
Organisational response to a volcanic eruption

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Abstract

This paper reports on the findings of a survey of organisational responses to the 1995 eruptions at Ruapehu volcano, New Zealand. The survey identified co-ordination, communication, training and management issues that had implications for the quality and effectiveness of an integrated organisational response to hazard impacts. This paper explores the implications of organisational structure and social (professional) identity for developing and sustaining integrated emergency management capability. It also discusses the implications of decision-making processes and group dynamics for response effectiveness. These issues are used to illustrate the nature and origin of the problems observed in the survey and to define strategies for their resolution and for promoting effective inter-organisational relationships and integrated emergency management capability.

Introduction

Ruapehu is an active, multivent, andesite composite volcano in the central North Island, New Zealand (Houghton *et al.*, 1987). A sequence of eruptions began on 18 September 1995 (Bryan *et al.*, 1996) and continued through late October and early November. Early eruptions through Crater Lake generated lahars down several rivers. As the lake disappeared, later phreatomagmatic eruptions were drier and more sustained, and deposited ash up to 250km from the volcano. Volcanic ash falls produced the most widespread effects (Johnston *et al.*, in prep.), affecting some 20 communities, large areas of agricultural land, disrupting air and road transportation and affecting water and national power supplies.

The 1995 eruptions at Ruapehu volcano resulted in an unprecedented response to activity at a New Zealand volcano. Several organisations had leading roles during the eruption crisis. The Institute of Geological and Nuclear Sciences (GNS) monitored the eruption, set the "Scientific Alert Level", and provided scientific information to the Ministry of Civil Defence (MoCD) and other organisations. The MoCD, assisted by a scientific advisory committee, advised the Government and regional and district councils. From the evening of 23 September to the end of the eruptive episode a management group comprising representatives of the Department of Conservation (DOC), GNS, ski field operators, Police, MoCD and Ruapehu District Council met regularly to consider the hazard to the public and to co-ordinate appropriate responses (Keys and Williams, 1996). The Civil Aviation Authority (CAA) and the Meteorological Service were responsible for monitoring airspace and declaring flight restrictions. At a community level several district councils, assisted by their respective regional councils, played significant roles in the dissemination of information and preparing for a potential escalation of activity. This paper will discuss the results of a pilot study conducted to examine the implications of the Ruapehu eruptions for the organisations involved.

Methodology

A survey questionnaire, based on that used by Saarinen and Sell (1985) to evaluate the

warning and response to the 1980 Mount St Helens eruption, was distributed to all key agencies and organisations which played significant roles in responding to the eruptions. Free response sections were added to each question to allow respondents to qualify and illustrate their responses. These data were content analysed and response frequencies were used for this analysis. The questionnaire was distributed in March 1996 to allow organisations sufficient time to evaluate their response. A total of 42 organisations were contacted. Thirty replied, giving a rate of return of 71 per cent.

Results and discussion

This paper is based on the quantitative and qualitative responses to the questionnaire from thirty organisations. Of these, all but four (13 per cent) reported having a response plan for dealing with large-scale disasters. Some 38 per cent of respondents stated that the effects of this eruption were greater than expected. Several organisations reported their surprise at the extent of the ashfall and its impact on them. This provides a useful context within which to evaluate response effectiveness.

The primary objective of this study was the identification of problems encountered by responding organisations. Table I lists the problems, the proportion of organisations reporting them as such, and their perceived importance (scored on a 1-3 scale from

unimportant to very important). Responses reveal that the problems encountered were perceived as important issues. This section will discuss the nature and implications of these issues, and offer tentative suggestions for further analysis and/or for promoting future response effectiveness.

Lack of responsibility for co-ordination

A "lack of clear responsibility for co-ordination" was reported as being problematic by 45 per cent of respondents. A related issue was the reporting of inadequate co-ordination of response (by 32 per cent of respondents) as a problem. The eruption effects covered a wide area and generated demands that transcended the expertise and/or jurisdiction of any one area or organisation.

Although a co-ordinating group was constituted, the unprecedented nature of the response to this eruption may have limited opportunities to develop inter-organisational operating networks (see Table II), rendering this activity more complex than anticipated, undermining co-ordination. A lack of familiarity between organisations and inadequately articulated co-ordination mechanisms would have undermined co-ordination efforts. Overall, the contents of Table I indicate the presence of several common indicators of team breakdown; inadequately defined and co-ordinated roles and poor communication. Developing a linked network of emergency operations centres to facilitate the co-ordination of localised contingencies may prove beneficial when dealing with widespread and multi-jurisdictional incidents (Hightower and Couta, 1996). The scale of hazard impact and its multi-jurisdictional implications also signal a need to explore the use of distributed decision-making procedures (Flin, 1996) and team-based responses.

Disaster response involves the co-ordinated activity of diverse organisations who have little contact with one another under normal circumstances. Integration requires that liaison mechanisms are established to accommodate their respective roles (Auf der Heide, 1989). This applies not only to the tasks performed, but also to the patterns of interaction between them. Inter-organisational differences in operating structures, procedures and terminology make this a difficult, but important, task, particularly if it becomes necessary for an external agency to exercise some authority over the activities of an organisation.

Table I Problems and constraints affecting organisation response effectiveness

Problem/constraint	Organisations reporting specific response problems per cent	Perceived Importance*	
		Mean	SD
Lack of clear responsibility for co-ordination	45	2.67	0.49
Media problems	43	2.50	0.67
Inadequate communication with other agencies	37	2.85	0.34
Lack of appropriately trained personnel	34	2.78	0.44
Management issues	35	2.33	0.71
Lack of equipment	29	2.75	0.46
Inadequate co-ordination of response	32	2.63	0.74
Inadequate communication with the community	26	2.60	0.55

*Scale is from 1 (unimportant) to 3 (very important)

Table II lists the agencies with whom networks were established and describes them in terms of their role as providers of information during the eruption. Inter-organisational networking was far from comprehensive. Consequently, several organisations would have found themselves interacting with diverse agencies on an *ad hoc* basis, contributing to both co-ordination and communication problems (see below).

The development of comprehensive inter-organisational networks, accompanied by simulations and exercises to identify multi-organisational and multi-jurisdictional co-ordination problems and how they can be resolved or contained prior to their being put to the test in earnest, should be afforded a high priority within reduction and readiness programmes. This process must go beyond establishing networks and operational structures and procedures. Achieving an integrated response also requires that appropriate decision-making processes are implemented (Flin, 1996) and that issues surrounding social (professional) identity are resolved (Bettenhausen, 1991; McGill, 1997). The latter issue reflects the fact that a comprehensive response requires the interactive contribution of several organisations and professional groups to tackle diverse, urgent problems. Consequently, a team-based approach is required.

Research into multi-disciplinary teams illustrates both the problems that emerge in this context and the solutions that can be implemented to resolve them. Two models in

particular seem appropriate in this context. These are the “collaborative team model” and the “metasystem consultation model” (Shute, 1997). The collaborative team model involves different professionals working as equals, contributing different perspectives to the decision-making process. The metasystem consultation model involves the “external” co-ordination of a collaborative team and the direction of team activities. One advantage of the latter is its ability to accommodate the implications of environmental (e.g. political and resourcing issues, and policy and cultural differences between collaborating organisations) factors.

Both of these models provide a framework for the kind of transitory organisation required to cater for the diverse and multi-jurisdictional demands that typify the disaster environment. Their effective use, however, requires that attention be directed to the dynamics of the collaborative group. In other words, promoting and sustaining effective integrated response involves the management of group mechanisms, structures and processes. Group processes, in particular, exercise a strong influence on the quality of the relationships between members and the effectiveness of their deliberations.

The influence of group identity and the stereotyping of in- and out-groups is more likely in the early stages of developing official relationships, signalling a need for team development and the resolution or containment of conflicts prior to the group responding to a disaster. This will be particularly pertinent in the process of establishing and maintaining local emergency management groups. Groups must work together extensively (in simulations, policy formulation, etc.) to promote their capability to operate as an integrated team.

Several models developed within social psychology, particularly those involving social identity theory and self-categorisation theory (Hogg, 1992), provide a framework for promoting effective group activity. Hogg argues that group cohesion requires consideration of:

- (1) the cognitive representations and processes by which participants define group membership and how it influences cohesion within a multi-disciplinary group;
- (2) patterns of interaction between group members in relation to institutional policies, structures and culture, and the language and terminology used; and

Table II The extent of inter-organisational networks and the role of external agencies as information providers

Outside organisation	Networking	Information provided per cent
	in place per cent	
GNS	–	63
Police	77	–
Civil defence	73	53
Fire	70	–
Ambulance	70	–
Regional councils	70	20
District councils	67	17
Health services	53	–
Military	43	–
Social services	43	–
Mental health services	30	–
Media	–	30

- (3) contextual factors such as understanding of integrated emergency management policies and practices, the status and power accorded to different members, and resource constraints.

A role for resource constraints in determining team effectiveness provides an additional avenue for explaining the observed co-ordination problems.

A decision not to declare a state of civil defence emergency reduced the resource (particularly financial) availability deemed necessary for managing the response. Resource constraints are a common source of divisiveness in multi-disciplinary groups, even if they were previously cohesive and effective. Conflict not only disrupts group process at the time, it also reduces future group cohesiveness and effectiveness. However, environmental constraints need not sound the death knell for multi-disciplinary teams. Where external factors interfere with team functioning, team integrity can be sustained by focusing on collective strategies for influencing funding, lobbying politicians or submitting their own policy statements and plans to decision-making bodies.

Having to make decisions under high stress conditions may also have contributed to co-ordination problems, particularly in a context defined by under developed inter-organisational relationships. Not only does high stress lessen team effectiveness, it also influences group dynamics and encourages participants to focus responsibility on higher status members (Flin, 1996), even though they may not possess the knowledge or skills to adopt this responsibility. While team functioning can be sustained if this individual performs a co-ordinating role, it is possible that group activity focuses on sharing blame rather than dealing the situation (Flin, 1996).

A final issue that emerged here concerned the fact that, for some respondents, co-ordination difficulties were attributed to their expectations regarding central (MoCD) co-ordination, with this assumption being central to their planning. However, because a state of civil defence emergency was not declared, it did not materialise, resulting in inconsistency between their response plans and procedures and the operating environment. This problem illustrates how planning, based on implicit and untested assumptions regarding operating contexts, can undermine response effectiveness (Flin, 1996; Paton, 1996, 1997a).

This observation highlights the need for more detailed and comprehensive planning, testing of plan assumptions, and the value of exercises and simulations that examine procedural and conceptual issues at the organisational level.

Inadequate communication with other organisations

"Inadequate communication with other organisations" was described as a problem by 37 per cent of respondents. Some difficulties were attributed to hazard activity (e.g. ash fall affecting communication equipment), but others were also identifiable. Effective communication between organisations is essential for integrated emergency management and for the quality of decision making and co-ordination in an environment characterised by multi-organisational involvement and conflicting and diverse demands. Developing effective inter-organisational crisis communication requires that information needs are anticipated and defined, that networks with information providers and recipients are organised, and crisis communication systems capable of providing, accessing, collating, interpreting and disseminating information are established. Effective integrated management also requires shared terminology and systems.

No respondent reported receiving too much information. Some 50 per cent reported receiving too little information and 56 per cent found information difficult to obtain. Some 41 per cent reported problems making decisions based on the information available and encountering inflexibility in information provision. From these observations several communication systems deficits can be inferred.

Comparison of pre-existing networks with information providers reveals both incomplete networks and inconsistencies with respect to information sources (Table II). This was particularly evident for the major information provider, GNS. Seeking information on an *ad hoc* basis will have contributed to communication difficulties.

Respondents generally acknowledged a need for more detailed organisational analysis of their information needs and how it should be formatted and processed to ensure compatibility with organisational needs and decision processes. The need to develop an organisational capability to interpret and use

information was also recognised. Communication analysis thus needs to define information processing and formatting needs. A lack of processing capability, or the need for additional processing, will introduce unnecessary response delays. In addition, training programmes are required to develop the capability of organisational personnel (in all interacting organisations) to specify information needs, to interpret it appropriately on receipt, and, if required, to adapt information for different functions and end-users. For example, district and regional councils not only require information from diverse sources to manage their response, they may also be called on to distribute processed information to the community, the media, and to counselors and policy makers.

Making effective use of information underlines the importance of appropriate decision-making processes. Prescriptive decision making, likely to typify routine decision making, is inappropriate for crisis circumstances. Rather the use of more naturalistic processes (e.g. recognition-primed decision making) and the development of crisis decision-making capability deserves consideration (Flin, 1996).

Organisational involvement and information needs also change over time and systems must be able to respond to changing needs and implications. For example, during the response phase, liaison with GNS and emergency services will predominate and define inter-organisational communication needs. During the recovery phase, liaison with mental health and welfare agencies and with insurance and compensation agencies will generate a different set of communication needs.

Lack of appropriately trained personnel

A "lack of appropriately trained personnel" was cited as a problem by 34 per cent of respondents. Given the infrequent nature of disasters, training is generally afforded a low priority in organisational thinking (Grant, 1996). Training programmes should be based on an all-hazards approach and designed to facilitate the development of a flexible and adaptable response capability (Auf der Heide, 1989; Lewis, 1988; Paton, 1996). In addition to developing an appropriate knowledge and skill base, training should address how the disaster context influences the applicability of training, operational effectiveness, and staff well-being (Paton, 1996). For example, performing unfamiliar roles and tasks in

unfamiliar circumstances, dealing with unfamiliar people with different operational philosophies and terminologies, rapid reassignment of duties, and higher than usual responsibility represent contextual factors that affect the applicability of training.

Training should also prepare personnel for demands unique to their area. The vulnerability profile of the area, its constituent populations, and their implications for hazard impact and social system disruption, will identify local needs and the specific skills and knowledge required to respond to them. Disaster training needs analysis must also accommodate multi-agency involvement and interaction to facilitate the development of knowledge, skills and systems capable of supporting an integrated response.

While a capability for training needs analysis may exist, the issues to be addressed in this context fall outside usual operating demands. Consequently, disaster-related training needs analysis must be deliberately planned for. Training programme development should be a participative exercise to capitalise on existing expertise, engender acceptability and commitment, and facilitate the development of a response capability that accommodates resource availability and constraints (Grant, 1996).

Training programme design can be facilitated by defining the skills and knowledge required for effective response. Training programmes for operational personnel would include, for example:

- hazard impacts and their consequences for physical and social systems;
- communication and decision making;
- roles, tasks and responsibilities within an integrated operating context;
- the implications of integrated emergency management for incident command, co-ordination and organisational responsibility;
- developing a flexible and adaptable response capability;
- nature and operation of prediction, warning systems and public information programmes and constraints on their effectiveness;
- reduction and readiness activities, their perception by community members, and their implications for risk status;
- mobilising and co-ordinating community response and recovery initiatives;

- governmental (local and national) and non-governmental policies: programmes for disaster relief and recovery;
- procedures for accessing and utilising these services; and
- plans and preparations for: evacuation and shelter, medical assistance, mental health services, rebuilding and rehabilitation programmes.

For senior emergency management personnel, training should address additional issues, such as:

- participative and consultative management for (contingent) planning, plan implementation, and co-ordination;
- creative problem solving and decision making;
- translating plans into action and adapting them in response to changing needs and circumstances at all stages of events and irrespective of their type, scale or complexity; and
- communicating with people with different abilities, backgrounds and interests.

Training should be supported by exercises and simulations that provide opportunities for practising skills and using knowledge in a wide range of realistic scenarios and conditions. Detailed process and content evaluation should follow such exercises.

Management issues

“Management issues” were cited as a response problem by 35 per cent of respondents. Prior to the occurrence of a disaster, organisational structure and systems function should promote the effective performance of routine operations rather than manage crisis demands. Centralised, bureaucratic systems constrain response effectiveness by their persistent use of established decision-making procedures even when faced with unusual and more urgent demands, internal conflicts regarding responsibility, and the desire to protect the organisation from criticism or blame (Flin, 1996; Powell, 1991).

Top-down, vertical structures are thus ill-suited to crisis management in complex multi-jurisdictional settings (Hightower and Couta, 1996). Structural characteristics will thus affect the ease with which multi-agency, integrated arrangements will be entered into and implemented effectively. A capacity for adopting a more organic structure when

responding to crisis demands should not be assumed, but this capability can be developed through planning and exercises (Hightower and Couta, 1996). Careful analysis of operating structure is called for. Organisations possessing highly mechanistic structures, designed to manage routine activities, will require considerable intervention to facilitate their adoption of a transitory organic structure better suited to managing in the dynamic, uncertain and ambiguous disaster environment. The difficulties inherent in facilitating and sustaining such a transition provide a strong argument for alternative, more customised approaches. The emergency management group concept is consistent with the needs suggested by this argument. Irrespective of the origins of the group, structural, procedural and identity issues remain to be dealt with. However, the ease with which they can be managed will be influenced by the manner in which the group is constituted.

From a managerial perspective, in addition to the training issues outlined above, response effectiveness will be influenced by the ability of organisational systems to deal with sudden and radical changes in the demands made on them. The issues that response systems must contend with include:

- delegating authority (possibly with little or no warning) to individuals of differing backgrounds and levels of expertise;
- high demands on, and uncertainty in, communication and decision processes;
- the transitory adoption of different operating and decision systems and processes;
- working with organisations who use unfamiliar procedures and terminology;
- managing the transitory transfer of control to external agencies when situational demands require it;
- co-ordination and task assignment in multi-jurisdictional/organisational operating contexts;
- the creation of new tasks and the assignment of responsibility for their performance (e.g. media and inter-organisational liaison, helpline/outreach development and administration).

Media problems

Media problems were reported by 43 per cent of organisations. Worldwide media interest, and the demand for information, created significant demands on organisations. Once systems were in place, media organisations

reported a satisfactory information flow (Keys and Williams, 1996). However, inaccurate reporting of hazard activity and its impact on communities added to the demands encountered by response agencies, organisations and communities.

Developing an effective media response involves defining information needs; addressing the logistics of sourcing, collating, analysing and disseminating information; identification of expert sources for referral; and establishing a media liaison function (Auf der Heide, 1989; Paton, 1997a). Media spokespersons will require special training to handle this aspect of the response. The issues that may emerge can be better anticipated by incorporating a media component within exercises and simulations.

Inadequate communication with the community

Problems communicating with community members were cited by 26 per cent of respondents. Community information needs during and after disasters differ radically from those prevailing within a non-disaster environment. Consequently, a detailed analysis of community information needs, sources, and dissemination mechanisms is required. A common problem is making inaccurate assumptions of community needs (Eränen and Liebkind, 1993; Paton, 1997b; Quarantelli, 1985). A starting point is to consider how hazard activity interacts with community vulnerability, functions and characteristics to create specific demands and information and response needs (Bishop *et al.*, 1997; Paton, 1997b).

Being in a position to readily provide for community information needs will free the communication system to deal with more dynamic and unpredictable requests. Community information needs will also change with time. Information about what is happening will predominate during the early stages, giving way subsequently to requests about, for example, inquiries, compensation issues, or the employment or economic implications of the disaster.

Implications for future response

On the basis of their response to the 1995 Ruapehu eruption, most organisations felt well prepared to deal with any future eruptions, with only one describing themselves as unprepared. When asked to evaluate the effectiveness of their response on a 4-point

scale from “not very effective (1)” to “very effective (4)”, organisations rated their response as effective ($M = 3.36$, $SD = 0.73$). When asked how effective they thought their response would be if faced with a more serious eruption, plans were described as slightly less, but similarly effective ($M = 3.16$, $SD = 0.69$). There was general agreement that a future eruption from Ruapehu was likely.

While the 1995 eruption did provide an opportunity to test systems, it did not constitute a major test of response effectiveness. Yet organisational perception, despite acknowledged response difficulties, describes a capability to respond to a more serious event. While this is true to some extent, care must be taken to ensure that this experience does not stimulate complacency and inappropriate inferences about future response effectiveness. It is thus pertinent to consider the organisational dynamics that influence interpretation of experience and perceptions of vulnerability and capability.

Emerging from a disaster relatively unaffected, or the perception of coping effectively with the demands of a specific disaster (as was the case here), can stimulate overestimation of future response capability, underestimation of risk, and constrain thinking about future events, making it difficult to conceptualise alternative demands, problems or outcomes. Organisations focus on positive performance outcomes and ignore the negative outcomes or potential inadequacies of crisis management systems (Dawson, 1986; Staw *et al.*, 1981). Consequently, intellectual, resource and performance issues are not considered within the review and evaluation process. Shortcomings are only revealed when faced with a more exacting test of response capability. Other issues also deserve consideration.

Respondents were asked to describe their response plans in terms of their coverage of a range of issues (Table III). Planning focused on technical and infrastructure problems, with community, economic and mental health issues receiving considerably less attention.

Limited recognition of mental health needs is reflected in the observation that high levels of anxiety, particularly amongst children, were frequently down-played by local officials (Ronan 1997; Ronan and Johnston, 1996). Plans accommodating political and economic issues were also under-represented. However,

Table III Issues addressed by response plans

Response issue	Plans addressing each issue per cent
Technical/infrastructure problems	87
Medical/physical health issues	63
Social/community issues	52
Economic issues	40
Political/national issues	27
Mental health issues	27

the experience of this eruption increased the salience of these issues (e.g. as a result of economic losses and social disruption within communities dependent on skiing). Detailed consideration of social, economic and mental health issues is also necessary because their effects can extend well beyond the period of tangible hazard impact.

Conclusion

Development of emergency management capability should be an evolutionary process and this is reflected in organisations perceiving the response to this eruption as a learning experience. Despite the generally positive nature of the response to this eruption, the fact that it did not constitute a major test of preparedness and response highlights the need to guard against complacency regarding future capability. The effectiveness of the (integrated) response was muted by communication, co-ordination, training, and organisational constraints. This signals a need to develop inter-organisational networks and the organisational structure, systems and management capability required for a comprehensive, integrated emergency management system. The development of a team approach requires that attention also be given to group dynamics and decision-making formats and processes.

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