

# **Community Resilience and Volcano Hazard: The Eruption of Tungurahua and Evacuation of the Faldas in Ecuador**

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*Official response to explosive volcano hazards usually involves evacuation of local inhabitants to safe shelters. Enforcement is often difficult and problems can be exacerbated when major eruptions do not ensue. Families are deprived of livelihoods and pressure to return to hazardous areas builds. Concomitantly, prevailing socio-economic and political conditions limit activities and can influence vulnerability. This paper addresses these issues, examining an ongoing volcano hazard (Tungurahua) in Ecuador where contextual realities significantly constrain responses. Fieldwork involved interviewing government officials, selecting focus groups and conducting surveys of evacuees in four locations: a temporary shelter, a permanent resettlement, with returnees and with a control group. Differences in perceptions of risk and health conditions, and in the potential for economic recovery were found among groups with different evacuation experiences. The long-term goal is to develop a model of community resilience in long-term stress environments.*

*Keywords:* community resilience, volcano hazard, evacuation, Ecuador.

## **Introduction**

There is a growing literature on hazard response and disaster mitigation practices that encompasses a range of academic disciplines (Alexander, 1993; Smith, 1996; Quarantelli, 1998; Mileti, 1999; Oliver-Smith, 1999). Much of this research has been productive, enhancing our understanding of hazard processes, facilitating the building of explanatory models and leading to practical applications. The research builds on this theoretical base, focusing attention on aspects of community resilience by examining perceptions of risk and human health issues associated with an ongoing disaster, and especially on the impact of large-scale, forced evacuations. The significance of community resilience is further placed within the broader context of prevailing cultural, economic and political factors.

While early sociological work indicated that disasters may have a therapeutic effect, creating community solidarity with an altruistic perspective (Drabek and Key, 1984; Perry and Lindell, 1978; Western and Milne, 1979), recent literature has shown that this period does not last and conflicts within social systems invariably arise (Bolin et al., 1998). Such conflicts develop because of competition for limited resources, and

those with the least resources — usually the marginalised — are often both the hardest hit and least able to cope (Peacock and Ragsdale, 1997; Yelvington, 1997). Indeed, hardships can multiply for populations facing adversity on a daily basis, as was demonstrated by the poor of South Dade County, Florida who remained homeless nearly a year following Hurricane Andrew (Dash et al., 1997). Thus, the promotion of community resilience requires that officials and disaster response teams be prepared for negative effects that follow from disasters (Bolin, 1988; Noel, 1998; Robertson, 1998). Community resilience in a disaster context, therefore, depends, in part, on how communities respond to crises in pre- and post-disaster situations.

To address community resilience, attention must be given to the contextual conditions of society, notably to issues of vulnerability. Human vulnerability to disasters is described by Blaikie et al. (1994) in terms of a model in which underlying factors and root causes embedded in everyday life give rise to dynamic pressures that affect particular groups and lead to unsafe conditions. Groups that are socially, economically or politically removed from the mainstream of society, that is the marginalised, tend to experience disproportionately high impact from natural hazards (Hewitt, 1997). For instance, Mileti et al. (1991) described the fate of displaced people from the 1985 eruption of Nevado del Ruiz in Colombia, who suffered from limited education, lack of economically viable skills and poverty prior to the disaster. The disaster merely exacerbated prevailing problems. Furthermore, economic and social marginality affects the ability of individuals and families to recover after a disaster. Those with personal resources or strong kin support networks can move away from dependence on assistance programmes and re-establish themselves using these other resources. Others cannot.

## **The volcano hazard and evacuation**

Volcanoes, especially those associated with strato-volcanoes that have a potential for major eruptions, often represent ongoing hazards. Certainly a major eruption can be devastating for adjacent areas, as witnessed by the explosion of Mount St. Helens in 1980 (Cook, 1981). The smaller scale secondary activity is more pervasive, however, in the form of minor eruptions, ash falls, pyroclastic flows, lahars, lava flows, landslides, and associated mud flows. These can continue intermittently for months or even years, and hence represent continuing problems that create damages and losses for a long time (Chester, 1993; Smith, 1996). For instance, ash falls destroy crops, harm livestock, contaminate water supplies and are implicated in an increase in respiratory diseases (Chester, 1993; Rees, 1979). Communities in such areas, therefore, face an enduring battle, and recovery efforts can be curtailed by further geophysical activity.

In addition, the disruption caused by volcanic disasters can lead to social change (Blong, 1984). Volcanic disasters may act as catalysts accelerating the rate at which adjustments in social and political institutions occur. Community resilience, therefore, is probably dependent on pre-existing social, economic and political conditions as well as post-disaster responses, relief efforts, mitigation strategies and longer-term rehabilitation programmes (Boyce, 2000).

One response to the imminent threat of disaster is evacuation: to remove people from impact areas (Lindell and Perry, 1992). While such evacuations have been successful in reducing the number of deaths accruing from such events (Tobin and Montz, 1997), there are a number of negative factors associated with evacuation

practices, especially when people are away from their homes for prolonged periods. Social disruption, unusual economic straits, increased communicable disease exposures, and political turmoil are all possible outcomes that are not fully understood (Cernea, 2000).

The effectiveness of evacuation practices is, in part, contingent upon:

- the decision to evacuate and dissemination of the warning message;
- the practical management of the evacuation; and
- the conditions of the place of refuge relative to previous domestic conditions.

It is also essential that the threat be perceived as real if individuals are to take effective remedial action (Lindell and Perry, 1992; Perry, 1982). Employing forced evacuations, perhaps through military intervention, can overcome this particular difficulty and save lives, but in the long term may introduce additional problems. Faith in the military may be diminished and there may be negative political fall-out for community leaders. An effective response to evacuation warnings is also contingent upon, first, individual or family units perceiving a positive outcome from their action; and second, family or households being assembled as a unit (Chester, 1993; Lindell and Perry, 1992) since these factors will help determine how people react.

In the case of volcanoes, evacuation can be a multifaceted problem because of the many secondary effects of the hazard. While these secondary events can be destructive, they also provide growing reminders of the volcano threat, and research has shown that visual evidence can significantly enhance hazard perception and hence elicit a better response to warnings (Lindell and Perry, 1992). Thus 'minor' events may help precipitate better responses. On the other hand, if a volcano has been dormant for some time, it may be difficult to initiate an effective evacuation (Punongbayan et al., 1996). Mileti et al. (1991) in Colombia in 1985 and Newhall and Punongbayan (1996) in the Philippines, showed that limited local experience with volcanic hazards was associated with poor perception of the risk which contributed to inappropriate responses.

Other factors, such as cultural and religious beliefs (Blong, 1984); fear that property left behind will be stolen (Lindell and Perry, 1992); and close ties to family income sources (farmland and animals) in the home location (Cola, 1996) also contribute to a willingness or reluctance to evacuate. Indeed, a strong attachment to place is closely correlated with a reluctance to evacuate (Cola, 1996; Dibben and Chester, 1999). The likely effects on local social networks and traditional economic systems must be considered more fully particularly if evacuation is to be long term. Ultimately, people often face two choices: return home where the risk of death or injury may be high, or remain in the evacuated area and suffer significant social and economic disruption that may place long-term livelihoods in question.

Conditions at the new location may contribute to the decision to return home. It is not unusual for displaced people to be housed in poor conditions, including tents, portable buildings and large halls with unsanitary communal facilities. Shelters are often over-crowded and supplied with few resources. As a result, communicable childhood diseases, such as chickenpox or measles, can sweep through shelters where many non-immunised children may be living in close proximity. Under such conditions, the spread of infectious diseases can be a significant problem, especially if nutritional status has declined as a result of reduced access to food supplies, or reliance on

unfamiliar foods (Inhorn and Brown, 2000). Furthermore, after several weeks living in such conditions, violence and other anti-social activities may occur (Yelvington, 1997).

In other instances, evacuees have been resettled in local communities. While these communities may at first welcome displaced people, after a time antagonism can build between groups as competition for resources increases, and evacuees receive more aid than local people. Again, such population movements can destroy traditional social networks and alter perception such that safety is compromised (Hewitt, 1997; Lindell and Perry, 1992). Thus, dissatisfaction with the new community can exacerbate a feeling of loss of well-being and nostalgia for the old location (Neumann, 1997) which can encourage the return of evacuees.

Therefore, the effectiveness of evacuation measures is determined by the interplay of different cultural, economic and political forces. These forces must also be placed within the temporal (historical) and spatial context of the specific location, if the ramifications of evacuation are to be fully understood. As with all forecasting and warning decisions, there is a trade-off between the reducing risk exposure through evacuation and the concomitant increase in social, economic and political disruption.

## **Health and disasters**

The second part of this research incorporates an anthropological focus by using community and public health indexes following a disaster, particularly cultural explanations for infectious disease and malnutrition, to illuminate the cultural context (Brown, 2000; Cody et al., 2000; Howarth, 1997; Inhorn and Brown, 2000; McClain, 2000; Mull, 2000; Nations and Monte, 2000; Nitcher, 2000; Noji, 1997). As Mull, Brown, Brown and Inhorn and Nations and Monte clearly reveal, infectious disease rates cannot be understood without an analysis of the cultural factors that impede or encourage the spread of disease. Indeed, as much of medical anthropology research has repeatedly demonstrated, over-reliance on epidemiological data without recourse to observational field studies too often results in misleading or incomplete information that hinders the design of effective mitigation strategies. The research being described here emphasises a medical anthropological approach to the understanding of health strategies and outcomes following an evacuation. The authors also recognise that mental and emotional status also influence the spread and expression of illness and disease, however, it was not possible to bring cross-cultural measures of mental health and illness into the current research. Mental health, while not addressed in this research, is an important topic (see for example, Canino et al., 1990; Murphy et al., 2001; Wood and Cowan, 1991).

Ethnographic field studies have long shown that people with compromised immune systems, people under high stress and those whose bodies have already withstood various assaults are at high risk of respiratory infection. Officially under-reported, respiratory illnesses disable individuals, not only reducing their ability to respond to crisis, but also sometimes developing into more serious (and reportable) illnesses such as pneumonia. For instance, the elderly and the very young are most at risk, and pregnant and nursing mothers are often unable to resist the upper and lower respiratory infections that sweep through crowded areas like schools or shelters. They are the sentinel members of the population; their health status may presage the health of other, more resilient individuals in the population. However, health data from these vulnerable populations — particularly at this early stage of illness — never reach the

epidemiological registers. These early indicators of compromised health status are not available from clinic registers because these very people (the old and the very young) are least likely to seek medical care early in their illness. Indeed, in populations under stress even serious diseases are frequently misdiagnosed at home as more common and less serious illnesses, resulting in no treatment being sought (Whiteford, 1999).

Upper respiratory infections include sore throats, and irritation and infections of the upper chambers of the lungs and bronchi, while lower respiratory infections often manifest themselves as pneumonia and other more serious infections. Such individuals experiencing an ongoing threat of a natural hazard such as a volcano, or those having been moved from their homes into temporary shelters will be in a high-risk category for infectious disease, particularly respiratory problems (Noji, 1997a).

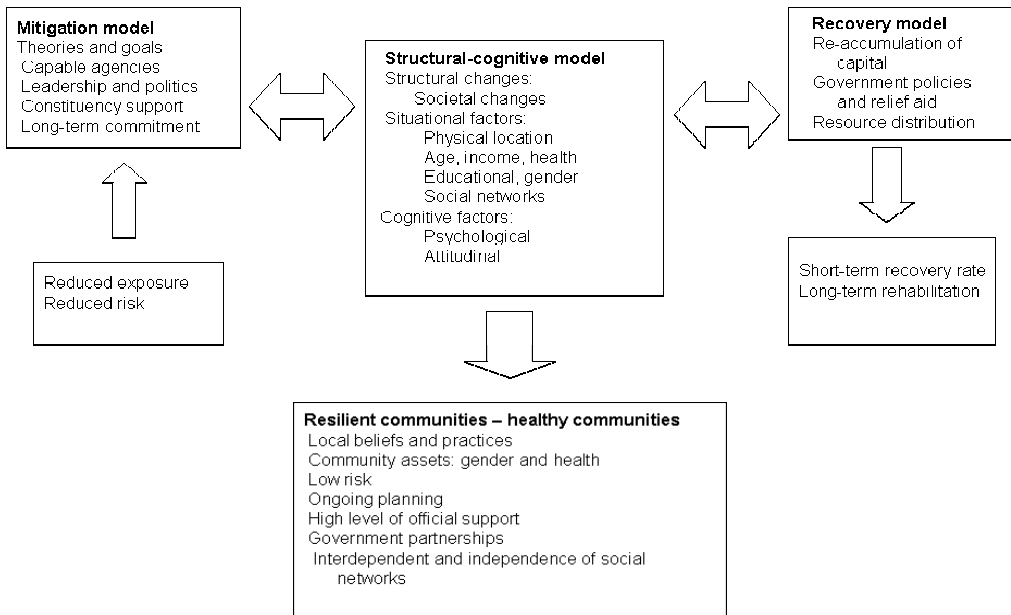
Medical anthropologists and other researchers in international health have long noted the high child mortality rates caused by infectious diseases such as ARI (acute respiratory infection). Indeed, in 1995, more than four million children worldwide died of ARIs (Kirkwood et al., 1995). Many variables are implicated in childhood ARIs, including poverty, malnutrition, lack of access to prompt, accessible and inexpensive health-care, crowded living conditions, indoor air pollution and food insecurity — all conditions exacerbated following an evacuation (Kirkwood et al., 1995). According to Mull (2000), most of these deaths were due to infections of the lower respiratory system, such as pneumonia. Thus, in volcanic areas, ARI is an important outcome variable because ash fall (which acts as a pulmonary and mucous irritant) and evacuation (which changes living conditions with overcrowding and increased food insecurity) can influence morbidity and mortality patterns. Therefore, for people already living in precarious conditions, the loss of resources which often accompanies a forced evacuation may plunge them into situations from which they have little recourse and their health may suffer. Their compromised health status may be expressed through respiratory or digestive disorders which at a non-acute level function as proximate variables for degree of social disruption.

In addition to increases in levels of infectious disease and malnutrition, public health may also be adversely affected during and following a disaster because public utilities may be destroyed or temporarily rendered unfit for use (Noji, 1997b). Basic health services may also be disrupted, which can be particularly detrimental in developing countries because they often lack the resources to set up alternative forms of health-care (Noji, 1997b). Moreover, shelters and other forms of temporary housing, can serve to spread a number of communicable diseases quite rapidly.

### ***Theoretical framework***

Geophysical aspects of disasters combined with mitigation strategies, such as evacuation, can have direct effects on community resilience and population health. Indeed, the ability of the community to recover is contingent upon not only a healthy population but also an effective response to the hazard. Thus, to understand how community resilience and health can be enhanced, the workings of the social, economic and political forces that operate within a community, looking at all phases of a disaster (pre-impact, impact and post-impact) must be examined.

The approach taken here is interdisciplinary, using aspects of the medical anthropological and socio-political ideas put forward by Bates and Pelanda (1994), the political-economy and human ecology approach outlined by Hewitt (1983), and as applied to health by Coreil et al. (2000), Whiteford (1999) and Whiteford and



**Figure 1** Healthy and resilient communities in hazardous environments: a framework for analysis. Adapted from Peacock and Ragsdale, 1997; Tobin and Montz, 1997; Waugh, 1996. See Tobin, 1999 for a full discussion

Manderson (2000). Thus, structural-functional views, conflict theory, competition for resources and other geo-sociological and anthropological principles are raised here as frameworks in understanding community resilience (Kreps and Bosworth, 1994). Figure 1 provides the structure for this analysis by bringing together various models (see Tobin, 1999 for details). The elements of three separate models have been adapted here to demonstrate how resilient communities might be created; the mitigation model proposed by Waugh (1996), the recovery model described by Peacock and Ragsdale (1997) and a structural-cognitive model put forward by Tobin and Montz (1997). The figure depicts a dynamic system, not necessarily one that is in balance; each model includes a listing of some of the important attributes that should be incorporated into any analysis. The flows or arrows indicate important relationships between components of the system that must be understood from a structural context, so that when one element changes, an appropriate response can be made to keep the system in some sort of dynamic equilibrium. The ultimate goal is to achieve community resilience in the face of prevailing natural hazards, so that better health, for example, might be maintained. Indeed, a sustained level of health is a significant outcome measure of a resilient community.

### **Study area: Tungurahua, Ecuador**

Community resilience is addressed through a broad examination of historical, political, geophysical, cultural and epidemiological processes at work in two provinces, Chimborazo and Tungurahua, Ecuador, both in the shadow of the volcano, Mt. Tungurahua. Mt. Tungurahua dominates both the physical and cultural landscape of

the area. It has been active on many occasions, with the last significant period being 1916 through 1925. The volcano also provides the income to the inhabitants of the area. The soils, climate and people combine to produce highly productive farming, with crops of potatoes, tomatoes, beans as well as livestock. Indeed, there are many small agricultural communities and peasant farmers scattered around the *faldas* (slopes of the mountain) supplying the markets at Pelileo, Penipe, Ambato and Riobamba. A secondary income for many is supplying the tourist industry with artisans' products, especially at Baños. Baños, the largest community in the *faldas*, is a major tourist centre of approximately 16,000 people sitting directly at the base of Tungurahua. It is a primary destination not only for internal Ecuadorian tourists, but also European and North American.

The problems in Chimborazo and Tungurahua provinces were first realised in September 1999, when Tungurahua showed signs of coming back to life by releasing steam and gases. This was followed in October by a series of large eruptions that have continued on and off for the last 24 months. During the initial phase, magma rose inside the mountain and tremors indicated that a major eruption might be imminent. Nightly showers of burning boulders could be seen from many miles away and an almost constant rain of ash fell on the *faldas*. A number of towns and villages were threatened including Baños, Pelileo and Penipe. Given the physical site of Baños, in a bowl at the base of the volcano, local residents have approximately seven minutes to escape following an eruption before bridges are destroyed by mudflows, pyroclastic activity or landslides. Disaster seemed imminent.

This tectonic activity helped to spur the official response. In October, government authorities, in consultation with the director of the Geophysical Institute (personal communication, 2000), decided that the danger of an eruption and the possible consequential loss of life demanded an immediate evacuation of Baños and the *faldas*. The goal, therefore, was clear: evacuate people to safe areas. Local residents were given 30 hours to leave after which the military would enforce the evacuation. In the following days, an estimated 26,000 people were moved to private homes, hostels and government shelters elsewhere in Tungurahua and Chimborazo where some remained for more than a year.

## **Methodology**

Ecuador was selected for study because of its historical record of disasters, the presence of an active volcano and also because one of the authors had extensive research experience in the country and could readily establish collaborative relationships with local policymakers and the governmental/non-governmental agencies involved in disaster mitigation. In addition, Ecuador has implemented several structural programmes that have both direct and indirect consequences on disaster mitigation and the ability of communities to reduce health risks. Since 1990, there has been massive decentralisation of governmental programmes and reductions in social services.

Government officials, relief workers, leaders and decision-makers were interviewed at three months, and then again at eight months, after the initial eruption. Specific data were collected on past disasters and current effects, particularly those aspects concerned with health. The national-level response to these disasters was reviewed, so that local-level information could be placed in context. This entailed a complete analysis of the hazard threat, an examination of the mitigation strategies

**Table 1** Number of respondents

	<i>Males</i>	<i>Females</i>	<i>Total</i>
Colegio Bolivar/Cubijies <i>albergues</i>	11	31	42
Quimiag resettlement	14	8	22
Baños returnees	14	20	34
Quimiag locals	7	26	33
Total	46	85	131

implemented and a critical evaluation of the role of different relief agencies. The recovery model, discussed above, will form the basis for the analytical component of this phase of the research. Re-accumulation of capital, local-level policies and programmes, private adjustments and resource distribution were each examined in a regional context to evaluate how it responded to the hazard.

In addition, three approaches were used to elicit information from volcano victims:

- direct field-based observations several times during the 12-month course of research;
- a qualitative study using small focus groups; and
- a quantitative survey using formal structured questionnaires.

Field-based observations consisted of informal interviews with community leaders and residents, mapping of homes, businesses, social, political and religious and educational institutions and structured observations of work and social occasions. The structured surveys were conducted eight months after the major eruption and evacuation of October 1999. Data were collected from evacuees with three different types of experiences. One group consisted of displaced people living in the *albergues* (temporary shelters) at Colegio Bolivar and Cubijies, another consisted of people who had resettled in the community of Quimiag and the third group were those who had returned early to their homes in Baños before the official evacuation had been lifted. A fourth group comprised non-evacuated local people from Quimiag who were used as a control. The social, economic and day-to-day living conditions were very different for these individuals and hence differences were expected regarding health and recovery (Tobin and Whiteford, 2000).

Four focus groups were formed, one at each research site. Each was composed of seven to 10 adult women, all members of local organisations, communities and shelters, who had been recruited through contacts already made at each site. The sessions lasted approximately two hours and were used to establish base-line data regarding issues associated with the evacuation and health effects. The sessions were recorded and comments later transcribed.

Concomitantly, formal, structured surveys were undertaken at each research site. This survey incorporated specific questions on personal characteristics, such as age, family relationships and household income, and was used to classify respondents' roles within household units. Some open-ended questions were also included in the questionnaire to obtain extra information from evacuees. Overall, the surveys took approximately 30 to 40 minutes per respondent to administer. Respondents were selected at each site through existing contacts and a resulting snowball effect that attracted additional people. While this did not ensure complete randomness, the



**Table 2** Decisions on evacuation by evacuation type (percentage)

	<i>Colegio Bolivar and Cubijies albergues</i>	<i>Quimiag resettlement</i>	<i>Baños returnees</i>
Left voluntarily	28.6	50.0	23.3
Forced evacuation	71.4	50.0	76.7

**Table 3** Opinions on the evacuation by evacuation type (percentage)

	<i>Colegio Bolivar and Cubijies albergues</i>	<i>Quimiag resettlement</i>	<i>Baños returnees</i>
Received help	81.0	68.2	55.2
Evacuation necessary	73.2	77.3	51.9
Want to return	80.5	81.8	N/A

resulting sample did exhibit an apparent cross-section of the local population (see Table 1). Setting up a structured random sample was not feasible given the conditions under which many respondents were living. These data were collated and analysed using standard statistical techniques.

## Results and discussion

The results are divided into three sections based on the three models (mitigation, recovery and structural-cognitive) shown in Figure 1 and described in the theoretical framework.

### *Mitigation model: strategies and concerns*

The primary official response to the volcanic eruption in October 1999 was to evacuate a large proportion of the population living in the *faldas* of Tungurahua. The relative merits of this strategy were assessed from the perspective of the mitigation model outlined in Figure 1. It was clear that there were mixed views on the success of the evacuation and the capabilities of the agencies involved. From the military and government perspective, the evacuation was a success. Over 26,000 people had been evacuated and no one was injured by volcanic activity (personal communication with Ecuador Civil Defense, 2000).

The perspective of residents from Tungurahua was very different. Groups here invariably expressed strong negative sentiments about how the evacuation had been carried out, speaking most critically of the military intervention, which would later lead to questions over the leadership, and support mechanisms associated with the evacuation strategy. For example, over 70 per cent of the respondents living in the *albergues* (shelters) and those from Baños, and 50 per cent of those living in the resettlement area were forced to evacuate by the military (Table 2). The focus group

**Table 4** Perception of government response by evacuation type (percentage)

	<i>Colegio Bolivar, Cubijies albergues</i>	<i>Quimiag resettlement</i>	<i>Baños returnees</i>	<i>Quimiag local control</i>
Little or nothing	47.6	52.6	88.2	51.6
Shelter, food, clothing, seeds, money	50.0	47.4	8.8	45.2
Other	2.4	–	2.9	3.2

from Baños was particularly vociferous about the military intervention, stating ‘They killed our chickens and cooked in our homes’. Not surprisingly, constituency support diminished as concerns over the military action escalated during the weeks following the evacuation and rumours of looting and burglaries of homes began to circulate. The situation was exacerbated when a Chilean television company showed evidence of looting by the soldiers (Chile television production broadcast 1999/2000). This culminated in conflicts between the people and the military and eventually there was a mass movement back into Baños as military barricades were over-run (Ecuadorian television production shown in Ecuador in 2000).

Respondents expressed different opinions about the evacuation (Tables 2 and 3). Over 73 per cent of Colegio Bolivar and Cubijies residents and 77 per cent of Quimiag resettlement respondents thought that the evacuation was necessary, compared with only 52 per cent of the Baños residents. The difference between these perceptions was not surprising given that Baños residents had already returned to their homes. On the other hand, the high response by others is indicative of the initial fear that existed in October 1999. Over 80 per cent in Colegio Bolivar, 68 per cent in Quimiag and 55 per cent in Baños reported receiving some help in evacuating. The situation for the evacuees, however, was not conducive to staying with over 80 per cent expressing a desire to return. On the other hand, the mitigation had effectively reduced both exposure and risk.

### ***Recovery model: relief aid and re-accumulation of capital***

Recovery can be examined through the re-accumulation of capital, through government relief policies and through resource distribution (see Figure 1). In each of these, it became clear that problems would arise in Ecuador once an evacuation programme had been implemented. For example, there was strong sentiment that the government had not done enough to help evacuees. Indeed, about 50 per cent of respondents in Colegio Bolivar and Quimiag (both locals and resettlement group) and nearly 90 per cent in Baños stated that the government had done little or nothing to help evacuees (Table 4). This aid had taken various forms, including the provision of shelter, food, money, clothing and seeds, but the consensus remained that the government should have done more. This was echoed by the focus groups, all of which complained about the lack of support and limited commitment by the government.

**Table 5** Reasons for not returning by evacuation type (percentage)

	<i>Colegio Bolivar and Cubijies albergues</i>	<i>Quimiag resettlement</i>
Because of the volcano	42.9	63.6
Health risk from returning	7.1	4.5
No resources at home, economic opportunities here	23.8	27.3
No schools at home, schools here	7.1	–
Other factors	19.0	4.5

**Table 6** Context: crises occurring during the disaster and after the evacuation by evacuation type (percentage)

	<i>Colegio Bolivar, Cubijies albergues</i>	<i>Quimiag resettlement</i>	<i>Baños returnees</i>	<i>Quimiag local control</i>
Loss of home	26.2	40.9	20.6	N/A
Loss of crops/ livestock/inability to plant	59.5	86.4	50.0	16.2
Loss of money, economic crises	71.4	77.3	85.3	63.6
Political turmoil	42.9	68.2	44.1	42.4
Disasters: volcano, floods, landslides	61.9	68.2	44.1	39.4
Family problems: illness, death	61.9	59.1	44.1	42.4
Theft of possessions	11.9	13.6	2.9	3.0

The limited resources probably helped precipitate the desire among respondents to return home. In particular, for instance, conditions in the *albergues* and at the resettlement community were not conducive to staying. The living conditions in the shelters were especially poor with overcrowding and unsanitary washing facilities provided in old school buildings. Large families were confined to partitioned spaces of little more than 20m<sup>2</sup> with no resources or privacy; meals were taken in a communal kitchen, and bathroom facilities were sparse. Members of the focus group from Colegio Bolivar also indicated that they had received insufficient food for themselves and their children, which potentially weakened their resistance to illnesses. The Quimiag evacuees also expressed serious concerns about their precarious economic situation especially since they were not generating any income but had many bills to pay.

Respondents gave various reasons as to why they had not returned in spite of these issues (Table 5). Forty-three per cent of those in Colegio Bolivar and 64 per cent in Quimiag had not returned because of perceived dangers of the volcano, including the possibility of associated health problems. About 25 per cent in each community also thought that economic options were greater in the new place, in part because of damages back home. However, it should be noted that at the time of the survey, the orange alert was still in effect and technically the evacuation orders still stood, notwithstanding that the Baños people had already returned.

By September 2000, when the last of the *albergues* closed, many residents still had not returned to Baños nor to the communities scattered about the *faldas*. There are various reasons as to why they did not return: crops were lost, animals dead, houses were damaged and the volcano was still active. Tungurahua, as of writing, continues to remind people of its instability through ash showers and rumblings. The evacuees, therefore, had few options and their ability to recover was severely compromised by limited relief operations, by poor conditions at the evacuation sites and by damage back home.

A major concern for a number of respondents in the Quimiag resettlement area was that they had been forced to sell their land and houses. Parts of the *faldas* had been declared too dangerous because of ash and potential eruption, so the property was purchased at very low prices. Since many of these people relied on agriculture for their livelihood, these sales effectively eliminated any immediate chance of recovery. Effectively, they became landless, homeless and jobless at once. It should be stressed that some farmland outside the risk areas had been donated to the evacuees on a long-term basis (five years) but this did not replace the land lost. It also led to other problems as land-lords insisted on keeping a share of the produce and in at least one instance took virtually the entire crop.

The political and economic realities of Ecuador further complicated recovery efforts. At the same time as the evacuation, the country was facing considerable political unrest and economic straits. The president was overthrown in January 2000 by a *coup d'état* after several indigenous groups converged on Quito. The economic crisis intensified as the World Bank insisted that price supports for food and fuel be removed, which increased the level of inflation. Furthermore, Ecuador was in the process of converting to the US dollar, which was not popular with the people. Thus, when placed in context, the volcano took on less significance than the economic crisis for the majority of the population. Table 6 shows the many crises that families faced during the eight months following the evacuation. While natural disasters still figure highly, the economic concerns and political movements have also affected the evacuees. This is not to say that the volcano did not have severe impact, since many people lost their homes and means of support, and some had possessions stolen. But, the government was not in a strong position to facilitate an active and ongoing recovery effort. Evacuees were left with little support and frustrated in their attempts to rebuild their resources. Re-accumulation of capital, as it is described in the model, was a remote possibility for most evacuees, which in turn threatens the long-term viability of the communities.

### ***Structural-cognitive model: perceptions and health concerns***

Situational, structural and cognitive factors all affect community resilience in different ways and will be influenced by evacuation strategies. The strength of societal relation-

**Table 7** Population and number of children under five

	<i>Total number of people</i>	<i>Mean number per household</i>	<i>Total number of children</i>	<i>Mean number per household</i>
Colegio Bolivar	210	5.00	26	0.62
Quimiag resettlement	108	4.91	18	0.82
Baños returnees	164	4.82	23	0.68
Quimiag locals	137	4.15	16	0.45
Total	619	4.73	83	0.63

**Table 8** Worries about the volcano by evacuation type (percentage)

	<i>Colegio Bolivar, Cubijies albergues</i>	<i>Quimiag resettlement</i>	<i>Baños returnees</i>	<i>Quimiag local control</i>
Little or no worries	21.4	22.7	70.6	30.3
Somewhat worried	14.3	13.6	14.7	12.1
Very/extremely worried	64.3	63.6	14.7	57.6

ships, demographic characteristics and health, as well as attitudes will all influence the outcome of evacuation strategies. Several examples below illustrate this in the context of the Tungurahua evacuation.

The socio-economic characteristics of the evacuees were quite similar. Data showed that most respondents were not wealthy, particularly those who evacuated to the *albergues*. Approximately, 30 per cent of the respondents in Colegio Bolivar and Cubijies were involved in household duties, baby-sitting or worked as maids compared to 27 per cent in the Quimiag resettlement, 26 per cent in Baños and 39 per cent of the Quimiag locals. Less than 5 per cent of the respondents in Baños and Colegio Bolivar and Cubijies were involved in agriculture. It was interesting to note, however, that those in the *albergues* were, for the most part, younger than those from other areas. For instance, over 64 per cent of respondents in Colegio Bolivar were between 21 and 40 years old compared to 27 per cent in Quimiag resettlement and 35 per cent in Baños. Nearly 62 per cent of the respondents in Baños and 55 per cent in Quimiag resettlement were over 41. However, this could be an artefact of the sampling process rather than a reflection on the age distribution in the community. Nevertheless, there were more people per household in Colegio Bolivar and Cubijies, followed by Quimiag resettlement, and there were more children under the age of five per household in the Quimiag resettlement group than elsewhere (Table 7). The lowest number was in the control group. The combination of these factors suggests that those respondents from the *albergues* and in the resettlement area were generally poorer and less able to recover from the evacuation than others. Given the disruption to their old social structure and social networks, the difficulties facing these individuals were immense.

**Table 9** Perception of current risk by evacuation type (percentage)

	<i>Colegio Bolivar, Cubijies albergues</i>	<i>Quimiag resettlement</i>	<i>Baños returnees</i>	<i>Quimiag local control</i>
Little or no risk	16.5	31.8	75.0	28.1
Some risk	16.7	4.5	16.7	15.6
Very/extremely high risk	66.7	63.6	8.3	56.3

**Table 10** Health statistics before and after the eruption of October 1999

<i>Morbidity</i>	<i>16 Oct. to 31 Dec. 1998</i>	<i>16 Oct. to 31 Dec. 1999</i>	<i>Increase (x)</i>
Upper respiratory infections	1,620	4,171	2.6
Lower respiratory infections	162	405	2.5
Conjunctivitis	73	170	2.3
Tuberculosis	24	54	2.3
Asthma	9	19	2.1
Dermatitis	110	205	1.9
Gastritis and duodenitis	85	142	1.7
Diarrhoea and gastro- enteritis	462	598	1.3
Intestinal parasites	789	979	1.2
Trauma	101	70	0.7
Total	3,435	6,813	2.0

Source: Ministerio de Salud Publica del Ecuador (2000).

The situation was also leading to a breakdown of social networks and leadership as evidenced by the responses of those in the Quimiag resettlement. Information from the focus groups revealed that at least two cliques had emerged over the months of evacuation and both had tried to influence community policy. A large majority of evacuees wanted to return immediately to their homes, while a minority wanted to stay because they feared the close proximity of the volcano. In addition, friction between the evacuees and locals had come to the fore on several occasions and both groups accused the other of stealing animals and food. In addition, according to information generated in several focus groups, domestic violence was on the rise, which is not an unusual feature for those families living in shelters.

The perception of the hazard differed among the four communities. There was a significant difference, for example, among the four groups regarding their worries about the volcano (Table 8). Those residents in the *albergues* and those in the resettlement area expressed the highest levels of fear, with over 60 per cent in the 'very' to 'extremely worried' category. This compared with the Baños returnees, over 70 per cent of whom had few or no worries. Only 30 per cent of the control group was not worried about the volcano. Similar patterns were evident from the perceived level

**Table 11** Health statistics: percentage of cases per total population for each area

	<i>C. Bolivar</i> + <i>Cubijies</i> ( <i>N</i> =210)	<i>Quimiag</i> <i>resettle-</i> <i>ment</i> ( <i>N</i> =108)	<i>Baños</i> <i>returnees</i> ( <i>N</i> =164)	<i>Quimiag</i> <i>locals</i> ( <i>N</i> =137)	<i>Complete</i> <i>data set</i> ( <i>N</i> =619)
Males	27.14	16.67	24.39	20.44	23.10
Females	32.86	30.56	21.34	32.12	29.24
Total	60.00	47.22	45.73	52.55	52.34
<i>Males</i>					
Resp/cold/flu	13.33	13.89	11.59	10.22	12.28
Eye/skin/throat	12.86	13.89	12.80	11.68	12.76
Stomach/diarrhoea	9.52	9.26	9.15	2.19	7.75
Other problems	14.76	8.33	17.68	10.22	13.41
<i>Females</i>					
Resp/cold/flu	18.10	20.37	7.93	21.17	16.48
Eye/skin/throat	18.10	22.22	13.41	17.52	17.45
Stomach/diarrhoea	12.38	13.89	6.71	1.46	8.72
Other problems	18.57	14.81	13.41	13.14	15.19
<i>All</i>					
Resp/cold/flu	31.43	34.26	19.51	31.39	28.76
Eye/skin/throat	30.95	36.11	26.22	29.20	30.21
Stomach/diarrhoea	21.90	23.15	15.85	3.65	16.48
Other problems	33.33	23.15	31.10	23.36	28.59

of risk. Over 60 per cent of *albergues* and resettlement respondents considered the risk very high to extremely high, whereas only 8 per cent of the returnees placed the risk in this category. Indeed, 75 per cent of returnees considered the risk minimal (Table 9). The control group again remained somewhere in the middle.

These results were to be expected given the behavioural responses of the respondents. *Baños* residents had already returned to the town when interviewed and hence it is logical that they would at least minimise the risk in their own minds. Although the volcano continues to erupt and periodically causes ash falls on *Baños*, it is probable that the residents have 'removed' it as a threat. Thus, an element of cognitive dissonance is probably playing a role in the lives of *Baños* residents. It may have been economic reasons that precipitated their return in the first place, but the volcano is currently downgraded as a risk. In contrast, those who had not returned still regarded the volcano as an active threat.

Previous to 1999, the health status of people living in the two provinces surrounding the volcano, Tungurahua and Chimborazo, demonstrated a trend toward improvements in nutritional status and reductions in the incidence of respiratory diseases. However, following the evacuation health status declined. In the first six months of 2000, Ministry of Health data showed an increase in both malnutrition and incidence of tuberculosis (Ministerio de Salud Publica del Ecuador, 2000; personal communication Ministerio de Salud Publica del Ecuador, 2001). The Ministry of Health also tracked the morbidity of other diseases, comparing disease incidences

following the eruption with the same period for the previous year (Table 10). Results indicated that the incidence of many illnesses more than doubled between the two periods of study, especially those associated with respiratory infections, eye and skin problems, and gastro-intestinal diseases. According to the Ecuadorian Ministry of Health, most of these increases were directly attributable to the ash fall, except for dermatitis which followed a rising trend throughout the region (Organizacion Panamericana de la Salud, y Organizacion Mundial de la Salud, 2000). These increases were on a par with findings from other international studies and hence point to the role of siliceous irritants found in volcanic ash as disease instigators (Ministerio de Salud Publica del Ecuador, 2000).

Equally disturbing are data showing an increase in the number of diagnosed cases of pneumonic plague. Plague is endemic in certain rural areas of these Andean states, however, since August 2000 there has been a large increase in the number of plague cases, and they are being found closer to the urban areas (personal communication Provincial Ministerio de Salud Publica del Chimborazo, 2001). At the moment there is no direct connection between the evacuation and incidence of plague cases, but large population movements with their domesticated animals (those associated with plague animal reservoirs include guinea-pigs, rabbits, rats) suggest that the problem should be investigated.

Respondents in this survey were asked to recall their health status and that of their families for the preceding six months. Results from the survey revealed that 52 per cent of the evacuated population had been sick during the previous six months (Table 11). However, it was noticeable that 60 per cent of those living in Colegio Bolivar and Cubijies had been sick compared to only 46 per cent in Baños. These data suggest that living conditions at the *albergues* could have led to additional health problems for the residents. When the illnesses are broken down into specific types, this pattern is confirmed. The three health categories: respiratory (including colds and flu); those considered possibly associated with ash falls (eye, skin and throat problems); and those connected with food issues (stomach and diarrhoea) were all found at higher levels in the Colegio Bolivar, Cubijies and Quimiag resettlement than in the other two groups. In general, more women were sick than men. Members of the focus groups in Colegio Bolivar and Cubijies, and those from the Quimiag resettlement group felt that the volcano still threatened their health and that of their children. Many also mentioned that the children had recurring nightmares about the disaster.

It would appear, therefore, that the evacuation has had a negative impact on health of respondents especially those residing in *albergues* and resettlements. The crowded conditions and lack of good sanitation in these communities certainly support this notion. This situation clearly affects community resilience since poor health restricts daily activities and perpetuates the problems for evacuees.

## Conclusions

The evidence accumulated from this preliminary test of the models suggests that if health status is used as a proximate variable for community resilience, then resilience has been compromised in Baños and communities in the *faldas*. In each part of the model, detrimental conditions were found, from the poor administration of the mitigation strategy, to the inadequate supply and distribution of aid, to the structural constraints on human activity. Overall, it would appear that the effects of this



evacuation could be extremely long lasting unless there is some effective national or international intervention. However, given the social, political and economic realities of the country, this seems highly unlikely. Indeed, an examination of those principal factors shown in the model (see the lowest box in Figure 1) reveal the inherent weaknesses of the situation for the evacuees and the threat to community recovery.

The research suggests that community resilience in each of the study sites has been affected by the evacuation experience, and further, that recovery will require assistance not presently foreseen. Each of the communities included in this research presented response patterns slightly different from each other; their similarity lay in their common social disruption caused by being evacuated. By using health status, particularly the early symptoms associated with potentially more dangerous diseases, as a proximate variable for the level of social disruption experienced, it is clear that the gradual improvement of health status was effectively interrupted by the economic crisis and then exacerbated by the evacuation. The poor are always disproportionately affected by economic crises. They lose whatever economic base they might have had. When followed by an evacuation, whatever resources they might have had such as chickens, pigs, cattle or crops are lost, making both economic and health recovery more difficult.

This research also found that women were disproportionately more often sick than men. In the population under study women worked alongside the men tending crops and livestock, and were more often responsible for household functions. Therefore, when a woman is sick, the household loses both economic and household support. In addition, households that were moved to public shelters were rarely able to evacuate in extended family groups — the very groups upon whom they depend during periods of crisis — increasing the consequences of any one family member becoming ill. Gender has been identified as a defining variable in responses to disaster and yet the evacuation strategy employed in Ecuador was to isolate and increase the responsibility of women at the very time when they most needed kin and friend support.

The current and continuing economic crisis in Ecuador doubtless contributes to the reversal of the trend of improvements in health status. Not discounting the national economic crisis, the reversal in health status for the two provinces surrounding the volcano and into which many of those evacuated fled, suggests that social disruption has had an impact on the health of residents, particularly as expressed in malnutrition and respiratory illnesses. The presence of plague, while endemic to the area, is of concern because of its increase. The Chimborazo Province Department of Health engaged in a vigorous campaign to remove stray animals from the city in an attempt to disrupt the transmission cycle.

The increase in tuberculosis is equally disturbing. Often associated with poverty, lack of access to resources and crowding, the existence (although not yet reported in the research area) of multiple-drug resistant TB is a worldwide concern. The treatment of preference for TB recommended by the World Health Organization is direct observation therapy. While highly effective, it is also expensive in terms of personnel required and unlikely to be provided in the provinces in this study. Therefore, any increase in TB can be imagined to continue to increase exponentially, finding populations especially vulnerable following the political, emotional and social disruption of an evacuation.

The results of this research suggest that community resilience and recovery effects need to focus on nascent and early health problems that may signal the potential for greater problems, reducing the ability of community members to help their own

areas recover. In addition to recovering their economic productivity, community members need to recover their health. Nutritional supplements to families and children, emotional support by allowing families to evacuate together, and relocating families to environments similar to those from which they were evacuated are each strategies which can increase individuals' and families' abilities to participate effectively in community recovery through increasing their own resilience. The innovative methods and models incorporated in this research stem from attempts to combine insights from hazards research, geography and medical anthropology and, while these results are still preliminary, they suggest that this is a fruitful combination to continue to explore.

### Acknowledgements

This research was conducted with the support of a grant from the Center for Disaster Management and Humanitarian Affairs (<http://www.cdmha.org>).

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