Bull Volcanol (2008) 70:605–621
DOI 10.1007/s00445-007-0156-z

RESEARCH ARTICLE

The issue of trust and its influence on risk communication during a volcanic crisis

Katharine Haynes · Jenni Barclay · Nick Pidgeon

Received: 27 June 2006 / Accepted: 24 April 2007 / Published online: 6 July 2007
© Springer-Verlag 2007

Abstract This paper investigates trust in the scientists, government authorities and wider risk management team during the ongoing volcanic crisis in Montserrat, WI. Identifying the most trusted communicator and how trust in information can be enhanced are considered important for improving the efficacy of volcanic risk communication. Qualitative interviews, participant observations and a quantitative survey were utilised to investigate the views and attitudes of the public, authorities and scientists. Trust was found to be dynamic, influenced by political factors made more complex by the colonial nature of Montserrat's governance and the changing level of volcanic activity. The scientists were viewed by the authorities as a highly trusted expert source of volcanic information. Mistrust among some of the local authorities towards the scientists and British Governor was founded in the uncertainty of the volcanic situation and influenced by differences in levels of acceptable risk and suspicions about integrity (e.g. as a consequence of employment by the British Government). The public viewed friends and relatives as the most trusted source for volcanic information. High trust in this source allowed competing messages to reinforce beliefs of lower risk than were officially being described. The scientists were the second most trusted group by the public and considered significantly more competent, reliable, caring, fair and open than the authorities. The world press was the least trusted, preceded closely by the British Governor's Office and Montserratian Government officials. These results tally well with other empirical findings suggesting that government ministers and departments are typically distrusted as sources of risk-related information. These findings have implications for risk communication on Montserrat and other volcanic crises. The importance and potential effectiveness of scientists as communicators, because of, and despite, the existence of political, cultural and institutional barriers, is exemplified by this study.

Keywords Communication role · Volcanic risk communication · Montserrat · Competing messages · Unofficial communications · Dimensions of trust

Editorial responsibility J. McPhie

K. Haynes · J. Barclay · N. Pidgeon
School of Environmental Sciences, University of East Anglia, Norwich, England, UK

K. Haynes (✉)
Risk Frontiers, Natural Hazards Research Centre, Room 817 Building E7A, Macquarie University, Sydney, NSW 2109, Australia
e-mail: khaynes@els.mq.edu.au

Present address:
K. Haynes
Centre for Risk and Community Safety, RMIT University, Melbourne, Australia
email: katharine.haynes@rmit.edu.au

Present address:
N. Pidgeon
School of Psychology, Cardiff University, Wales, UK

Introduction

Trust is a prerequisite for many important functions within a society. It has been shown to be a crucial factor influencing the perception of risk, effective risk communication and attitudes to risk management policy (Renn and Levine 1991; Kasperson 1992; Slovic 1993; Breakwell 2000). This paper explores issues affecting the credibility and trust placed in the scientists and wider risk management

teams during the ongoing volcanic crisis on Montserrat, WI. This is the first study of its kind to apply a methodology more commonly associated with anthropogenic and environmental health risk research in a natural hazards setting. The methods and findings are widely transferable to volcanic risk communication in other geographical settings.

Understanding the perception of risk has become increasingly salient to improving risk communication and reducing risk associated conflicts. Much risk communication literature now accepts that heterogeneity among communities will result in a single message or warning being interpreted in different ways. This spectrum of risk perception can be attributed to peoples' differing beliefs, attitudes, judgements and feelings as well as wider social or cultural values and dispositions that people adopt towards hazards (Pidgeon et al. 1992, p89). Intrinsic to all these factors is trust, in particular, trust in the information source and trust in elements of the information's delivery and context (Slovic 2000). For example, individuals with no previous experience of an event must rely upon mediated information, often from an expert source (Sjöberg 2000). As a result the relationship between 'expert' and 'lay' perspectives is frequently influenced by evaluations of the trustworthiness of risk managing institutions (Wynne 1980).

Pidgeon et al. (1992) noted the difficulty with which trust is gained and the ease with which it is lost [also described as the 'Asymmetry Principle' (Slovic 1993)]. However, the effective management of uncertain hazards requires a tentative balance between precaution, reassurance, warning and a large element of trust in the risk management team. Dealing with uncertainty, by means of a precautionary attitude and long-term evacuations, can lead to the perception of false alarms, undermining the credibility of the risk management team. On the other hand, managers pressured to give a precise prediction or maintain a more relaxed management policy in the face of uncertain information, may unintentionally neglect the implications of this uncertainty.

Different goals, for example between science and policy, can often lead to differences in characterising and conveying uncertainty and risk, differences that can compromise effective communication between scientists, policymakers and the public (Kinzig and Starrett 2003). The natural desire to live in a controllable and knowable world is sometimes stronger than the evidence at hand (Kinzig 2003). The absence of more accurate data, in turn, puts increased demand on expert judgement (Hammond 1996), with unanticipated outcomes being interpreted as indications of flawed decision-making. In the worst case, a serious incident or actual disaster can lead to a complete breakdown in trust (Pidgeon et al. 1992).

In 1999, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) produced guidelines of professional conduct for volcanologists (Newhall et al. 1999) as a response to problems of personal and institutional interaction seen to occur during volcanic crises. The guidelines examined past problems and made suggestions for future crises under the premise that life safety is the most important criterion. In terms of managing uncertainty, the guidelines recommended that the scientists and authorities understand each other's expectations, methods and limits. The scientists have to make clear that zero risk is unattainable. The guidelines encouraged discussion among the scientists, officials and the public about hazards, acceptable risk and the trade-offs with the aim of reducing economic problems and increasing scientific credibility (Newhall et al. 1999).

The aim of our study was to investigate, in detail, aspects of trust during a specific volcanic crisis, i.e. who is most trusted, what factors are important for trust and how is trust won or lost? As the first study of this kind, the paper starts with an overview of what constitutes trust and what has governed the gain and loss of trust in analogous risk situations. We investigate the views and attitudes of the public, authorities and scientists. To facilitate transference of our results to other volcanic regions, we endeavour to place these findings in their societal context.

Background

Dimensions of trust

There remain numerous diverging definitions within the literature regarding what actually constitutes and contributes to trust (McKnight and Chervany 1996; Poortinga and Pidgeon 2003; Poortinga 2004). However, it is possible to identify similar patterns of trust across a range of contexts. For example, Poortinga (2004) noted that whereas doctors, environmental and/or consumer organisations and quality media are generally highly trusted information sources, government ministers and departments, as well as industry are typically distrusted sources.

The main factors in the creation and destruction of trust in government and other institutions that regulate and communicate risk in anthropogenic and environmental health risk research (e.g. climate change or radioactive waste disposal) are summarised in Table 1. These analyses make a useful starting point for study of trust in volcanic regions.

Wider trust factors can be decomposed into two general dimensions. An example is the approach of Hovland et al. (1953, in Poortinga and Pidgeon 2003; also Peters et al. 1997, in Sjöberg 2001), who found that information is accepted more easily when the communicator is seen as "expert" and "trustworthy". The two empirical models proposed by Frewer et al. (1996) and Metlay (1999), offer

similar dimensions of "general trustworthiness". However, they diverge at the second dimension, with Metlay suggesting "competence" (similar to Hovland) and Frewer et al. suggesting "vested interest" as a measure of integrity.

Earle and Cvetkovitch (1995) described a further dimension of "value similarity", where trust is an 'affective social bond' between the communicators and those at risk. In this case, trust judgments are more intuitive than based on carefully reasoned arguments and evidence. Thus, as Poortinga and Pidgeon (2004, p1476) stated, "trust links people together who share social identities and/or have a similar understanding of a specific situation".

Empirical research conducted by Poortinga and Pidgeon (2003) explored the two dimensions of trust while comparing their own findings with those of Frewer et al. (1996), Metlay (1999) and Earle and Cvetkovitch (1995). Their results shared the characteristics of the "general trust" dimension and the second dimensions shared similarities with the "vested interest" factor of Frewer et al. (1996), but they included aspects of credibility and reliability, referred to as a "scepticism" dimension (Table 1). Value similarity was found to be the least important factor.

Limits to trust: distrust and critical trust

Sjöberg (2001) argued that there is only a weak link between public risk perception and trust, suggesting that people believe there to be clear limits to the amounts of knowledge possessed by scientists and experts. Earle and Cvetkovich (1995) stated that distrust is not simply the opposite of trust, but reflects the degree of certainty with which we can believe or rely on someone else. It is therefore the functional equivalent of trust. To this end, Trettin and Musham (2000) questioned the utility and achievability of engendering public trust in risk management institutions. Barber (1983) suggested 'effective' distrust as a prerequisite for a healthy democracy whilst Walls et al. (2004) described a continuum of trust ranging from "uncritical emotional acceptance" to "(downright) rejection". It is therefore perhaps unwise to consider distrust in risk management institutions as wholly negative. It should instead be perceived as part of the constantly evolving deliberative process by which the public assess the situation and form their judgements accordingly.

Perry and Greene's (1983) study of people living around Mt. St. Helens found far greater belief in the risk message amongst those who were warned by an official compared to those who were first warned by the mass media or a friend, although 80% of respondents tried to confirm the information with a different source. They cited many authors who also found a positive relationship between belief in the warning source and taking action. They noted that initially, during a volcanic crisis, the risk is considered small whoever the warning source. Ronan et al. (2000) noted that, in New Zealand, friends and relatives were the most used sources of volcanic information. Although some agencies were perceived as more credible than others, no single agency was found to have a monopoly; different people recognised different agencies as the best source of information. Scientific information was found to reduce distress concerning the volcano among children, whilst sensationalised media coverage had the opposite effect. Gregg et al. (2004) considered the blanket provision of the same information unlikely to be effective as it fails to accommodate specific needs, and may engender a sense of mistrust in the agencies providing that information.

The methodology developed to investigate trust has utilised and tested the theoretical findings identified in prior research, as outlined above. However, it has also remained liberated enough to allow the identification of new issues previously unmeasured or specific to a volcanic crisis and to Montserrat.

Table 1 The factors of trust, adapted from Poortinga and Pidgeon (2003)

Renn and Levine (1991), Kasperson (1992)	Frewer et al. (1996)	Metlay (1999)	Poortinga and Pidgeon (2003)
Perceived competence, objectivity, fairness, consistency, faith.[a] Commitment, competence, caring and predictability[b]	*General Trust*: truthful, good track record, trust worthy, favour, accurate, factual, public welfare, responsible, knowledgeable, (negative characteristics) distorted, proven wrong in the past, biased. *Vested interest/ accountability:* accountable, self-protection, vested-interest vs sensationalism	*General Trust:* Tightly interconnected set of 'affective' beliefs about institutional behaviour. *Competence:* Perception of how competent the institution is	*General Trust:* Competence, care, fairness, openness. *Scepticism*: credibility, reliability and integrity

[a] Renn and Levine (1991)
[b] Kasperson (1992)

Volcanological and socio-political context

The British overseas territory of Montserrat was selected as the case study for this research because of the ongoing volcanic crisis and its dramatic impact on the population and the island. Communication problems among scientists, authorities and the public have been compounded by the complex socio-political factors on this small island and its colonial administration (Clay et al. 1999; Possekel 1999; Skelton 2000; Aspinall et al. 2002). The scientists were working hard to overcome these problems and, along with the authorities, were keen to instil trust in the population whilst improving their communication abilities. The timing of our fieldwork coincided with a period of volcanic uncertainty and evacuations (October 2002–July 2003), thus providing a unique research environment for an investigation of trust and its influence on risk communication.

The Montserrat Volcano Observatory (MVO) was established at the outset of the eruption (1995) by scientists from the Seismic Research Unit (SRU) of the University of the West Indies in Trinidad and the British Geological Survey (BGS). Support was also provided by the Volcanic Disaster Assistance Program of the United States Geological Survey, the University of Puerto Rico, the Institut de Physique du Globe de Paris (Guadeloupe Volcano Observatory and Martinique Volcano Observatory) and numerous researchers from universities in the UK and the USA. Due to financial and organisational factors, the BGS took dominant control of the observatory early in the crisis. However, it was not until mid-1997 that a contract was finally approved for the BGS to fully manage the MVO (Aspinall et al. 2002; Pattullo 2000). Currently the MVO consists of four BGS and eight local government employees. The MVO had been based in several rented houses but moved to a purpose built observatory in 2003.

The ongoing eruption (1995 to present) of the Soufrière Hills volcano has been well described elsewhere (Kokelaar 2002; Herd et al. 2005). In short, activity has been characterised by cycles of dome growth and collapse with some explosive activity. At the time of writing (June, 2006) the activity is in its third cycle of dome growth after the May 2006 collapse. The two periods of fieldwork (January–April 2003 and February–April 2004) coincided with the second cycle of dome growth and second hiatus of dome growth, respectively. Activity during the first phase of fieldwork was characterised by comparatively slower dome growth with less frequent collapse events and correspondingly larger domes. As the dome grew to an unprecedented height and volume between August 2001 and September 2002, combined with periodical switches in growth direction, the MVO warned that new areas could potentially be affected. In September 2002, the dome began to grow to the north and northwest, increasing the likelihood of a collapse in those directions and elevating the risk to the Belham Valley area (see archived scientific reports on the MVO web site). On the 9th of October, 2002, residents living on the margins of the Belham Valley were given 48 h to evacuate by the civil authorities. Approximately 300 families were evacuated for 10 months.

In late 2002, and despite the continued volcanic threat, a group of evacuated residents issued legal proceedings against the British Governor as they considered the evacuation unjust and an infringement on their human rights. In late December, a USA expatriate was arrested and charged after trying to return to his home in the exclusion zone (Aspinall and Sparks 2004). The first phase of fieldwork commenced at this time of evacuation and increased volcanic risk (January–April 2003). Dome growth continued until the 13th of July, 2003 when the dome collapsed to the east (away from the excluded area) down the Tar River Valley resulting in the largest recorded dome collapse event to date (VEI 2–3; Herd et al. 2005). Following this event, a hiatus in dome growth occurred, leading to the rehabitation of the Belham area. The second phase of field work was carried out at this time (February–April 2004). A series of minor vulcanian explosive eruptions occurred in March 2004 and through June and July 2005.

For a detailed summary of the social impacts throughout the crisis, the reader is referred to Pattullo (2000), Clay et al. (1999), Kokelaar (2002), and Haynes (2005).

The majority of the 4,491 strong population[1] now live in the more recently developed northern and established central areas of the island, although a number of islanders still inhabit the most recently evacuated Belham areas. Eighty-two percent (3,683) of the population are considered nationals, with non-nationals defined as those who have settled on the island since 1991. Prior to the start of the eruption, the health and education infrastructure on Montserrat was of a good standard and Montserrat had one of the highest standards of living in the Caribbean and a well-educated population (Clay et al. 1999; Possekel 1999; Skelton 2000).

Montserrat is now 1 of 6 UK overseas territories in the Caribbean and 1 of 12 worldwide. Formerly a crown colony, it became effectively self-governing in 1961 with the formation of a locally elected ministerial government (Fergus 2001). Unlike their Caribbean neighbours, Montserratians have never sought independence. Many felt that the island was too small, lacking the infrastructure and skilled personnel to

[1] Data from the 2001 population and housing census May, 2001, Statistics Department, Montserrat. The 1991 census reported a population of 10,625 which has been slowly decreasing since its post-war high of 14,333 (Clay et al. 1999).

support and run the country as an independent nation (Skelton 2000; Fergus 2001) and the idea was always vigorously opposed by the business community (Pattullo 2000). In addition, the need for aid following Hurricane Hugo in 1989 and the volcanic activity since 1995 have made independence currently unfeasible. In July 1997, the British Government gave Montserratians right of abode in the UK, which included the right to find employment and, in 2001, islanders received full UK citizenship making the possibility of future independence even more remote (Fergus 2001).

As a British overseas territory, Montserrat is locked into a complex set of economic and political relationships (Pattullo 2000). Power is tripartite comprising the democratically elected local Montserratian Government, the British Governor (representative of the Queen) and the British Government in Whitehall, London. The British Governor is responsible for external affairs, defence, judiciary, security, administration of the public sector and the offshore financial sector. Skelton (2000) stated that many Montserratians view the British Governor as a stabilizing and balancing influence on the island.

Methodology

In methodological terms, it has become increasingly clear that questionnaire-based research alone cannot capture the complexity of risk perception. As a result, methods more sensitive to the context are needed (Krimsky and Golding 1992; Horlick-Jones et al. 2003). Thus, to measure trust, arguably one of the most multifaceted factors, a methodology that combined both quantitative and qualitative techniques was chosen.

Quantitative methods (e.g. statistical analysis of questionnaires) are highly effective in measuring the 'cause and effect' of single variables and circumstances and have been used with some success in other areas of volcanic risk perception (Johnston et al. 1999; Gregg et al. 2004). However, results can be difficult to interpret when trying to understand the underlying reasons for attitudes and behaviour (Henwood and Pidgeon 1992). Qualitative methods on the other hand involve rich, detailed and penetrating accounts of the incidents and subjects under investigation (Bryman 1988).

The first phase of fieldwork (January to April, 2003) attempted to capture and understand the various feelings of trust that different groups, (e.g. lay public, authorities, and scientists) held and/or perceived others to hold. Thus, the first two methods chosen were semi-structured interviews and the more anthropologically based ethnographic process of 'participant observations'. The second phase of fieldwork (February to April, 2004) involved a quantitative survey to triangulate the issues from the first phase to a wider sample and explore relationships within the data with statistical analysis. Analysis of the qualitative data was fundamental to the design of the survey questions which, rather than being predetermined by a researcher, addressed the issues identified by respondents. These were worded in the respondent's own vernacular. The three methods generated data that were both robust and sensitive to the context. For more details on the benefits of a mixed-methods approach see Hammersley (1996) and for risk perception research in particular see Horlick-Jones et al. (2003).

Semi-structured interviews

Trust in the volcanic information received (both official and unofficial) and the decisions made by the authorities on the island were introduced for discussion in each interview. It was also up to the respondent to explore the issue of trust as they wished with minimal direction or guidance from the researcher. By using a more inductive and flexible method, it was hoped that a deeper understanding of the wider social situation could be gained along with other previously unknown issues introduced by the respondent. These issues were explored further during the interview and in repeated interviews carried out between January and April 2003. Thirty-five members of the public (Table 2) and thirty-one scientists and authorities (elites) were interviewed. The aim of the public sample was to obtain a group representative in terms of demographics and volcanic experience, capturing the range of views and opinions of the population towards the volcano and its management and, in particular, the population's feelings towards the evacuation at the time of interview. In qualitative research methodology, it is common to use a sampling strategy oriented to provide a spectrum of views on the topic (Pidgeon and Henwood 2004). The interview sample is reasonably representative of the population on Montserrat with only slightly more interviewed in the older age group and the higher education brackets than the demographic census data suggest.

The elites included: 13 scientific 'informers'—staff either working at the observatory or associated with it through research or consultancy positions on the biannual risk assessment panel; and a group which will be referred to as 'the authorities', including nine government officials—British foreign office staff associated with the British Governor's office and elected (or previously elected) Montserratian Government officials; four civil authorities dealing with the management of the crisis—emergency operations, police and a religious leader; two development personnel from the Department for International Development; and also three key members of the island's media. It was felt that the sample represented the range of possible

Table 2 Demographics of the public interview respondents

Characteristic	Percentage
Gender	
Male	60
Female	40
Age	
<18	3
21–35	14
36–50	25
51–65	39
66 or more	19
Highest qualifications obtained	
No formal qualifications/skills learnt at work	31
GCSE/O-LEVEL/CSE/CXE (school exams at approximately 16 years)	17
A-levels/high school leaving cert/CAPE (school exams at approximately 18 years)	17
Tertiary	28
Unknown	8
Employment	
Full time	31
Part time	19
Unemployed	11
Retired	25
Homemaker	11
Student	3
Birth location[a]	
Montserrat	63
Other Caribbean (Trinidad)	6
Outside the Caribbean	31[a]
Length of time living on Montserrat (years)	
Always	56
>15	25
10–15	6
5–9	6
2–4	0
<2	8
Distance currently living from the volcano	
4–5 km (Salem/Old Town/Belham area)	33
7 km (Woodlands/St Peters area)	28
>9 km (Cudjoe Head and all areas farther north)	39
Evacuation history	
Most recently 2002	40
Previously 1996–2000	49
Never	11

[a] Of these, 35% were born in the USA, 55% in the UK and 10% from other areas (Asia, S. America and Germany)

organisational perspectives. Many selected for interview had dealt with the crisis throughout and offered a comparatively longitudinal perspective without being restricted to the past. Others had also dealt with the crisis from an off-island position before or since being more closely involved.

Participant observations

To extend our understanding of the complex interactions of trust between the scientists and authorities interviewed, interactions during meeting situations were observed. This ethnographic method enabled the researcher to gather in-depth knowledge about the motivations, beliefs and behaviour of individuals and groups (Bryman 1988; Burnham et al. 2004). This approach provides an analysis of the environment within which the events and situations are viewed and enables the perspectives of the different actors (scientists and authorities) to be better understood. These ethnographic observations were undertaken over both research phases January to April 2003 and February to April 2004, a total period of 22 weeks (Table 3). The notes, when integrated with the interview data, provide a backbone and depth to the investigation, allowing validation through triangulation with the interviews and exposing the bureaucratic context within which the volcanic assessment, management and communication must be performed.

A thematic analysis was chosen to analyse the qualitative data (generated from the interviews and participant observations), placing emphasis on meaning rather than the quantification of the materials (Millward 1995). The data are examined for salient categories which are then given a label or code. This is not merely a description of the text, but a theoretical name indicative of the wider issues prominent in the data (Gibbs 2002). Due to the large volume of data, the CAQDAS (Computer Assisted Qualitative Data Analysis) software NVIVO was used to manage and aid the analysis. The qualitative data are presented with

Table 3 Meetings observed

Meeting	Date
Fieldwork phase one	
EPG	2 February 2003
EPG	17 February 2003
EPG	10 March 2003
EPG	24 March 2003
EPG	7 April 2003
Fieldwork phase two	
SAC 4 day meeting	1–4 March
Bench meeting	5 March
EPG	8 March
Science meeting	11 March
EPG	22 March

EPG, Emergency Policy Group (head scientists, government officials, civil servants and emergency managers); *SAC*, Scientific Advisory Committee (external and MVO scientists); *Bench meeting*, MVO board meeting (head scientists, external board members, government officials); *Science meeting*, all MVO scientists and technicians plus visiting scientists

verbatim quotes that typify the points made. Respondents' names have been changed and the names of elites removed to ensure the anonymity promised to all respondents.

Questionnaire survey

The quantitative investigation dealt exclusively with the views of the public and comprised the following aims: (1) overall comparison of trust in the various sources of volcanic information—both official and unofficial; (2) detailed exploration of the different dimensions of trust in the three main sources of volcanic information—scientists, British Governor's Office and Montserratian Government. These institutions were evaluated with 11 statements covering eight different attributes of trust (Table 4). The attributes and their defining statements were selected based on the findings from the first qualitative phase and also a review of similar work (Poortinga and Pidgeon 2003; Frewer et al. 1996; Johnson 1999). The impact of unofficial and conflicting information was measured with six statements, directly reflecting issues identified in phase one of the study. The questions asked are presented alongside the results Table 10. A copy of the actual questionnaire survey employed and the question topics discussed in the semi-structured interviews are available from the first author.

Table 4 Trust statements used to evaluate the scientists

	Truth statements
Competence	'the scientists at the MVO have been doing a good job in monitoring the volcano'
	'the scientists at the MVO have the necessary skills and experience to monitor the volcano'
Credibility	'the scientists at the MVO distort information released to the public'
Reliability	'the information released by the MVO is reliable'
Integrity	'the MVO and the decisions they make are too influenced by the British Government'
Care	'the role of the scientists at the MVO is to look after the safety of the people on the island'
Fairness	'the scientists at the MVO are acting on behalf of the ordinary people on Montserrat with regard to the volcanic monitoring and advice given'
	'the decisions the scientists make regarding the volcano are fair for everyone on the island'
Openness	'the scientists at the MVO provide all the information concerning the volcano to the public'
Value Similarity	'the scientists at the MVO have the same opinion as me about what dangers and risks are okay to take'
	'the scientists at the MVO do not have the same ideas as me about how dangerous the volcano is'

Equivalent statements were used for the British Governor's Office and the Montserratian Government

The survey questions were measured on a five-point Likert scale. This psychometric technique is the most widely used in survey research and increases the detail drawn from the data. Respondents are asked to specify their level of agreement to a list of statements, for example, 1='distrust a lot', 3='neither trust nor distrust' and 5='trust a lot'. The questionnaire was carried out between February and April 2004.

The questionnaire sample is fairly representative of the population on Montserrat (Table 5). Of the 215 questionnaires distributed, 173 were returned, giving a high response rate of 80%.[2] The sample deviates slightly from the population in terms of the number of non-nationals interviewed, which make up 28% of the sample but only 18% of the population in 2001.[3] However, there has been a considerable influx of migrant workers from other Caribbean islands since the 2001 census. Also, many non-nationals (known colloquially as the 'snowbirds') are on the island for 6 months of every year, typically between November and April and therefore were missed by the census.

Qualitative results

General trust in volcanic information

Authority's trust in the scientists

Trust in the scientists and their advice was generally very high among the majority of the authorities, particularly among the British authorities and members of the civil authorities in implementation roles. It was generally felt that the scientists were the experts and that their advice had been proven through the duration of the crisis.

> *"I think we are very trusting. It's almost like a doctor–patient relationship...I think that's healthy, and I think it's right... at the end of the day we're reliant and trust their expertise."* senior police representative

> *"I have always believed that the scientists are giving us the correct information. Over time I have seen all the predictions come true and we know what it can do and where it can affect."* Montserratian Government minister

Only two of the local ministers and one ex-minister expressed some doubt about the scientists' advice. Their arguments were framed around issues of uncertainty, value similarly and integrity. However, because of issues of liability it

[2] Total population at the time of interview=4,303 people. Only respondents over the age of 15 were asked to participate in the survey.

[3] Data from the population and housing census May, 2001, Statistics Department, Montserrat.

Table 5 Demographics of the questionnaire survey respondents

Characteristic	Percentage
Gender	
Male	46
Female	54
Age	
16–19	4
20–29	14
30–39	21
40–49	23
50–59	20
60–69	13
>70	6
Highest qualifications obtained	
No formal qualifications/skills learnt at work	34
GCSE/O-LEVEL/CSE/CXE (school exams at approx. 16 years)	21
A-levels/high school leaving cert/CAPE (school exams at approx. 18 years)	15
Degree/Diploma	21
Masters/PhD	9
Birth location	
Montserrat	56
Other Caribbean	16
Outside the Caribbean	28[a]
Length of time living on Montserrat (years)	
Always	43
>15	28
10–15	8
5–9	10
2–4	8
<2	3
Distance living from the Volcano	
4–5 km (Salem/Old Town/Belham area)	31
7 km (Woodlands/St Peters area)	21
>9 km (Cudjoe Head and all areas further north)	48
Evacuation history	
Most recently 2002	12
Previously 1996–2000	57
Never	31

[a] Of these, 54% were born in the USA, 33% in the UK and 12% from other areas (Asia, S. America and Germany)

was generally agreed that those governing the crisis always had to follow the scientist's advice whether they trusted it or not.

> *"We are never sure the scientists have given us the correct information...even if I wasn't totally convinced, the fact that the scientists say, I have to act on their advice*." Montserratian Government minister

Public trust in the authorities

When asked who they trusted for volcanic information, the vast majority of respondents stated 'the scientists', whom they considered had more competence than the government authorities.

> *"I believe 100 percent what the scientists say. One night I hear the Chief Minister say something and I said he is not the scientists... if the scientists say so then I will go."* Winston, Montserratian

Many admitted that they did not automatically trust the scientists and had learned through experience. Some recounted the activity in 1997 and how they had learned their lessons the hard way, feeling that people had died because they had not listened to the scientists.

> "*The scientists were perfect, we have to listen to what they say. I believe everything they say because everything they say happened...people lost their lives already 'cos they told us things and we never believe them."* Trevor, Montserratian

It was believed by all the scientists and the majority of the authorities that the Montserratian public were trusting of their information and it was only a vociferous minority who were distrusting. One scientist in particular expressed frustration at the attitude of those who distrusted them and felt that as the experts they should automatically be trusted.

> "*It's like going to a medical doctor if you've got an ailment you put your trust in that person, and likewise we're experts with the volcano... I don't think you should blindly accept what we say but to a limit they should accept that the only volcanologists on this island are in this building...."* Scientist

Dimensions identified as defining trust

A number of the dimensions defining trust, which were identified in the literature, were also induced from the discourse used by the scientists, authorities and public. These include:

Competence

> *"I know they are doing their work and they get many sleepless nights and it is because of us they are trying to protect and I respect them."* John, Montserratian

The authorities and vast majority of the public respondents felt that the scientists were exceptionally hard working, well trained, proficient at their tasks and interpreting the monitoring equipment correctly. A minority stated that certain scientists did not have enough experience of the volcano's activity to put the 2002/2003 activity into context. Some complained about the high staff turnover at the observatory, leading to a weakness in the monitoring. The competence of the authorities

was also mentioned in relation to their ability to interpret the scientific information and uncertainty, whilst balancing it with the economic and social aspects of the island's development. Many felt that, initially, the local Montserratian Government and the British Government (via the Governor's Office) were perhaps putting too much weight on the economic considerations. However, during the recent crisis, some respondents felt the opposite was true and the authorities interpreted the scientists' information too strictly.

It was believed by scientists and authorities that changing levels of activity affected the ways in which the scientists and the British Governor were seen by the public. During high levels of activity the scientists' information was corroborated by the public's observations. Low levels of activity (not necessarily a sign of reduced risk) coupled with high levels of caution were seen to undermine the scientists' competence in the eyes of the public.

Integrity

The majority of the scientists, authorities and some members of the public interviewed felt the scientists were more trusted due to their independent and impartial stance. They felt that the scientists simply presented the scientific and factual information to the authorities as they monitored it. However, some of the public considered that the information they were being given was being distorted by non-scientific factors and that the BGS was too close to the British Government (both on and off island) to deserve this credit. The local Montserratian Government officials were viewed with a healthy dose of scepticism as being politically motivated.

> *"I think it's a little bit of politics...not between political parties but between maybe the Government and the observatory and the British Government."* Alex, Montserratian

> "*I don't think the Governor should use the scientists' report and twist it to his own plans or agenda. People are losing confidence in the scientists' reports because they are being meddled with."* Abigail, Trinidadian

Value similarity

Related to the issue of integrity (and differences in risk acceptability) was the dimension of 'value similarity'. The authorities and scientists felt that the local population, including the local authorities, had greater trust in Caribbean-born scientists who they perceived had similar values to them and understood the Caribbean way of thinking. This view was reciprocated strongly by the Montserratians who commented on the differing values that the non-Caribbean (dominantly British) scientists and the British authorities had to their own. They felt that whilst they may be competent at their job, they did not have the same investment in the future of the island and therefore could not see the risks in the same way. Many felt that perhaps local or Caribbean scientists would be more trusted because of their similar cultural values and outlook on life.

> *" they don't have the same interest in the island as if your life savings are here, they can't have, it's a different way of looking at it"* Susan, British expatriate

> *"I think we would have been at ease if there were... I don't want to sound racist because I am not, but I would say having Caribbean people involved."* Derek, Montserratian

Openness

A tendency to mix well, be relaxed and open and become 'part of the community' was felt to increase trust in the scientists but was thought to vary considerably among individuals. This response was corroborated by the public who appeared to trust some scientists more than others due to their perceived openness.

> "*Too often it's personalities involved. If the scientist is a gregarious, happy go lucky person then everything is fine, it totally depends on the person"* Virginia, USA/ Montserratian

Conflicting messages of safety and danger

It was noted by the scientists and a few members of the authorities that politically oriented rumours, opposing scientific views and misconceptions were circulating amongst the public via word of mouth, the internet and the local newspaper. This information ran counter to the scientists' information, allowing distorted and competing messages to spread very rapidly around the island.

> *"I think there is a lot of rumour and a lot of information put out deliberately to misinform by people who don't like what's happening with the volcano or the exclusion zone."* Scientist

One member of the lay public was singled out as being the source of much of this competing information and was considered by many of the elites to be valued and trusted by a public minority who opposed the management of the exclusion zone. An interview with this individual (who had a background in the biological sciences) revealed a sense of duty to counteract the official science as it was thought to be inaccurate and the cause of recent unjust evacuations. The main competing arguments included a number of

physical reasons why the lower Belham Valley area was not at risk from volcanic hazards and engineering solutions that could potentially further reduce the risk. For a minority, this respondent's science reinforced their differences of opinion and lower perceived risk.

> *"There are certain* [people] *in the community that people respect and once they speak, they take that line of view on it, if them people say the MVO is doing crap then everybody else is going to think that.*" local civil authority

> *"There's this guy* [#], *I think he's a scientist or something...basically... they're* [the scientists] *giving him the opportunity and then they're just sitting back... one of the problems is that* [#], *basically to us, seemed like he knew what he was really talking about. He's basically using not similar but the exact figures that they're using and coming up with a different thing.... the scientists just keep it as if he's talking the truth, so if you don't hear the dispute he's talking the truth."* Derek, Montserratian.

Conflicting messages commonly existed over the locations of safe and dangerous areas and the provision of scientific information that could not be visually verified. For some respondents, because there was no visible sign of activity within the area recently evacuated, they perceived the situation to be low risk and that the scientists' reports must therefore be inaccurate. This was related to their experience, level of confidence, their understanding of the hazards and of the uncertainty involved in volcanic monitoring.

> "*So you're looking at the mountain because normally when there's a big activity you look at the mountain and see things. There must be some clear evidence of something, you know, whether it be ash flows or something, you want to be able to see it*." Derek, Montserratian.

The effect of these competing messages was to breed rumour of conspiracy among some respondents. There was also a large element of denial and blame at play; respondents did not want to believe that they may lose their property to the volcano. Instead, through a different interpretation of the uncertainty and a belief in the unofficial information, it was easier to blame the authorities, particularly the UK-based British Government, for various underhand plots.

> "*You always felt that they were blowing things out of context ....it was difficult to accept that we were going to have to give up all that we had worked for. We started blaming the authorities... we thought the British wanted to do this and that so we started to put our blame on someone, you know, silly things which just came out because people were experiencing loss."* Nick, Montserratian

Quantitative results

Respondents were asked to indicate their trust in the different institutions and organisations on the island to tell the truth about the volcano. These results are shown in Table 6 and Fig. 1, along with the mean response for each source and the standard deviation.

Friends were considered most trustworthy, with a mean of 4.24 (1.05), well above the mid-point on the scale and well within positive trust. The scientists come a close second with a mean of 3.94 (1.24), again well above the mid-point on the scale. The ZJB radio station (the main

Table 6 Overall Trust—percent of respondents

Information source	Distrust a lot (1)	Distrust (2)	Neither trust or distrust (3)	Trust a little (4)	Trust a lot (5)	Weighted mean score[a]	Standard Deviation
Friends and family	3	4	17	20	57	4.24	1.05
Scientists	7	10	9	31	43	3.94	1.24
ZJB radio station	4	8	19	30	39	3.91	1.13
Emergency Operations Centre	6	10	16	38	31	3.77	1.16
The Montserrat Reporter	9	11	20	40	20	3.51	1.19
Salem Volcanic Crisis Committee	11	10	34	27	18	3.31	1.20
Opposition politicians	9	18	30	27	17	3.25	1.19
British Governor's Office	20	16	18	23	23	3.15	1.45
Montserratian Government	15	24	19	25	16	3.03	1.33
World press	35	11	24	18	12	2.59	1.42

[a] The weighted mean is calculated by multiplying each value by its weight factor (1–5) then dividing the sum of the products by the sum of the weights

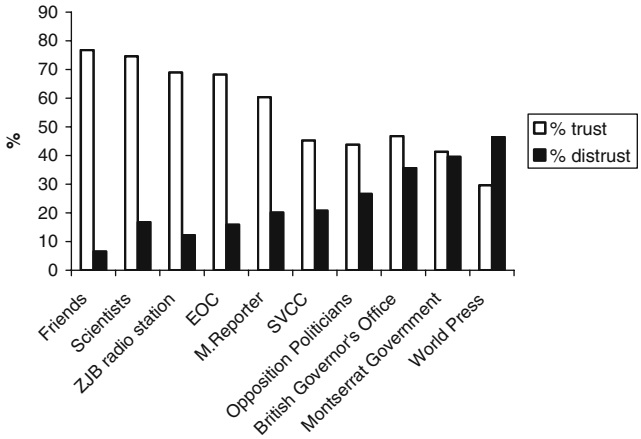

Fig. 1 Trust against distrust—Percent of respondents who trusted and distrusted each source

forum the scientists use to communicate their information) and the Emergency Operations Centre are also closely and highly rated. The Montserrat Reporter (local newspaper) is the last source to be positively trusted by a slight majority of the sample. The Salem Volcanic Crisis Committee (evacuated residents group) and three remaining government sources (opposition politicians, British Governor's Office and the Montserratian Government) are trusted by less than half the respondents, with the Montserratian Government faring the worst. The world press is rated at the bottom overall and is the only group with a mean score indicating negative trust, with a majority of 47% distrusting them, and a mean score of 2.59 (1.42) putting their average score in 'distrust'.

To investigate whether there were groupings of institutions that people viewed as having similar values or dimensions, a factor analysis was conducted. This analysis tests the pattern of the correlations between a set of variables to investigate whether groups can be summarised by a set of simple, or 'latent' variables.

The results (Table 7) show that organisations which load highly on factor 1 are the scientists, British Governor's Office, Montserratian Government, Emergency Operations Centre and the local radio station ZJB. These are all official organisations from which people expect to hear formal information about the volcano. Factor 2 represents the more unofficial organisations that are the major sources of competing information about the volcano; the Salem Volcanic Crisis Committee (evacuated residents group), the opposition politicians and the local newspaper (The Montserrat Reporter). The third group of sources comprises friends and the world press.

Detailed comparison of the main sources of information and decision makers

Eleven statements were tested covering eight issues of trust, for the scientists, British Governor's Office and the Montserratian Government (Table 4). Cronbach's reliability test (Cronbach 1951) was used to examine the internal consistency of this scale and three duplicate statements were removed, leaving one statement for each issue (Table 8).

A repeated measures ANOVA (Analysis Of Variance) was conducted to examine whether respondents differed in their mean response concerning the three major institutions for volcanic information and risk management across each of the eight statements of trust measured. The analysis indicates whether there is a significant difference between the institutions for each particular trust statement. A repeated measures ANOVA was also conducted in order to analyse the overall relationship between the variables, giving the overall means and the significance of the difference. A *post hoc Bonferroni* pair-wise comparison test (Field 2000) was conducted for the statements where the ANOVA indicated a difference, identifying which means were significantly different.

The data (Table 8 and Fig. 2) demonstrate clearly that the scientists are the most trusted source while the Montserratian Government and British Governor's Office rank very closely. The issue of *Care* is rated the collective highest with all mean responses for the three institutions rated above the midpoint on the scale. *Integrity* is rated the lowest with all mean responses below the midpoint on the scale. The mean responses for the authorities hover around the midpoint on the scale for *Competence*, *Credibility* and *Reliability* and just below it for *Fairness*, *Openness* and *Value Similarity,* whereas the mean responses for the scientists for these variables are well above the midpoint.

The significance column on Table 8 shows the variables for which the ANOVA reached statistical significance. The

Table 7 Factor loading after Varimax[a] rotation

Variables	Components		
	1	2	3
Scientists	**0.82**	−0.17	0.02
British Governor's Office	**0.89**	−0.04	0.07
Montserratian Government	**0.71**	0.35	−0.05
Opposition politicians	0.40	**0.69**	−0.12
Emergency Operations Centre	**0.86**	0.05	0.05
Friends and family	0.02	0.07	**0.83**
Salem Volcanic Crisis Committee	−0.20	**0.79**	0.23
ZJB radio station	**0.67**	0.26	0.20
The Montserrat Reporter	0.08	**0.76**	0.19
World press	0.11	0.14	**0.62**
Eigenvalue	3.38	1.92	1.23
Explained variance (total=65.3%)	33.80	19.20	12.30

Factor loadings higher than 0.40 are in bold

[a] Varimax rotation aids the interpretation by making it clearer which variables relate to which factors (Field 2000)

Table 8 A comparison in the trust of the three main institutions

Trust dimension	British Governor's Office	Montserratian Government	Scientists	*F**	*p* value
Competence	3.05 (1.471)	3.00 (1.460)	**4.27** (1.039)	(2, 336)=83.08	<0.001
Credibility	2.94 (1.384)	3.04 (1.252)	3.18 (1.382)	(1.893, 302.92)=2.78	(n.s.)
Reliability	3.14 (1.406)	3.15 (1.304)	**3.85** (1.244)	(2,338)=36.32	<0.001
Integrity	2.20 (1.207)	2.40 (1.379)	2.48 (1.464)	(2,330)=2.74	(n.s.)
Care	3.60 (1.299)	3.69 (1.279)	**4.05** (1.168)	(2,332)=10.09	<0.001
Fairness	2.72 (1.473)	2.89 (1.410)	**3.39** (1.440)	(1.810, 305.94)=23.44	<0.001
Openness	2.76 (1.432)	2.76 (1.391)	**3.36** (1.386)	(2, 336)=22.40	<0.001
Value similarity	2.73 (1.458)	2.86 (1.381)	**3.08**[a] (1.521)	(1.988, 333.94)=5.27	<0.01
Overall mean	2.91	2.96	**3.44**	(1.775, 257.35)=44.11	<0.000
Cronbach alpha	0.88	0.84	0.87		

Standard deviations are given in parentheses. The means which the Bonferroni (Field 2000) indicated were significantly different from the others are in bold

[a] Value similarity is only significantly different between the Scientists and British Government

*F**=column details the *F* ratio and the degrees of freedom from which it was calculated. The *F* ratio is a measure of the variation explained by the model against the variation explained by unsystematic factors

figures in bold indicate the means which differed significantly from each other. The scientists' score is significantly different from the other two institutions for five of the issues measured and significantly different from the British Governor's Office for value similarity (3.08). No significant difference is seen between the British Governor's Office and the Montserratian Government for any of the issues. The scientists score very highly and significantly differently from the other two for *Competence* (4.27) and *Care* (4.05) They score moderately highly for *Reliability* (3.85), *Fairness* (3.39) and *Openness* (3.36). This result indicates, therefore, that people agreed the scientists were more competent to deal with the volcano, more reliable in giving information, more caring and fair in their advice and decisions and provided more of their information than the authorities.

The overall relationship between the variables indicates that the scientists have a significantly higher overall mean for all the trust issues. In comparison, the British Governor's Office and Montserratian Government are not considered to have similar values to the public (the scientists only just score a positive value) or to be as open or fair in their decision-making. None of the institutions are seen to have integrity, with the majority of the public perceiving them to be too heavily influenced by the UK-based British Government.

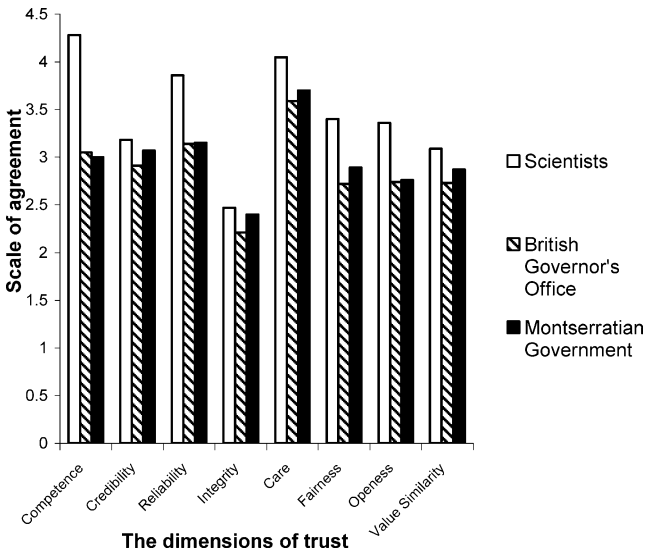

Fig. 2 Comparison of the different dimensions of trust for the scientists, Montserratian Government and British Governor's Office

What is important for trust?

To investigate which issues or dimensions of trust are important for the trust of the scientists, the Montserratian Government and the British Governor's Office, a multivariate backward regression analysis was used to identify which of the eight issues of detailed trust are significant predictors for explaining the Montserratian public's trust in these three institutions.

Table 9 shows that *Reliability* (consistency and dependability), *Competence* (the ability and skills to do a good job), *Openness* (openness in providing all of the relevant information) and *Integrity* (morality to do the job for honourable reasons), are focal for trust in the scientists. These predictors explain 55% ($R^2_{ADJ} = .55 \times 100$) of the variance seen in trust of the scientists, with *Reliability* having the greatest influence.

Table 9 shows that *Competence*, *Reliability* and *Fairness* (in their decisions) are the issues important for trust in the British Governor's Office and the Montserratian Government, explaining 58 and 37% respectively, with *Competence* having the greatest influence.

Table 9 Predictors for trust in the scientists, British Governor's Office and Montserratian Government

	β_{Std}	Significance value
Predictors for trust in the scientists		
Reliability	0.377	0.000
Competence	0.246	0.001
Openness	0.163	0.012
Integrity	0.142	0.018
$R^2_{ADJ} = 0.55 (f = 51.370, p =< 0.001)$		
Predictors for trust in the British Governor's Office		
Competence	0.487	<0.001
Reliability	0.225	0.002
Fairness	0.140	0.044
$R^2_{ADJ} = 0.58 (f = 78.688, p =< 0.001)$		
Predictors for trust in the Montserratian Government		
Competence	0.349	<0.001
Reliability	0.239	0.003
Fairness	0.163	0.018
$R^2_{ADJ} = 0.37 (f = 35.070, p =< 0.001)$		

The R^2_{ADJ} value represents the percentage of the variation in trust which can be explained by the retained predictor variables. The *f* value is a measure of whether the model is better at predicting the outcome than by simply taking the mean of the data, with a value of 1 or more indicates that the fit of the regression model is greater than the inaccuracies within the model. This value comes associated with a significance *p* value, which indicates the probability of this value occurring by chance (Field 2000)

The β_{Std} value is the number of standard deviations overall trust will change with one standard deviation change in the predictor. This value comes associated with a significance value (Field 2000)

Competing messages

As shown in Table 10, half and just under half of the respondents agreed with statements 1 and 2, "*the information I have seen is different to what I have received'* and '*I have less confidence therefore in the information I have received*", giving mean scores of 3.07 (1.45) and 2.84 (1.50) respectively. Statement 3, "*if the scientists can go into the exclusion zone then so can I*", was the most disagreed with, giving the lowest mean score of 2.61 (1.57). Statement 4, "*decisions made are not justified by the volcanic activity*", was agreed with by over half the respondents with a mean of 3.50 (1.44), well above the mid point of the scale. Statement 5, "*the scientists exaggerate the chance of volcanic activity*", was the most agreed with statement, with the highest mean score of 3.69 (1.47). The final statement 6, "*it is sometimes difficult to know who to believe*", was agreed with by just under half the respondents with a mean score of 3.13 (1.52), just above the mid-point. Therefore, statements 2 and 3 were the only two statements with mean scores below the mid point of the scale.

Discussion

In considering issues of trust and risk communication on Montserrat, it is clear that the authorities generally viewed the scientists as the most expert source of volcanic information and consequently received a high degree of trust. However, distrust among some of the local ministers was based upon the scientists' (in)ability to reduce uncertainty and issues relating to value similarity and integrity.

The scientists correctly perceived that, apart from a vociferous minority, their information was trusted by the Montserratian public. It is largely believed within the scientific community that the public should receive the majority of their volcanic information from the government or emergency management officials, not from the scientists (Peterson and Tilling 1993; Peterson 1996). However, these results demonstrate that people have greater trust in the information they receive about the volcano directly from the scientists. The emergency management officials were trusted more than the other government officials but still fell short of the scientists.

The finding that the scientists were more trusted by the public than the authorities tallies well with other empirical studies which suggest that government ministers and departments are typically distrusted information sources (Poortinga and Pidgeon 2003, 2004). This result has implications both for communication on Montserrat and during other volcanic crises as it highlights the importance and potential effectiveness of the scientists' communication role, because of, and despite, the existence of political, cultural and institutional barriers. Despite the immediate need during a volcanic crisis for scientists to concentrate on 'science', response agencies often presume that scientific agencies will not only supply scientific advice, but also provide advice relevant to their educational and emergency management decisions (Ronan et al. 2000). In addition, when people are confronted with complex issues about which they have poor understanding, they may transfer all responsibility for their protection to the requisite experts, e.g. scientists (Paton et al. 2000). There is, therefore, a need to prepare volcanologists for the social demands encountered in playing an active crisis management role (Ronan et al. 2000). Assessing dimensions of trust in an 'at risk' community will provide vital information about *who* should rapidly and effectively convey risk messages, as the distribution of trust found on Montserrat may not apply to other volcanic situations.

The IAVCEI guidelines for the professional conduct of volcanologists (Newhall et al. 1999) advocate a balance of volcanological methods, research and a wide communication strategy. Discussion with the public and authorities to achieve a community understanding of a working level of acceptable risk is also encouraged. However, there is no reference to a wider interactive communication framework

Table 10 Competing messages—% of respondents

	Disagree strongly (1)	Disagree a little (2)	Neither agree nor disagree (3)	Agree a little (4)	Agree strongly (5)	Weighted Mean[a]	Standard deviation
1, The information I have received from the MVO is different to what I have seen with my own eyes	23	13	16	29	19	3.07	1.45
2, I have less confidence in the information from the MVO because what I see and hear are not always the same	30	13	15	24	17	2.84	1.50
3, If the scientists can go into the exclusion zone so can I	39	15	12	16	19	2.61	1.57
4, On occasion the decisions made by the EPG are not justified by the volcanic activity I have seen	17	7	15	29	31	3.50	1.44
5, The MVO and Governor's Office exaggerate the chance and danger of volcanic activity	17	3	13	24	41	3.69	1.47
6, It is sometimes difficult to know who to believe as there are different views about the volcano	25	10	16	24	25	3.13	1.52

Cronbach's reliability of statements 1 to 6=0.84

[a] The weighted mean is calculated by multiplying each value by its weight factor (1–5) then dividing the sum of the products by the sum of the weights

where involvement of, and feedback from, the public is used to improve or adapt the communication. Instead, a one-way method of communication is implied, largely via the media. In addition, scientists are not necessarily trained for outreach roles and, although the report recommends a diverse team including communication specialists, it does not mention the inclusion of social scientists or recommend a more interdisciplinary outlook.

Montserrat is a small community with a complex political environment resulting from its status as a UK Overseas Territory. There was no historical precedent to the current activity, no pre-existing volcano observatory and a recognisably shaky start to the management of the crisis (e.g. Kokelaar 2002; Aspinall et al. 2002; Pattullo 2000). Nonetheless, at the time of this study there was a functional volcano observatory (MVO), enmeshed within the island's administration. All volcanological research was conducted in collaboration with and the knowledge of the MVO and information was regularly conveyed from the MVO to the British Government, Montserratian Government and the general public.

The regression results from this research demonstrate that high trust in the scientists was based on high perceived reliability, competence, openness and integrity, whereas government authorities scored highly on perceived levels of competence, reliability and fairness. It seems that competence and reliability are the most important issues for trust in all institutions. Although the government authorities need to be perceived to be fair, openness and integrity are only important for the scientists. It can be surmised, therefore, that this indicates the healthy scepticism noted by Walls et al. (2004). Government officials are expected to follow political motivations that are in conflict with complete openness and integrity, whereas the scientists are expected to have integrity and be open with their scientific information.

Fluctuating volcanic activity, especially periods of low activity but high risk, greatly affected the level of trust. Misunderstandings of the uncertainty of volcanic monitoring and the necessary levels of precaution taken for emergency management were often confused with incompetence. Although the scientists remained a highly trusted source, expectation among a minority of the public often gave way to frustration and a tendency to place greater reliance upon personal judgement and competing information than on the scientists' information and abilities.

Competing messages often stemmed from scientific information which conflicted with individual observations. Similarly to Handmer's (2000) finding that unofficial communications undermine or deflect official communications, these conflicting observations had a tendency to propagate opposing views, confusion and distrust in the MVO and authorities. Some placed their trust in 'lay scientists' whose scientific views suggested minimal risk to their homes, thereby justifying the activity they had seen and expected. The majority of the respondents were found to have been affected to some degree by the competing messages they received about the volcano, with over half stating that the information led them to believe the decisions had not been justified by the volcanic activity. In many cases, it is not the content of rumour, but rather the fact that rumours and conspiracy theories exist that should act as an important signal to risk communicators.

At the time of this study, no 'competing' groups of volcanologists were offering alternative sources of information, as has been the case during other volcanic crises. However, our analysis of trust on Montserrat would seem to provide evidence for the need for a united approach in disseminating volcanic information (as set out in IAVCEI guidelines). A comparative study of trust in a volcanic region where competing scientific messages have unfortunately occurred would be insightful.

The dissemination of information is always more complex than generic guidelines, suggesting that, if possible, informal and trusted networks should be identified and exploited to disseminate information and provide feedback from the community. We have found that the most trusted source of information concerning the volcano was friends and family. This result echoes earlier findings at Mt St. Helens (Perry and Greene 1983) and within New Zealand (Ronan et al. 2000). It therefore comes as no surprise that competing messages are easily spread and believed within the community. Early on in the crisis, certain individuals, including radio presenters, local personalities and church leaders had been used by the scientists and authorities as 'translators'. These individuals were trusted and influential among large sections of the Montserratian population, often bridging cultural and technical gaps in the volcanic communication during difficult periods. Apart from the questions fielded by radio presenters when interviewing the scientists, this method of 'translation' by local trusted sources was not being utilised during the fieldwork period.

Conclusions and recommendations

The process by which trust is won or lost on Montserrat is complex and dynamic, with deeply rooted cultural and political influences, a situation that has been exacerbated by Montserrat's complicated governance. Friends and relatives are considered the most trusted source for volcanic information. The scientists are the second most trusted source, being considered significantly more competent, reliable, caring, fair and open than the authorities. For the scientists, Montserratian Government and British Governor's Office it was found that reliability and competence were considered most important for trust.

The British government authorities, and, in particular, the local government authorities, need to carefully consider their low trust rating. As numerous studies have demonstrated, it is standard for government authorities to experience an ongoing element of distrust. Although healthy scepticism is natural and not necessarily indicative of complete distrust, in the light of this finding, it may be prudent for government officials to rethink their role in emergency management. The results from this study suggest that as the most trusted sources, scientists and emergency management officials should continue to play a large role in disseminating information concerning the volcano on Montserrat. This situation may not be the case in other countries where differing dimensions of trust may be important or where scientists have damaged some dimensions of trust via for example open scientific conflict.

Although the scientists and emergency management officials are still highly trusted, uncertainties about the natural processes, accompanied by a necessarily precautious management, have caused levels of trust to fluctuate. It appears that within this uncertain environment of financial and social loss, public observations—which are limited to physical signs, will differ from the more detailed scientific analysis. When coupled with different levels of risk and benefit acceptability, high trust in the opinions of friends and family allows competing messages to reinforce similar (often inaccurate) beliefs. Such competing messages are inevitable. Although highly trusted, the scientists and emergency management authorities need to work hard to maintain this trust and plan strategically to adapt to the context both before and during a volcanic crisis, particularly when involved with prolonged eruptions.

Scientists and authorities must therefore develop workable methodologies to implement the recommendation within the IAVCEI guidelines (Newhall et al. 1999) to negotiate levels of acceptable risk and trade-offs with the public. In the context of long-lived eruptions such as Montserrat, sharing the dilemma of uncertainty through innovative techniques such as a 'citizen's jury' can improve understanding and trust in a fairer decision-making process, thereby reducing the perception of false alarms and mistaken scientific advice. Trusted members of the public (religious leaders, local personalities and respected members of the community) should be identified as quickly as possible and used as intermediaries to spread the scientific messages and provide feedback to the scientists and authorities. In addition, official communicators should engage with the community in an unofficial and relaxed setting. This engagement is perhaps most important for the scientists who need to be perceived as open and free with their scientific information. 'Rum shop meetings' (as small village chats are colloquially known on Montserrat) enable the communicators to become trusted members of the community and allow an understanding of how the community views the volcano to develop. The result is a window into the community's perception of the volcano which can act as a valuable resource for the adaptation of risk communications. Each volcanic crisis will unfold in a different socio-cultural environment and care must be taken to deliberately plan communications so that a trusting relationship is developed and maintained.

Acknowledgment The authors wish to thank the people of Montserrat, the MVO staff and associates, members of the British and Montserratian governments, DFID representatives, and the Montserrat emergency management and police force for the time they invested partaking in this study. Miguel Dorio and Wouter Poortinga are thanked for their statistical advice. Thanks are also due to Tom Lowe and John McAneney for proof reading earlier drafts of this manuscript. We would particularly like to thank Shane Cronin and Douglas Paton for thorough and insightful views and Jocelyn McPhie for careful editorial handling. Their insights into how to make a study of this nature more applicable and accessible were especially appreciated. This work was supported by the UK NERC/ESRC and carried out within the School of Environmental Sciences at the University of East Anglia.

References

Aspinall WP, Sparks RSJ (2004) Volcanology and the law. IAVCEI News 1:4, http://www.iavcei.org/pubs_w.html

Aspinall WP, Loughlin SC, Michael FV, Miller AD, Norton GE, Rowley KC, Sparks RSJ, Young SR (2002) The Montserrat volcano observatory: its evolution, organization, role and activities. In: Druitt TH, Kokelaar BP (eds) The eruption of Soufrière Hills Volcano, Montserrat, from 1995 to 1999. Geol Soc Lond Mem 21:71–91

Barber B (1983) The logic and limits of trust. Rutgers University Press, New Brunswick

Breakwell GM (2000) Risk communication: factors affecting impact. Brit Med Bull 1:110–120

Bryman A (1988) Quantity and quality in social research. Unwin Hyman, London

Burnham PK, Gillard K, Grant W, Layton-Henry Z (2004) Research methods in politics. Palgrave Macmillan, Basingstoke

Clay E, Barrow C, Benson C, Dempster J, Kokelaar P, Pillai N, Seaman J (1999) An evaluation of HMG's response to the Montserrat volcanic emergency, 2 vols. Evaluation Report EV635, Department for International Development, London

Cronbach LJ (1951) Coefficient alpha and the internal structure of tests. Psychometrika 16:297–334

Earle TC, Cvetkovich GT (1995) Social trust: towards a cosmopolitan society. Praeger, London

Fergus H (2001) Montserrat in the Twentieth Century: Trials and Triumphs. UWI School of Continuing Studies, Montserrat

Field A (2000) Discovering Statistics using SPSS for windows. Sage, London

Frewer LJ, Howard C, Hedderley D, Shepherd R (1996) What determines trust in information about food related risks? Underlying psychological constructs. Risk Anal 16:473–485

Gibbs G (2002) Qualitative data analysis: explorations with NVivo. Open University, Buckingham

Gregg CE, Houghton BF, Johnston DM, Paton D, Swanson DA (2004) The perception of volcanic risk in Kona communities from Mauna Loa and Hualalai volcanoes, Hawaii. J Volcanol Geoth Res 130:179–196

Hammersley M (1996) The relationship between qualitative and quantitative research: paradigm loyalty versus methodological eclecticism. In: Richardson TE (ed) Handbook of qualitative research methods for psychology and the social sciences. BPS Books (The British Psychological Society), Leicester, UK, pp 159–174

Hammond KR (1996) Human judgement and social policy: irreducible uncertainty, inevitable error, unavoidable injustice. Oxford University Press, New York

Handmer J (2000) Are flood warnings futile?: risk communication in emergencies. Australas J Disas Trauma Std 2: http://www.massey.ac.nz/~trauma/issues/2000–2002/handmer.htm

Haynes K (2005) Exploring the communication of risk during a volcanic crisis: a case study of Montserrat, WI. PhD thesis, School of Environmental Sciences, University of East Anglia, Norwich, UK

Henwood KL, Pidgeon NF (1992) Qualitative research and psychological theorizing. British J Psychol 83:97–111

Herd RA, Edmonds M, Bass VA (2005) Catastrophic lava dome failure at Soufrière Hills Volcano, Montserrat, 12–13 July 2003. J Volcanol Geoth Res 148:234–252

Horlick-Jones T, Sime J, Pidgeon N (2003) The social dynamics of environmental risk perception: implications for risk communication research and practice. In: Pidgeon N, Kasperson RE, Slovic P (eds) The social amplification of risk. Cambridge University Press, Cambridge, pp 262–285

Hovland CI, Janis IL, Kelley HH (1953) Communication and persuasion: psychological issues of opinion change. Yale University Press, Newhaven

Johnson BB (1999) Exploring dimensionality in the origins of hazard related trust. J Risk Res 2:325–354

Johnston D, Bebbington MS, Lai CD, Houghton BF, Paton D (1999) Volcanic hazard perceptions: comparative shifts in knowledge and risk. Disast Prevent Man 8:118–126

Kasperson RE (1992) The social amplification of risk: progress in developing an integrative framework of risk. In: Krimsky S, Golding D (eds) Social theories of risk. Praeger, pp 153–178

Kinzig A (2003) Uncertainty and the Scientist. Ambio 32:329

Kinzig A, Starrett D (2003) Coping with uncertainty: a call for a new science-policy forum. Ambio 32:330–335

Kokelaar BP (2002) Setting, chronology and consequences of the eruption of Soufrière Hills Volcano, Montserrat (1995–1999). In: Druitt TH, Kokelaar BP (eds) The eruption of Soufrière Hills Volcano, Montserrat, from 1995 to 1999. Geol Soc Lond Mem 21:1–44

Krimsky S, Golding D (1992) Social theories of risk. Praeger, Westport, CT

McKnight DH, Chervany NL (1996) The meanings of trust. Technical report MISRC working paper series 96-04. University of Minnesota, Management Information Systems Research Centre. http://www.misrc.umn.edu/wpaper/wp96-04.htm

Metlay D (1999) Institutional trust and confidence: a journey into a conceptual quagmire. In: Cvetkovich GT, Lofstead RE (eds) Social trust and the management of risk. Earthscan, London, pp 100–116

Millward L (1995) Focus groups. In: Breakwell GM, Hammond S, Fife-Shaw C (eds) Research methods in psychology. Sage, London, pp 274–292

Newhall C, Aramaki S, Barberi F, Blong R, Calvache M, Cheminee J-L, Punongbayan R, Siebe C, Simkin T, Sparks S, Tjetjep W (1999) Professional conduct of scientists during volcanic crises. Bull Volcanol 60:323–334

Paton D, Smith L, Johnston D (2000) Volcanic hazards: risk perception and preparedness. New Zealand J Psychol 29:86–91

Pattullo P (2000) Fire from the mountain: the tragedy of Montserrat and the betrayal of its people. Constable, London

Perry RW, Greene MR (1983) Citizen response to volcanic eruptions: the case of Mt. St. Helens. Irvington, New York

Peters RG, Covello VT, McCallum DB (1997) The determinants of trust and credibility in environmental risk communication: an empirical study. Risk Anal 17:43–54

Peterson DW (1996) Mitigation measures and preparedness plans for volcanic emergencies. In: Scarpa R, Tilling RI (eds) Monitoring and mitigation of volcanic hazards. Springer, Berlin, pp 701–718

Peterson DW, Tilling RI (1993) Interactions between scientists, civil authorities and the public at hazardous volcanoes. In: Kilburn CRJ, Luongo G (eds) Active lavas. UCL, London, pp 339–365

Pidgeon N, Henwood K (2004) Grounded theory. In: Hardy M, Bryman A (eds) Handbook of data analysis. Sage, London, pp 625–648

Pidgeon N, Hood C, Jones D, Turner B, Gibson R (1992) Risk perception. In: Royal Society Study Group (ed) Risk analysis, perception and management. Royal Society, London, pp 89–134

Poortinga W (2004) Public perceptions and trust in the regulation of genetically modified food. PhD thesis, School of Environmental Sciences, University of East Anglia, UK

Poortinga W, Pidgeon N (2003) Exploring the dimensionality of trust in risk regulation. Risk Anal 23:961–972

Poortinga W, Pidgeon N (2004) Trust, the asymmetry principle, and the role of prior beliefs. Risk Anal 24:1475–1486

Possekel AK (1999) Living with the unexpected. Springer, Berlin

Renn O, Levine D (1991) Credibility and trust in risk communication. In: Kasperson RE, Stallen PJM (eds) Communicating risks to the public. Kluwer, Dordrecht, pp 175–218

Ronan KR, Paton D, Johnston DM, Houghton BF (2000) Managing societal uncertainty in volcanic hazards: a multidisciplinary approach. Disast Prevent Man 9:339–348

Sjöberg L (2000) Factors in risk perception. Risk Anal 20:1–11

Sjöberg L (2001) Limits of knowledge and the limited importance of trust. Risk Anal 21:189–198

Skelton T (2000) Political uncertainties and natural disasters: Montserratian identity and colonial status. Interventions: Internat J Postcolonial Stud 2:103–117

Slovic P (1993) Perceived risk, trust and democracy. Risk Anal 13:675–682

Slovic P (2000) Perception of risk. In: Slovic P (ed) The perception of risk. Earthscan, London, pp 220–231

Trettin L, Musham C (2000) Is trust a realistic goal of environmental risk communication? Environ Behav 32:410–426

Walls J, Pidgeon N, Weymann A, Horlick-Jones T (2004) Critical trust: understanding lay perceptions of health and safety risk regulation. Health Risk Soc 6:133–150

Wynne B (1980) Risk, technology and trust: on the social treatment of uncertainty. In: Conrad J (ed) Society, technology and risk. Arnold, London, pp 83–117