PROVENTION CONSORTIUM

Community Risk Assessment
and Action Planning project

VANUATU – Ambae Island

Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management

CRA Toolkit

CASE STUDY

This case study is part of a broader ProVention Consortium initiative aimed at collecting and analyzing community risk assessment cases. For more information on this project, see www.proventionconsortium.org.

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Click-on reference to the **ReliefWeb country file for Vanuatu:**
http://www.reliefweb.int/rw/dbc.nsf/doc104?OpenForm&rc=5&cc=vut .

Note:
A Guidance Note has been developed for this case study. It contains an abstract, analyzes the main findings of the study, provides contextual and strategic notes and highlights the main lessons learned from the case. The guidance note has been developed by Dr. Ben Wisner in close collaboration with the author(s) of the case study and the organization(s) involved.

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RESEARCH ARTICLE

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Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu

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Abstract Ambae Island is the largest of Vanuatu's active volcanoes. It is also one of the nation's potentially most dangerous, with 60 million m^3 of lake-water perched at over 1340 m in the summit caldera and over the active vent. In 1995, small phreatic explosions, earthquake swarms and heightened gas release led to calls for evacuation preparation and community volcanic hazard awareness programs for the ~9500 inhabitants. Differences in perspective or world-view between the island dwellers adhering to traditional beliefs (Kastom) and external scientists and emergency managers led to a climate of distrust following this crisis. In an attempt to address these issues, rebuild dialogue and respect between communities, outside scientists and administrators, and move forward in volcanic hazard education and planning for Ambae, we adapted and applied Participatory Rural Appraisal (PRA) approaches. Initial gender-segregated PRA exercises from two representative communities provided a mechanism for cataloguing local traditional viewpoints and hazard perceptions. Ultimately, by combining elements of these viewpoints and perceptions with science-based management structures, we derived volcanic hazard management guidelines, supported by an alert system and map that were more readily accepted by the test communities than the earlier "top-down" plans imposed by outside governmental and scientific agencies. The strength of PRA approaches is that they permit scientists to understand important local perspective issues, including visualisations of volcanic hazards, weaknesses in internal and external communication systems, and gender and hierarchy conflicts, all of which can hinder community emergency management. The approach we describe has much to offer both developing and industrialised communities that wish to improve their awareness programs and mitigative planning. This approach should also enhance communication and understanding between volcanologists and the communities they serve.

Keywords Participatory Rural Appraisal · PRA · Community education · Volcanic hazard mapping · Ambae · Vanuatu · Emergency management

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Introduction

Vanuatu suffers one of the highest levels of volcanic hazard in the southwest Pacific (Wong and Greene 1988; Wiart 1995; Howorth and Elaise 1997). Several inhabited islands in the Vanuatu chain are currently in a state of volcanic unrest, including Ambae, Ambrym, Lopevi, Gaua and Tanna. Despite this threat, one of the main challenges facing hazard and risk management in Vanuatu and other countries of the South Pacific is to make sure that community-through national-level planners utilise scientific information within practical risk reduction policies and programs. A second major challenge is to have villagers accept the scientific information from the outside alongside local or traditional knowledge. The other side of this coin is the challenge for scientists and planners to identify and integrate aspects of traditional community knowledge within risk reduction strategies.

Ambae Island is the largest and most hazardous of Vanuatu's volcanoes (Wiart 1995). Past attempts to introduce volcanic hazard awareness and education programs on Ambae involved scientists visiting villages, where they showed videos and distributed hazard maps in English and French. These visits were of limited success, primarily due to the confrontation of outside scientific ideas and local traditional (Kastom) perspectives (Esau 1997a). In 1995, a warning to prepare for evacuation during a period of heightened volcanic activity was issued by scientists (Robin et al. 1995). Some communities responded by immediately fleeing while others ignored the warnings. Since no major eruption ensued, levels of distrust in outside scientific knowledge increased (Esau 1997b), resulting in a poor reception by villagers and community leaders of an externally-developed draft volcanic operational support plan (SPDRP 1997).

While the strong adherence to Kastom beliefs in parts of Vanuatu is immediately viewed by many scientists and professional emergency planners as a hindrance to public hazards education, we believe instead that standard scientific methodology and approaches to volcanic hazard education commonly cause confrontation with local perspectives or beliefs. Similar problems have characterised other development initiatives conceived and instigated by outsiders for the benefit of underdeveloped and "poorly" educated communities, in a so-called top-down approach (see Chambers 1994a, 1994b, 1994c, 1997). In the Ambae case, part of the conflict may be due to failures by outside experts with a scientific world view (such as volcanologists) to accommodate other perspectives into their thinking (see Webber and Ison 1995).

To address these issues, we adapted a series of Participatory Rural Appraisal (PRA) methods (Chambers 1997; Bar-On and Prinsen 1999) to:

1. Incorporate local Kastom knowledge with outside scientific ideas for community volcanic hazard and risk assessments and awareness building.
2. Develop participatory community level volcanic risk management strategies and emergency management plans.

Despite criticisms of PRA as an educative tool (Von Kotze 1998), the benefits of the approach in building partnerships of respect between "outsiders" and "insiders" made it attractive to us as a dialogue-building strategy in the communities of Ambae. In addition, this strategy has the potential to foster educative change without further eroding the cultural values and diversity of the area; central aims of UNESCO, the agency that has funded our ongoing program. We report here on the development and application of various PRA-style methods in two communities on Ambae, and demonstrate an alternative approach to introducing scientific ideas and knowledge to community risk management.

Ambae and Lombenben volcano: the scientific perspective

Ambae Island (~405 km^2) represents the emergent portion of the largest of Vanuatu's volcanoes, rising around 3900 m from the sea floor to reach 1496 m above sea level. The basaltic shield volcano has two collapse calderas in the summit region (Fig. 1), containing Lakes Vui and Manaro, holding ~50 million and ~11 million m^3 of water, respectively (Warden 1970; Garaebiti 2000).

Little detail is known of the eruptive history of Ambae following its emergence above sea level sometime after 0.7 million years ago (Warden 1970). The Lake Vui cone and crater were probably formed during eruptions around 1575, when lava flowed down its northern slopes (Warden 1970). Lava flows on the western flanks destroyed N'dui N'dui around 1670. Lahars accompanied eruptions in 1870 and were caused by landslides in 1914. In both cases, they destroyed villages and caused many fatalities (de la Rüe 1956; Blot and Priam 1962; Williams and Warden 1966). Since then, many small scale phreatic and gas-release events have emanated from Lake Vui. Steam plumes, acid rain and explosions in 1995 led to widespread alarm on the island, along with calls for partial evacuation (Robin et al. 1995; Metaxian et al. 1996).

Garaebiti (2000) considers the greatest volcanic threat to be lahars originating from the summit lakes, with the highest potential for hazard centred on the major stream valleys, and areas within range of phreatic explosions from Lake Vui. Additional hazards are posed by lava eruptions along the central long-axis of the island through the formation of new fissure systems. Judging by the density of eruptive centres, this latter hazard is considered highest at the NE and SW extremities of the island (Garaebiti 2000), where the interaction with seawater could lead to more explosive eruptions.

Ambae has a basic continuous monitoring system in place, including a seismometer and a satellite-monitored lake temperature and acoustic recorder (Lardy and Halbwachs 1996). When operating effectively, this system can provide pre-event warnings that can be used along with visual reports by the Vanuatu Department of Geology, Mines and Water Resources (DGMWR) to set volcanic alert levels. From these, the National Disaster Management Office (NDMO) is tasked with initiating appropriate emergency response measures. This system does not operate entirely in real-time. The data are recorded directly in New Caledonia, and if unusual activity is noted, it is manually reported to DGMWR staff. In practice, delays of several days to a week may occur before warning information is transmitted to the villages on Ambae. Hence, most initial eruption reports within Vanuatu are based on villagers directly telephoning the DGMWR office or the NDMO.

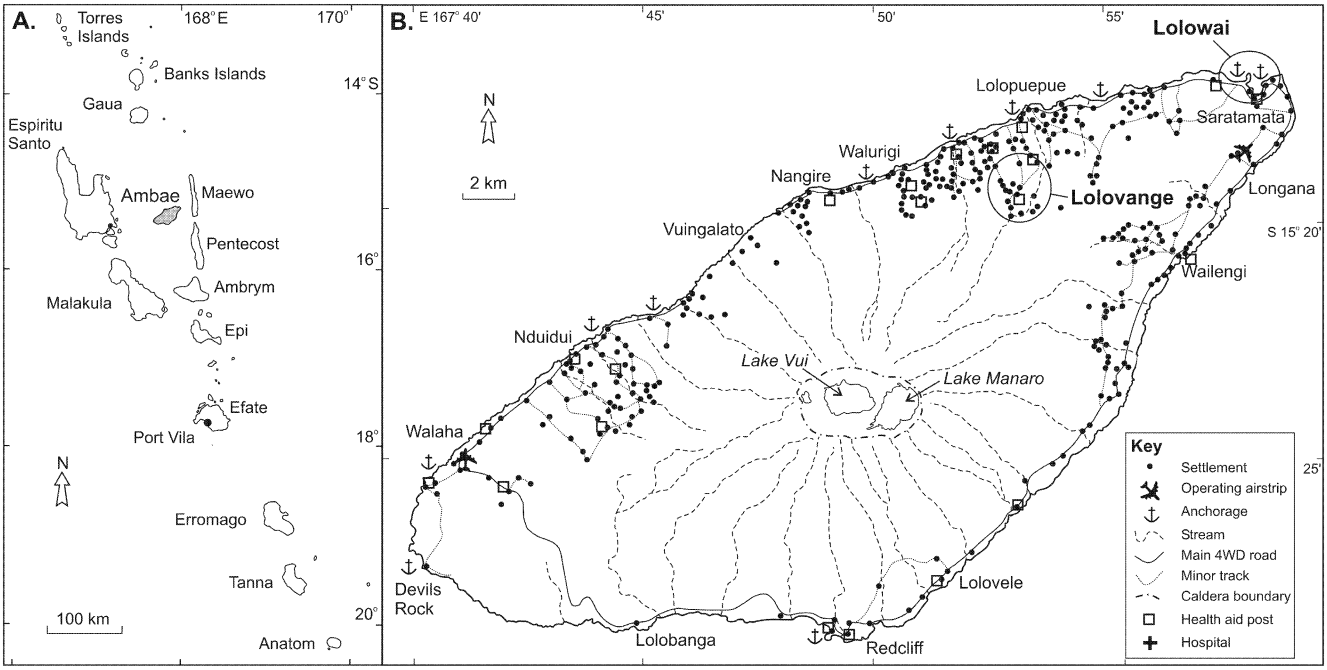

Fig. 1 **A** Major islands of the Republic of Vanuatu. **B** Ambae Island, showing locations of settlements (after Wallez 2000), main stream channels and roads. The target communities of Lolovange and Lolowai are approximately enclosed within the ellipses indicated

Population and social factors

Around 9400 people lived on Ambae in 1999 (National Statistics Office 2000), dispersed amongst more than 276 small extended family settlements and villages (Wallez 2000). Settlements are mostly restricted to the lower island slopes within 4 km of the coast. The highest population densities occur at the northeast and southeast ends of the island (Fig. 1). Subsistence agriculture is the main economic activity; copra, beef and kava provide small additional cash returns.

Two main languages are spoken on Ambae (Lynch 1994), with the distribution of them roughly divided east-west. Up to 12 dialects of these two languages are known (Tarisesei 1999). A Vanuatu form of pijin, Bislama (Crowley 1995) is the lingua franca and the main national language. English and French are taught at schools, but in rural areas such as Ambae, usage is very low. There is a low overall level of basic western-style education; around 89% of children attend the island's 26 primary schools, but only 26% attend secondary school (personal communication, Penema Province Rural Economic and Social Development Initiative Team 2001).

Village/settlement administration is overseen by male chiefs who, depending on the degree to which Kastom is practiced, rise to power through grade-taking (pig-killing) ceremonies or otherwise through deeds and accumulation of wealth, particularly in the form of pigs. Male elders and sorcerers/traditional healers also occupy positions of power; women and youth are the lowest ranking community members. Island-wide administration is achieved

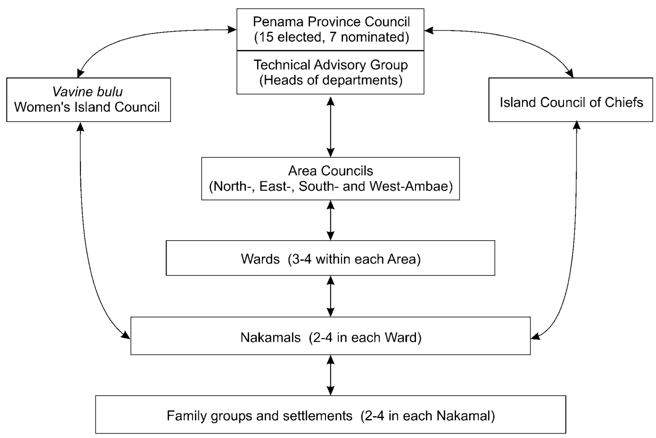

Fig. 2 Generalised organisation/administration structure and communication paths from Province Council to communities on Ambae Island

through a hierarchical structure (Fig. 2). The Provincial Council oversees administration of the Penama Province (consisting of the Penticost, Maewo and Ambae islands). The Council is made up of elected representatives, plus appointed representatives of women (1), youth (2), chiefs (2) and churches (2). A Province administration centre is also located at Saratamata (Fig. 1), and includes administration officers and officers representing various government departments, including police, women's affairs, public works, education and health.

Health services on Ambae include 16 aid posts, four dispensaries and the Penama Province Hospital, located at

Lolowai (Fig. 1). Four-wheel-drive roads service many parts of the island, but no circum-island road exists. Two operating airstrips at either end of the island have scheduled commercial flights. Communications facilities include 11 radio-telephone hubs, 10 that can carry eight lines and one at Saratamata that carries 24 lines. Most of these lines are out of service due to non-payment of accounts.

Methods

Participatory Rural Appraisal (PRA)

To achieve the aims described above, our overall strategy was to build respect and greater understanding between outsiders and the communities of Ambae. At the same time, we wished to identify, revive and promote knowledge and organisational strengths in risk management existing in the villages/settlements. This involved a two-way process of learning, for which Participatory Rural Appraisal (PRA) methods (see for example Chambers 1992, 1994a, 1994b, 1994c, 1997) were considered to be best-suited. These techniques, now also known as Participatory Learning and Action (Chambers 2002) have been developed through social development practice, particularly in areas of agricultural education in drought and famine-stricken developing nations. One of a range of participatory approaches (Rietbergen-McCracken and Narayan 1998), PRA concentrates on exploring diversity in communities, reversing standard power structures of outsider versus insider, and allowing communities to design solutions to their own problems.

The main principles of PRA-style approaches focus on modifying the attitudes, behaviours and mindsets of development practitioners (Chambers 1994a; Wetmore and Theron 1998; Bar-On and Prinsen 1999), and include:

- Listening instead of lecturing, encouraging development practitioners to learn from local people rather than the opposite.
- Emphasising visual and diagrammatic over verbal techniques to allow input from all.
- Taking a measured and patient approach whose tone helps establish effective lines of communication with all sectors of the community.
- Settling for an optimal level of relevant information given limited time and budget.
- Verifying information using a range of overlapping methods.
- Seeking out diversity of opinion, rather than looking for averages.
- Facilitating activities, but then standing back and letting local people run them alone.
- Recognising and self-correcting dominating behaviour by facilitators.
- Remaining sufficiently flexible to modify goals as participants better realise their needs.
- Focusing on community strengths rather than dwelling on weaknesses.
- Emphasizing the group over individuals and comparisons over precise measurements.
- Identifying and empowering local analysts.

The PRA approach suffers from a few flaws, even in the underpinning concept that solutions to all problems can be found exclusively within an ordinary community (Bar-On and Prinsen 1999). There remains a large gap between a community's ability to identify problems, and its ability to solve them under its own initiative (Mosse 1994). In addition, purely bottom-up planning is not always feasible, especially in the development of emergency plans where coordination of activities between communities and other agencies/administrators is needed. Finally, the typical orientation of PRA is to place more value on local knowledge than on outside or "western" knowledge (Chambers 1994b), but sometimes this may result in neglect or disparagement of non-local knowledge (Kapoor 2002), and a loss of opportunity for education (Von Kotze 1998).

Despite these drawbacks, the PRA method suited both the community's and our purposes well, since we did not wish to begin a new round of conflicts between outside scientific knowledge and inside traditional knowledge on Ambae.

Community selection

The following attributes were sought in two target communities in order to maximise the effectiveness of our program:

- Recent experience of hazards, including volcanism or related events.
- Good internal organization.
- Good repository of traditional knowledge.
- Some degree of openness to outsiders.
- A willingness to develop a village-level emergency plan.
- Representative of other communities on Ambae.

Following local negotiations, and consulting geologic hazard information, we chose the communities of Lolovange and Lolowai.

Lolovange, representative of a traditional, hillside, rural-subsistence community on Ambae, lies adjacent to one of the major stream valleys draining the central crater area. This location places the community and surrounding area at immediate risk from lahars and floods triggered by eruptions from the Lake Vui crater. Like most rural communities on Ambae, the 600–800 Lolovange inhabitants are not contained with one large central village, but instead are dispersed within small family-based clusters near gardens.

Lolowai is a coastal community of more than 1000 people that contains a mixture of traditional subsistence farmers, staff at the province hospital, other government workers associated with the Provincial Office, staff and students of church missions, and the staff and students of a boarding school. The community lives dispersed over a rugged landscape characterised by tuff cones and tuff rings, considered to be only a few hundred years old (Warden 1970). This area is at risk from similar flank eruptions, triggered by explosive interaction of rising magma and seawater. Conversely, Lolowai faces only relatively low levels of hazard in the event of minor eruptions involving Lake Vui. Given these circumstances, with its hospital and large school, Lolowai can act as an important refuge area or staging point.

Facilitators

The participatory exercises were run with local Ambae-based or Port Vila-based facilitators who could communicate in Bislama and easily develop a rapport with village groups. In addition, we chose people who would benefit from the experience of facilitation and be able to participate in subsequent PRA programmes or instruct others in PRA techniques and community disaster management strategies.

To prepare our facilitators, we emphasised before and between the exercises that they should balance the roles of encouraging group discussions and activity work with listening and allowing groups to come up with their own solutions and ideas independently. In addition, we considered it vital that the facilitators remained unbiased and open-minded to unusual explanations or new, alternative ideas and solutions proposed by the participants, even if they appeared strange. Like all best-laid plans, the passage of Tropical Cyclone Sose forced withdrawal of some of our original team members. The final facilitation team for the first visit included two scientific/technical officers from Port Vila (one of whom is a chief from another island in Vanuatu), the director of the Vanuatu association of Non-Governmental Organisations from Port Vila, and four Ambae-based people, including a police officer, the province education officer, the province chief health officer and a community health officer. Unfortunately, only one female facilitator was available, and therefore either worked with more than one group at a time, or co-opted a male facilitator to assist. Foreign team-members did not take an active role in group exercise facilitation; instead, to minimise their impacts on the process, they remained in the background to provide a supporting role to the local facilitators.

During the second visit, a third facilitator from the Province Office was added to the team when other province activities and illness prevented many members of the original team from participating.

Community diversity and working procedures

The first day-long part of this program in each community (following a period of initial visits, meetings and arrangements with each community) involved group exercises, to compare and contrast knowledge held by different sectors of the community, and to form an understanding of community diversity. At each location, the participants assembled themselves into groups, each containing 6–14 people. Groups were formed of chiefs/elders (1 group), women (1–2 groups) and men (2–3 groups). A female facilitator worked with the women's groups to encourage open disclosure of traditional knowledge and legends in a positive environment. The high-ranking chief in our facilitation team worked with the chief's group. Each group recorded their results, diagrams and maps using coloured pens on large sheets of newsprint paper, and one or more group members presented the results to a plenary discussion session.

Traditional requirements at the beginning of such meetings include prayers, welcoming speeches from both visiting and receiving parties, plus the presentation of gifts to the ranking chief in the area. This establishes a relationship of good faith upon which the program activities can follow. Traditional gifts often include food items such as pigs. However, we used this opportunity to introduce the nature of our proposed activities, by providing tools (an axe and bush knives). The main spokesperson for the facilitation team (Douglas Charley) explained how the community disaster plans we were helping them develop were also tools, because with these plans the community would be better able to help itself during times of disaster. In follow-up visits to the communities, six months later, the gifts provided were metal files and new axe handles, to convey the message that we intended to help the community in maintaining and improving the effectiveness of their disaster management tools.

Approaches and exercises

Of the huge range of PRA approaches and methods available, we based our approaches on community vulnerability analysis tools outlined by Vrolijks (1998), and on personal experiences of those that worked best in similar community or government workshops in Fiji (Cronin and Kaloumaira 2000), Samoa (Cronin et al. 2000a) and Solomon Islands (Cronin et al. 2000b). These techniques included:

– Community timelines – of events in the history of a community.
– Changing village situation – a table comparing the present community with that of 20 years ago (the approximate date when Vanuatu became an independent republic).
– Storytelling – past volcanism, past disasters.
– Seasonal calendar timeline.
– Daily activity timeline.
– Transect exercise – recording features along a path taken through the village.
– Community mapping exercise 1 – recording geography, village resources, areas of highest exposure to natural hazard (from any hazard type), interpretation of safe and dangerous areas nearby.
– Community mapping exercise 2 – placing a chosen "safe" area in the centre, drawing a map showing the closest food, water and other resources, paths to and from this location, and the vicinity to hazard areas. Use of this map to promote the chosen "safe" area to other workgroups.
– Drawing diagrams of community organisation structures and those activated for emergency management decision making.
– Drawing diagrams of the relationships between the community and outside support agencies and links for emergency management decision making.
– Description of local traditional disaster management practices, diagrams or charts.
– Listing and ranking exercises concerning perceived emergency planning needs.
– Community emergency planning, diagram or chart of the main steps of a volcano emergency plan, including roles and responsibilities of community members.

Each group took part in 3–6 of these exercises, depending on their progress, and overlaps and omissions were made depending on the nature of exercise outcomes.

First visit

Lolovange

Three men's groups (8–11 members), one women's group (14 members) and one chief's group (5 members) took part in the exercises.

Volcanic history and hazardscape

A summary village history emerged from the presentations of three groups (Fig. 3). This history included four references to volcanism, along with earthquakes, landslides and tsunami-like events. Interestingly, while the European records (see above) describe lahars in 1914 as

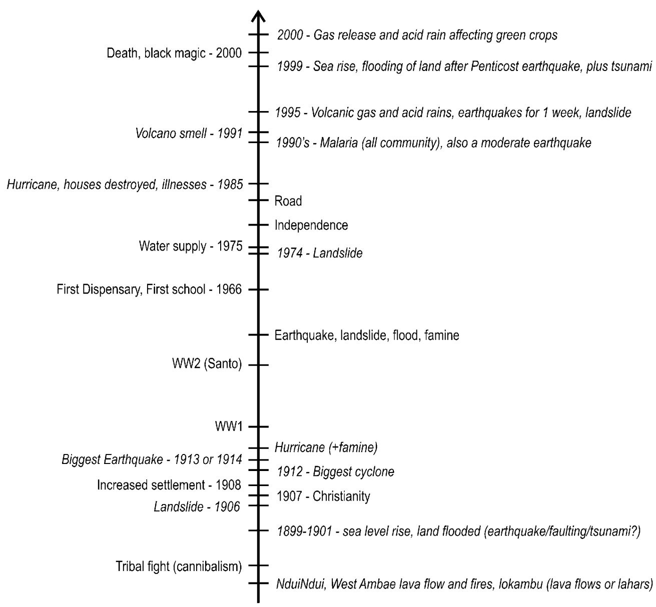

Fig. 3 Summary history of major events (focusing on natural disasters) that have affected the community of Lolovange, as constructed from group exercise results

Table 1 Hazardscape of Lolovange area, constructed from group discussions and exercises

Hazard	Frequency	Area affected	Warning signs
Cyclone	large: 15 years; medium: 2–3 years	open area, top of hill, *solwota*	heat, lots of fruit flies, radio
Landslide	large: 90 years	coastlines, on/below steep hills	heavy rains or earthquake
Earthquake	large: 90 years	steep hills and coastlines	sound (short time)
Flood	1 year	major creeks and coastline	sound, heavy rains and clouds
Volcano	5 years	major creeks (mudflows, floods and lavas), downwind areas (gas), near the summit craters	sounds, smell, lake colour, bubbles in lake, vegetation damage around lake, earthquake, hot soil (and warnings on the radio from the geology dept)
Drought	10 years	all	long dry season
Malaria	1 year	all	heavy rain/wet season
Diarrhoea	1 year	all	after cyclone
Tsunami	Lolovange not affected	coast	earthquake

being probably related to volcanism, the oral traditions of Lolovange area linked these lahars to the biggest earthquake ever to have affected them. In oral traditions, the two major past volcanic events occurred when Walaha area villages were destroyed (by lava flows or lahars?); later landslides affecting this area might also have originated from the volcano. Precursory evidence the villagers linked to volcanism included pervasive gas smells, death of trees around Lake Vui, unusually active bubbling and other lake disturbances, lake water colour changes (to brown or grey), rumbling and booming from the crater, and the rapid rotting of taro roots in the ground.

According to the chief's group, the Manaro area (summit caldera including Lake Vui) is highly significant in Kastom belief, and visits are normally forbidden (tambu or tabu). If this respect is broken, volcanic activity can result. Therefore, one of the main traditional forms of volcanic hazard management is to respect this prohibition of visiting the summit lakes area. Following certain protocols, outside experts are permitted to visit and monitor the crater lakes, although even this is not universally accepted (see, for instance, Wallez and Charley 2000).

In an additional open forum session, the hazardscape of Lolovange was further discussed, and all hazards were considered in terms of their frequency, area of impact and warning signs (Table 1).

Community activities

Exercises concerning seasonal or daily activities were often used as warm-ups, to encourage groups to work together more effectively for later exercises. However, the results, showing the distribution of different sectors of the community at different times of the day, as well as seasonal changes in food supplies, were factors in the discussions for appropriate village-warning systems and assembly points.

Resources, vulnerable elements and hazard perceptions

Mapping exercises were carried out with the greatest enthusiasm, possibly because all group members could easily contribute. The women's group split into two subgroups, depending on which side of the main river valley they lived, and two men's groups also carried out this exercise. The presentation and discussion of maps (for example Fig. 4) emphasised the widespread nature of the population. People live in small settlements of 1–3 households, at variable distances from their gardens (up to 3 km).

The four maps of Fig. 4 are not to scale, but generally show the ~15 km^2 area of the Lolovange community, and a diagrammatic representation of where the important streams originate. All groups noted that the terrain was characterised by parcels of land separated by major stream catchments, and that these valleys posed the greatest hazard, not only from volcanism, but also from cyclone-related floods (Fig. 4). Hence "safe areas" were identified on high-ground or major interfluves. Despite all streams in the area being ephemeral, all groups were able to distinguish valleys that were particularly dangerous.

Some of the groups described that during volcanic activity, they were told by Province authorities that they should move eastward along the coast toward Lolopuepue, where Penama Province has located an evacuation pick-up point. They also noted that if volcanic activity had already begun, this evacuation path would involve several crossings of highly dangerous areas.

Most people had seen the existing volcanic hazard map for Ambae (Monzier and Robin 1995), but since this map also displays details of geology and several different hazard zones relating to central crater, flank and ash fall hazards, they did not understand how to interpret it. As a result, they relied instead on their own perception of hazardous areas.

Community organization and outside links

Women's groups and a men's group identified similar, although not identical, hierarchies within the community

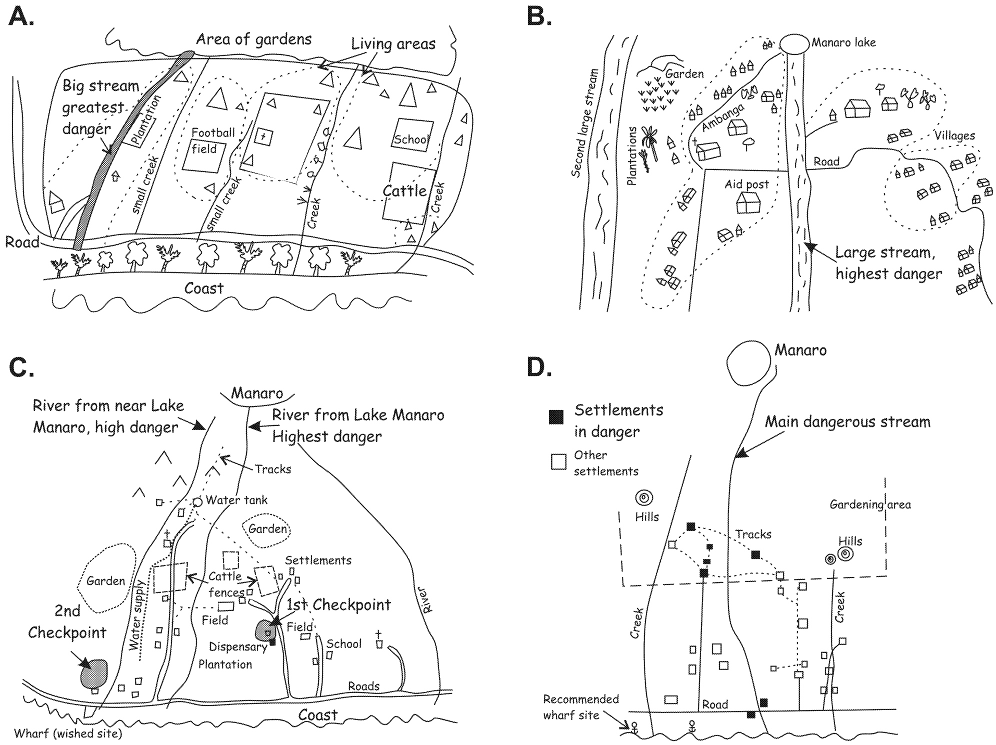

Fig. 4 Four different work-group maps of the Lolovange area. The maps are not to scale, but all show views of the ~15 km^2 area of the Lolovange community. The diagrams have been traced directly from digital photographs of the original maps, and Bislama has been translated into English. **A** Women's group from Lolovange; **B** women's group from Ambanga (related community); **C**, **D** men's groups from Lolovange. All maps are oriented with the summit area at the top (North is roughly downward). Note common features, including that main hazard areas are related to the major stream draining Manaro area, and the secondary hazard from another large stream to the east

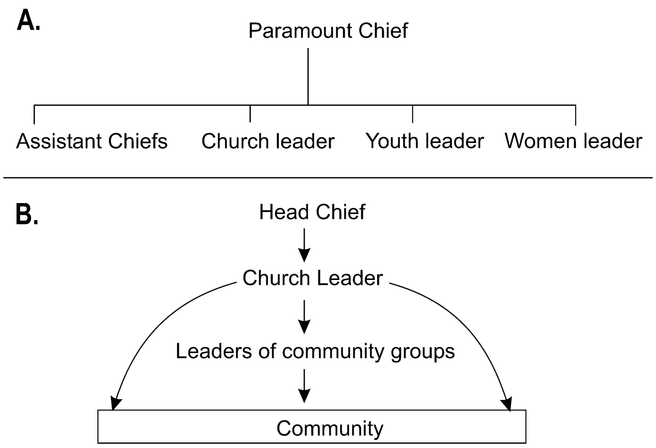

Fig. 5 Diagrams of the internal organization or decision-making structure of the Lolovange community, as perceived by a working group of **A** men and **B** women

(Fig. 5). The men's group noted that the paramount chief makes most decisions in times of emergency or disaster warnings, mostly in close discussion with assistant chiefs. The women's group described how most decisions and discussions were at the chief level, and, in many cases, little or no information about potential disaster warnings reached them at all. In the exercise session (not the open presentation), the women's group described that in past warnings of disasters from Province officials, the chiefs would not respond to them or tell others in the community, due to political rivalries or differences and distrust. The women were concerned that potentially important information concerning disaster warnings was not reaching them so they could make timely decisions about what was best for their children.

The chief's group described how it was traditional for the chiefs to make all decisions concerning community welfare during times of danger or disaster. Where signs of the onset of a hazardous event were detected, urgent meetings of assistant chiefs and high-ranking men were called using tamtams (wooden drums) or bubu (blowing into a conch shell).

The external links and assistance the community has received in past emergency or disaster situations were described by a men's work group. They included:

- Warning and awareness information from Radio Vanuatu, and the Meteorological Department.
- Survey and damage assessment from Police and Mobile Forces.
- Relief goods from Non-Governmental Organisations (NGO), Red Cross and overseas donors.

The main additional assistance that the group felt was required was the improvement of communication systems, mainly telephone and radio. The lack of communications has hindered warnings and response in past disaster events.

Warning systems, communication and information flow

Internal and external aspects of hazard warning systems proved to be of paramount importance to the Lolovange community. Therefore, an additional discussion session with the plenary group was used to address issues of communication between themselves and outside authorities, as well as within the community.

Typically, volcanic warnings (including several between 1991 and 2000) are generated by the Volcanology section of DGMWR and issued through the NDMO to the Province HQ (Saratamata, Ambae) and to Radio Vanuatu. Apart from the generating authority, the same dissemination applies for cyclone warnings. In many cases, information arrived too late to the community or not at all. The group considered that the poor communication was a function of political issues between the community and Province HQ, the absence of operational telephones in the Lolovange area and the scarcity of working radios and batteries.

The facilitators attempted to address the issues of poor internal-community information flow (raised especially by the women's group), by asking the plenary group how warning and hazard information could be spread most efficiently within the community. A suggestion was made to form a disaster committee. Ultimately, with encouragement from the facilitators, the plenary group decided that the committee should consist of Paramount Chief (chair), assistant chiefs, church leader(s), women's leader, and youth leader. The key roles of this committee were to evaluate the seriousness of warnings received from outside and coordinate those warnings with local traditional hazard monitoring signs. Decision-making roles are not challenged by this structure, and it enables a better flow of information to less powerful community members.

Community volcanic emergency plan

At the conclusion of the plenary session, a single group was charged with the task of producing a volcanic emergency plan. Because many aspects of the plan had already been identified in the previous exercises, the work of this small group helped primarily to formalise these ideas within the structure of a plan. A draft plan in the form of a flow chart (Fig. 6) was developed to identify specific internal community actions and linkages to Province-level disaster plans, upon receipt of warning from outside agencies or upon recognition of local traditional signals of volcanic unrest.

Local follow-up activities

All resources, charts, maps and diagrams were left in the community on the understanding that they would be posted in one of the church rooms and serve as the focus of later discussions. The emergency plan draft was to be scrutinised and revised by the villagers in preparation for our next visit.

Lolowai

Two men's groups, two women's groups (7–10 members) and a smaller chief's group took part in the exercises. Traditionally-living community members and other professionals living in the community were split into separate groups.

Volcanic history and hazardscape

The chiefs described that between 1700–1800 AD (about the time of Captain Cook), the present Lolowai harbour (formed by a semi-circular eroded volcanic tuff cone) was entirely closed to the sea, and was instead filled by a swamp. In addition, they also noted that four other old volcanic craters were present in this area, including Waimemea and Wailebutaga, which currently contain lakes. Their traditional views were that spirits live in these craters, and the benevolence of the volcano depends on respecting these spirits. Past changes in the local craters were apparently related to periods of drought when water level and quality was affected. They reported a single period of two weeks sometime since 1800 when dead fish were found floating on the sea surface, an event attributed to the volcano.

Traditional warning signs of volcanism from the summit (Lake Vui) region include dreams, strange sounds and unusual animal behaviour. Birds on the island migrate to Pentecost or Maewo (such as in 1994 when "smoke" – in fact steam – came from the summit area), and ants come out of the ground and swarm over the vegetation. Other signs include earthquakes and bad weather.

Volcanic events in the recent past have affected crops and food supply. Taro leaves were burnt by acid rains, and taro roots rotted quickly in the soil. In addition, mango trees did not bear fruit. Other impacts included the rapid rusting of galvanised metal, such as water pipes in the area, and impaired breathing when volcanic gases (apparently SO_2) affected asthmatics.

Resources, vulnerable elements and hazard perceptions

Mapping exercise results concentrated on the benefits of this area as a potential refuge point for evacuees from more hazardous parts of Ambae (Fig. 7). Facilities identified in the community included:

- The Provincial Hospital.
- The Provincial HQ (at nearby Saratamata).
- Vureas Secondary School (boarding school).
- Church and mission buildings.
- Commercial centre, co-op and small store.

All groups considered the Lolowai area to be safe during most types of activity centred at Lake Vui (locally known also as Manaro), largely because of its comparatively large distance and the absence of streams sourced

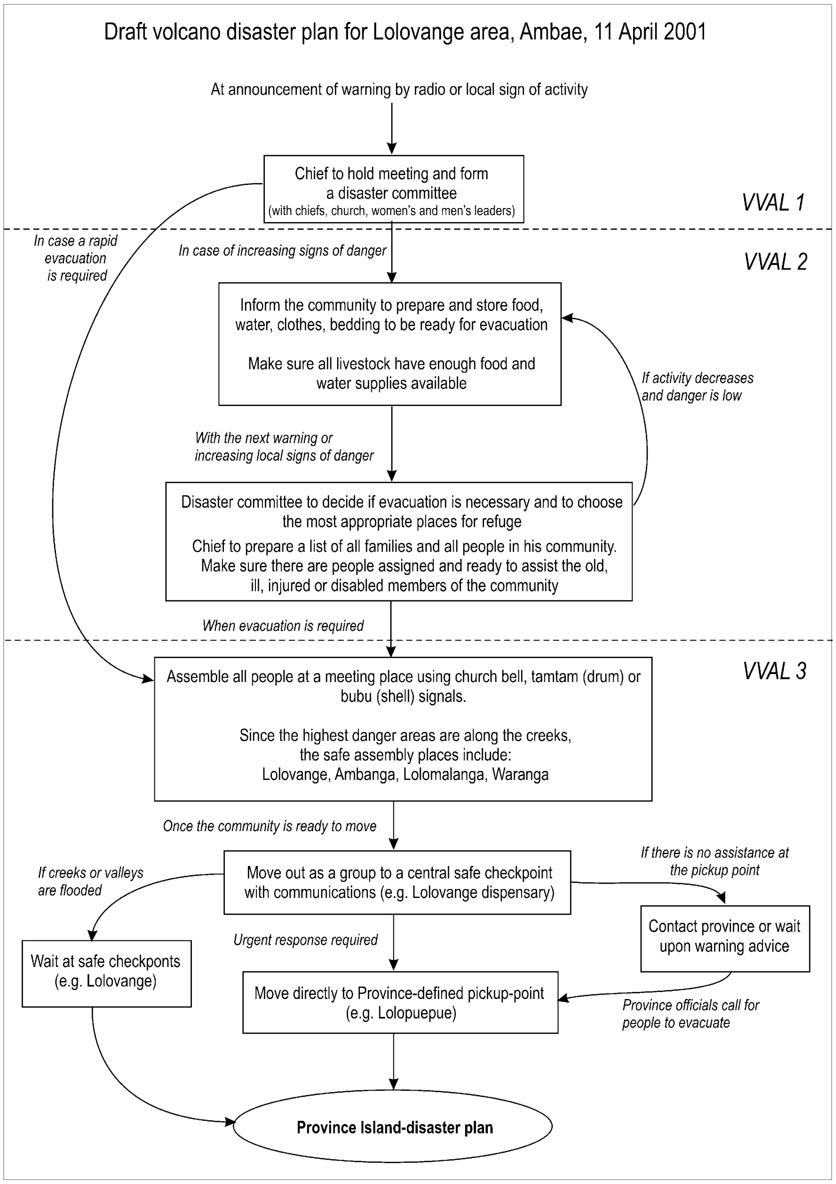

Fig. 6 Lolovange community volcanic emergency plan (translated from Bislama) as devised and revised by working groups from Lolovange. Note that VVAL numbers on the right hand side indicate corresponding Vanuatu Volcanic Alert Levels for Ambae, as shown in Table 2

from the summit area. Men's groups identified three locations in the area where an evacuation off the island could be staged, and where relief supplies could be landed. In addition, both women's and men's groups considered the Provincial Hospital grounds as an appropriate refuge, because of its many houses and radio and telephone communications. Another possibility for nearby accommodation included the Vureas Boarding School, while the nearby Provincial HQ area at Saratamata was considered unsafe since it is in a low-lying area vulnerable to tsunami. The women's group outlined the location of water supply lines, and based on their knowledge of community structures, determined that up to 1000 people could be housed temporarily in this area.

Warning systems, communication and information flow

The community organization structure of Lolowai is more complex than that of Lolovange. There is an abundance of high-ranking people, including the paramount chief(s), the Head Province Health Officer, Church and Mission leaders, Principal of Vureas School, business leaders, as well as heads of departments located in nearby Saratamata. Once again, women reported that they were poorly represented in decision-making processes. Unlike Lolovange, however, communication of villagers with outside agencies was easier, due to greater availability of telephones and radios and proximity to the Provincial HQ. Not surprisingly, past emergency management decisions for the community were made largely by the chiefs, the Head Provincial Health officer, and the Vureas School Principal.

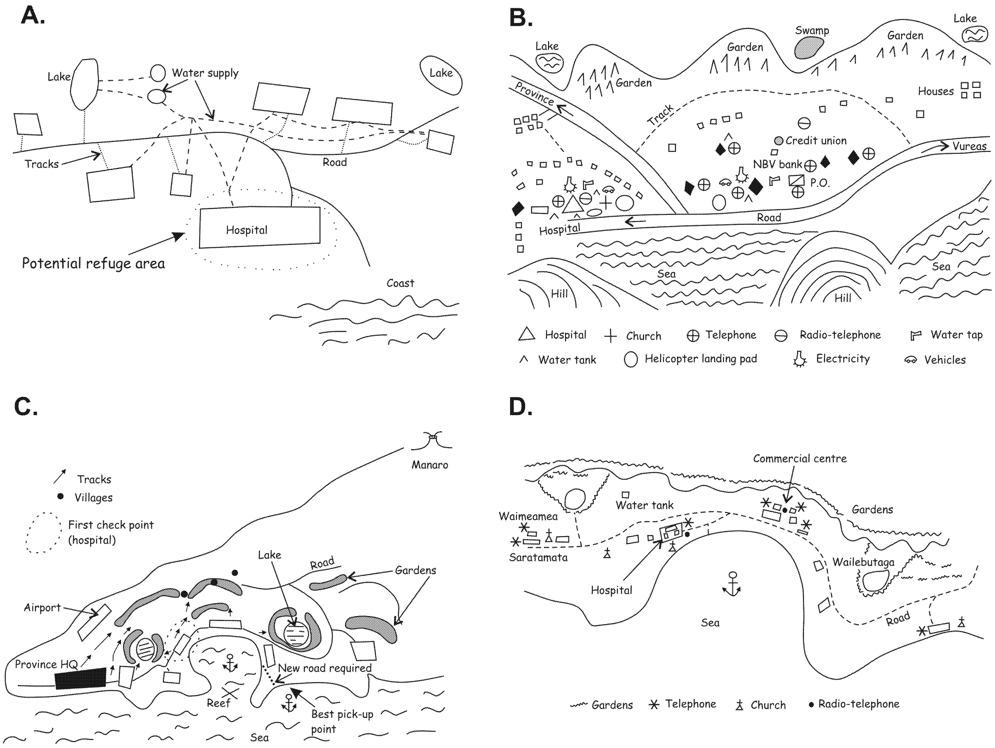

Fig. 7 Maps of the Lolowai area, locations of facilities and services, and potential refuge and pick-up locations from the perspectives of four working groups. The maps are not to scale, but all show views of the ~20 km^2 area of the Lolowai community. The diagrams have been traced directly from digital photographs of the original maps, and Bislama has been translated into English. **A**, **B** Women's groups; **C**, **D** men's groups. Map view is with coast at base (North is roughly downward). Note that the two lakes common to all maps, the refuge area indicated at the hospital, and the preferred pick-up point of group C in the deep-water harbour west of the Hospital bay (with reef at entrance). No volcanic hazards are indicated on the map, since these are associated with stream valleys that are far from this area

Community volcanic emergency plan

Group results were combined during a plenary session into a summary volcanic emergency plan for Lolowai using a flow-diagram format (Fig. 8). The plan that emerged included protocols for receiving incoming evacuees from elsewhere on Ambae, in case of a Vui-centred volcanic eruption that does not threaten the Lolowai area. The plan also considered the case of a large-scale volcanic emergency where Lolowai would be forced to serve as a staging point for a larger scale off-island evacuation.

Local follow-up activities

This community decided to set up a disaster management committee, consisting of the paramount and assistant chiefs, church and mission leaders, hospital and local department heads, Vureas Principal, business leaders, a women's group leader and a youth group leader. The Lolowai disaster committee decided to meet afterwards to consider the outputs of the workshop, particularly in terms of refining aspects of the draft community volcanic disaster plan.

Follow-up visit

Three main activities were carried out six months later in a follow-up visit to the two target communities on Ambae.

Revision and relation of community-developed volcanic emergency plans to province and national-level plans

The original draft community plans were prepared using a dual format of Bislama and English; subsequently, we revised these plans to be reported entirely in Bislama. In addition, ongoing improvements to the warning systems of the Volcanology Section of DGMWR led to development of a five-level volcano-alert or hazard-status system (Vanuatu Volcanic Alert Level system, VVAL; Table 2). This numerical system conveys the DGMWR scientific assessment of the volcano activity status. For each volcano in Vanuatu, historic eruption descriptions and local geological parameters have been used to develop individual decision-support tables, where observation and/or instrumental-based activity thresholds are triggers for setting VVALs (Tables available from DGMWR, Port Vila). Once decided by DGMWR, the VVAL status is declared through the National Disaster Management

Fig. 8 Lolowai community volcanic emergency plan (translated from Bislama) as devised and revised by working groups. This plan takes into account this area's potential role as a refuge centre for evacuees from more hazardous parts of the island during summit-based eruptions. Note that VVAL numbers on the right hand side indicate corresponding Vanuatu Volcanic Alert Levels for Ambae as shown in Table 2

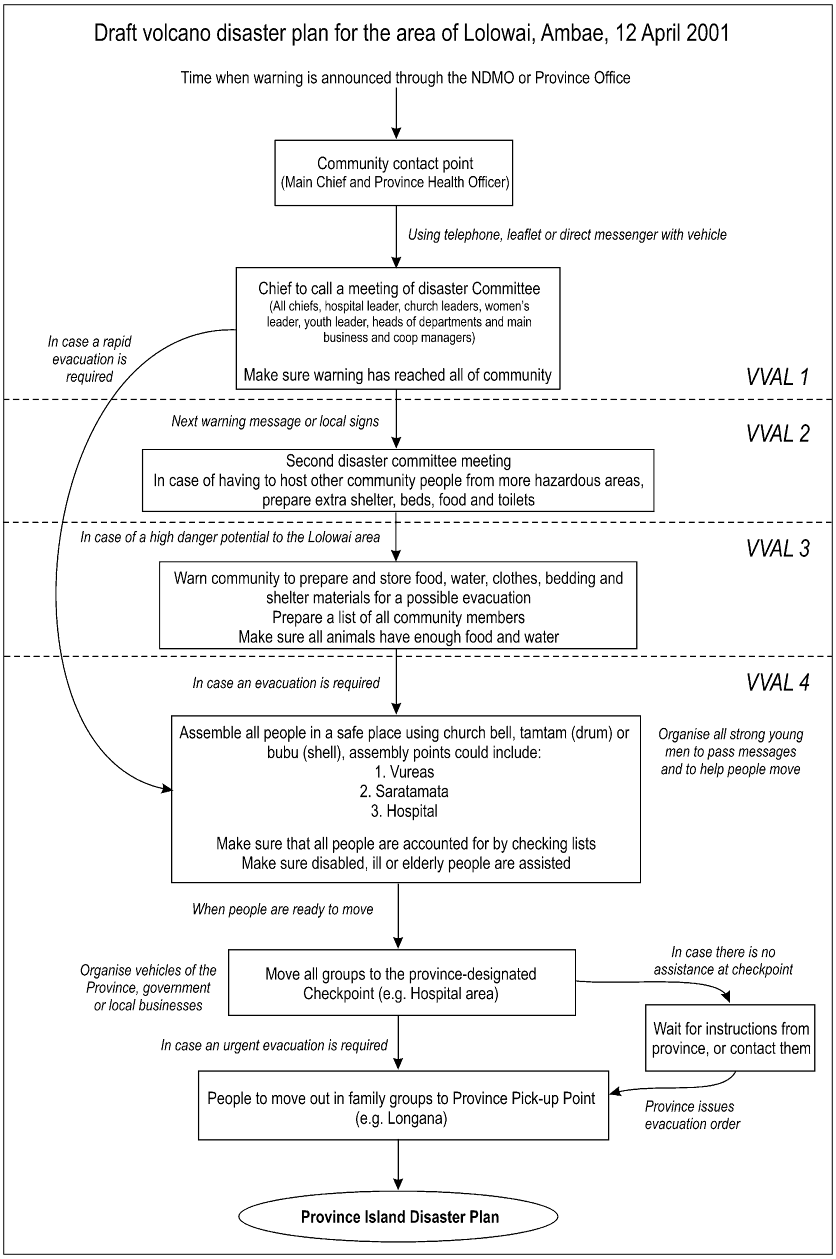

Table 2 Department of Geology, Mines and Water Resources Vanuatu volcanic alert level (VVAL), or activity status system developed for re-awakening volcanoes such as Ambae (in English and Bislama)

VVAL	Characteristics of activity and areas affected (refer to Ambae volcanic hazard map, Fig. 9)	Wanem kaen aktiviti blong ol Alet o stanbae Level
0	Normal, quiet	Nomol. Volkeno islip kwaet nomo.
1	Signs of awakening	Ol saen blong volkeno iwandem faerap bakegen.
2	Confirmation of awakening, minor eruptions and danger near to crater within parts of Red Zone	Volkeno hemi kirap o aktiviti blong volkeno istap incris. Volkeno istap faerap smolsmol. Ikat denja kolosap long maot blong volkeno, insaed long Red Kala Eria.
3	Moderate to large eruption, danger in Red Zone and parts of Yellow Zone	Volkeno ifaerap smolsmol mo faerap bikwan. Ikat bik denja kolosap long maot blong volkeno mo insaed long ol men hol blong wota mo krik. Denja hemi stap insaed long Red mo Yelo Kala Eria.
4	Very large eruption, island-wide danger (including areas within Red, Yellow and Green Zones) and potential impacts on neighbouring islands	Volkeno ifaerap bikwan. Ikat bikfala denja long aelan mo bikfala efek mo denja long ol aelan kolosap. Denja hemi stap insaed long Red mo Yelo mo Grin Kala Eria.

Office. This system provides a simple potential framework to help trigger various phases of the community and higher-level emergency response plans, and help community leaders commit to decisions within their own response plans (Figs. 6, 7, 8).

Discussion of a revised volcanic hazard map based on both scientific and local perceptions

The existing volcanic hazard map for Ambae (Monzier and Robin 1995), although widely distributed, was not understood by many in the local community. From our first visit, we noted that this problem did not appear to be due to different perceptions of where the hazards were higher or lower, but more to different perceptions of how these hazards were portrayed on a map or visualised in terms of the local landscape. In addition, we determined early on to concentrate more on the physical manifestation of the volcanic hazard processes, particularly lahars, than on the beliefs or traditions of how and why volcanic activity was started. By combining the traditional perspective of tambu/tabu concerning the summit area with the scientific knowledge that this was the active vent area, this region became part of a "high hazard zone" on the map. It was not necessary for either party to convince the other of their reasons (traditional versus scientific), because the net result was the same – the area is subject to high hazard and should be avoided. In the same way, lahars are also viewed by both groups as being fast-moving mixtures of mud, rock and water that sweep down particular valleys, without any need to challenge either party's perception as to how they were formed. The most important aspect of this exercise was that the Lolovange participants wanted to emphasise that the valleys were particularly dangerous, something that was not clear from the circular hazard zones of the previously existing scientific map. In addition, our perspective was also that lahars posed the highest threat, because the most recent events from the volcano were centred on the summit crater, and even small eruptions within the summit crater lakes have the potential to generate lahars with little warning.

The resulting map used local recommendations from the village exercises to produce an island hazard map that is different from previous versions as follows:

– All geological mapping details have been removed.
– All expected hazard processes (ashfall, gas, surge, and lahar) are contained within three relative hazard zones.
– Three solid colours are used to cover the entire island, whereas the previous map had five, partly overlapping, unfilled ovals or circles for different hazard processes that left parts of the island unzoned.
– A colour system of red (high relative hazard), yellow (medium), and green (low) was adopted.
– Lahar hazards are highlighted by thick red lines that follow all major drainage channels from the central caldera (emulating the village map emphasis).
– The text is in Bislama and is reduced to the important message of relative hazard levels, replacing the lengthy French/English volcanic descriptions.
– The activity of the central crater is the primary consideration.

The map that resulted (Fig. 9) is not sufficiently precise for land-use planning or determining hazards on a settlement-by-settlement basis, but it represents both scientific (Monzier and Robin 1995; Garaebiti 2000) and traditional views of the relative levels of hazard on Ambae. The main use of this map is in public education, and as a focal point for encouraging volcanic hazard mitigation and response planning.

Community volcanic emergency management guidelines developed from the Lolovange and Lolowai target community exercises

Following the two original community exercises, a general volcanic emergency management framework was developed in Bislama, listing the main tasks required at various volcanic alert levels. This document was designed to disseminate the village-based exercise results and complement ongoing awareness and developmental planning programs on Ambae and other volcanic islands of Vanuatu.

Specific issues raised in follow-up visits

At Lolovange, 24 adults participated, including 7 women; most had taken part in the initial visit. Regional differences in Bislama were the focus of many comments concerning the community volcanic emergency plan. In addition, discussions and a letter from the community disaster management committee addressed two main concerns. First, the plan hinges on communications with the Provincial Office, and the assembly point defined in the plan has no working radio-telephone (although the infrastructure is in place). Second, the province-specified evacuation centre at Lolopuepue requires crossing several high-risk valleys, one of which is known to be impassable during floods. To address the second point, it was considered that evacuation to Lolopuepue should be carried out before lahars began. If lahars were flowing, the community should wait at a safe interfluve location (like central Lolovange) until the danger had passed. Questions were also raised regarding prior arrangements about evacuating people off the island in the event of sustained volcanic activity. These questions obviously stemmed from suspicions raised during the evacuation planning that took place in 1995.

Hazard map amendments which were requested included adding village locations and province evacuation centres, along with text changes to replace English terms with descriptive terms (for instance, "explosion" was replaced by "nois blong volkeno").

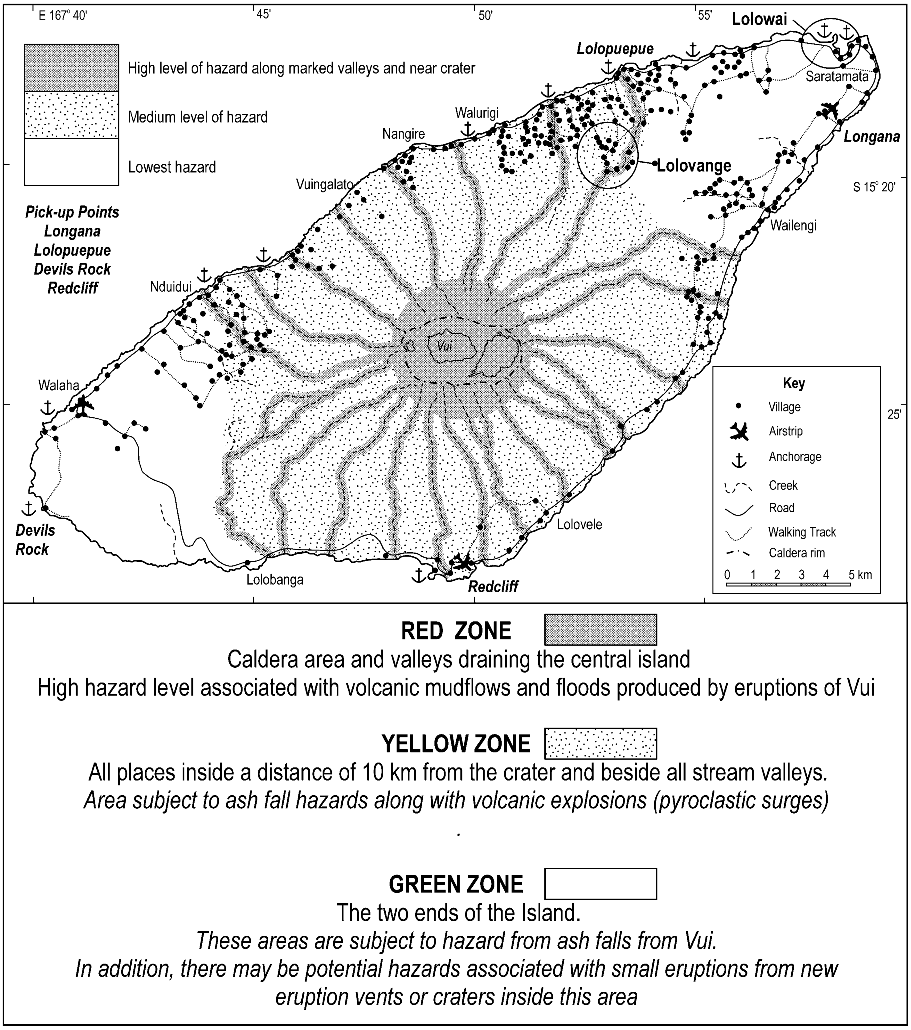

Fig. 9 Black and white, English language version of the revised three-colour hazard map for Ambae, primarily taking into account renewed activity of the main summit crater and disturbance of the crater lakes. The three hazard zones indicate high, medium and low relative levels of hazard to life

At Lolowai, 49 adults (including 23 women, and 16 children) took part in a similar series of group activities as described for Lolovange. This group responded similarly to the community plan and hazard map text. Additional concerns of this community included the need to revise an assembly point location, and uncertainty about the disposition of their livestock (an important economic resource) in the event of an evacuation. Experience has shown that if animals remain penned or secured when people leave for less than a week, they will probably not damage crops and gardens. However, if an evacuation is longer, penned animals could starve, necessitating that they be set free and recaptured later. This situation occurred in 1995 on Ambae. Animals were set free and much to the villagers chagrin, the evacuation was short and many subsistence gardens were destroyed.

Discussion

Integrating scientific and local world views

As described earlier, we did not attempt to integrate or reconcile belief systems between local and scientific viewpoints with respect to the causes and generation of volcanism on Ambae. This seemed an unnecessary, undesirable and unattainable endeavour, considering the variety of local cultural views. However, we aimed to integrate both inside and outside views of the physical hazards posed by volcanism, particularly the physical nature of lahars and the hazards they posed. The issues discussed were not complex, so we could focus our common points of understanding with the simple facts that lahars are dangerous and similar to sediment-rich floods, and they flow in valleys, especially in valleys draining the crater or tambu/tabu area at the summit of Ambae. Hence, the best way to protect the community from lahars was to retreat to the high interfluves, or if there was sufficient warning, to locations such as Lolowai. Other common ground is found simply by using the local concept of tambu/tabu, where for either religious or scientific reasons, approaching or developing the summit area of Ambae is discouraged. These seem like small steps, but they are steps toward improved understanding between local and outside scientific viewpoints, and are important to engender trust and a sense of common ground for the development of local education materials and community and island-based planning.

PRA implementation

Typical implementation of PRA takes between one and three weeks, including preparation and follow-up synthesis activities and about 4–6 days to gather data (Chambers 1992; Bar-On and Prinsen 1999). Chambers (1992, 1997, 2002) emphasises the aspect of "relaxing not rushing". We found, however, that despite the intention of not rushing, the communities on Ambae were not available to work on a participatory program day after day. Irregular events such as funeral preparations and festivals, along with normal community, church and food gathering activities, leave little other time free, necessitating that our visits be short and efficient. In order to balance the need for full consultation with the intrusion on community life, we found that a full day with groups of 30–50 people was sufficient to conduct the main exercises and activities and produce useful results. This compromise minimised issues of villager resentment that their time was being taken away from other activities. Differences in community approaches must also be considered, because, while spending longer periods over several days in relatively unstructured activities with small groups was possible in Lolowai, it was not in Lolovange, where it was considered impolite to engage in activities that did not involve chiefs.

The success of the working groups appeared to depend primarily on their individual compositions, with the presence of strong personalities who possessed good organisational skills a major factor contributing to success. Facilitator skills appeared to play a secondary role to having strong group members, although facilitators with patient and respectful demeanours and who possessed familiarity with the communities appeared to be the most successful in helping establish good communication within the groups.

We estimate that between 3–8% of the members of each community took part in our initial or follow-up activities. With such a small percentage, it is not clear whether the sample population with whom we interacted was representative of the community as a whole. Through a series of preliminary meetings and visits by Province officials and the facilitators, the communities were sensitised to the activities and, judging from the inputs into mapping exercises, the participants came from the full geographic range within each community. Pragmatically, however, it seems likely that the most accessible and highest-ranked members of the communities were overrepresented.

Power roles and concerns

In both communities, women's groups raised the concern that whatever suggestions and plans they made would be overlooked, as would their role in any disaster management decisions. Traditionally, decisions are made by high-ranking males in the community, especially head and assistant chiefs. The women considered that the chief's power in these matters would ultimately lead them to being the sole decision-making body for internal warnings and evacuations. The women's group in Lolovange was particularly concerned that they had not been informed about past warnings that were supplied to chiefs from Province officials.

The gender-separated participatory exercises proved valuable for identifying and voicing these within-community community gender and power issues, but only within the working groups. Bringing these issues into a community-wide discussion was not straightforward using traditional PRA approaches; that is, women's group presenters were not sufficiently confident to discuss these issues in an open forum, and at best their views were only acknowledged fleetingly. To maintain trust and dialogue with the community, we felt bound to focus on issues of internal information transfer, and not on internal community power structures. It would have been easy to "take sides" with a particular sector of the community and thereby lose the trust of other sectors. In addition, any attempt to bring about change in community structure during our activity not only would have been impossible but also folly. To address gender-based issues in a positive way, we encouraged villagers to consider filling their disaster committees in a manner similar to those used for church groups and for developmental planning, which include women and youth. We argued that including women and youth members on the disaster committee would improve the efficiency of transferring warning and decision-making deliberations to their sectors of the community. We also held the hope that discussions within the home between husband and wife might indirectly influence chiefly decisions with respect to hazard management.

The weakness of inter-gender community interactions is a failure common to many PRA activities (see Humble 1998; Percy 1999); apart from the measures outlined above, we could provide no realistic basis by which to mediate it. A potential future strategy for addressing gender issues within the community would be to develop and implement gender-separate education programs on natural hazards and hazard management. These programs could be organised through church groups or within ongoing cultural-development programs in the rural community. Building greater awareness of hazard issues among women and youth in the community may lead to greater internal pressure to be part of decision-making discussions.

That PRA activities rarely allow participants to move beyond publicly "safe" discourse has been described in other case studies (see, for example, Bar-On and Prinsen

1999) as intimidation of the weak by the powerful at meetings (Kapoor 2002). Despite the spirit of open communication and reversal of power hierarchies during PRA activities, the participants on Ambae seemed well aware that they would return to their normal societal roles afterwards.

By involving the powerful chiefs in a structured way during our activities, we managed to avoid the problems of "elite capture" (refer to Bar-On and Prinsen 1999); that is, a restricted discourse with the powerful only. We considered it important to involve the elite class, both in group meetings and later in the plenary session, to minimise issues of distrust amongst community members and enable this upper class to hear perspectives from the community that they might not otherwise hear. Chiefs did not participate in other male group exercises, and instead were part of a group facilitated by a high-ranking chief (albeit from another part of Vanuatu).

Education versus facilitation

PRA is often criticised because it overemphasises indigenous knowledge, legitimising it as being equal to mainstream knowledge; at times, PRA may also deride non-indigenous knowledge (Bar-On and Prinsen 1999; Kapoor 2002). In addition, the claims of Chambers (1992, 1994a, 1994b, 1994c, 1997), that the best solutions to community issues are to be found within the community itself have been called into question (Mosse 1994). Related to this issue is that conventional PRA facilitators are non-interventionist and neutral, excluding their roles as educators (Von Kotze 1998). We considered it important to heed these criticisms of PRA, but within the framework of a respect-based partnership or dialogue with the two communities on Vanuatu. The PRA approaches, used initially in a standard facilitative manner, were an ideal way to begin building this respect, bring traditional knowledge to the forefront, and allow its critical appraisal. In later open forum sessions, and during the second stage of our activities, we introduced outside scientific and hazard management perspectives, and tried to integrate these ideas into a revised volcanic hazard map and the community volcanic emergency plans and guidelines.

Community volcanic emergency plans

Like many communities in the southwest Pacific, the villages on Ambae are isolated and poorly serviced with telecommunications. Therefore, local initiative is essential in responding to volcanic or other natural emergencies. Cyclones and their preceding signs are heeded by Ambae communities; both the natural preceding phenomena and publicly broadcast warnings. For volcanic activity, although less common, similar warning is possible. Traditions of the older community members included both directly sensed volcanic warnings (explosive sounds, gas release, steam plumes, acid rain, earthquakes) as well as indirect signs of activity (warm ground, strange activity of ants and birds, visions and dreams). Chiefs and elderly participants of the PRA activities say that some of these traditions are being lost or modified with new education and church teachings. We hope that by including these locally derived data in community plans, valuable pre-event warning knowledge will be preserved and also more widely distributed in the community, in addition to the VVAL warnings.

One of the main features of Ambae communities is that they are not concentrated in large central villages, but instead are dispersed into relatively small family groups. In addition, it was revealed that due to local conflicts and political rivalries, communication with, and trust of other communities or the Province administration can be strained. These factors hinder rapid internal information dispersal, as well as the operation and applicability of externally developed top-down emergency plans. Our project has so far indicated that community boundaries, internal communication structures and political allegiances are best addressed when communities are assisted to derive their own emergency plans. If evacuation is a possible outcome of a plan, the community will ultimately decide itself whether or not to move.

Conclusions

Scientists and emergency managers are always going to be faced with difficulties of conveying knowledge of volcanic hazards to non-specialists. In the case of Ambae, Vanuatu, the gulf between scientific and local perspectives is even greater, beginning with fundamentally different world-views and beliefs. This need not be a barrier to communication, and we demonstrate a methodology by which traditional and scientific knowledge can be partly merged in order to better prepare communities at risk from volcanic hazards. During modified participatory rural appraisal activities, we were able to link a series of broad concepts, including the means by which lahars are generated from volcanoes with crater lakes and how they move, with local knowledge of past lahar events as preserved in oral history. By making this link, we established a common ground for communication about hazards that also demystified the science.

Through PRA approaches, a dialogue based on respect between communities and outsiders can be built. Both parties are more disposed to learn through the PRA activities. Later-stage activities can move beyond the PRA maxim of non-interventive listening, and the belief that all solutions can be found within the community. Instead, a dialogue allows introduction, criticism and adoption of strategies and plans based on a combination of inside and outside (scientific) information. Community exercises demonstrated how hazards are visualised by the local population, providing a key to the development of a more readily-understood volcanic hazard map. In addition, traditional warnings and decision-making practices could be combined with outside ideas to develop community volcanic emergency plans.

Problems we identified in our approach included the following: only a small proportion of the community, dominantly the elite or better-informed, are directly involved in activities; concerns raised in gender-segregated and hierarchical exercises are not addressed satisfactorily; without ongoing commitment, successes may be short-lived.

While we describe an activity in a developing country where contrasts in perspectives are huge, the principles of considering local views can be used to adapt and communicate scientific hazard information to non-scientists anywhere.

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