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Research paper

Whose reality counts? Factors affecting the perception of volcanic risk

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Abstract

Understanding how people perceive risk has become increasingly important for improving risk communication and reducing risk associated conflicts. This paper builds upon findings, methodologies and lessons learned from other fields to help understand differences between scientists, authorities and the public. Qualitative and quantitative methods were used to analyse underlying attitudes and judgements during an ongoing volcanic crisis on the Caribbean Island of Montserrat. Specific differences between the public, authorities and scientists were found to have been responsible for misunderstandings and misinterpretations of information and roles, resulting in differing perceptions of acceptable risk. Difficulties in the articulation and understanding of uncertainties pertaining to the volcanic risk led to a situation in which the roles of hazard monitoring, risk communication and public protection became confused. In addition, social, economic and political forces were found to have distorted risk messages, leading to a public reliance upon informal information networks. The implications of these findings for volcanic risk management and communication are discussed.

Keywords: Montserrat; volcanic risk communication; volcanic risk management; risk tolerability; unofficial communications

1. Introduction

Understanding how people perceive risk has become increasingly important for improving risk communication and reducing risk associated conflicts. However, risk communication problems associated with volcanic eruptions or indeed any type of natural hazard remains relatively under-researched. This paper uses findings, methodologies and lessons learned from other fields of risk communication to investigate differences between various actors in the processing and communication of risk during the ongoing crisis on Montserrat.

The limited literature pertaining to volcanic risk communication is heavily based on documentary analysis and retrospective accounts by volcanologists (Fisk, 1984; Voight, 1990; Tayag et al., 1996; Cardona, 1997; Aspinall et al., 2002). More recent studies have begun to examine the communication process at various stages of volcanic activity: investigations before and after eruptions, e.g. Johnston et al. (1999) and Greene et al. (1981); during periods of quiescence, e.g. Dominey-Howes and Minos-Minopoulos (2004) and Gregg et al. (2004); and post-eruption e.g. Paton et al. (2000). Use of qualitative data is rare, with exceptions being studies by Cronin et al. (2004a,b) and Loughlin et al. (2002). This paper is the first to investigate the risk communication process during a volcanic crisis from the perspective of all stakeholders involved and utilising both qualitative and quantitative techniques.

Risk communicators hope to warn and educate the lay public to make informed, independent judgments to minimise loss of life and damage to property. Traditionally these approaches assume an objective risk analysis and an ignorant public whose knowledge 'deficit' requires that they are provided with simple information. Frequently such communications are only partially successful. Controversies are often associated with public "over-reaction" to risks that are perceived by experts to be negligible, whilst, on the other hand, the public are sometimes labelled as "irrational" when official warnings fail to motivate

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protective behaviour in the face of highly catastrophic hazards (Horlick-Jones et al., 2003; Kasperson et al., 2003). The failure in these educational warnings is due to a fundamental difference in the way expert practitioners and members of the lay public view and make decisions about risks (Slovic et al., 1980; Slovic, 1987; Pidgeon et al., 1992; Wynne, 1996; Jasanoff, 1998; Morgan et al., 2002). It is now understood that there is not necessarily a direct link between awareness, perceived risk and desired (by risk managers) preparations or behavioural responses (Handmer, 2000; Kirschenbaum 2005; Sims and Baumann 1983). This has significant implications for rethinking how we communicate and control risks.

In identifying differences between expert and lay risk perceptions, it must be considered that expert judgments are based on formal quantitative assessments, for example, estimates of the probability of a hazardous event and the likely number of fatalities. In comparison, it is suggested that the judgments made by the lay public are based upon a balance between the risks they face and the benefits associated with taking or living with those risks. These judgements are heavily influenced by people's beliefs, attitudes and feelings as well as their wider socio-economic values and pressures (Slovic, 1987; Wynne, 1996; Jasanoff, 1998, in Pidgeon et al., 1992; Horlick-Jones et al., 2003).

Much risk communication literature now accepts that a single message or warning will be interpreted in different ways by a heterogeneous population. This paper investigates differences in the processing and communication of risk information between the *scientists*, *government officials* and *members of the public* during a period of volcanic crisis on the Caribbean Island of Montserrat. It explores each group's underlying attitudes and judgements towards the volcanic risks, how they feel the issues should be managed and the ways in which risks should be communicated.

2. Background literature

2.1. Risk communication

The development of risk communication has been extensively reviewed in Pidgeon et al. (1992), Fischhoff (1995), and Bier (2001a,b). These authors detail a process, which has evolved from a traditional one-way or 'top down' process, in which the message moves simply from an expert to a non-expert, to one where there it is a two-way interaction. Critical to this has been the development of methodologies that allow experts and the lay public to engage in the process in an equitable manner, e.g. adaptation of Participatory Rural Appraisal (PRA) approaches for volcanic risk management advocated by Cronin et al. (2004a,b).

During an emergency, time will not allow for an interactive process. Nonetheless it is preferable that even simple advice and the answers associated with emergency warnings be framed appropriately, with a shared understanding of the risks, emergency instructions and public responses to what will now be 'one-way' commands (Handmer, 2000). A poor understanding of the potential reactions of the public is a likely contributor to a natural hazard becoming a catastrophe. Since the first United Nations World Conference on Natural Disaster Reduction in 1994 (WCNDR) there has been a drive towards increased preparation and resilience accompanied by a decreased emphasis on response and recovery (Handmer, 1995; Jeggle, 2005). This was reiterated at the recent WCNDR in January 2005 where a more holistic disaster risk reduction approach was outlined, known as the Hyogo Framework for Action (HFA). Negotiation and 'bottom-up' communications are becoming accepted means of achieving a more effective community response and increased resilience through disaster risk reduction (Quarantelli, 1993; Nilson, 1995; Comfort, 1999; Twigg, 1999–2000; Handmer, 2000; Wisner et al., 2004).

2.2. Risk perception theory

Risk perceptions, acceptance or tolerance of risks[1] are related to knowledge and experience, which in turn are influenced by socio-economic factors, worldviews and affective judgments (Pidgeon et al., 1992; Slovic, 2000b). The credibility and trustworthiness of the risk management team and the process of risk communication that is utilized will also affect people's perceptions and choices (Cvetkovich and Löfstedt, 1999; Haynes et al., in press).

The social amplification of risk refers to the ways in which social and individual factors, including communications, act to amplify or attenuate perceptions of risk (Kasperson et al., 2003; Pidgeon et al., 2003). This framework recognises the extensive intertwining of risks and risk events with psychological, social, institutional and cultural processes. It suggests that risk communicators can do little but set their messages adrift on a "sea of amplification and attenuation" (Breakwell, 2000 p118). However, the framework also provides a tool to guide how the message will be modified and added to by society.

One of the main expectations of science from the general public is the reduction or elimination of uncertainty (Kinzig and Starrett, 2003). People, scientists included, respond to uncertainty using a range of 'heuristics' (Tversky and Kahneman, 1973, 1974; Slovic, 2000a). Examples include: a complacency to only expect the experienced, making people insensitive to changing risks (availability bias/normalisation bias (Mileti and O'Brien, 1993); a reduction in perceived risk through a belief in technological solutions, the presence of experts or religious faith (levee bias/risk transference); and orienting emotions that allow people to navigate efficiently through complex and uncertain decisions, by drawing on positive and negative feelings associated with particular risks and benefits, i.e. the greater the perceived benefit of the choice under consideration, the lower the perceived risk (affect heuristic (Alhakami and Slovic, 1994; Finucane et al., 2000)).

3. Case study location, social and political context

The empirical data for this research were collected on the Caribbean island of Montserrat which has been experiencing a

[1] The use of tolerability rather than acceptability denotes the trade-off that the public make as they do not accept risks but tolerate them to secure certain benefits (Pidgeon et al., 1992).

Table 1
Demographics of the public interview respondents

Characteristic		%	Characteristic		%
Gender	Male	60	Birth location	Montserrat	63
	Female	40		Other Caribbean (Trinidad)	6
				Outside the Caribbean (USA, Europe and Asia)	31
Age	<18	3	Length of time living	Always	56
	21–35	14	on Montserrat	>15	25
	36–50	25		10–15	6
	51–65	39		5–9	6
	66 or more	19		2–4	0
				<2	8
Highest qualifications obtained	No formal qualifications/ skills learned at work	31	Distance currently living from the volcano	4–5 km (Salem/Old Town/Belham area)	33
	School exams taken at 16	17		7 km (Woodlands/St Peters area)	28
	School exams taken at 18	17		>9 km (Cudjoe Head and all areas further north)	39
	Tertiary	28			
	Unknown	8			
Employment	Full time	31	Evacuation history	Most recently 2002	40
	Part time	19		Previously 1996–2000	49
	Unemployed	11		Never	11
	Retired	25			
	Homemaker	11			
	Student	3			

volcanic crisis since July 1995. Communication problems between the scientists, authorities and the public have been compounded by the complex socio-political factors on this small British Overseas Territory (Clay et al., 1999; Possekel, 1999; Pattullo, 2000; Skelton, 2000; Aspinall et al., 2002; Haynes, 2006). The timing of the first phase of this fieldwork coincided with a period of volcanic uncertainty and evacuations (October 2002–July 2003). For more detail on the volcanic situation at the time of this fieldwork see Haynes et al. (in press); for more general volcanological background, the reader is referred to Druitt and Kokelaar (2002) and Herd et al. (2005).

Montserrat is one of six UK overseas territories in the Caribbean. Formerly a crown colony, it became effectively self-governing in 1961 with the formation of a locally elected ministerial government (Fergus, 2001). Governance is tri-partite, comprising the democratically elected local government, the British Governor (representative of the Queen) and the British Government in Whitehall, London.

4. Methodology[2]

The first phase of fieldwork (January to April, 2003) was an attempt to capture and understand the perceptions of risk held by the public, authorities, and scientists. The methods chosen were semi-structured interviews and the ethnographic process of participant observation. The second phase of fieldwork (February to April, 2004) involved a quantitative survey to further explore the issues identified within the public with a wider sample and statistical testing. In-depth interviews and participant observations also continued over the second phase of fieldwork. Social science research is often criticised for not employing rigorous methodologies. It is therefore important to clearly describe the methods used in the course of this research.

4.1. Groupings of the participants

Despite referring to 'the lay public', 'authorities' or 'experts' throughout, the authors do not view these groups as generalised or homogeneous. Recognition of the diversity of views, perceptions and attitudes is central to this work and is implicit throughout. These groups are collectively referred to in some instances as the 'elites'; in others they are dealt with separately. 'Elites' were purposefully pre-selected and sampled but the public were interviewed in a snowball fashion while paying close attention to include a demographically and geographically representative grouping that spanned the full range of experience in terms of time spent on the island and re-location as a consequence of volcanic activity (Table 1).

4.2. Semi-structured interviews

Thirty-five members of the public (Table 1) and 31 scientists and authorities (elites) were interviewed to provide a spectrum of views (see Pidgeon and Henwood, 2004). Although there were initial plans to interview Montserratians who had previously been evacuated from the island, the escalating volcanic activity at the time of field work focused the research on the current crisis and evacuations. Those who had most recently evacuated their homes (2002/2003) had not left the island in significant numbers, as had occurred in 1997, and were living on the island in temporary accommodation, in shelters or with friends and family.

The 'elites' included: scientific staff either working at the Montserrat Volcano Observatory (MVO) or associated with it through research or consultancy positions on the biannual risk assessment panel ($n=13$; 9 interviewed on-island); Government officials – British Foreign Office staff ($n=3$) associated with

[2] A copy of the actual questionnaire survey employed or the question topics discussed in the semi-structured interviews are available from the first author.

Table 2
Demographics of the questionnaire survey respondents

Characteristic		%	Characteristic		%
Gender	Male	45.7	Birth location	Montserrat	55.6
	Female	54.3		Other Caribbean	16.4
				Outside the Caribbean	28.0
Age	16–19	3.6	Length of time living on Montserrat	Always	43.4
	20–29	13.9		>15	28.3
	30–39	20.6		10–15	7.5
	40–49	23.0		5–9	9.8
	50–59	20.0		2–4	8.1
Highest qualifications obtained	No formal qualifications/skills learned at work School exams taken at	34.1	Distance living from the volcano	4–5 km (Salem/Old Town/Belham area)	31.0
	16	21.2		7 km (Woodlands/St Peters area)	20.8
	School exams taken at 18	14.7		>9 km (Cudjoe Head and all areas further north)	48.2
	Degree/diploma	20.6			
	Masters/PhD	9.4	Evacuation history	Most recently 2002	11.6
				Previously 1996–2000	57.0
				Never	31.4

governance and elected (or previously elected) Montserratian Government officials ($n=9$); civil authorities dealing with the management of the crisis – emergency operations, police and a religious leader ($n=4$); and personnel from the Department for International Development ($n=2$). In addition, 3 key members of the island's media were interviewed.

Questions covered the broad topics of the 'process of communication'; 'estimates of risk and danger'; 'factors affecting information filtering' and 'behaviour and attitude' as well as information relating to the respondents' roles and responsibilities. The key questions were partially framed following discussions with scientists in the U.K. who had experience on Montserrat but were reviewed reflexively after pilot interviews.

All interviews were recorded and transcribed soon after. A thematic analysis was chosen to analyse the data; placing emphasis on the meaning rather than the quantification of the materials (Sayer, 1992).

4.3. Elite observations

Observations were made of the complex interactions between the scientists and authorities during meeting situations. Notes were taken of how and what the scientists communicated to the authorities, how the authorities reacted to this information, the questions asked by the authorities and how all those involved related to each other. These observations were used during analysis as a means of triangulation with the semi-structured interviews, to provide appropriate weight to replies that might have been inconsistent or guarded in their nature and to provide additional context for the questionnaire data.

4.4. Questionnaire survey

Members of the public were asked to specify their level of agreement to a list of statements concerning risk communication, management of the crisis, and their behaviour. Apart from the knowledge and behaviour sections, all questions were measured on a five-point Likert scale. This allows an average score to be calculated[3] as well as other standard statistical parameters such as standard deviation. A further 36 questions were used to explore volcanological knowledge and the respondents' degree of confidence in their knowledge. The statements were scored on a five-point scale. Thus, if the answer to a statement was *true* then the statement would be scored as follows: 'true'=2; 'maybe true'=1; 'don't know'=0; 'maybe false'=−1 and; 'false'=−2. The questionnaire was pre-tested fully. 215 questionnaires were distributed and 173 were returned, giving a high response rate of 80%.

All potential respondents were approached and asked to participate verbally to increase the response rate and ensure that the questionnaire was fully understood prior to completion. In order to gather a wide range of participants, representative of the diverse population on Montserrat, different areas of residence, work and recreation were consistently targeted. The sample obtained is shown in Table 2.

5. Results

The following section details the qualitative results and observations gained from the scientists and authorities and an integration of the qualitative and quantitative results from the public. We first examine contextual factors, such as cultural and political background, liability issues and the communication process. Next, more specific issues such as trust, knowledge and levels of acceptable or tolerable risk are explored.

5.1. Scientists and authorities

Several key features of the interviews with the elites elucidated findings within the public domain but also highlighted attitudinal differences among the elites themselves.

[3] The weighted mean is calculated by multiplying each value (1-5) by its weight factor then dividing the sum of the products by the sum of the weights. Unless otherwise stated, where percentages are presented they refer to a combined score, e.g. grouping of categories 1 and 2 or 4 and 5.

5.1.1. Political context

It was felt by many of the scientists and British authorities that the colonial history of Montserrat, its dependent territory status and patronage Government, was the source of complex racial and political issues that greatly affected the risk communication and management of the crisis. Although these issues had always been present, it was felt that the volcano had accentuated the situation. Many felt it inevitable that the local politicians would publicly disentangle themselves from any culpability over the unpopular decisions made over the crisis, whether they agreed with them or not. The accrual of management knowledge through experience, or "corporate knowledge", was thought to have been impoverished by the high turnover of instrumental figures. The scientists felt that the time taken to educate the new ministers and civil servants and bring them up to speed on the volcano was greatly underestimated by the decision-making officials. Importantly, liability had become an increasingly influential aspect governing information provided by the scientists to the authorities and the public following the deaths on the 25th of June, 1997 and the 2002 evacuations (see Aspinall and Sparks, 2004).

5.1.2. Perceived roles of the scientists

Many of the scientists who had been involved early-on in the crisis, stated that initially they had tried to follow the more standard procedure of communicating largely to the authorities. However, they developed more of an outreach orientated role as they adapted to the situation and gained experience. Public meetings and radio phone-ins were considered by the scientists to be the best method for communicating to the public as the information could be adapted to meet individual needs. However, these interactive processes had declined and were very infrequent by the time this study was undertaken. The scientists felt that their role was misunderstood by many of the authorities and public who, seeing them as the most trusted group, sought their direct guidance.

5.1.3. Communication and risk perception issues

The scientists were generally viewed by the authorities 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' inability to reduce uncertainty. Distrust between the scientists, the Governor and Montserratian authorities was based on differing values, e.g. judgements of risk tolerability and integrity. The Governor was under pressure from local government ministers to ease restrictions (allowing the island to function more normally) whilst the U.K. Government demanded a strict adherence to safety protocol. The unique powers and difficult position of the Governor led many scientists and civil authorities to question his management decisions when they occasionally departed from the scientific advice given. In turn, the local ministers questioned decisions that they felt were too safety conscious and were detrimental to the functioning of the Island.

The scientists considered that the level of volcanic knowledge among the authorities was generally low. This was corroborated in meeting observations as many of the same issues were repeatedly discussed and misunderstood. However, when interviewed, the ministers felt their own level of knowledge was adequate and had no complaints about the communication from the scientists. It was generally felt by the authorities that the population of Montserrat was well-informed in terms of volcanic terminology. They were confident that the population not only recognised technical terms but understood their meaning. Only a few of those interviewed (particularly some of the scientists), thought that certain sectors of the public were assumed by the authorities to have more knowledge than they actually had.

The scientists and authorities considered that direct experience was a major factor; they believed that people needed to witness events for themselves before they would fully appreciate the consequences of what the scientists had told them. However, a negative aspect of experience was also noted by many who felt that it gave people (including some members of the authorities) a false sense of security. The scientists also felt that some members of the public and authorities considered themselves confident lay scientists, feeling that their own interpretations of the physical signs were reliable.

Quantitative Risk Assessment (RA) evolved as a process for attaining scientific consensus and improving the communication of risk to the authorities. The method utilises the expert elicitation process (weighted combinations of anonymous expert judgments) with decision-conferencing and numerical modelling to produce consensus probability distributions which were used as inputs into the various 'event trees' of plausible eruptive scenarios (Aspinall et al., 2002). The process is carried out by external senior scientists independent of Montserrat Volcano Observatory (MVO) staff, but who had previously been involved at the MVO in a research or monitoring capacity.

The RA method provided estimates of the numbers exposed and potentially killed as a result of a particular hazard within a limited location and timeframe. The UK Chief Medical Officers' Risk Scale was then used to convey a broader qualitative description of that risk for communication to the authorities and policy-makers. The RA method was considered by many of the scientists a successful advance for volcanic emergency management; however, many of the island's authorities considered that the use of the British Chief Medical Officer's (CMO) risk scale and, in particular, the British authorities' judgments of an acceptable level of societal risk, did not fully consider the subjective nature of assessing risks. They felt that a certain level of risk had to be tolerated. The more risk-averse believed that others were more likely to take risks because of the political and economic pressures they were under.

The scientists felt that the authorities and public had an inflated belief in the predictive powers of the MVO to provide accurate and timely warnings and to eliminate uncertainty. They were often dismayed when activity did not materialise after an evacuation. Using probabilities was considered to complicate communications as the likelihoods and associated uncertainties were neither well-explained nor understood. On some occasions (e.g., defining the exclusion zone boundary in 2002), the

authorities were thought to have interpreted the scientific advice with too much precision; the more likely scenario had not been adequately appreciated by the public because of the emphasis on less likely risks of greater consequence. In turn, the authorities felt that the uncertainties and implications had not been well deliberated or explained by the scientists who were trying to distance themselves from an emergency management role and any associated liability. Thus, some of the scientists and authorities felt that there should be a more qualitative or 'blurred' element to the communication and management of the risks to more adequately represent the inherent uncertainties.

5.2. The public

5.2.1. Communication issues

From the semi-structured interviews it became clear that the perception of volcanic risk was influenced in the public domain by its method of dissemination: the degree and opportunity for public feedback; competition from unofficial sources ranging from word of mouth to visible changes in volcanic behaviour itself and; the perceived roles of the elites and consequently their role in the communication process. Methods of information dissemination and unofficial information are explored in more detail in Haynes et al. (in press).

5.2.2. Feedback and deliberation

Respondents felt that the communication process had become less interactive in the past two years with a decrease in the detail of information as the most recent crisis and 2002 evacuations developed. The qualitative interview data highlighted a division amongst the public relating to the adequacy and need for increased consultation of the public by the scientists and authorities. The split appears to correlate with cultural divisions on the island, with some groups more happy with the level of interaction and information detail; they perceived the scientists to be doing as much as they could. In contrast, others (predominantly those born in the USA, Europe and some highly educated, more affluent Montserratians) felt they should be more involved with the risk management, preferring to make their own decisions on what actions to take. For this critical group, it was implied that the authorities (in this case those charged with making risk-related decisions) were not accurately judging risk.

In agreement with this dichotomy of viewpoint, the quantitative results identified that 51% of the respondents either agreed or strongly agreed that the public should have more power in terms of the volcanic management decisions and 58% stated that '*if more notice was taken of the public the decisions made would be fairer*' (mean 3.55; s.d. 1.32). Exactly half of the respondents agreed that '*individuals should have the freedom to make their own risk decisions*' (mean 3.08; s.d.1.65). However, just over half of the respondents admitted that they were pleased that the decisions were made for them (mean, 3.40; s.d. 1.54). For a significant proportion of those questioned, a lack of transparency in risk-related decisions led to the conclusion that improvements could be made in the decision-making process.

5.2.3. Unofficial information and competing sources

Conflicting messages over the locations of safe and dangerous areas and contrasts between scientific information and what could actually be seen, were common. 48% of respondents agreed or strongly agreed with the statement '*the information I have received from the MVO is different to what I have seen with my own eyes',* leading 41% to state that '*I have less confidence therefore in the information I have received*', (mean score, 3.07; s.d.1.45; and mean, 2.84; s.d. 1.50 respectively). '*Decisions made are not justified by the volcanic activity*' was agreed or strongly agreed with by 60% of respondents (mean, 3.50 s.d. 1.44). '*The scientists exaggerate the chance of volcanic activity'* was the most agreed with statement, with 65% answering positively, (mean, 3.69; s.d. 1.47). The final statement, '*it is sometimes difficult to know who to believe'* was agreed with by 49% of respondents (mean, 3.13; s.d. 1.52).

The effect of the competing messages was to breed rumour of conspiracy among some respondents. There was also an element of denial and blame at play, with respondents not wanting to believe that they may lose their property to the volcano. Instead, belief in the unofficial information made it easier to perceive that the authorities, especially the British Government, were responsible for various underhand plots.

From the interviews it became clear that the majority of the public felt the scientists should concentrate on the science and not take the economic and social aspects into consideration. Despite this, many (including the authorities) still thought the role of the scientists should be much more proactive; more of an emergency service than simply a scientific advisory centre. They seemed confused as to the distinction between the scientists' role and that of the administrative authorities. Examples of this confusion are noted below:

> 'They have the audacity to turn round and say we don't have anything to do with the policy-making. But if there was high activity tomorrow, they would close it, not the government. They control the destiny of this island.' Susan, UK resident living on Montserrat with reference to the Daytime Entry Zone.

> 'The way I see it [Scientist X] is right on top. I mean it all boils down to… no matter what [Scientist X] he is the decision-maker.....he is just like the Governor' Derek, Montserratian.

Questionnaire results also revealed that 87% (mean, 4.46, s.d. 1.05) of respondents felt that the scientists have a responsibility to advise the public on all issues concerning the volcano. The Volcano Executive Group (VEG) was considered by 61% of people to be the appropriate group for volcano policy-making. Notably, 67% of respondents felt that they should always follow the scientists' advice compared to a lower 54% who felt they should always follow the advice of the VEG.

Fifty-three percent of the sample stated that they were unclear as to the responsibilities of the scientists and authorities in managing the crisis. Respondents were asked to pick (from three) the option which best described what the scientists role should be: 63% considered that their role was to '*give advice to*

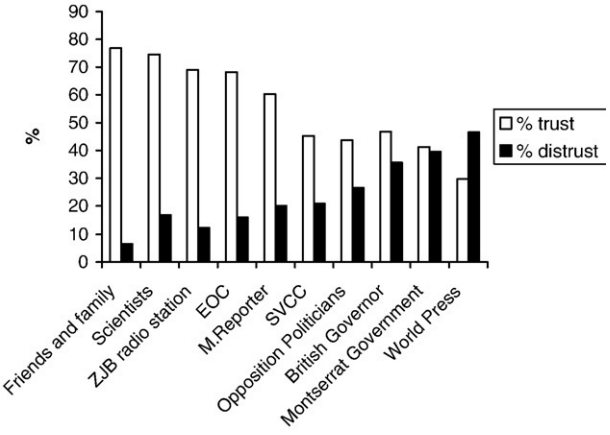
the authorities for the long term management of the island'. 28% felt their role '*was to give real time warning to people who were in a dangerous area*' and 9% considered that the scientists should fulfil both of these roles. This confusion and lack of clarity somewhat mirrored the confused perception; echoing the gulf between the 'ideal' and 'perceived' practice among the elites.

5.2.4. Risk perception issues

Both qualitative and quantitative results identified *friends and family* (mean 4.24, s.d. 1.05) as the most trusted source for information about the volcano, followed closely by *scientists* (mean 3.94, s.d.1.24). The government sources (British and Montserratian) were trusted by less than half the respondents, with the Montserrat Government faring the worst. The World Press were rated worst (see Graph 1).

Trust in scientists was based on their assumed competence and attributes such as hard-working and well-trained. Other dimensions considered important for trust, or cited as reasons for distrust included: integrity e.g., independent and impartial; value similarity e.g., cultural, social and institutional influences on judgments and balances concerning the tolerability of risk, and; openness e.g., a tendency to mix well, be relaxed and free with information and 'part of the community'.

The quantitative survey further explored trust in the three main sources of information (scientists, Montserratian authorities and British authorities). Issues identified within the qualitative phase and also those identified in previous studies (see Poortinga and Pidgeon, 2003) were tested. A repeated measures ANOVA (Analysis of Variance) and post hoc Bonferroni pair-wise comparison revealed that the scientists were considered more competent (mean 4.27, s.d. 1.039), more caring (mean 4.05, s.d. 1.168), more reliable in giving information (mean 3.85, s.d. 1.244), fairer in their advice and decisions (mean 3.39 s.d. 1.440) and more open (mean 3.36, s.d. 1.386) than either the British and Montserratian government authorities. A detailed description of these issues can be found in Haynes et al. (in press).



Graph 1. Trust against distrust — % of respondents who trusted and distrusted each source. Trust was measured on a 5-point Likert scale as detailed above. The percentage scores have been combined to form two categories of trust and distrust. EQC = Emergency operations centre; SCVV = Salem Volcanic Crisis Committee.

The quantitative survey measured knowledge with 36 statements selected to evaluate respondents' knowledge of the Montserrat volcano, hazards and scientific monitoring. These were divided into three sections: Primary — basic information about the volcanic hazards most directly relevant to the public; Secondary — more complex information about the volcanic hazards, but still relevant to the public, and; Expert — physical interpretation of what the volcanic phenomena monitored represent. Overall, volcanic knowledge was high, with over 70% of respondents answering the primary questions correctly and over 50% answering the secondary questions correctly (e.g. 94% of respondents knew that pyroclastic flows and surges were hotter than boiling water and could not be outrun. An overwhelming 61% knew that volcano-tectonic earthquakes are associated with rock fracturing at depth). However, a noteworthy statement, for which less than 50% of the respondents scored correctly, was '*Dangerous activity only occurs if the volcanic dome is growing*'. This statement is false and was considered to be primary knowledge. Education was only an influencing factor for the 'expert' group of questions where those with no formal education had significantly lower scores than those with high school and tertiary qualifications.

However, volcanic knowledge or understanding did not explain the attitudes of the respondents toward the official advice and management of the crisis. Those more knowledgeable did not uniformly agree with the scientists and authorities and likewise those who did not understand the volcanic phenomena did not uniformly disagree. A clear division was seen within those who were not happy with the management decisions. A minority of this group felt there was no more the scientists could tell them; while the majority wanted more detailed information in order to openly debate why their theories were different. This latter group was confident in its ability to interpret the real-time state of the volcano, so much so that some felt they no longer needed any interpretive information and evacuation warnings from the scientists. In comparison, those who were happy with the decisions made by the authorities felt that they were receiving the appropriate level of information from the scientists.

Almost all respondents felt that after living with the volcano for eight years they could interpret the activity to estimate the level of risk with a varying degree of confidence. Belief that future activity (areas affected and magnitude) would be the same as that already experienced and survived, greatly influenced some respondents' interpretive confidence.

Scientists' efforts to inform people of where flows were going did not involve the use of visual images. Therefore, people's direct visual experiences of activity in comparison to the scientists', who were continually monitoring and making detailed observations of the activity, were very much reduced and bounded. Because of the presence of the Centre Hills obstructing the volcano, residents in the north of the island could not see evidence of activity and rarely received ash fall. Therefore, they perceived a much lower activity than was actually occurring.

Many people felt the level of risk considered tolerable between the authorities and themselves to be very different. Respondents felt that there was a difference in the amount of volcanic activity experienced; the scientists, the current

Governor and the Chief Minister were not seeing the current level of activity in relation to a more active past. Many respondents also felt that there was an ultimate conflict in goals that influenced differences in risk tolerability; the scientists and authorities had a lower level of risk tolerability, because of their responsibility and sense of duty to the islanders. In comparison, because of their very different economic and social goals, some respondents felt that the benefits of ignoring expert advice were worth the risks.

A number of the respondents interpreted the lower tolerability of risk of the authorities to be a positive change, feeling that people *should* be kept out of the exclusion zone. The reasons given for people entering the exclusion zone in 1997 and the perceptions of the cause of the deaths of 19 people within this zone were mainly related to the issue of tolerating some risk for various benefits. People believed it happened as a result of economic hardship and the appalling living conditions in the shelters.

The quantitative survey further examined people's differing tolerability of volcanic risks by asking them to evaluate nine activities within the exclusion zone (identified as occurring during phase one of the fieldwork) and associated with increasing exposure to risk. "*Imagine that an area has been evacuated and is said to be dangerous. It has a limited 3 hour daytime entry. How acceptable do you rate the activities below, thinking about the danger you think is involved and the likely benefits that people get?"* The results are displayed in Table 3 in the order of most tolerable to most intolerable. Respondents ranked the statements in terms of the risk they felt they would be facing against the benefits they would receive. In comparison, although statement 3 carries little risk, it also carries little benefit and therefore is rated below two other statements which carry more risk. It is therefore clear that respondents evaluated the activities in terms of the benefits involved and their exposure to risk and not simply the risks involved.

Those who had already lost their properties and livelihoods within the exclusion zone had no choice but to look for a future in the north of the island. It was much harder for those whose properties were as yet untouched. Many of these respondents did not interpret the uncertainty of volcanic forecasting with the same precautionary attitude as the scientists and authorities. Previous evacuations, where no volcanic activity had materialised, were interpreted as false alarms or 'manipulations', creating a reduction in trust and making re-evacuation more difficult. A majority of the respondents had interpreted the danger behind the most recent evacuations (2002) as immediate. They felt that they had been given this impression by the scientists and the authorities. Some professed that because no activity had materialised after four months, the evacuations were not justified and people should be able to return to their homes.

The quantitative exploration of people's interpretation of the management of uncertainty further reinforces the qualitative findings: 46% of respondents considered that '*sometimes people are evacuated when there is no chance of an area being affected*' (mean, 3.04; s.d. 1.60); 34% considered that the scientists '*have made a mistake when no volcanic activity occurs after an evacuation* (mean 2.82; s.d. 1.46); 32% felt that '*when an area is evacuated and no volcanic activity occurs after a few weeks, people should be able to return*' (mean 2.60; s.d.1.47). 29% felt that '*the scientists think they can predict the activity more accurately than they can*' (mean 2.62; s.d.1.43). However, a majority of 57% felt that '*the scientists have shown in the long-term that their advice has been justified*' (mean 2.53; s.d. 1.41).

For some respondents, small probabilities of risk, when balanced against other economic and personal issues, are tolerable. For a minority, their belief in the competing information, distrust in the official viewpoint and their experience of living with the volcano, created a reality for them of no uncertainty and no risk. They simply denied that there was even a small chance of the volcano affecting their home. Many respondents were confused about the different terms, percentages and numbers that were being discussed. Terms such as 'High', 1 in 100 (actually described by the scientists as >1 in 100) or between 1 and 30% were queried.

Many respondents, when asked about the uncertainty involved in volcanic prediction, did not relate it to the current level of

Table 3
An exploration of tolerable risk

Statement	Very intolerable (1)	Fairly intolerable (2)	Neither tolerable nor intolerable (3)	Fairly tolerable (4)	Very tolerable (5)	Mean	Std. Dev.
1 Going into the zone to save a life	11%	7%	8%	27%	47%	3.92	1.34
2 Going into the zone once to pick up property	14%	8%	8%	40%	31%	3.68	1.35
3 Standing on the edge of the exclusion zone and looking in	14%	7%	12%	32%	35%	3.66	1.38
4 Going into the exclusion zone every day for 3 h to look after your house	23%	20%	12%	21%	23%	3.03	1.51
5 Taking a walk into the zone	36%	17%	11%	22%	15%	2.65	1.52
6 Going into the exclusion zone every day to look after livestock and crops	39%	19%	11%	15%	16%	2.51	1.52
7 Going into the exclusion zone all day every day to live in your house (more than 3 h)	67%	9%	8%	7%	10%	1.84	1.38
8 Staying overnight from time to time in your house in the exclusion zone	70%	8%	6%	6%	11%	1.79	1.38
9 Staying in your house full time	74%	5%	6%	4%	11%	1.71	1.35

The mean is calculated by multiplying each value (1–5) by its weight factor then dividing the sum of the products by the sum of the weights. The statements were answered by all 173 respondents.

scientific understanding or the ability of the scientists to monitor the volcano, but to the fact that the island was at the mercy of God. This rationale was used during the first years of the eruption as a reason for ignoring the scientific and management advice. However, during the recent evacuations religious convictions were cited as the reason many were happy to follow the authorities and scientists' advice — they felt they were interpreting God's work. The minister interviewed stated that this had been something the church had been trying very hard to reinforce.

5.3. Public behaviours and attitudes

5.3.1. Scientists' and authorities' perceptions

The minority of members of the public that re-entered the exclusion zone were believed to hold two broad perceptions of risk: 1) those who accepted there were risks but considered them tolerable, and 2) those considered to be in denial who, due to misconceptions and distrust, perceived the risks to be lower than officially described or non-existent. This second group was characterised by some of the scientists and authorities as being 'irrational' in respect to the risk. Very broad cultural differences in attitude and behaviour were expressed; the Montserratians were considered by the scientists and authorities to be more accepting and more likely to do what they were told, whereas the expatriate or wealthier Montserratian community were more vociferous and opinionated and less likely to do as they were told unless legally challenged.

5.3.2. Public behaviours and attitudes

Respondents' behaviour and attitude towards the evacuation advice (which was a legal requirement) was measured by asking respondents to tick one statement from three, choosing the one which most closely reflected their opinion about their evacuation behaviour.

- *'I usually follow the advice of the scientists and the laws enforced by the authorities as it is the right thing to do'*
- *'I usually follow the advice of the scientists and the laws enforced by the authorities as it's the law, otherwise I wouldn't'*
- *'I do not always follow the advice and regulations but generally do what I think is the best thing to do'*.

The results identified that 60% followed the advice to evacuate because it was the '*right thing to do*', 25% admitted that their motivation was due to legal reasons and not because they agreed with the advice and finally 15% maintained they did not follow any advice but just did what they thought was best. Following advice because it is the '*right thing to do'* is clearly the most desirable response from the risk communication point of view; however, 25% of respondents also took appropriate action, if only for legal reasons. Thus, from a risk management perspective, 85% of respondents adopted the desired response.

The qualitative results allow us to both verify and explore these statistical findings further. In particular, the complexities of people's beliefs about their actions and attitudes are likely to be represented in the in-depth interviews. The interviews were also carried out at a time when people had been evacuated. Discussions therefore related to an existing situation which, in some cases, was observed by the lead author.

The majority of those previously evacuated, and a minority of those evacuated in the recent 2002/3 evacuations, had similar perceptions of the risk to the scientists and were in agreement with the decisions taken by the authorities. For some, this was because they did not think they had the knowledge or right to question experts or those in positions of authority. These respondents were not affected by the competing messages and had a low tolerability to take risks. The majority saw little benefit from entering the exclusion zone and followed the advice to evacuate because it was the 'right thing to do'.

A majority of those who perceived little risk to the area evacuated in the 2002/3 area had homes, businesses or vested interests within the zone. They were willing to tolerate these risks or, alternatively, denied that any risk existed. Many were highly distrustful of the scientists and those in authority; they were influenced by the sceptical competing messages which reinforced their opinions of low risk. Their motivation for evacuating and following the entry restrictions were purely legal; they did not want to be deported, arrested or fined. Many within this group were unhappy about their lack of involvement and control and tried to take back power through community meetings and legal proceedings. The majority of this group were expatriates and wealthier inhabitants.

A small minority of respondents admitted to returning to the exclusion zone outside the authorised hours to visit their property, look for livestock and sometimes to stay the night. This predominantly underprivileged Montserratian group perceived little risk, or, considered that the risks were outweighed by the benefits of returning. They did not demand the right to take their own risks, but quietly went about their business anyway.

6. Discussion and risk communication implications

Fig. 1 provides a schematic overview of the risk communication process identified to be occurring on Montserrat. This can be thought of as a specific manifestation of the Social Amplification of Risk Framework discussed earlier. The scientific communications appeared to be almost as complex to the authorities as they were to the public. A number of contextual factors (political context, roles, liability) and attributes of both the scientists and authorities (trust, risk tolerability) affected the production and movement of the message to the public. Feedback from the public also appeared to modify the first stage of the communication process; however, at the time of this study, this process was not leading to message improvement. Instead, the negative feedback from a vociferous minority, liability issues and the politicisation of the crisis management had led to a reduction in the interactive aspects of the communication.

While the scientists believed that the majority of the local authorities were unable to comprehend the scientific information, or were simply disinterested, the authorities considered themselves to have sufficient understanding of the scientists' key

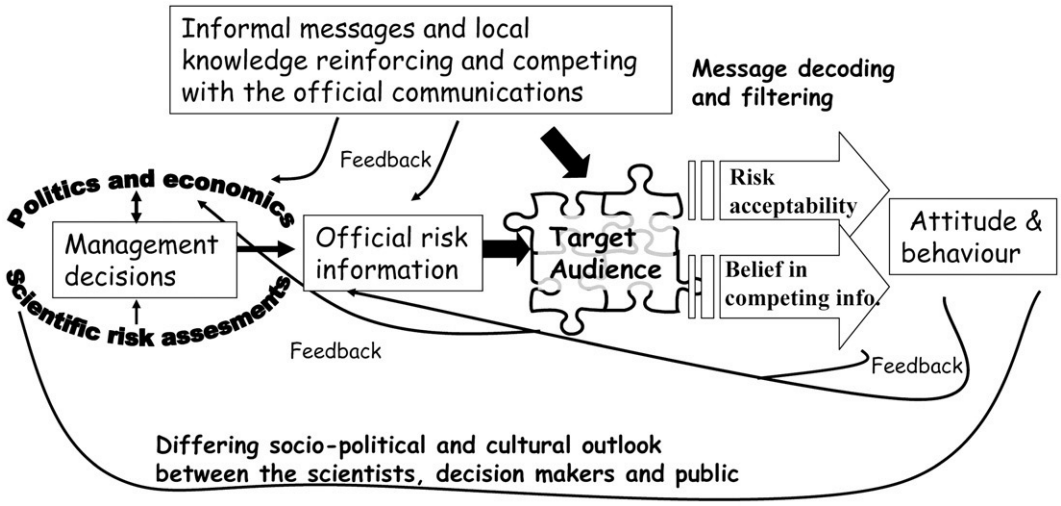


Fig. 1. A schematic overview of the risk communication process on Montserrat.

messages to allow them to make decisions. Neither side fully recognised the need to improve the communication situation.

Empirical evidence suggests that preferred channels or styles of communication will vary within a community or population (Sorensen and Mileti, 1991). This was true of Montserrat as some interested individuals relied heavily upon daily radio reports, while others preferred the more interactive approaches of radio phone-ins and formal and informal meetings. A small minority chose not to listen to the official communications, placing a greater trust in unofficial sources.

The importance of feedback and public consultation, to improve the communication process, was recognised among many of the elites and lay interviewees. However, it appeared that little had been done or was likely to be done to enhance the capacity for gathering and acting upon public feedback. Some public and elites perceived the communication process to have become much less interactive and detailed over time. In some ways, the scientists believed that their educational role was complete, having engaged the public in meetings, school visits and seminars from the early stages of activity. Many now considered the public's knowledge to be sufficient to allow them to comprehend the scientific information. However, this withdrawal from proactive engagement led to a reduction in interaction with and feedback from the public. 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 of this study.

The scientists realised the importance of their role in communicating to the public, although there was some variation in opinion concerning the extent to which this role should be accepted. However, the authorities and public very much considered the communication of the volcanic risk as part of the scientists' responsibility, with the public most trusting of the scientists as a source of official information. Although most scientists were adamant that their role was only to offer scientific advice and preferred not to become embroiled in emergency management issues, it was very clear that the scientists experienced pressure from the authorities to go beyond their basic role.

The identification of variations in the communication needs of certain groups on the island highlights important cultural differences in attitudes towards the management of risk. The small group making complaints about the level of interaction were, in fact, not among those most likely to be at risk. Instead, those with most to lose quietly entered the exclusion zone illegally. Thus, different attitudes towards feedback and interaction were observed among identifiable groups, the outcomes of which could not have been easily predicted based upon the signs and signals received by the scientists and authorities.

Two key elements emerged in influencing attitudes and behaviour:

Tolerability of risk; this was frequently displayed through competing views on the benefits associated with taking risks: those who considered they had most to gain from entering the exclusion zone were more likely to perceive the risks as tolerable.

Competing information; a belief in competing information was likely to exacerbate differences of opinion relative to the scientific consideration of risks. Some individuals considered the 'official' view of the risks of entering the exclusion zone as being exaggerated.

We now consider the above issues and their implications for risk communication and management.

The situation on Montserrat is unique due to the length of the crisis (which has now gone beyond its 11th year) and its wide-ranging impact on every facet of the Montserratian society. Thus, a large proportion of the population has been exposed to risk communications and possess a high level of volcanic awareness. However, the level of knowledge or volcanic understanding was not identified as a primary factor in determining the attitudes and behaviour of the respondents to the official advice and

management of the crisis. More knowledgeable respondents did not uniformly agree with scientists and authorities and, likewise, those who did not understand the volcanic phenomena did not uniformly disagree. These findings are supported by other studies which suggest no direct link between knowledge, awareness and preparedness and that, in some situations, a proportion of those who are more informed may even feel less concerned about the hazard (Johnston et al., 1999; Paton, Smith and Johnston, 2000; Gregg et al., 2004). Some respondents' views of the dangers posed by the volcano were diluted by misconceptions about the terms used and dubious arguments about the level of risk. These opposing views on the level of risk were linked to belief in the competing information, trust and risk tolerability.

Many of the local authorities, public respondents and a number of the scientists considered that the British authorities were too risk averse, stating that a certain level of risk had to be tolerated. Empirical evidence suggests that communities are more willing to take risks than is often recognised (Pilgrim, 1999). The International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) subcommittee for crisis protocols (Newhall et al., 1999) notes that it is unrealistic and unnecessary to seek a condition of zero risk, suggesting that "local leaders should engage citizens in a dialogue about the level of risk that citizens are willing to accept before major precautionary steps such as evacuations must be taken" (p330). However, responsibility and the threat of litigation appear to have been significant pressures upon the authorities in defining their acceptable level of risk. No real public consultation has ever occurred on Montserrat to involve the public in this decision making process.

The local government placed considerable pressure upon the Governor to relax the exclusion rules in order to ease some of the economic and social pressures upon the population in the north of the island. Many members of the authorities believed that the siren and monitoring abilities of the MVO reduced the risks sufficiently that the strict boundary and hours of entry into the zone could be relaxed. This transference of responsibility to others and a belief in the reduction of risk from technological solutions or the presence of experts is a very common heuristic when making judgements about risk (Slovic et al., 2000). However, in accordance with Hood (2002), who notes the political agendas which often underlie the acceptability of risks, many scientists and British authorities questioned the extent to which a greater acceptability of the risks was being used for political gain by individuals who did not fully realise the risks.

Some public respondents did not take the same precautionary attitude towards uncertainty as the scientists, authorities and other respondents, feeling that the small probabilities should be balanced against economic or other personally more salient considerations. Survey respondents rated their activities in terms of both the risks involved and the perceived benefits; with greater benefits likely to encourage the tolerability of greater risks (a robust finding identified in many previous risk perception studies, Fischhoff, et al. 1978; Vaughan, 1995; and often termed the 'affect heuristic' Alhakami and Slovic, 1994; Finucane et al., 2000) highlighting the range of issues for which individuals are prone to tolerate risks. Thus, going into the zone once to pick up property was a tolerable risk for the majority of those surveyed, whilst only a small minority considered staying over night or a permanent return a tolerable prospect.

'Livelihood' approaches to disaster risk reduction are becoming increasingly common in the social sciences, with recognition of the relationship between livelihood insecurity and vulnerability to environmental hazards (Sanderson, 2000; Twigg, 2001; Wisner et al., 2004). Livelihood strategies influence the hazards to which people are exposed and how they respond to them. Analysis of how people make a living can help to explain the factors that influence the decisions people make in response to risk. This is clearly seen on Montserrat, with the majority of those returning to look after crops, livestock or because they cannot afford comfortable accommodations elsewhere.

Similarly to some of the authorities, a number of respondents could not comprehend the uncertainties involved in volcanic forecasting or the probabilities used to describe risk and uncertainty. Volcanic activity on Montserrat had both a negative and positive impact on risk perception, with some respondent's confidence increasing and other's decreasing. This is also in accordance with similar studies in New Zealand (Paton et al., 2000; Ronan et al., 2000) on the direct experience of a volcanic hazard (ash) on risk perception. For some Montserrat residents it instilled belief and fear of the unexpected, whilst others drew upon their available personal experience as a predictor of the likelihood and magnitude of potential future events, referred to in the literature on decision-making as '*availability bias*' and '*anchoring and adjustment*' (Mileti and O'Brien, 1993; Slovic, 2000a). This was utilised by respondents to assess their ability to cope with future hazards and the likelihood of its occurrence.

Thus, some of the public *normalised* the risk, believing that future activity would only impact areas previously affected and, as Kates (1962, in Slovic, 2000a, p14) states, they saw "*the future as a mirror of that past*". This also reflects a general observation termed '*unrealistic optimistic bias*' seen in previous volcanic environments where individuals think of themselves as more knowledgeable and therefore less vulnerable than others in the community, thereby reducing their interest in new information (Johnston et al., 1999; Breakwell, 2000; Gregg et al., 2004). Having experienced previous evacuations of the same area with no resulting volcanic activity, acted to further reduce trust in the official viewpoint. However, while survey data identified that half of the respondents felt that sometimes the evacuations were not warranted and the scientists were over confident in their predictive capability, a majority clearly understood the need for evacuation, sometimes over long periods.

Competing messages often stemmed from scientific information that conflicted with individual observations. Similarly to Handmer's (2000) finding that unofficial communications can undermine or deflect official communications, they had a tendency to propagate opposing views, confusion and distrust in the MVO and authorities. A minority placed their trust in 'lay scientists' whose scientific views suggested minimal risk to their homes and corroborated with the activity they had seen

and expected. This '*confirmation bias*', where individuals reach a viewpoint and then choose to ignore additional information, is a very common heuristic (Nickerson, 1998). The majority of the respondents were found to have been affected to some degree by the competing messages, with over half stating that the information led them to believe the decisions made were not justified by the volcanic activity. In many cases, it is not the content of rumour itself but rather the fact that rumours and conspiracy theories exist that should act as an important signal to risk communicators.

The most trusted source for information concerning the volcano was found to be friends and family. This 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 unofficial messages are easily spread and believed within the community. Although the scientists and emergency management officials are still highly trusted, uncertainties about the natural processes, accompanied by a necessarily cautious management, have caused levels of trust to fluctuate. Clearly within this uncertain environment, public observations, which are limited to physical signs of activity, will differ from the more detailed scientific measurement and analysis. When coupled with different levels of risk and benefit tolerability, high trust in the opinions of friends and family allows competing messages to reinforce similar (often inaccurate) beliefs. Interestingly, our findings show that the media are not universally distrusted sources of information (as is sometimes assumed), with much greater trust placed in the local ZJB radio station compared to the World Press. While this result will reflect to some degree quite subtle local cultural and historical factors associated with the local media (so generalisations must be made with caution) it does suggest that some local media sources may well be very useful vehicles for risk communications in volcanic crises.

7. Conclusions

The process of risk communication on Montserrat is complex and dynamic, with deeply rooted racial and political influences. Political pressures also impact the scientists: first, the politicians and authorities wished to escape blame by pushing responsibility on to the scientists, and secondly, the authorities, under pressure to ease restrictions, felt that an increased reliance on warning systems (e.g. sirens) and the scientists' ability to provide real-time warnings could reduce the level of risk.

Our study highlights a division amongst the public relating to the adequacy and need for increased public deliberation from the scientists and authorities. The split appears to correlate with cultural divisions on the island with some groups more likely to be happy with the level of interaction and information detail, perceiving the scientists to be doing as much as they could. In contrast, others (predominantly those born in the USA, Europe and some highly educated, more affluent locals) felt they should be more involved and preferred to make their own decisions on what actions to take. A third group, who were actually returning to high risk areas within the exclusion zone, were Montserratians, who felt powerless to fight the exclusion orders, preferring instead to enter the exclusion zone quietly when they wished to attend to their crops, livestock and homes.

Differences in the perceived need for deliberation and interactive decision-making among groups present a challenge for those aiming to improve risk communication. Thus, while contemporary empirical evidence and theoretical literature point towards the advantages of deliberation and community involvement in risk reduction, a prerequisite for such involvement is recognition among individuals and groups that such participation is necessary and worthwhile. In addition, the authorities walk a fine line between arousal and reassurance with some members of the authorities stating that public consultation could alter the status quo by amplifying the risks (through the deliberation of potential scenarios) in the eyes of a majority who are, in general, happy to receive commands. The authorities also felt that deliberating with certain groups of the public could lead to a relaxation in control and a pressure to tolerate greater risks, thus pushing them towards a situation in which false alarms[4] are less frequent but the risks of death and injury are increased.

What is clear is that in highly uncertain volcanic situations, science and quantitative estimates of risk cannot be relied upon to provide all of the answers. Traditional risk perception work has concentrated on the deficit of the lay publics' understanding and efforts have been made to bridge the gap between the experts and lay public with improved and targeted risk communication information. However, judgments of risk have been shown to be heavily influenced by a trade-off between risks and benefits. Thus, robust methodologies need to be developed to enable dialogue between the community (the most vulnerable of whom may not feel they have rights or power to participate) and the authorities to develop a mutual understanding of an acceptable or tolerable risk. Resilience can only be encouraged by tackling the root causes of vulnerability. Emergency managers must therefore consider the 'nuts and bolts' of people's day to day survival; helping to promote diverse and sustainable livelihoods rather than only reducing exposure to hazards.

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[4] The use of the term 'false alarm' is not intended to indicate a negative consequence but rather precautionary steps taken in the face of uncertainty.

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