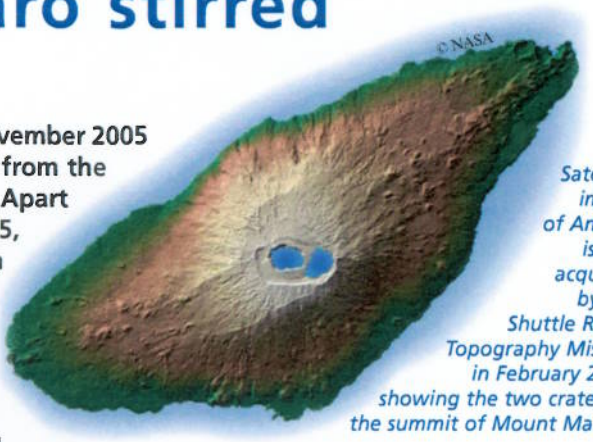
# The day **Mount Manaro stirred**




*Satellite image of Ambae island acquired by the Shuttle Radar Topography Mission in February 2000, showing the two craters at the summit of Mount Manaro*

**The tranquil peace of Ambae Island was shattered on 26 November 2005 as a plume of steam and black 'smoke' was sighted rising from the crater-lake at the summit of the island's volcano, Manaro. Apart from small 'hiccups' with steam plumes in 1991 and 1995, Ambae's 10 000 inhabitants had not seen a large eruption for more than 100 years. Hence, Ambaens were justifiably tense although by no means panicked. Instead, by 28 November, a local disaster committee had formed and evacuation had begun. Within another eight days, more than 3300 people had been relocated from endangered areas to refuge centres in two different parts of the island.**

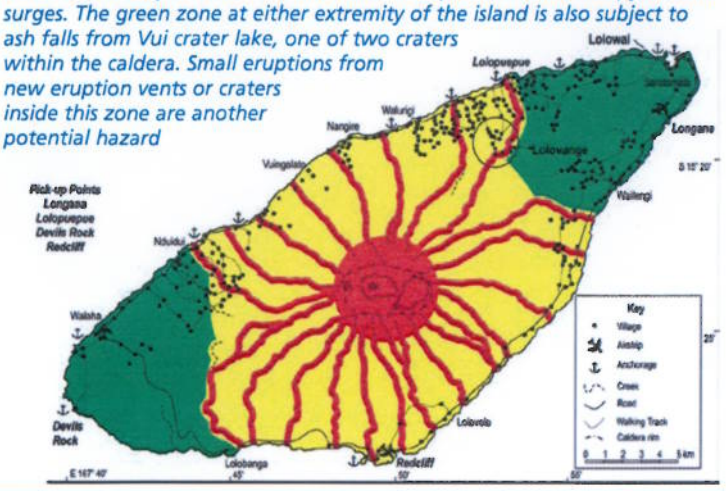
**This mini-success story was not without its problems or minor controversies but the locally based emergency response was well planned, rapidly executed and involved minimal expense or outside assistance. What can be learned from the eruption and how can it be used to improve community emergency planning in both this and other parts of the world?**

Ambae Island comprises the largest and arguably the most hazardous of Vanuatu's volcanoes. Past eruptions have involved both lava flows and lahars, which are volcanic mudflows. The more recent eruptions known to have caused casualties are thought to date back to 1870 and 1914.

The islanders lead a subsistence lifestyle. They are widely dispersed among more than 276 small extended family settlements and villages. The community is strongly fragmented. Two main languages are spoken and up to 12 dialects. In addition, communications on the island are limited, with no road linking the eastern and western tips and many settlements lacking telephone communications.

***Hazard map for eruptions from the central vent of Mount Manaro***

*The red zone is comprised of the caldera (see overleaf) and valleys draining the central peak. This high hazard zone is associated with volcanic mudflows and floods. The yellow zone spans a distance of 10 km from the crater and is subject to ash fall and volcanic explosions known as pyroclastic surges. The green zone at either extremity of the island is also subject to ash falls from Vui crater lake, one of two craters within the caldera. Small eruptions from new eruption vents or craters inside this zone are another potential hazard*




The local administration includes two parallel systems: the government service reporting to Vanuatu's capital Port Vila on Efate Island, represented by the Penema Province office and a local hierarchical structure of community governance that steps up from Nakamals (2–3 extended families) to Wards (several Nakamals) and finally Areas (several Wards), each with their own chiefs.

## The stage is set for an emergency

Village-based emergency management planning in developing countries has been the focus of many recent initiatives and policies, including those driven by most major development agencies. Increasingly participatory techniques are being adapted to disaster management.

Since 2000, UNESCO's Office in Apia has been working with a team of researchers led by Dr Shane Cronin of the Institute of Natural Resources at Massey University in New Zealand, as well as the government and local communities in Vanuatu, to use a blend of volcanology and traditional (*kastom*) knowledge as the starting point for disaster-preparedness planning.

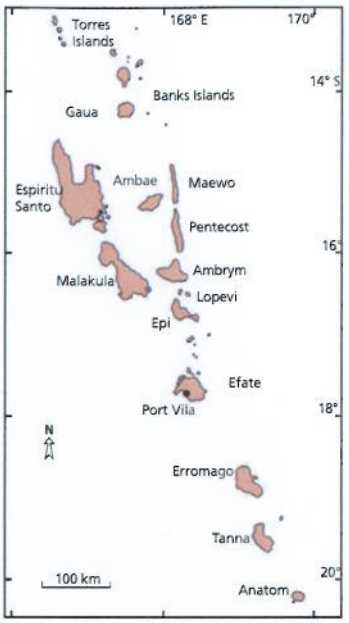
Using a strategy developed from case studies in Fiji and the Solomon Islands, Shane Cronin and his colleagues ran a series of participatory community workshops supported by UNESCO and others on Ambae from 1999 to 2003. The workshops sought to develop trust in scientific warnings and volcanic monitoring tools so that these could eventually be installed on the island. A second purpose was to preserve the traditional knowledge of community hazard preparedness and volcano-influenced cultural practices and

incorporate these into modern disaster management plans for rural parts of Vanuatu.

A range of group exercises were used in the participatory workshops to develop skeletal Nakamal emergency response plans both for the communities which would need evacuating and those which would be hosting the evacuees.

To improve the visual presentation of volcanic hazard, the template for a new hazard map (see facing page) was developed through workshop exercises that elucidated how the Ambaeans themselves represented landscapes and volcanic processes/impacts on sketch maps.

The results of these exercises in several volcanic islands around Vanuatu were eventually




*Ambae island is part of the New Hebrides island arc in Vanuatu, an archipelago of 83 islands. An island arc is a string of volcanic islands (usually curved) that forms when one oceanic plate subducts (or plunges) under another oceanic plate. One crust has to plunge beneath the other because the Earth's diameter is constant: when a new surface forms, an equivalent surface has to disappear, otherwise, the planet would swell like a balloon! As the oceanic crust descends into the Earth's mantle, it progressively heats up until, at a depth of 100–150 km, it loses the seawater it contains. This leads to the partial fusion in that part of the mantle of periodites (rocks at depth composed of iron and magnesium silicates) and to the formation of magma. This magma rises vertically and pushes through the overriding plate to reach the surface, creating a chain of volcanoes. The Lesser Antilles, the Aleutian Islands, Vanuatu and Tonga are all examples of island arcs. When the crust of the upper plate is continental rather than oceanic, a volcanic mountain chain is formed near the edge of a continent. This is known as a cordillera arc, like the Andes Cordillera in Latin America. (Taken from Bouysse, P. (2006)* Explaining the Earth: *UNESCO Publishing/ Nane Publishing)*

## One of the world's 10 most dangerous volcanoes?

Mount Manaro may have no visible vents at its apex, only crater lakes, but it is obviously active (as opposed to dormant or extinct), as the steam and ash (phreatic) eruption in November 2005 so aptly demonstrated.

A phreatic eruption occurs when rising magma makes contact with ground or surface water. Also known as steam-blast or ultravulcanian eruptions, phreatic eruptions are generally quite weak. They occur when surface water or cold ground comes in contact with hot rock or magma. This causes expanding steam to explode, blowing out water, ash, rock and volcanic bombs (a ball of molten rock greater than 65 mm in diameter) ranging from 600 °C to 1170 °C. Phreatic eruptions occasionally create broad, low-relief craters called maar, as in the case of the Manaro eruption in November 2005. The main feature of phreatic explosions is that fragments of solid rock but no new magma are erupted from the central vent. A less intense geothermal event may result in a mud volcano.

Manaro has been described as one of the world's top ten 'most dangerous' volcanoes, in terms of potential for a catastrophic eruption. One theory has it that, in a large eruption, the water in Manaro's crater lakes could become superheated steam and cause a massive phreatic explosion. The resulting landslides down the island's steep slopes could cause tsunamis within Vanuatu's northern archipelago. Phreatic explosions can be accompanied by emissions of carbon dioxide or hydrogen sulfide. The former can asphyxiate at sufficient concentration, as in Java in 1979 when a phreatic eruption killed 149 people, most of whom were overcome by poisonous gases.

*Sources: US Geological Survey; Wikipedia online encyclopedia; Bouysse, P. (2006)* Explaining the Earth. *UNESCO Publishing/Nane Publishing*

US Geological Survey

*A phreatic eruption from a 'grey volcano', Mount St Helen's in Washington (USA). It is believed the 1883 eruption of Krakatoa along the Indonesian arc was a phreatic event. Source US Geological Survey*


*There are two main types of volcano: 'red' volcanoes like Mauna Loa (Hawaii, USA), which have effusive eruptions in which partially fluid magma emerges to form a lava flow; and 'grey' volcanoes like Ambae, which have explosive eruptions in which gas and fragmented lava (as ash or thick blocks depending on the size of the particles) are projected into the air. 'Grey' volcanoes can produce catastrophic eruptions, whereas 'red' volcanoes generally present little danger to neighbouring populations*

*Source: US Geological Survey*

incorporated into a central national volcanic warning system (the Vanuatu Volcanic Alert level System), and hazard planning templates based upon this for communities, Province administration, businesses and national authorities. This process was extended on Ambae by the concurrent development of the Penema Province Disaster Plan, which included specific responses to changes in alert level during a volcanic crisis on Ambae.

### A climate of distrust

Prior to the workshops, a climate of distrust prevailed in the community, born of the conflicting *kastom* and scientific viewpoints when it came to volcanic hazard and hazard management. Much of *kastom* belief is built on legends like, for example, eruptions can be started and stopped by sorcerers. Designated *tambu* (forbidden) zones are one form of *kastom* hazard mitigation.

In 1995, this inherent distrust was stoked by miscommunication and an aborted evacuation attempt during minor volcanic unrest. Part of the problem lay in that fact that previous versions of a complex scientific volcanic hazards map had been misread in the community.

The group exercises during the workshops held between 1999 and 2003 had gone some way towards bridging the gulf between scientific and *kastom* perspectives on Ambae, especially by incoroporating traditional warnings and decision-making practices in community volcanic emergency plans. Local knowledge of warning signs is particularly important on an island with no permanent volcano monitoring equipment. These signs include the migration of birds off the island, unusual insect and animal behaviour, die-off of vegetation and changes in lake colour.

The scope of the workshops was limited however by the fact that only a small proportion of the community (3–8%) actually participated. In addition, many of the community concerns raised in gender-segregated and hierarchical exercises were not satisfactorily addressed, including the lack of representation of women and youth in decision-making and difficulties in province–community relationships.

### Eruption!

On 26 November, steam plumes from the summit of Ambae about 1400 m above sea level alerted the local inhabitants to the start of the eruption. Vanuatu volcanologists released a bulletin on 29 November confirming that an eruption was in progress and that, since explosions were rising through the water-filled crater known as Lake Vui, there was a risk of lahars or mudflows.

Difficult weather and access prevented the first scientific observers from reaching the eruption site via air or land before 3 December. The eruption had formed a new island in Lake Vui and spectacular but small explosions continued, building up in magnitude to a peak around 12 December. By around 22 December, explosions had become very small and rainfall was starting to erode the newly-formed island. Small eruptions continued until mid-January and a small steam plume has persisted ever since.

With hindsight, it transpires that there was little risk of lahars during the escalation phases of the eruption. This was just as well, since there was little scientific advice available and no monitoring equipment. When Mount

## What is a caldera?

A caldera is a large, usually circular depression which forms when a volcano collapses onto itself. This happens during an eruption when the magma chamber empties, creating a void beneath the summit of the mountain which weakens the structure. A caldera can form during a single massive eruption or gradually in the course of a series of eruptions.

Calderas and craters are both circular depressions but craters are much smaller than calderas and are created mainly by the excavation of rock during explosive eruptions. Whereas a crater forms at the summit of a volcano, a caldera collapses the volcano, as in the photo.

Caldera are 'supervolcanoes' resulting from an eruption measuring at least 8 in the Volcanic Explosivity Index. Caldera-forming eruptions are the largest on Earth, expulsing at least 1000 km$^3$ of magma and pyroclastic material. They are thought to be so powerful that they destroy virtually all life for hundreds of kilometres around.

Examples of caldera are Ambae in Vanuatu, Long Valley (see photo) and Yellowstone in the USA (formed approx. 640 000 years ago), Toba on the Indonesian island of Sumatra (approx. 71 000 years ago) and Taupo in New Zealand (approx. 27 000 years ago). The Taupo caldera encompasses a crater lake 46 km long and 33 km wide, as well as several towns. One of Yellowstone's three caldera is 45 km wide and 75 km long!

The eruption of Mount Toba is believed to have plunged the Earth into a volcanic winter for six years and into an Ice Age for 1000 years that was colder than the last Glacial Maximum (18 000–21 000 years ago). This would have decimated the human population, with the few survivors finding refuge in tropical pockets of equatorial Africa, a theory substantiated by genetic evidence.

*Source: US Geological Survey*

US Geological Survey

*Long Valley caldera in the USA is a 15 x 30 km depression. It formed during an eruption 760 000 years ago. As tens of thousands of years can separate two eruptions of a caldera, it is difficult to say whether a specific caldera is dormant or extinct*

Photo K. Nemeth

Photo M. Harrison

*Explosions through crater lake Vui at the summit of Ambae on 4 December 2005 (left) led to the formation of a new island in the crater which can be seen (right) letting off steam here eight days later. This type of eruption, involving contact of hot magma and water, is known as a Surtseyan, after descriptions of the eruption of Surtsey Island in Iceland*

Manaro stirred, the void created by a lack of community knowledge of past deadly eruptions or lahars in 1870 and 1914 left the islanders with no choice but to improvise.

### The islanders organize themselves

As soon as the volcanic activity was confirmed on 28 November, local government officers stationed in the area and members of the Provincial Council set about forming the Penema Disaster Coordination Committee at the provincial government headquarters in Saratamata in the northeast. A similar group, the West and South Ambae Disaster Committee, soon followed suit in Walaha in the southwest.

The Penema Committee began by requesting the support of a volcanologist; it then developed an operational structure, activated area and Ward disaster committees, sent delegations to the areas accessible by road and communicated by telephone with West Ambae.

### Time to evacuate

The first advice bulletin from government volcanologists announced an escalation of activity to Vanuatu Volcanic Alert Level 2. This corresponds to a state of readiness in the Penema Province disaster plan, as opposed to Level 3 necessitating evacuation. Disregarding the level of alert, the Penema Disaster Coordination Committee immediately called for evacuation of the highest hazard "red" zones (*see map p. 16*) over the coming days to refuge centres in "green" areas in east and west parts of the island. In some cases, people in the "yellow" areas between the "red" valleys also evacuated of their own accord for fear of seeing their escape route blocked later by volcanic flows.

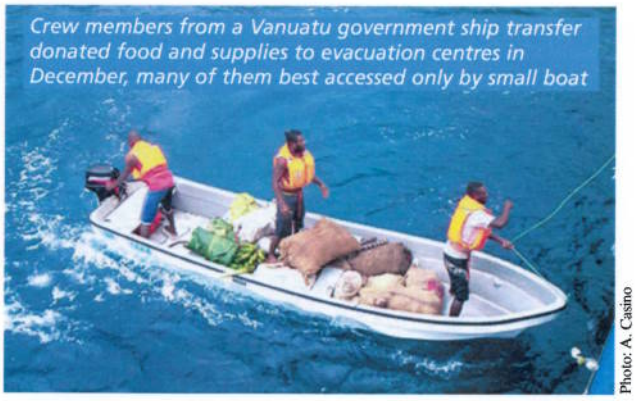
The evacuation process was spread over eight days. People either travelled on foot or via local transport operators. Taxi and truck drivers volunteered their services. Two ships were sent by the central government sent to evacuate people. Ten 'safe centres' were established in east Ambae for 2 370 evacuees and two in west Ambae for a further 954 people. Welfare was regulated by Nakamal chiefs of the host communities.

Despite high levels of tension, overcrowding, inadequate facil-ities and poor sanitation, there was little unrest in the camps. Food and supplies were donated throughout the evacuation period by major Vanuatu NGOs, church groups and businesses, as well as by the Penema Province communities of Pentecost, Santo and Vila. The Red Cross deployed personnel and resources to help with managing welfare and supplying water.

By 24 December, the volcano had become less active, so the National Disaster Management Office and other central government agencies began urging evacuees to return home. However the Penema Committee waited until a further investigation by Vanuatu and New Zealand volcanologists before declaring it safe for communities to return home on 29 December.

At this point, the Penema Disaster Coordination Committee announced a staged repatriation using local transport to be completed by 3 January. By this time, several communities had already returned, or partly returned in some cases when women and children stayed back at the safe centres. Morale was high by this stage.

Those in the western zone repatriated quickly following the order by the Penema Committee but many evacuated Nakamals in the eastern zone chose to remain for combined 'end of crisis' and New Year celebrations. Once everyone had been repatriated, the Penema Committee set about recovery operations consisting of a clean-up, damage assessment and operational review over the coming month.



*Crew members from a Vanuatu government ship transfer donated food and supplies to evacuation centres in December, many of them best accessed only by small boat*

Photo: A. Casino

## Doing better next time

There were a few incidences of friction at the start of evacuation, even though cooperation improved as the operation progressed. Here are some of the lessons learned for next time:

**Maintain good communications with communities to ensure commitment to the plan**

Some Nakamal groups refused to evacuate and a number of community disaster committees never formed. Several Nakamal groups also used safe areas defined during earlier community planning initiatives rather than those in the current plan. This led to an impromptu safe centre having to be set up for 400 evacuees in one case.

**Support local decisions and leave criticism until later**

The central government entrusted responsibility for the evacuation to the Province. This was due to a combination of the low-level threat, established procedures for the island in the case of an eruption and the recognition that the Province-level management required only backup support. Despite this, when the Penema Disaster Coordination Committee made the decision to evacuate early, before the alert reached level 3, the national agencies and to a certain extent donors were privately or openly critical of the decision. This differing opinion led to tension between the Committee and the national authorities. This was because the National Disaster Committee had experienced several eruptions of greater magnitude and impact over the past five years on other islands, including Lopevi, Paama, Ambrym and Tanna. This disagreement meant that financial support from the central government did not reach the Committee until late in the operation, even although people and other resources were committed earlier.

**Recognize the limits of community self-reliance**

The vulnerability of this local approach would have been exposed had the volcanic activity spread to other parts of the island, especially within the green zones. The management committees would have been at risk and a second evacuation to off-island safe centres would have been required. It is not certain that national-level emergency managers would have been ready for this.

**Balance local priorities against national ones**

Relations between the local Committee and the national authorities were further confused by the presence of an impromptu Vila-Ambae Disaster Committee made up of Ambaens in senior government positions who were concerned that there was not enough national commitment to welfare. This group was effective in leveraging funding from the central Government but went beyond its brief by criticizing both the government and the local Committee, causing conflict with government employees from other islands.

**Establish effective media management**

The eruption was sensationalized by local and foreign media, which resulted in critical and erroneous reporting. This fuelled many of the conflicts described above and drove the local Committee to overreact by limiting media contact to the sole person of the Province Secretary-General.

The formal damage assessment concluded that the main losses were due to the evacuation and temporary abandonment of gardens. Interruption in the planning of cash crops had also hampered local communities' efforts to raise school fees. Although the Committee had initially budgeted 14 million vatu (*circa* $US140,000) for the evacuation, actual outgoings only came to about half this amount, thanks to the provision of food and other supplies almost exclusively in-kind.


*A safe centre on the day it opened on 6 December 2005 in the Lolowai area of northeast Ambae. Morale remained high in the camps, despite crowding and limited water supplies*

### A beneficial false alarm

This case study demonstrates that community management of an emergency on some scales is possible. The Ambae community successfully arranged for one-third of its population to be evacuated for over a month, thanks largely to the inherent independence of Ambaens and the high-level of local political organization on the island.

The participatory approach encouraged by the workshops also appears to have played its part in establishing community-level emergency plans that interlocked with island-wide efforts, even in the absence of a full-blown follow-through programme.

In some ways, the eruption was a false alarm, in that the actual threat was not as severe as first thought. It nevertheless galvanized the community in the face of an emergency. This enthusiasm is now being channelled into new community initiatives. These include the establishment of a community-funded Ambae disaster trust, the development of local training workshops in emergency management for the community and the scoping of off-island safe centres for bigger emergencies.

Shane J. Cronin[1], Karoly Nemeth[1], Douglas Charley[2], Hans Dencker Thulstrup[3].

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1. *Volcanic Risk Solutions, Institute of Natural Resources, Massey University, New Zealand*
2. *Department of Geology, Mines and Water Resources, Port Vila, Vanuatu*
3. *UNESCO Office for the Pacific States in Apia, Samoa*