The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2053-3

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

17 - 28 August 2009

The management of a volcanic crisis at the Soufriere Hills Volcano, Montserrat

Stephen Sparks
University of Bristol
U.K.

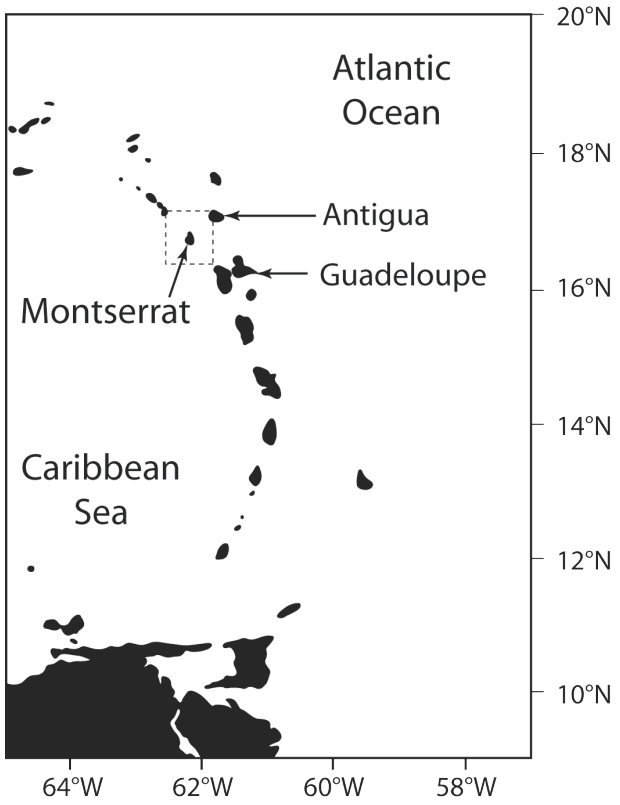
The management of a volcanic crisis at the the Soufrière Hills Volcano, Montserrat

ICTP, 20 August, 2009

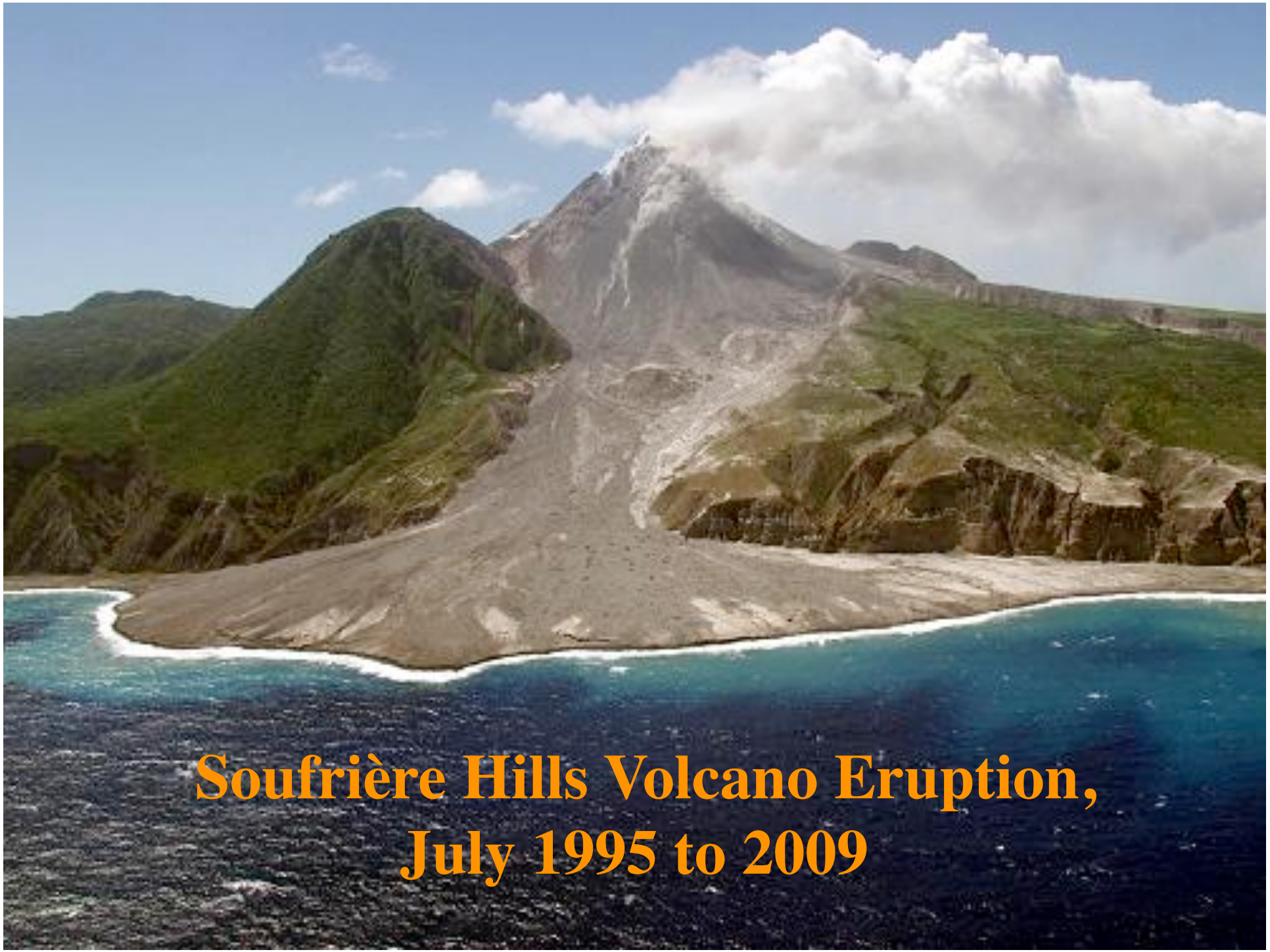
brisk
Bristol environmental risk research centre

Steve Sparks

Location

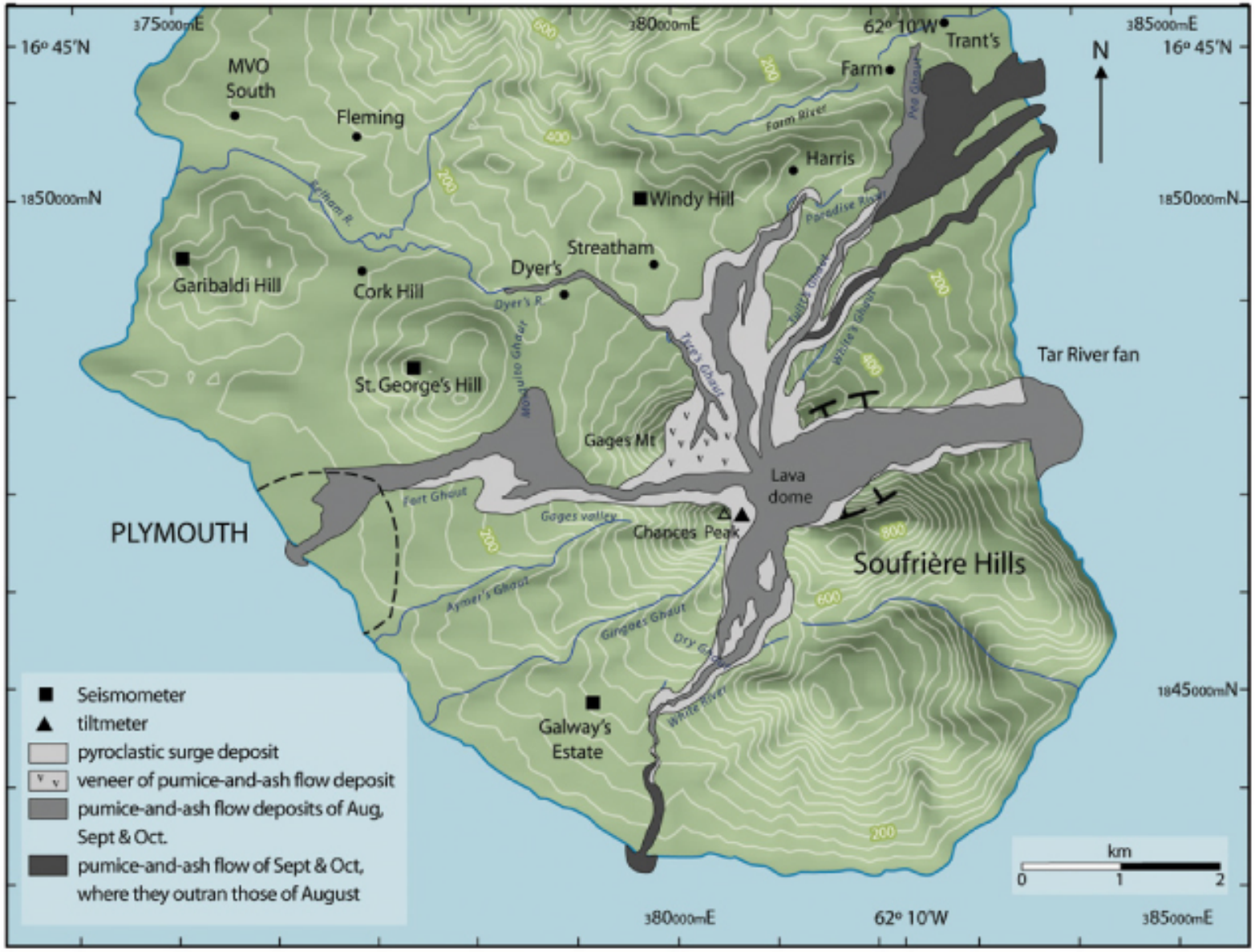

Atlantic Ocean
Antigua
Guadeloupe
Montserrat
Caribbean Sea
20°N
18°N
16°N
14°N
12°N
10°N
64°W
62°W
60°W
58°W

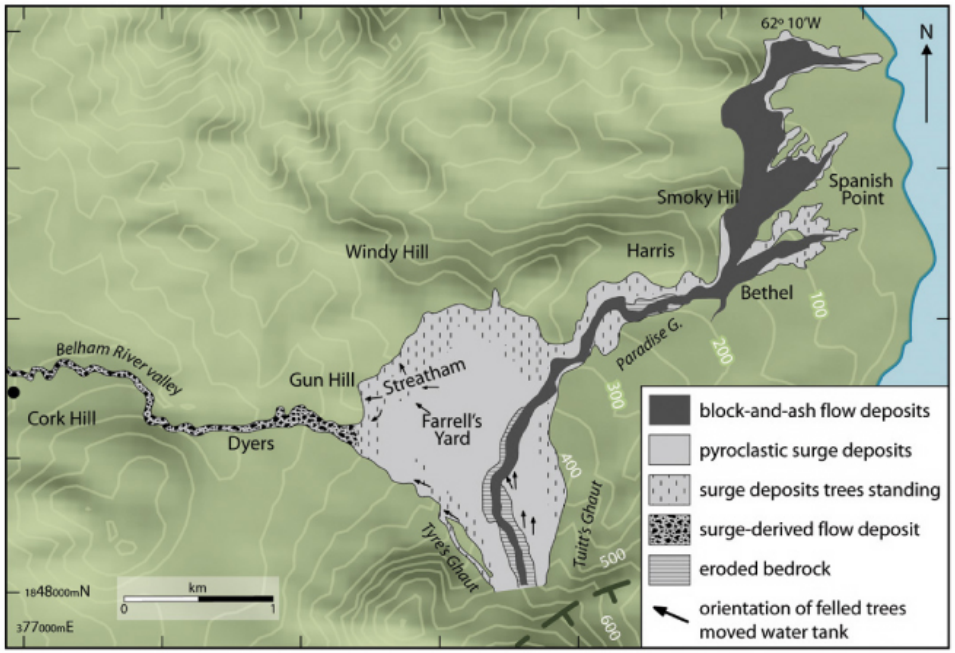

North West Bluff
MAR DEI CARAIBI
Yellow Hole
St John's
18°5'
Cudjoehead
Woodlands Bay
Trant's Bay
Blackburne Airport
CENTRE HILLS
Salem
Bethel
Harris
Cork Hill
SOUFRIÈRE HILLS
Chances Peak 914m
PLYMOUTH
Kinsale
18°45'
Germans Bay
Morris
Landing Bay
Old Fort Point
Shoe Rock
62°10'


Soufrière Hills Volcano Eruption,
July 1995 to 2009

Collapse and Fill

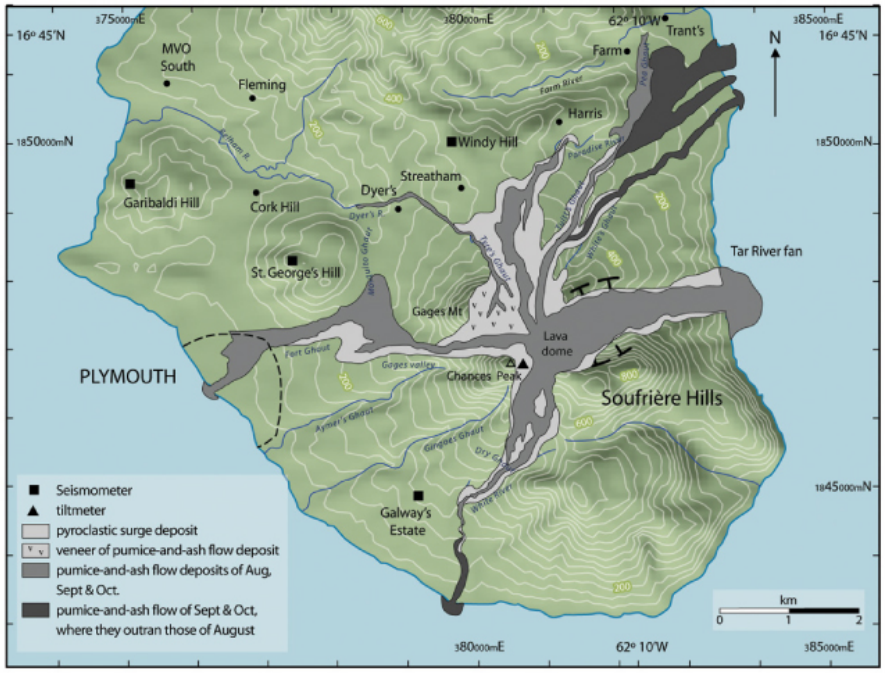
1997 Map of pyroclastic flow deposits





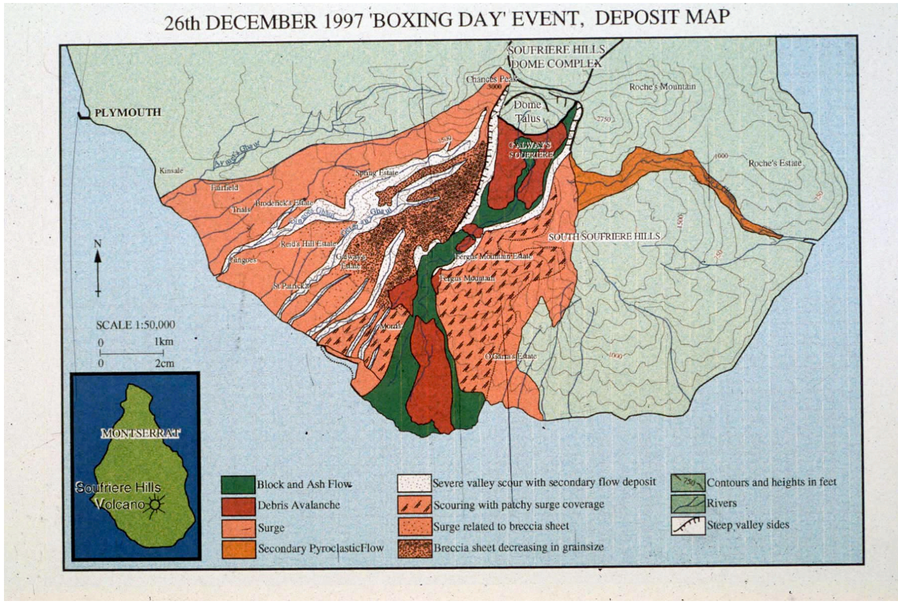
25 June 1997
20 people killed

Destruction of Plymouth

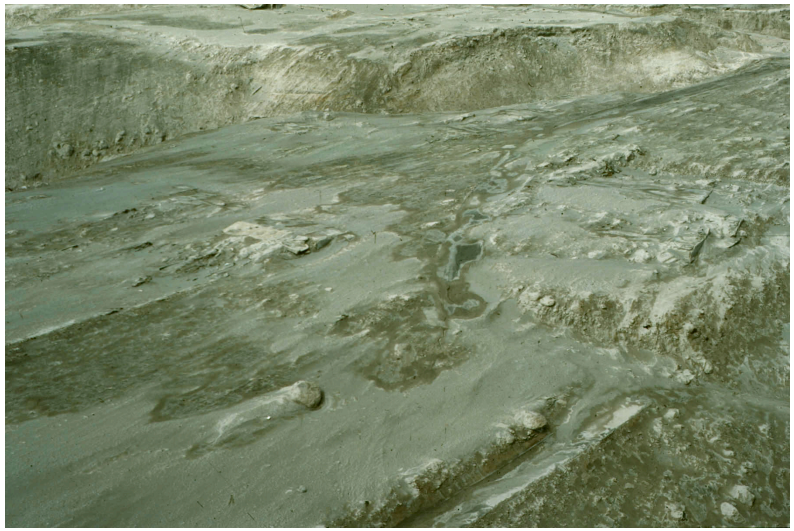


Galways Wall Crisis

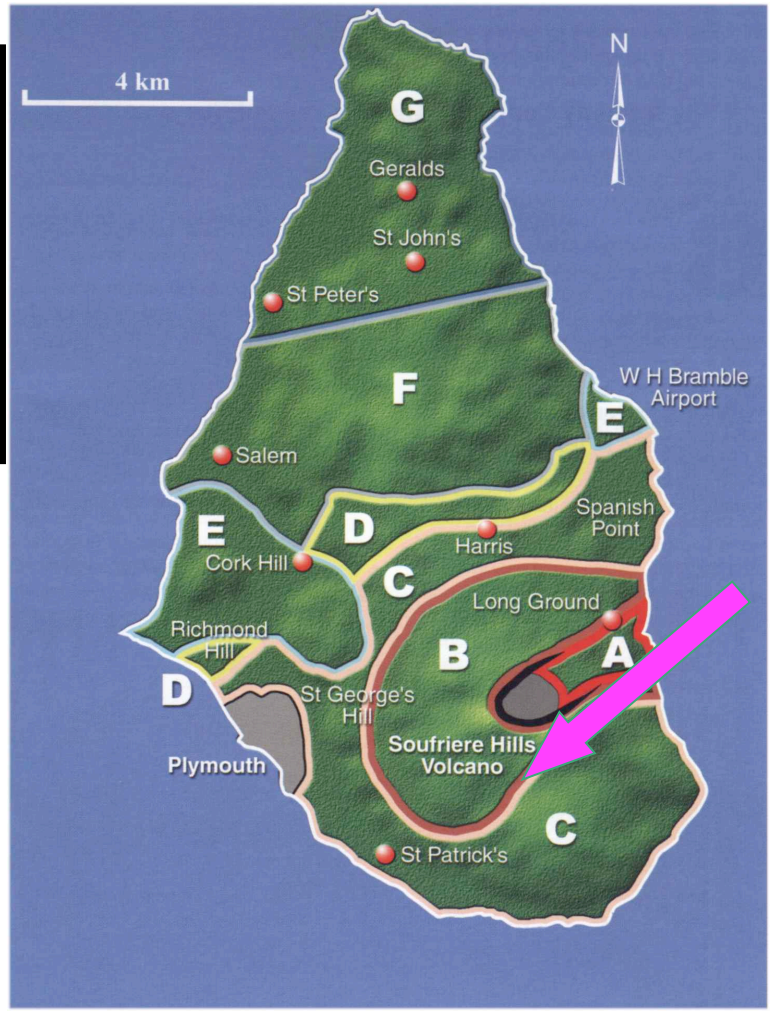
21st December 1997


26th DECEMBER 1997 'BOXING DAY' EVENT, DEPOSIT MAP
SOUFRIERE HILLS DOME COMPLEX
Chances Peak
3000
Dome Talus
Roche's Mountain
2750
PLYMOUTH
GALWAY'S SOUFRIERE
1000
Roche's Estate
Kinsale
Fairfield
Spring Estate
Trials
Broderick's Estate
Reid's Hill Estate
Gingoes
Galway's Estate
St Patrick's
SOUTH SOUFRIERE HILLS
Fergus Mountain Estate
Fergus Mountain
Morris
O'Garra's Estate
1500
750
N
SCALE 1:50,000
0 1km
0 2cm
MONTSERRAT
Soufriere Hills Volcano
Block and Ash Flow
Debris Avalanche
Surge
Secondary PyroclasticFlow
Severe valley scour with secondary flow deposit
Scouring with patchy surge coverage
Surge related to breccia sheet
Breccia sheet decreasing in grainsize
Contours and heights in feet
Rivers
Steep valley sides

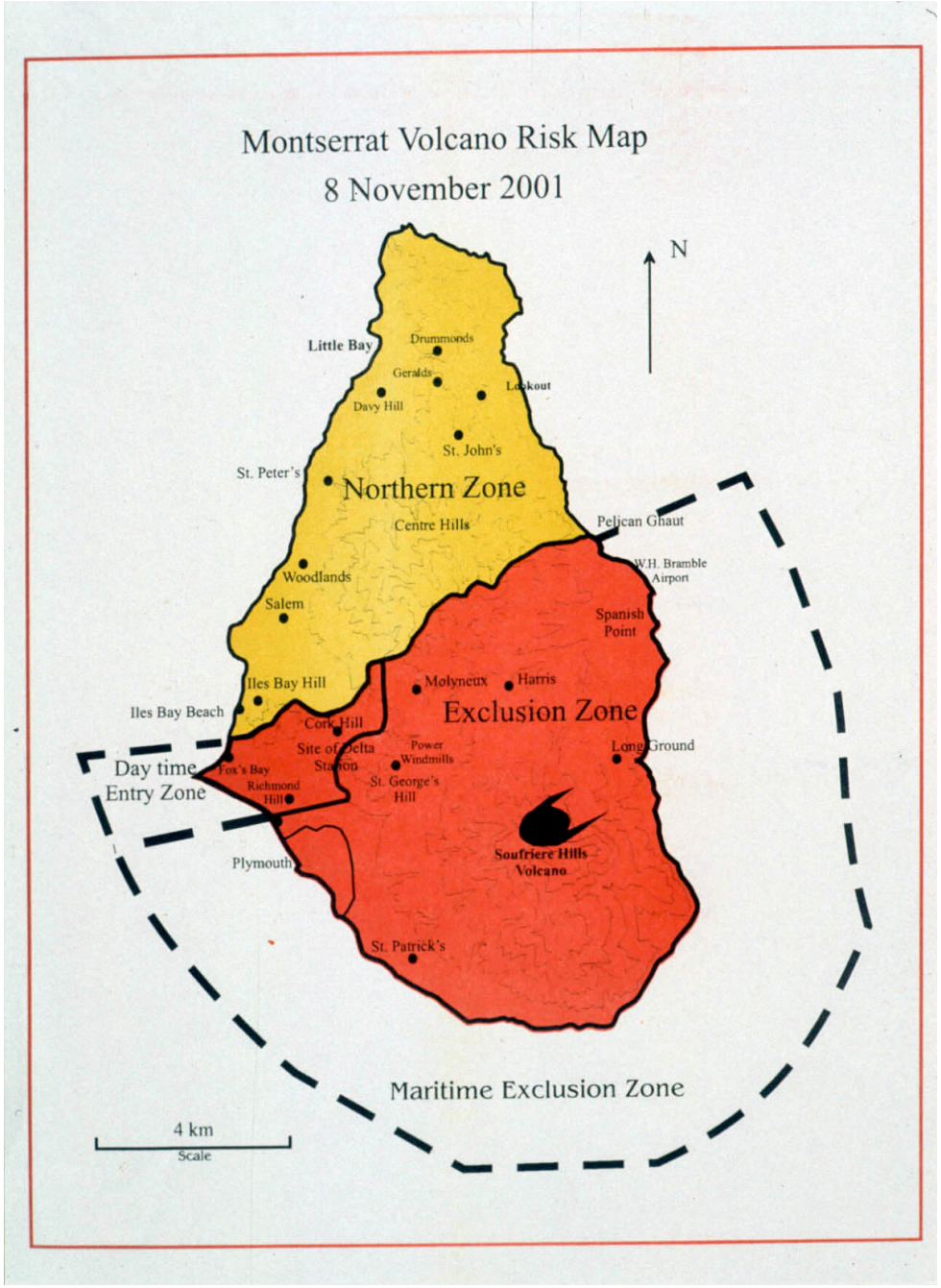
Volcanic Blast: Destruction



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 as a report, event trees, 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

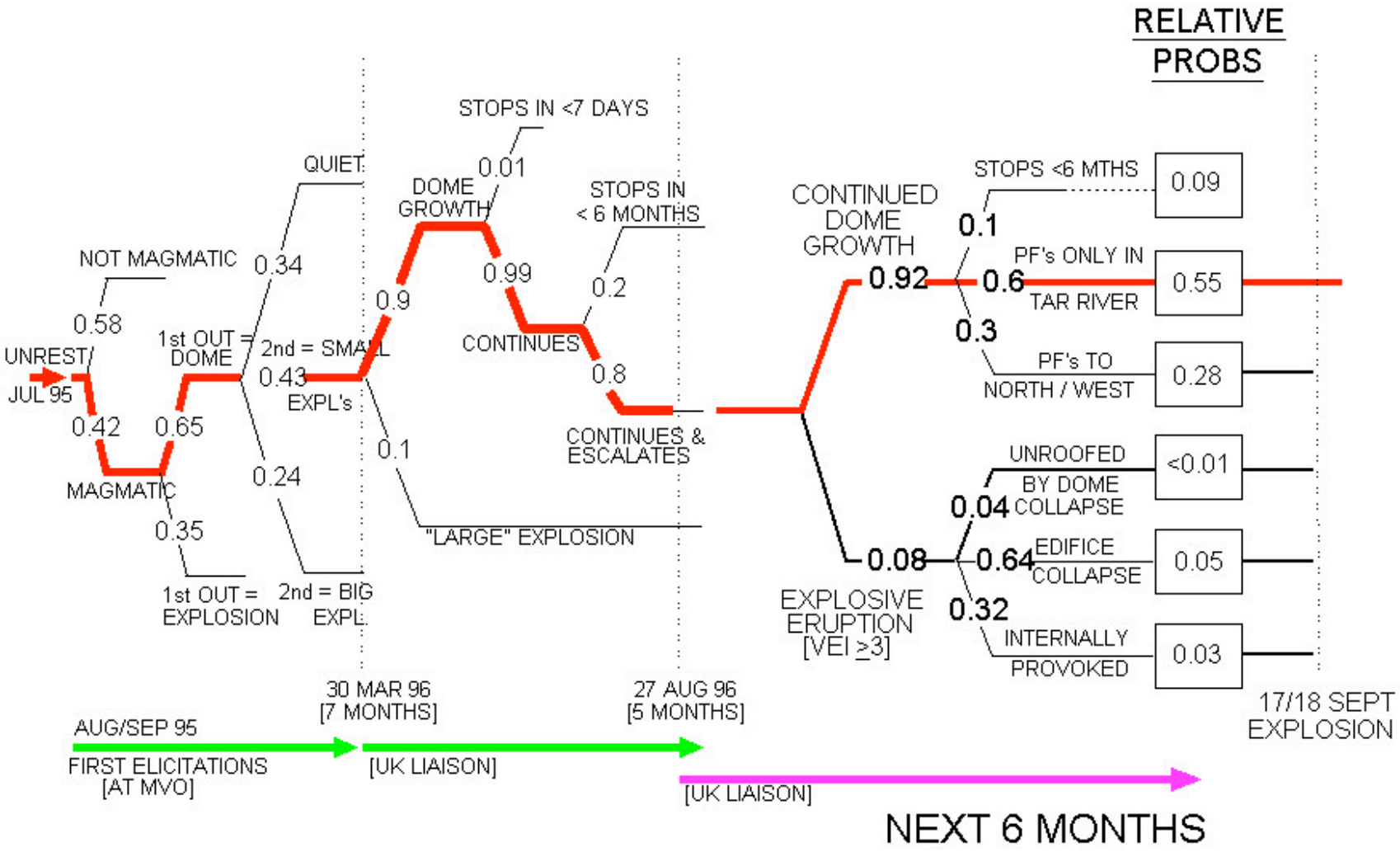
- Under UK guidelines for SAC (Sir Robert May CSA)

Advice given to Governments of UK and Montserrat

MVO structured elicitation procedure for scientific advice

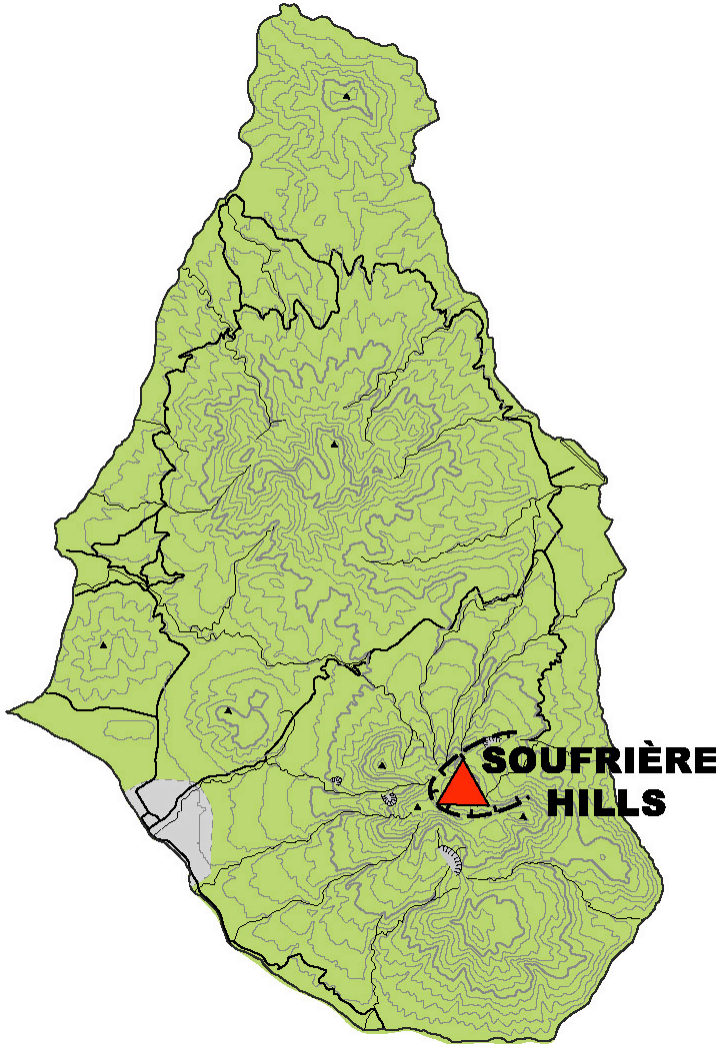
MONTSERRAT VOLCANO CRISIS

EVENT PROBABILITY TREE - UPDATE 27 AUG 96



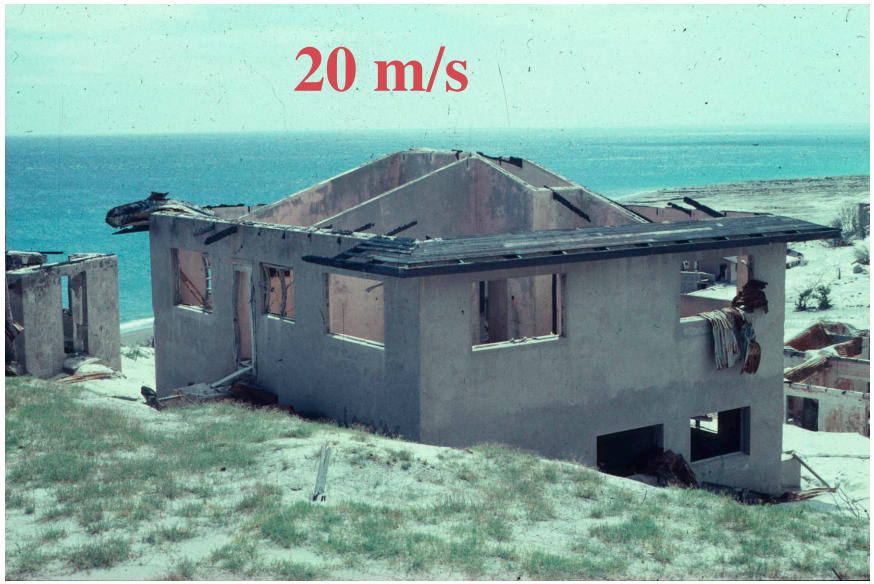

Spine
(1098m)
Tyres
Ghaut
to Upper
Belham Valley
Quantitative risk assessment
Pyroclastic flow hazards on Montserrat

Lower Belham valley, Montserrat
Evacuated 8 October 2002



Ingredients of model I

- Probability of collapse to the northwest
- Probability of pyroclastic flow reaching area (>3 million cubic metres)
- Surge cloud behaviour
- Number of people in area (casualties)
- 6 month time period



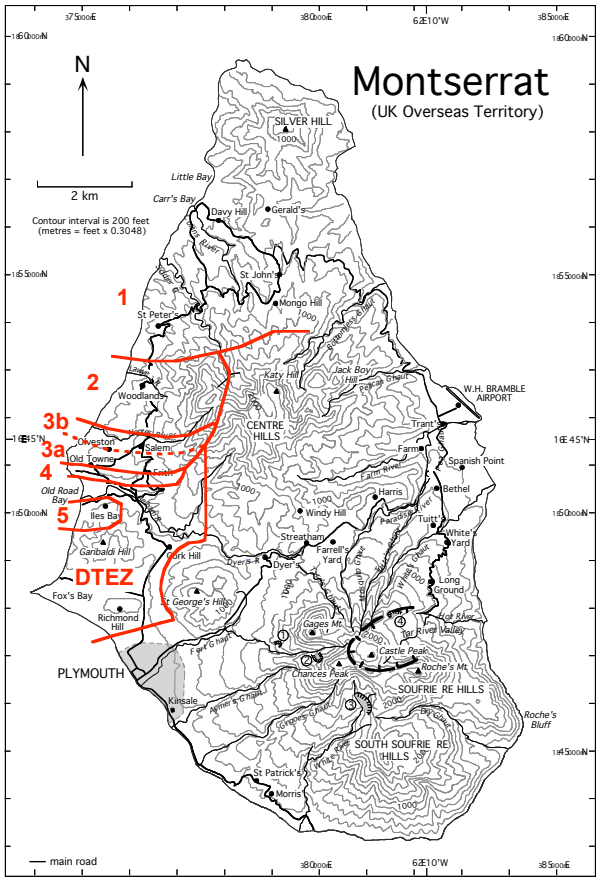


Fig. 4 Montserrat: population zones used for risk assessment modelling

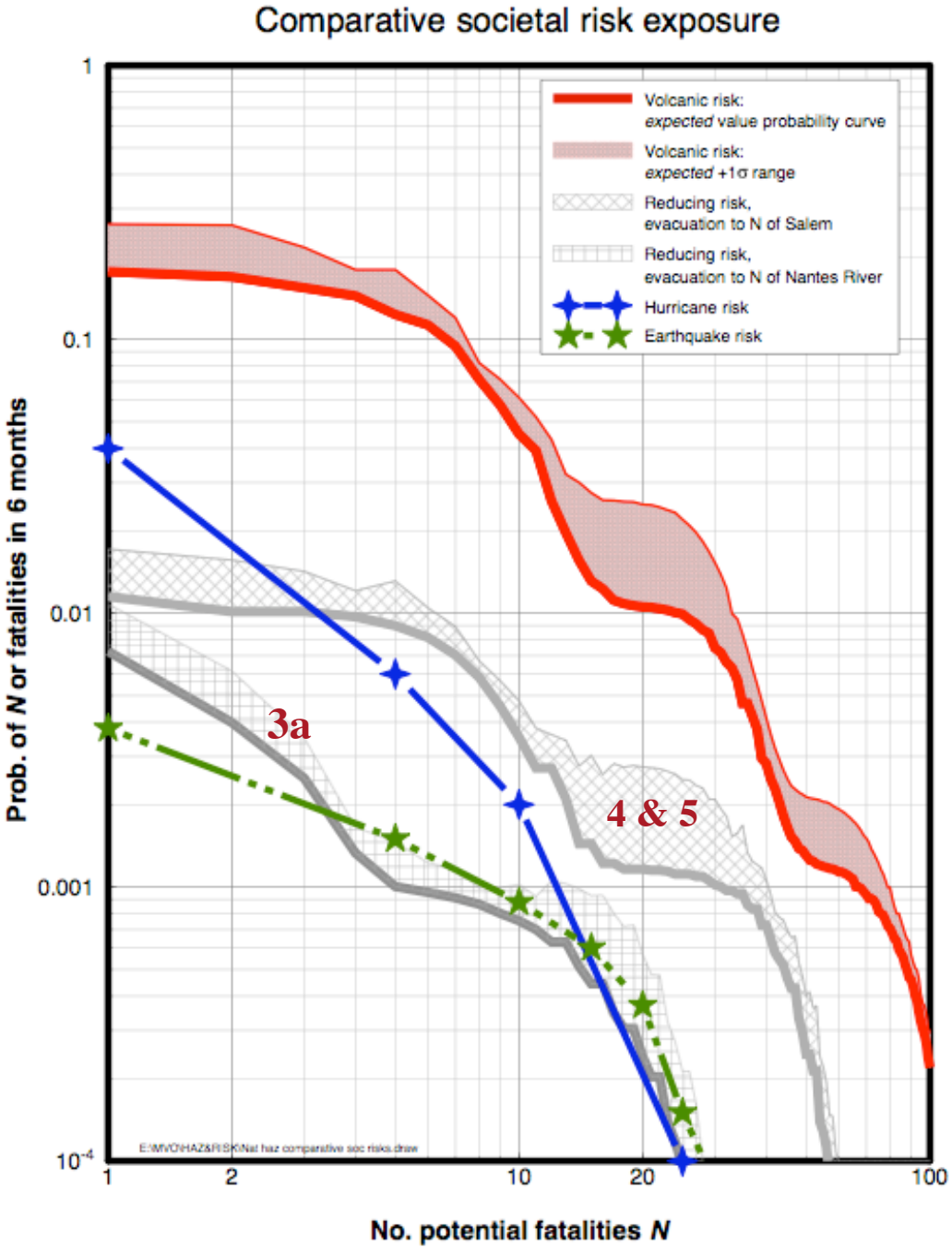
Ingredients of model II

Evaluation of probabilities and their uncertainties by:

- **Models**
- **Empirical evidence**
- **Expert elicitation methods**
- **Monte Carlo sampling of uncertainties**

15% chance of pfs getting to Belham Valley
70% chance of collapse to the east

Willy Aspinall: facilitator



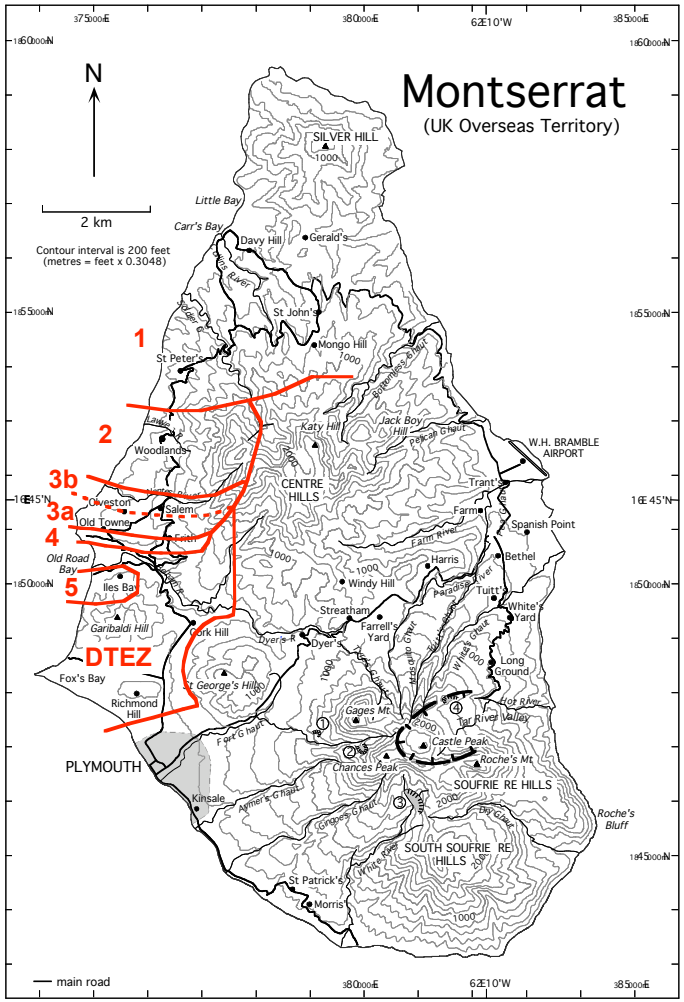


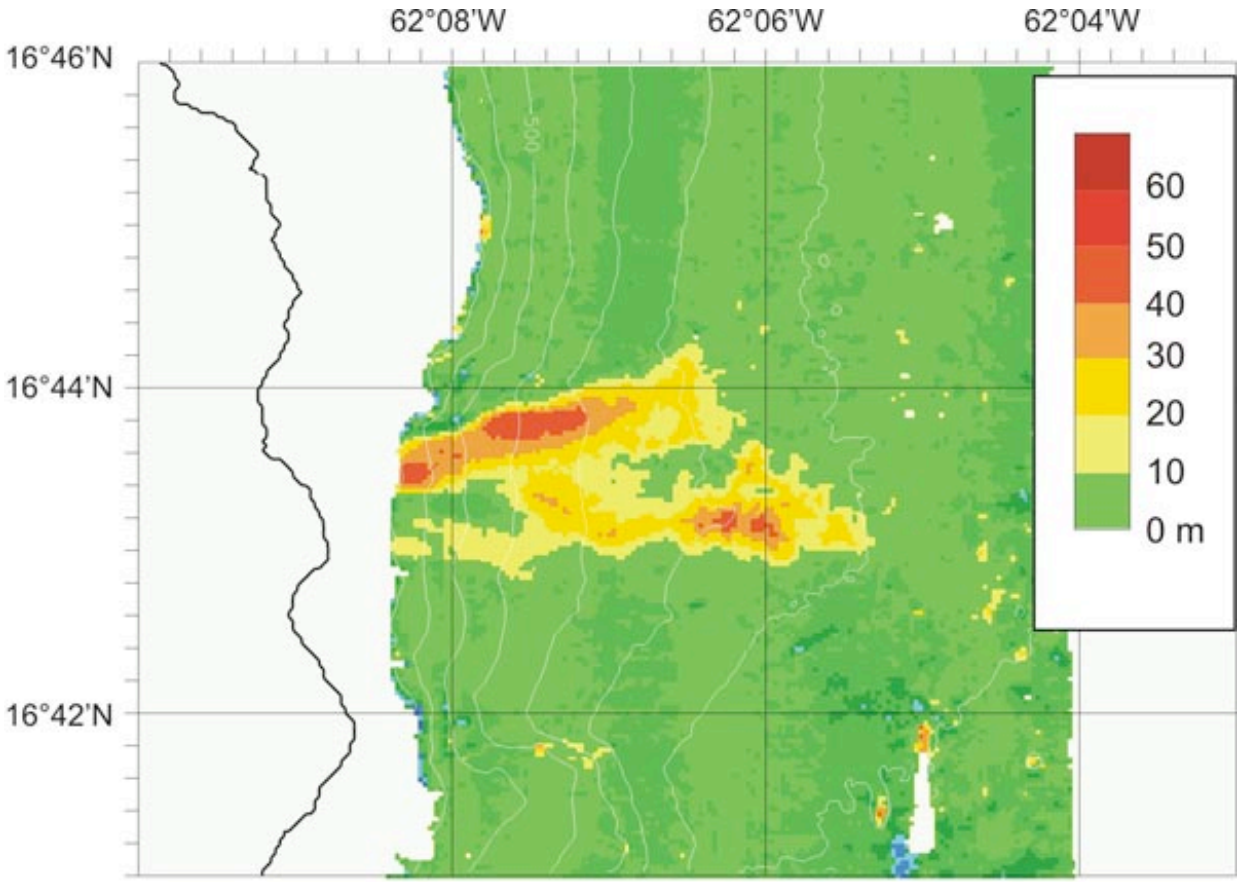
Fig. 4 Montserrat: population zones used for risk assessment modelling

UK Individual Risk Scale

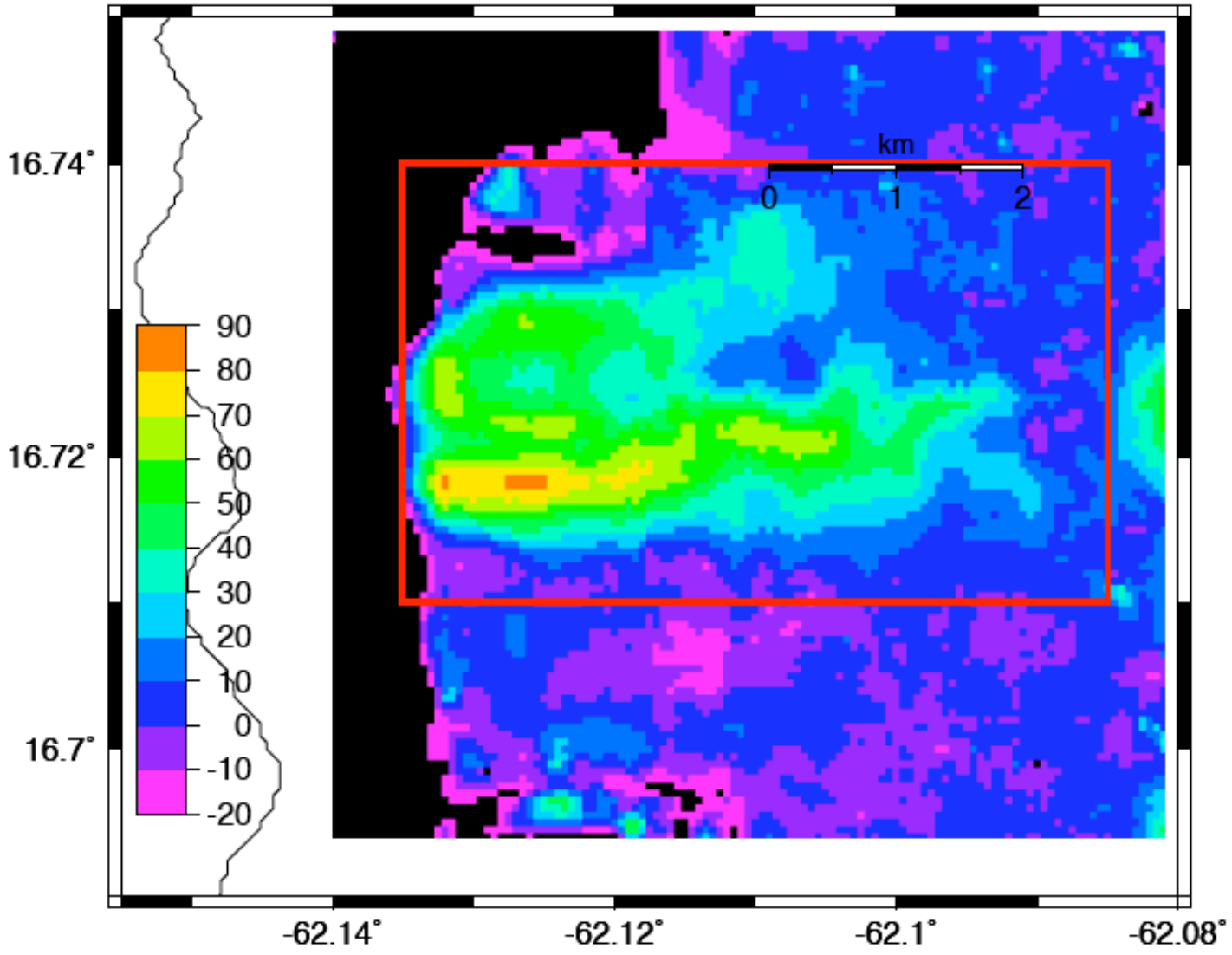
HIGH	**>1 in 100**
MODERATE	**1 in 100 to 1 in 1000**
LOW	**1 in 1000 to 1 in 10000**
VERY LOW	**1 in 10000 to 1 in 100000**
MINIMAL	**1 in 100000 to 1 in a million**


12 July 2003
What happened?


Largest historic dome collapse
(210 million cubic metres)
on 12th July 2003
13th July 2003
Risk reduced!
People moved back



Submarine fan extends offshore



Pyroclastic flows reached 10 km from dome

December 1997: abandon the island?

- At this time the Department of International Development was considering advising evacuation of whole island and permanent relocation
- I was Chief Scientist of Observatory and advisor to UK and Montserrat Governments
- Meeting around 11 December with key UK Government officials in London and Chief Scientist to UK (Sir Robert May)
- Quantitative risk assessment was presented to meeting that evaluated north of island at low risk
- Decision to abandon island was abandoned

Many thanks