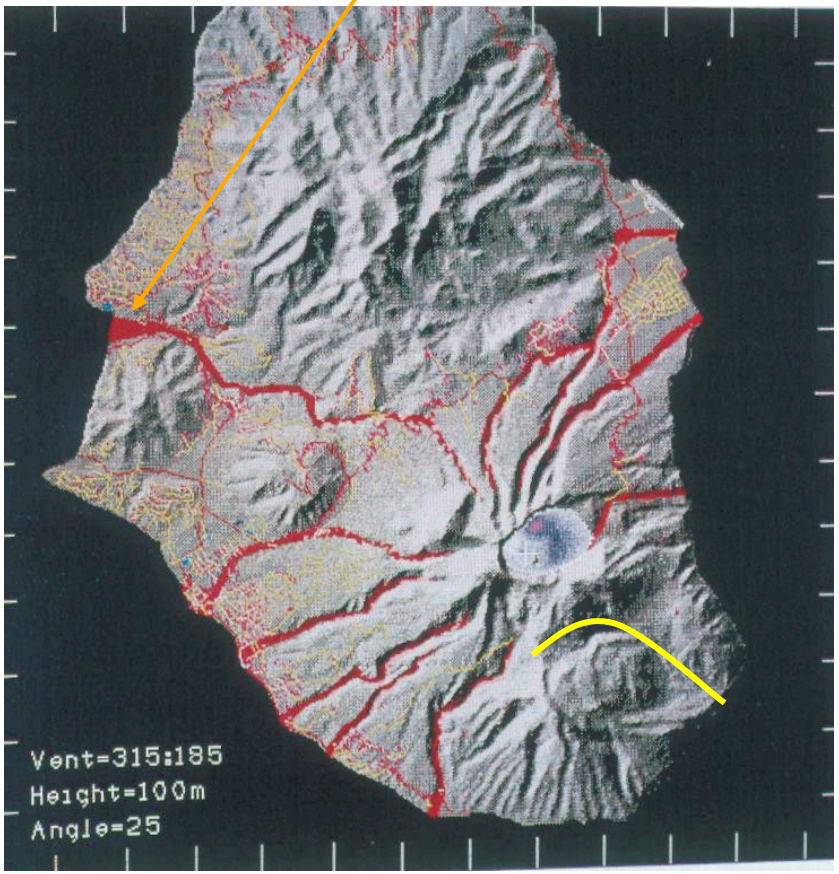
No flows

Yellow is unexpected flow



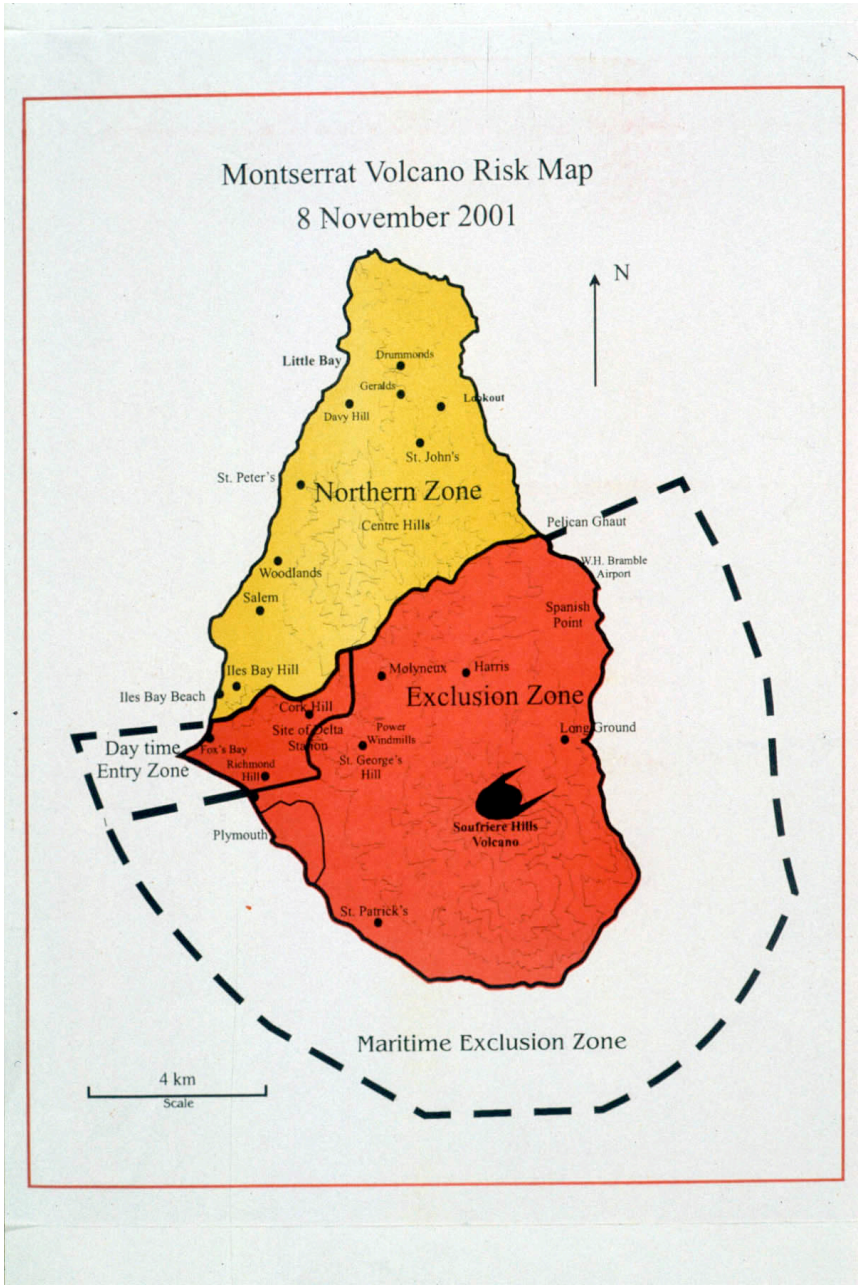
Pyroclastic flow deposits Montserrat (1996-1997)

Predicted Flows



Pyroclastic flow models

A hazards map depicts areas likely to be affected by future volcanic activity and related phenomena (e.g. pyroclastic flows)



Administrative zone maps are developed from hazards map but may take account of other factors (e.g. roads, infrastructure, etc)

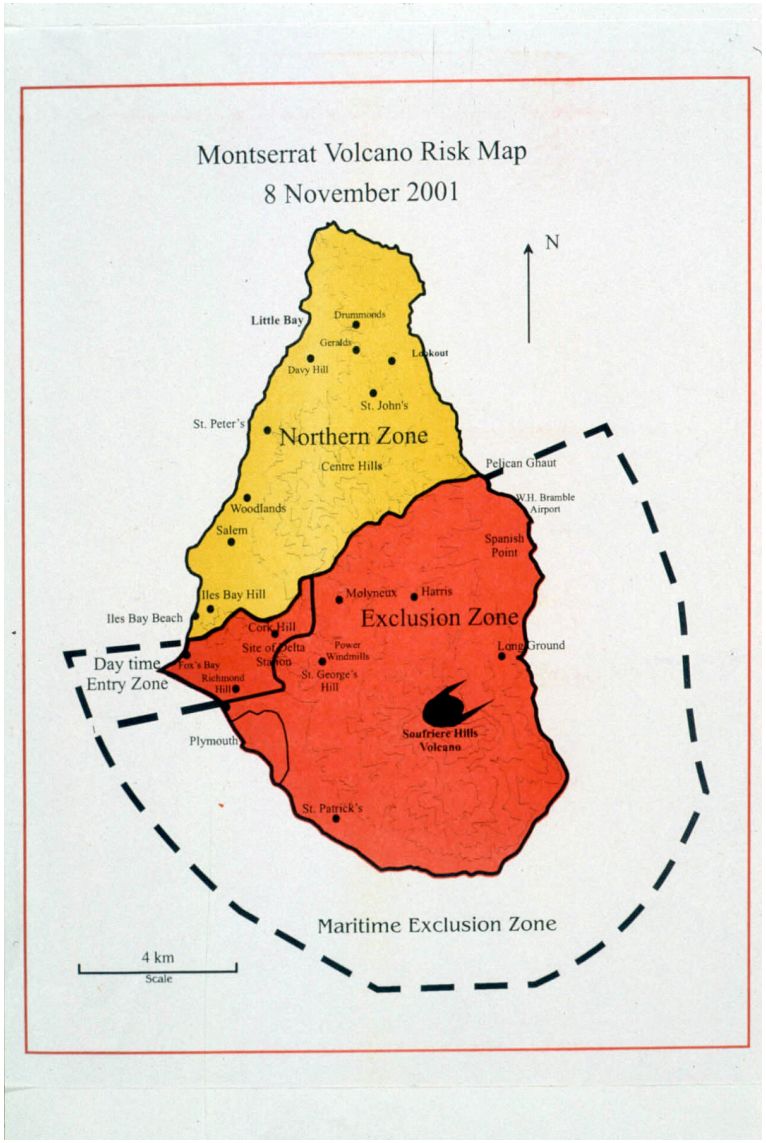
These maps used for planning and crisis management

Uncertainty

- Volcanic hazards maps are depictions of the LIKELIHOOD of future volcanic phenomena affecting places and people
- Volcanic phenomena are naturally variable, often complex and not fully understood
- There are many sources of uncertainty in forecasting the areas that volcanic activity will effect and the severity of the effects
- Uncertainties arise from: natural variability, inadequate data, biased data, incomplete data, lack of understanding of the processes, limitations to predictive models, ambiguity, unknown unknowns

THE DESCRIPTION OF VOLCANIC HAZARDS IS THUS NECESSARILY PROBABILISTIC AND REQUIRES ASSESSMENT OF UNCERTAINTIES

Issues that arise from the probabilistic nature of volcanic hazards and the intrinsic uncertainties



- zonation maps require well-defined boundaries for pragmatism
- boundaries cannot divide areas that are completely safe from those that are unsafe
- levels of danger or safety need to be defined to decide on and justify boundaries through concepts of vulnerability (vulnerabilidad) and risk (reiesgo)
- more data, better observations, improved models may reduce uncertainties, BUT can increase uncertainties
- probabilities inferred by statistical techniques are hard to communicate

Hazards are only of concern when they pose risks to communities

Risk = Vulnerability x Hazard

Vulnerability and Risk defined in terms of humans and society

Vulnerability (Vulnerabilidad)

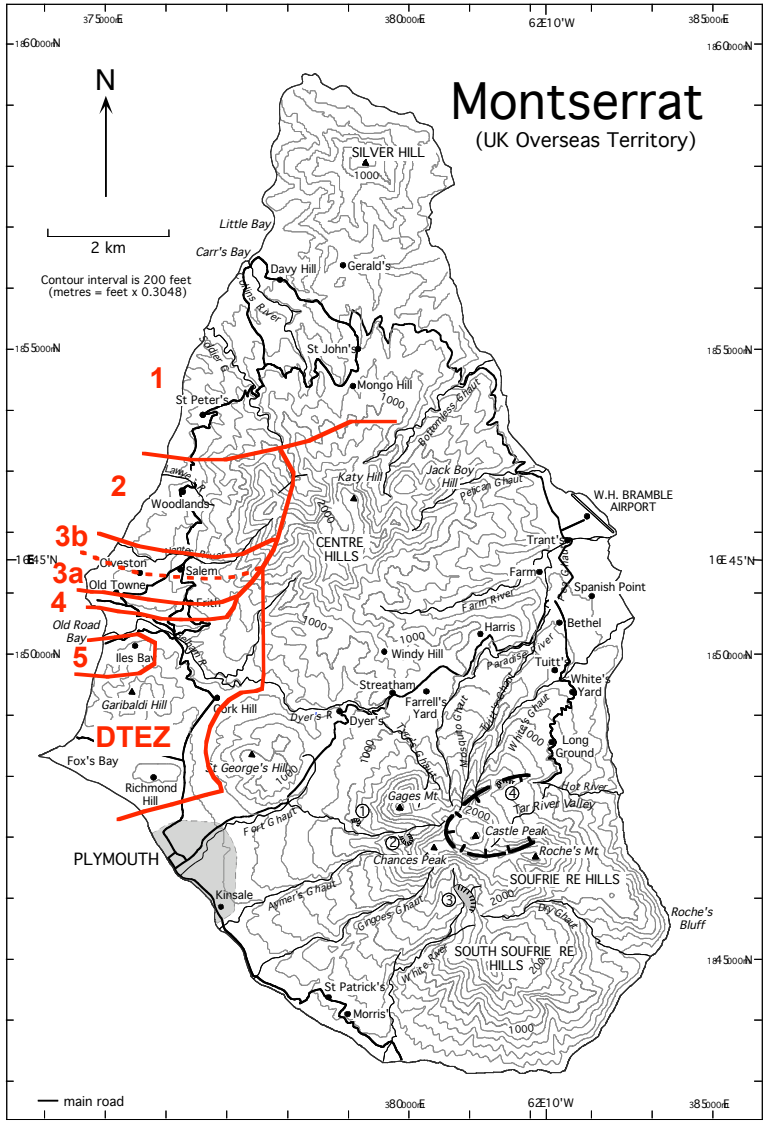
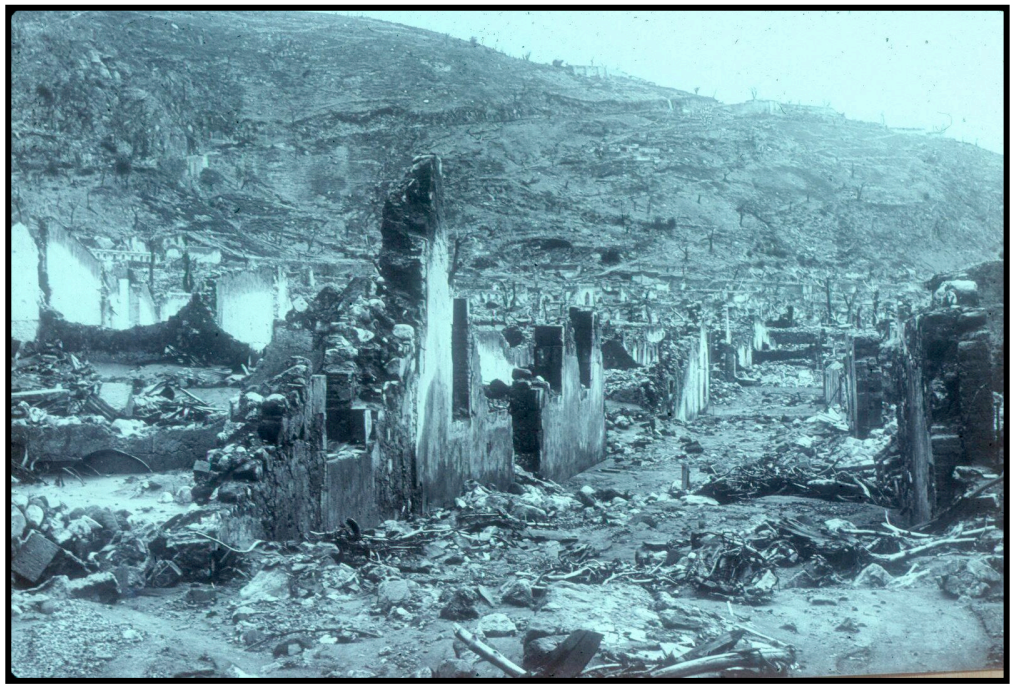


Fig. 4 Montserrat: population zones used for risk assessment modelling



St Pierre, Martinique (1902)
29,000 people died
from a pyroclastic flow

Typically volcanic vulnerability is defined in terms of people living in area under threat from volcanism

Risk

Typically risk in volcanic crises is defined in terms of loss of life

Individual risk: the chances of an individual being killed

Societal risk: the chances of a society experiencing a certain number of deaths

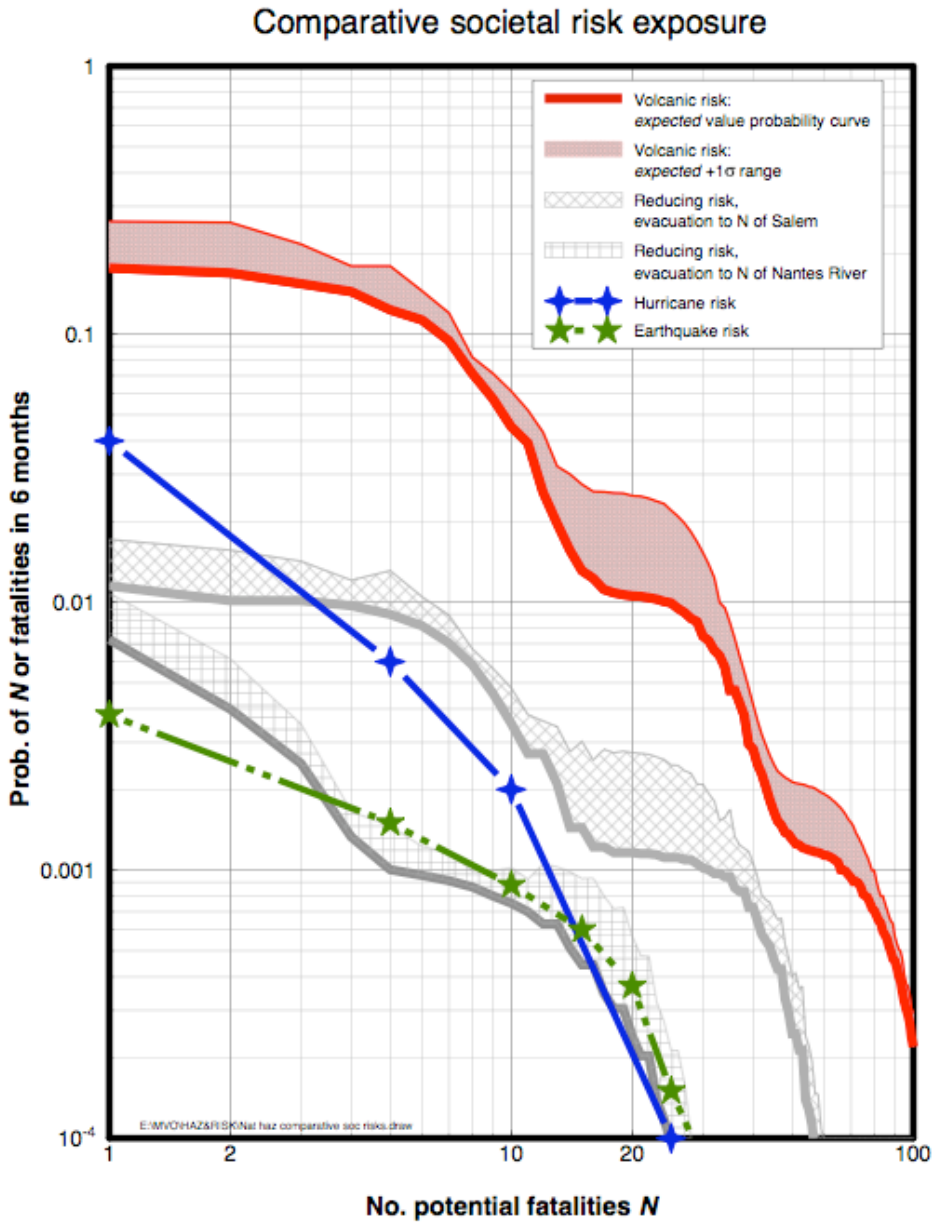
Normally expressed as annualised probabilities (chances of being killed in a year)

These risks are not just determined by the hazard but are also influenced by human behaviour (e.g risk perceptions, denial, exaggeration of threat) and societal responses (e.g. land-use planning, evacuation, development strategies)

UK Individual Risk Scale

HIGH	**>1 in 100**
MODERATE	**1 in 100 to 1 in 1000**
LOW	**1 in 1000 to 1 in 10000**
VERY LOW	**1 in 10000 to 1 in 100000**
MINIMAL	**1 in 100000 to 1 in a million**

Chief Medical Officer

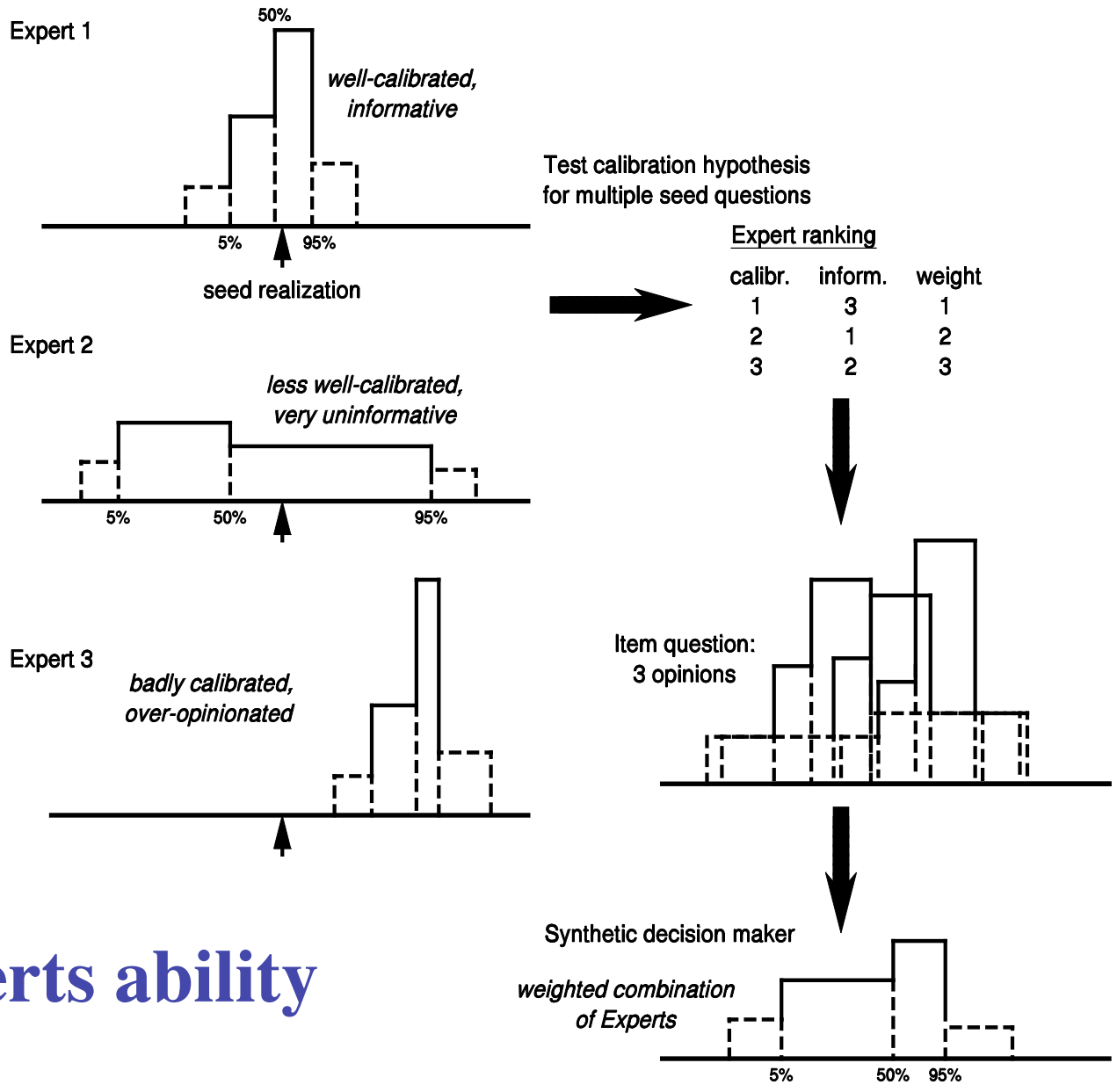

Comparative societal risk exposure
Volcanic risk:
expected value probability curve
Volcanic risk:
expected +1σ range
Reducing risk,
evacuation to N of Salem
Reducing risk,
evacuation to N of Nantes River
Hurricane risk
Earthquake risk
Prob. of N or fatalities in 6 months
1
0.1
0.01
0.001
10-4
1
2
10
20
100
No. potential fatalities N
E:\MVO\HAZ&RISK\Nat haz comparative soc risks.draw

Expert elicitation for assessing uncertainty and risk

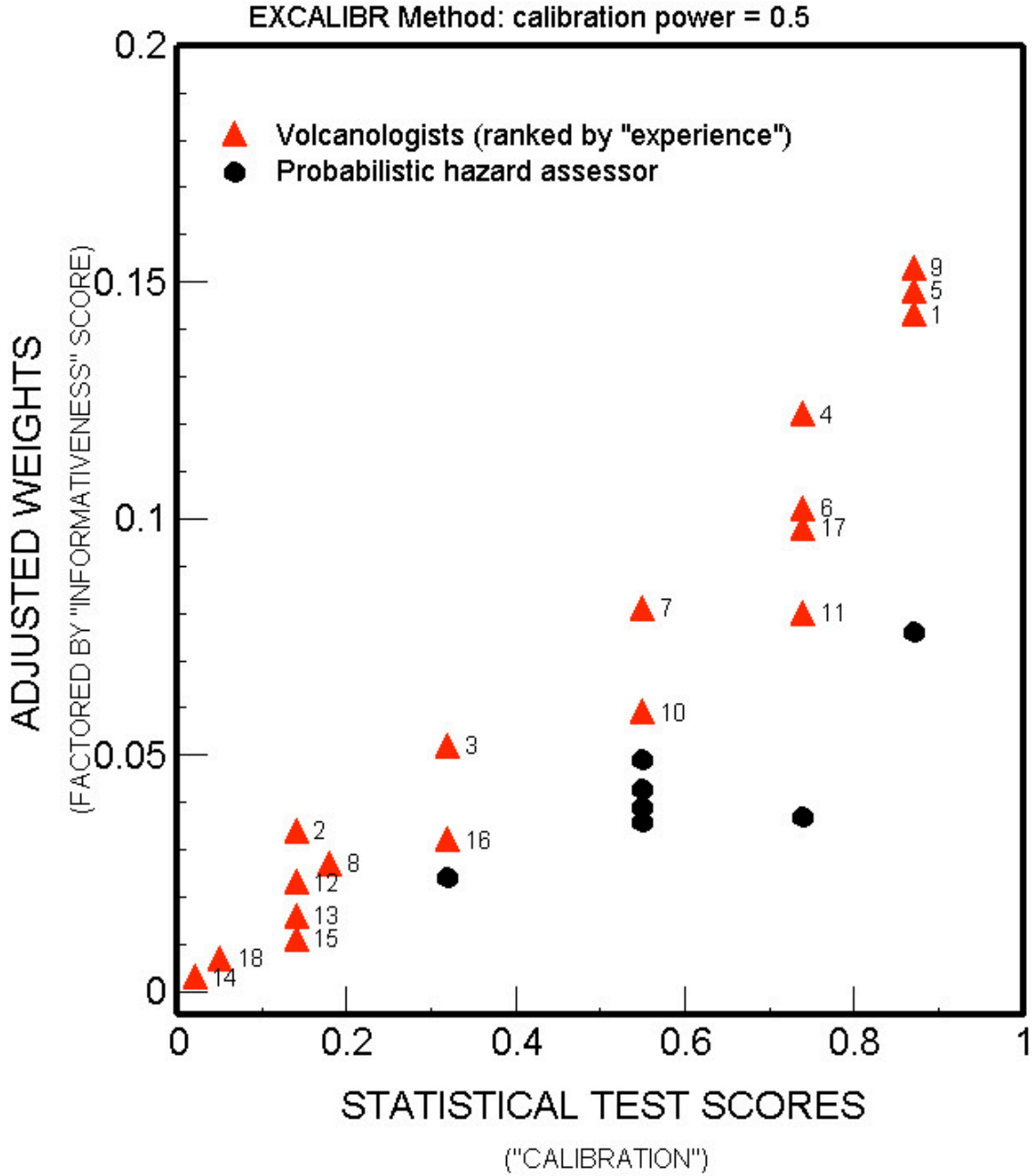
Pooled estimates and opinions:

What is the chance that a village 6 km NW of the volcano will be inundated by a pyroclastic flow?

Experts ability



ELICITATION WEIGHTS FOR INDIVIDUAL SCIENTISTS



Thank you