RISK PERCEPTION OF NATURAL HAZARDS IN THE VOLCANIC REGIONS OF ECUADOR AND GUATEMALA

By

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A THESIS

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Chapter I. Introduction

While natural hazard events are not the leading killer in the world, they are a significant source of economic loss. Average annual economic losses from disasters have increased from $75 billion in the 1960s, $138 billion in the 1970s, $213 billion in the 1980s, to more than $659 billion in the 1990s. These estimates, however, fail to capture the impact on lives in developing nations, where 85 percent of the people exposed to natural disasters reside (NRC 2006)[1].

All over the world people live in hazardous areas. In some cases, these locations are sought after and the wealthy pay handsomely for prime real estate in high risk zones. In others, the poor are pushed into these areas as no one wants to live there. In volcanic regions, the soil is rich and fertile for agriculture. This hazardous land is an opportunity for jobs and brings in people for work. Which group of people will be most negatively affected by a natural hazard? How do human perceptions of the hazardous regions contribute to the nature or the extent of the disaster?

Compared with other hazard events, volcanic eruptions represent only 0.1 percent of the deaths that occur from hazards. However while some eruptions are predicted events that are seen as majestic and beautiful, others are unexpected and vicious killers. But how does this affect people living in regions with active volcanoes? Why would they stay in this kind of environment? Do they understand the risk they are taking by living in a high volcano risk area? Or does the volcano even impact their daily lives?

[1] All loss estimates based on 2002 dollars.

I chose to conduct my thesis research in three volcanic sites in Latin America. I traveled to these regions and gathered information on the perceptions people living in these areas have about the risks. This project is pertinent because there is a large research gap on risk perception in developing countries in academia. While baseline risk perception data is collected in industrialized countries, developing countries are usually only entered after a disaster has occurred. This thesis project is significant because the information collected here has not been done before.

There is a necessity for scientists and government officials to understand the risk perception of the local populations in order to ameliorate communication of hazards. Paying attention to the local perceptions of a hazard can increase the effectiveness of projects implemented by scientists who might need to communicate risks in the future, governments who may need to order evacuations in the future, and future researchers planning to conduct similar projects. While this work is not solely directed to this audience, many of the findings are specifically relevant for these groups. I have made specific recommendations for scientists and researchers working in the field, and for governments responsible for populations living in hazard zones.

Chapter II. Background

A. Natural Hazards

Natural hazards are "relatively abrupt events that endanger lives and property" (Ernst 2001). Hazards are problems for humans as populations grow and people encroach upon hazard-prone areas so that the risks increase dramatically. The belief that hazards are external events impinging on unsuspecting populations is no longer relevant as hazards are now understood as events caused by interactions between humans and nature (Mitchell 1994). Hence, hazards are clearly neither solely of physical origin nor simply the result of irresponsible human activities (Tobin and Montz 1997).

Disasters differ from hazards in that disasters are defined by the consequences of a hazard event. In order for an event to be considered a natural disaster, one of the following must occur: ten or more people must be reported killed, a hundred people must be reported to require emergency assistance, a state of emergency must be declared, or there must be a call for international assistance (CRED 2000). In order to understand the true and underlying causes of disasters, research must focus on the physical and human processes that interact to create natural disasters.

Hazards research primarily focuses on mitigation, disaster preparedness, and vulnerability. Mitigation refers to changes made in advance of a disaster to try to reduce the impact and potential harm, physically and socially. Some examples are structural mitigation such as renovating buildings to meet new codes for seismic hazards, or regulating development in high hazard zones. Actions taken prior to a

disaster to deal with anticipated problems of emergency response and disaster recovery demonstrate an area's preparedness. The development of disaster plans and insurance based on actuarial risk are examples. Research shows that social vulnerability represents the threats of hazards to the well-being of human populations and related economic losses, but it also includes the relative potential for "physical harm and social disruption to subpopulations of societies and their larger subsystems based on socioeconomic status, age, gender, race and ethnicity, family structure, residential location and other demographic variables" (Cutter 2003; see also NRC 2006). Vulnerability is determined by all of these elements in different combinations. Changing one element alters the vulnerability (Tobin 1997).

Exposure and vulnerability to hazard are not equal within societies, nor is the willingness to prepare. Additionally, "cognition of risk influences behavior in the face of hazard, and risk perceptions are often amplified or attenuated by sociocultural and psychological processes" (Mitchell 1994). Therefore, in order to understand people's behavior before, during, or after a hazard event, it is necessary to understand how the risks are understood by the local peoples, and the cultural context in which they were developed.

B. Risk Perception

People respond to a risk or hazard in ways consistent with their perception of that risk. It is their perception that influences behavior or action (Mileti 1993). Understanding public perception of natural hazards is necessary in order to impact hazard preparedness, and can be a problem because residents of at-risk areas often have inaccurate beliefs about the hazard agent and its impacts, are unaware of

available adjustments, and may have erroneous beliefs about the effectiveness of the adjustments of which they are aware (Lindell and Perry 1993). Research shows that adaptive actions are motivated by awareness of the hazard, knowledge of how it can affect the community, and feelings of personal vulnerability to the potential consequences (Janis and Mann 1977).

Two studies conducted on the risk perception of the public living near Mt. St. Helens in Washington show varying results (Lindell and Perry 1993). The first study was conducted during the first week of April 1980. Mt. St. Helens had just reawakened after 123 years of dormancy and the governor declared a state of emergency. A catastrophic explosion occurred just six weeks later on May 18th. The follow-up study was conducted in 1983 to assess the long-term perception and adjustments made by local area residents. There were consistencies in the comparison report showing that the awareness level of the residents increases with proximity to the volcano, and with locality along the rivers in the area. Overall, the study shows that the eruption caused considerable changes in risk perception. Before the eruption, but after the awakening of the volcano, perception had increased, but knowledge of the hazard was low. Only 69% of respondents could identify a single threat from a possible eruption, whereas in the second study the knowledge of threats ranged from 97 to 100 percent depending upon locality. The second study revealed that the severity of the risk motivated the development of family evacuation plans as well as other adjustments.

Mt. St. Helens is located in an industrialized country with involved scientists and media to analyze the hazard and provide information to the public. This is not

the case in all countries. Frequent exposure to hazard relevant information does not automatically elicit attention and comprehension, let alone the acceptance, personalization, and retention required to initiate hazard adjustments (Mileti and Sorensen 1987). Lindell and Perry argue that people do not actually need to understand the hazard in order to be motivated enough to prepare, but they need to believe that the hazard really exists and that protection is needed (1993).

Often, the reason people have difficulty taking action regarding a hazard is that they do not believe it really exists. One explanation is that people rely on past experience. In 1992, Hurricane Andrew destroyed 80,000 homes in southern Florida and put 12 insurance companies out of business with its unprecedented force. Even though evacuation was mandatory, many people refused to leave, as never before in their memory had a hurricane traveled as far inland as Andrew. The people who were reluctant to evacuate were simply making rational decisions based on past experience (Tobin and Montz 1997).

This raises a significant question on the perception of volcanic hazards. Hurricane season begins in May and ends in November annually. A hurricane is not going to hit the same area every year, but it is known that there is a possibility every year. Volcanoes, however, have the capability of going to sleep for centuries then waking with a violent and destructive start. Thus, judging the future based on previous experience is extremely unwise in these cases, and the experience of one lifetime is insufficient to judge the hazard.

Some villages might possess collective memories that date back to the last active period of the volcano, but volcanoes also have the ability to change. In 1985,

Nevado del Ruiz awoke in Colombia. While Ruiz was dormant it was seen as a protective being for the people, according to Bruce (2001). The risk was not taken seriously by the area's inhabitants, and signals given by the scientists and media were mixed. An eruption occurred that was hidden by the clouds, and the people of Armero slept peacefully while some tried to evacuate them, but others such as the town priest and mayor declared that there was not any danger. Twenty-three thousand people were declared dead from a mudflow that flattened the town two hours after the eruption. Today, the volcano is seen as a destructive force (Bruce 2001).

C. Locations for Research

My research is funded by a National Science Foundation grant awarded to the geology department at Michigan Tech: Remote Sensing for Hazard Mitigation and Resource Protection in Pacific Latin America. The benefits to me of working on this project are numerous, one specifically being that I had the opportunity to work with Peace Corps students in their field assignments who are enrolled in the Masters International Program (PCMI) for natural hazards at Michigan Tech. I contacted all of the students in the chosen locations before I selected their locales as research sites, and the students were willing to work with me, as they saw my research goals as advantageous for their own projects.

I identified three volcanic research sites where PCMI students offered to assist me in my project for a period of two to three weeks. All of these students had been in their sites for at least one year, and they believed that they had built a strong enough

network of local contacts that would assist me in the short time I had to spend with them.

i. Cotopaxi Volcano

Cotopaxi is Ecuador's most active and best known volcano, based on long-term activity and immense vertical extent measuring 5897 meters in height (Figure 1).

Figure 1: Ecuador and location of Cotopaxi research site (EE 2006).

It has erupted 50 times since 1738 with either lahars (volcanic rocks mixed with water to form a grinding cement river), giant blocks, pyroclastic flows, or ashfall. The 1877 eruption melted snow and ice on the summit, which produced lahars that traveled 100 km from the volcano all the way to Esmeraldas on the Pacific coast. This is the last major eruption from Cotopaxi, which killed 1,000 people. The area now has ten times the population of 1877 (D'Ercole 1996). Pyroclastic flows descended all sides of the volcano. The most recent eruption of Cotopaxi ended in 1904. Reports of an eruption in 1942 have not been confirmed. The most recent activity was an increase in steam emissions, melting snow, and small earthquakes from 1975-1976 (GVP 2006). The density of population has increased in the lahar hazard zone since 1877. Cotopaxi endangers now more than 150,000 people, who live on valley floors that have been repeatedly swept by massive lahars from even modest-sized eruptions of the volcano (NOVA 2002). Of these people, 35,000 live in a major lahar risk zone (D'Ercole 1996).

The hazardous area southwest of Cotopaxi has an estimated population of 120,000 people (IGEPN 2006), including the cities of Latacunga and Salcedo. I conducted my research in three small villages south of Cotopaxi. These villages are located near the southwest lahar drainage zone of the volcano (Figure 2).

Quisinche Bajo is a small community that developed along the bus route from Latacunga to Mulalo. The residents here have property for their animals, and other land set aside for growing crops in the more fertile soils. This is a rural community with only a primary school with about thirty students. The community has about fifty to eighty families living in Quisinche Bajo.

San Ramon is a larger community that contains a town center and a few stores. This town is only accessible by private car or foot, as buses do not travel as far as the village. The town is comprised of rural area with the houses and property surrounding the town center. Based on my observations there may be up to 100 families living in San Ramon.

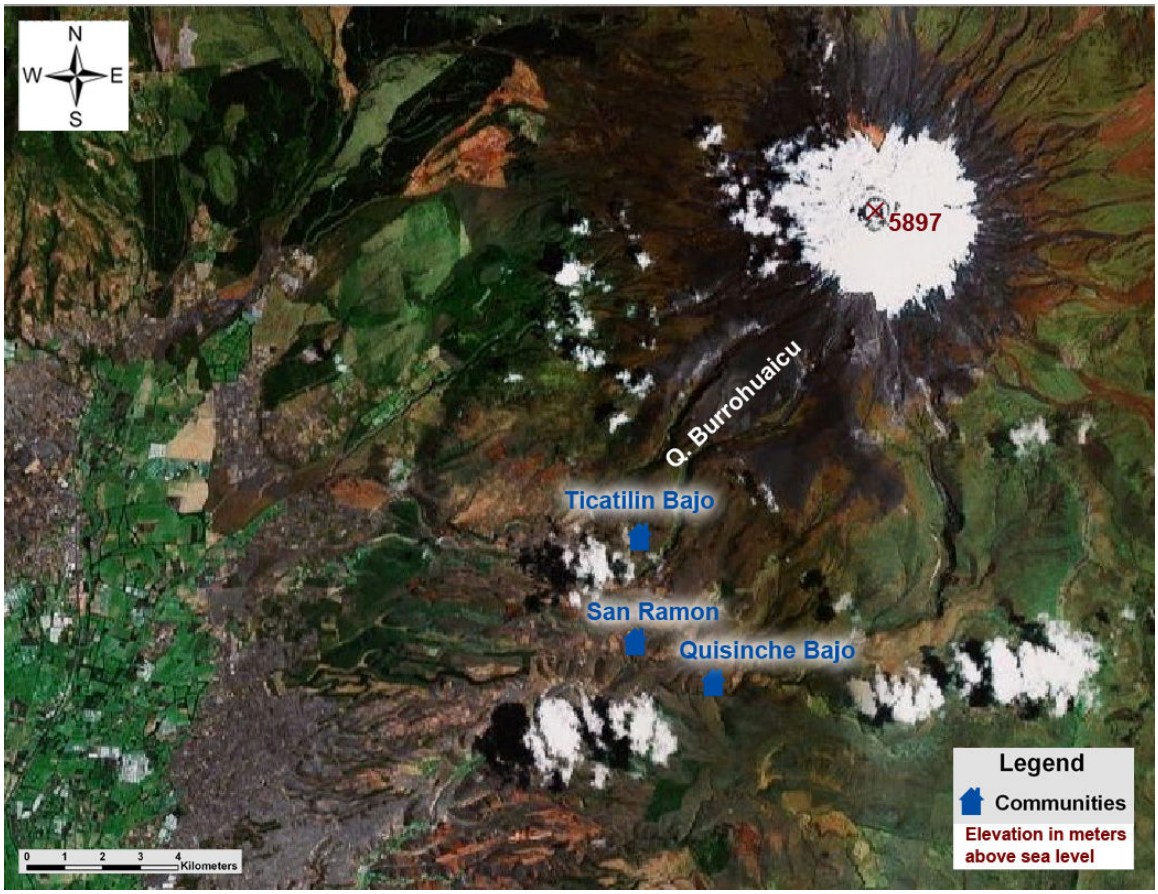

Figure 2: Aerial map showing communities southwest of Cotopaxi Volcano.

Ticatilín Bajo is a small community located on the road to Ticatilín Alto from San Ramon. Ticatilín Alto is a larger community, but Ticatilín Bajo is not much more than a hacienda with a few houses and a small number of inhabitants. There are most likely fewer than fifteen families in this area.

Quisinche Bajo is located 0.5 km east of the high hazard zone limit from lahars according to the new thematic map of Cotopaxi released in 2004 (Mothes 2007). This means that Quisinche Bajo has never had historical lahar flows. San Ramon is located near the union of the Saquimala and Burrohuaicu *quebradas*. San Ramon has a possibility of being affected by lahars because of piratization of lahars in channels as occurred several centuries ago. Technically, San Ramon is located above the main lahar channels and is just on the margin of the high hazard from lahars. This community is also in the high hazard zone for ash falls. Ticatilín Bajo is located upriver from San Ramon on the Burrohuaicu *quebrada*. It is just south of the high hazard zone limit from lahars (Mothes 2007). In summary the people I interviewed at Cotopaxi were longtime residents without second homes and are among the more vulnerable people living near hazard zones. Although they do not live within the hazard zones their lives would be profoundly affected by lahars if Cotopaxi became active.

ii. Santiaguito Volcano

The next two research sites are at two of the three currently most active volcanoes in Guatemala (Figure 3).

Santiaguito is a currently active volcano measuring 2,510 meters. Santiaguito produces continuous eruptions and currently has a massive dome complex, which has

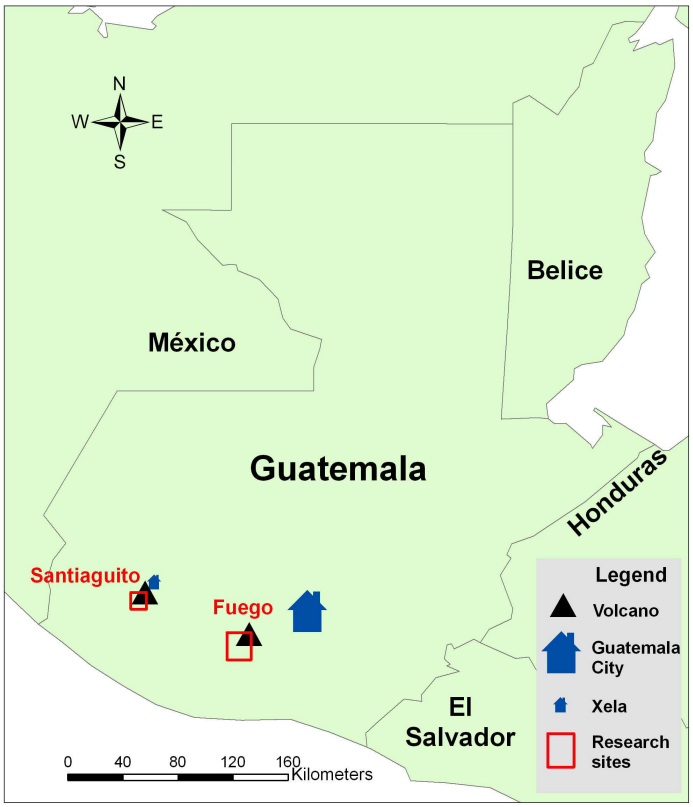

Figure 3: Location of research sites in Guatemala.

been growing since 1922 from vents within the 1902 crater. The crater was formed after a large explosive eruption which devastated much of southwest Guatemala and killed at least 5000 people. Along with dome growth, there have been continuous minor explosions, with periodic lava extrusion, larger explosions, pyroclastic flows, and lahars (GVP 2006). A major dome collapse in 1929 killed hundreds of people in the region between the volcano and Antiguo Palmar. The areas around the volcanic front in Guatemala are densely populated. In cases of volcanoes such as Santiaguito, these people are an at-risk population. Risks include a dome collapse which would

result in dangerous puroclastic flows and the collection of volcanic debris in the rivers south of Santiaguito (Rose 1989).

Santiaguito is located in the Quetzaltenango Department of Guatemala. The 2002 census found 624,716 people living in the Quetzaltenango Department (INE 2006), most of these in the capital city Xela. Population data are difficult to find for the farms and villages within the departments and municipal areas, however I was able to find information from a census conducted in 1994 (Table 1).

Table 1: Population estimates for Santiaguito regions.

Community	1994 Census Estimate*
La Florida	92
El Faro	167
El Patricinio	43
El Palmar	5318
Las Marías	1108

*1994 Census (INE 1994).

More recent data are not yet available. Much change has occurred in this region in the past thirteen years, therefore projecting 2007 estimates from the 1994 data would not be reliable. Guatemala's population is growing at an annual rate of 2.3%. Most urban areas in Guatemala have been growing, but rural populations appear to be steady or declining.

For instance, La Florida is currently occupied by only seven families, so there is little likelihood that 92 people live in the *finca* today. These families manage the farm and work with the crops themselves without bringing in extra workers. El Faro has experienced a boom in the past eight years and it is possible that population

growth has occurred, however population on *fincas* varies with the growing seasons, and the owner of El Faro complains of a shortage of workers. There are a number of houses set up for permanent workers on the plantation, and a larger building to house the temporary workers who stay for the entire harvest season. The housing does not seem adequate for 167 people. The estimates for El Patricinio, El Palmar, and Las Marías could be accurate, as there have not been any known causes for population decline.

I conducted interviews in *Finca* El Faro, Las Marías, *Finca* Patricinio, Nuevo Palmar, and *Finca* La Florida (Figure 4). El Faro is located along the Nimá Dos, a river where material from Santiaguito drains, but it is not located in the lahar hazard zone. It *is* located in the hazard zone for ash fall and for low mobility debris avalanches caused by edifice collapse (INSIVUMEH 2003). Las Marías and Nuevo Palmar are outside these hazard zones. Nuevo Palmar is a resettlement from the village now called Antiguo Palmar, which is located inside the lahar hazard zone. *Finca* Patricinio is also located alongside the lahar hazard zone, but is at a much higher elevation than the drainage river. *Finca* La Florida is located in the pyroclastic flow hazard zone for Santiaguito, as well as the zones for ash fall and debris avalanches. All of these locations could be affected by high mobility debris avalanches caused by edifice collapse, such as the one caused by Santa María in 1902 (INSIVUMEH 2003).

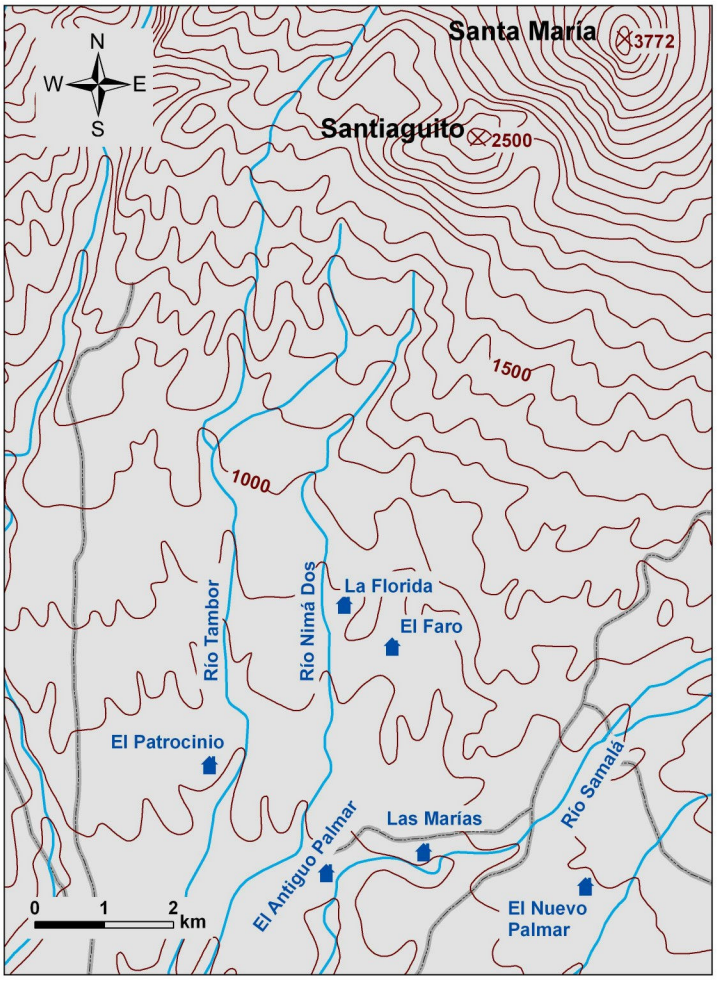

Figure 4: Communities around Santiaguito Volcano.

iii. Fuego Volcano

Frequent vigorous historical eruptions have been recorded at Fuego since the onset of the Spanish era in 1524, and have produced major ashfalls, along with occasional pyroclastic flows and lava flows. Fuego is currently one of the most active volcanoes in Central America and measures 3,763 meters in elevation. The

population density in the area of this volcano is 492 people/sq. km (GVP 2006). Hazards for this densely populated area include ashfall which can occur to distances of more than 100 km due to Fuego's high columns, falling blocks, avalanches, lava flows, and mudflows. Flooding is also a possible consequence, and detailed maps of these hazard zones are widely available (Vallance 2001).

Fuego is in the Chimaltenango Department, which was home to 446,133 people in 2002 (INE 2006). Population data for the communities I visited are only available from the 1994 census (Table 2) as newer data has not been released.

Table 2: Population estimates for Fuego regions.

Community	1994 Census Estimate
Panímaché Uno	213
Panímaché Dos	86
La Morelia	1072
Sangre de Cristo	32

*1994 Census (INE 1994).

In the past thirteen years, there have been unemployment problems in these communities. A coffee famine and an overabundance of workers have caused major problems in this area. I only met three people who have moved into this area in the last thirteen years. However, these estimates are possible according to my observations. While visiting the communities I learned that approximately seventy families live in Panímaché Uno, thirty families live in Panímaché Dos, 400 families live in Morelia, and five families live in Sangre de Cristo. If these 2007 estimates are correct, that would mean the average family size for Panímaché Uno and Dos and

Morelia would be about four. This seems likely. The estimate for Sangre de Cristo would mean a family size of almost nine, which I believe to be too high. In 1994, eighteen of the people living in Sangre de Cristo were fourteen or under with half being six or under. The adult population consisted of fourteen people between the ages of fifteen and sixty-five. There were no people over the age of sixty-five (INE 1994). The eighteen individuals under the age of fourteen would now all be over the age of fourteen, and there does not currently seem to be room in this community for that many adults. The town consisted of four houses and a school, with a few grazing animals. I believe this community has a high birth rate resulting in a younger population, and that many of the adults move to other more productive areas.

Panímaché Uno, Panímaché Dos, Sangre de Cristo, and La Morelia are all located in the ash-cloud-surge hazard zone south of Fuego as shown in Figure 5 (Vallance 2001). Panímaché Uno and Dos are split by the lahar hazard zone should a lahar have a volume of two million cubic meters. The greatest probability for a lahar is one million cubic meters (Vallance 2001). La Morelia is adjacent to the Río Tempigeal which renders it vulnerable to lahars with a volume of four million cubic meters or more. Sangre de Cristo also faces the risk of being completely surrounded by lahars, as the Zanjón Barranca Seca curves around the village. All of these villages are in the pyroclastic flow, lava flow, and ash cloud surge hazard zones (Vallance 2001).

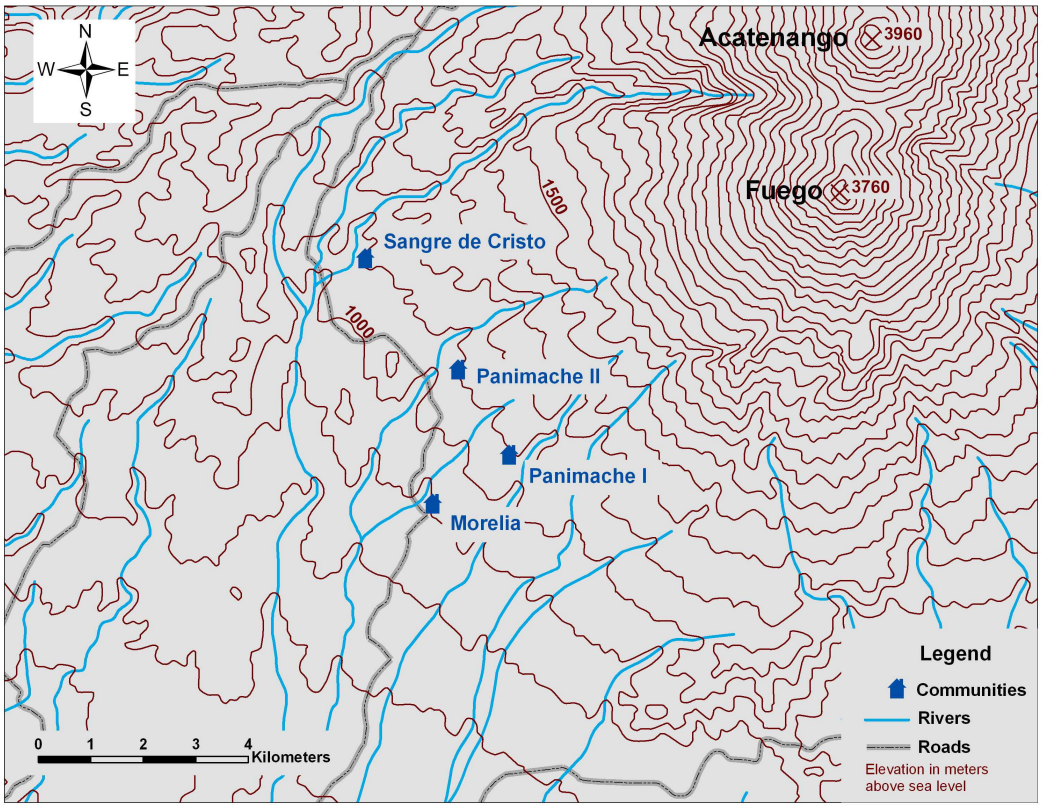

Figure 5: Communities around Fuego volcano.

Chapter III. Research Design

A. Methodology

The main goal of this research is to understand what people living in the area surrounding an active volcano know about the hazard risk and how they view the nature and risk of volcanic activity. The best way to acquire information from the public is to use a combination of qualitative methods. As my project was fieldwork conducted in a relatively short timeframe, I used participant observation and semi-structured interviews as my primary methods. The unpredictable nature of hazards makes qualitative research ideal for the study of the human dimensions of those hazards, as it can capture realistic human behavior and "acknowledges the existence of multiple realities, holistic investigation, the mutual influence of research and respondents, and the use of thick, rich description to form a context for understanding" (Phillips 2002).

Participant observation requires the researcher to immerse oneself into a community to gain a deep knowledge about the intricacies and inner workings that could not be obtained from literature or a method that elicits second-hand information. As such immersion is not possible in only two months, I attempted to use the trust acquired by Peace Corps volunteers in my field sites. I ran into my first difficulty when I was forced to fend for myself in Ecuador, as the Peace Corps volunteer who I had planned to work with was no longer in the country. Because of this setback, I adjusted my research plan by spending more time in Quito than originally planned. I used the time in Quito to gain extremely valuable knowledge

about traveling around Ecuador, and to take two last minute emergency Spanish brush-up courses before I visited my first site. In my first site in Guatemala, I encountered my second setback when I realized that Adam Blankenbicker lived in a private farm where transportation was difficult. My last site was ideal for participant observation, as the people were all extremely cordial and trusted the Peace Corps volunteer of their area, John Lyons, deeply. In Panímaché Uno, where I stayed and did most of my research, I was perfectly able to walk around by myself, and because I was associated with John I was welcomed into any household.

I conducted eighty-seven interviews (Table 3).

Table 3: Interviews conducted.

	Cotopaxi	Santiaguito	Fuego
Total	15	12	60
Men	7	10	20
Women	8	2	40
Age: Youngest	24	Mid-20s	22
Age: Oldest	79	96	78

I digitally recorded each interview, and kept a research journal for notes and summaries immediately following the interviews. A journal is beneficial for documenting impressions of a participant's body language and emotional mood, as well as writing a brief summary of the interview for quick reference (Orcher 2005). It is difficult to take notes while people are watching or speaking, so I only brought out my journal once, during the interview with the health inspector of Nuevo Palmar. I

believe people enjoyed the digital recorder, as they had not seen one before, and they especially enjoyed listening to themselves after the interview. I do not believe it inhibited any participants, as they mostly just ignored it and spoke to me, with the exception of a few people in Quisinche who insisted on holding it like a cellular phone. After that, I resisted handing the recorder to the participant, thinking it might be a bit of a distraction. The recorded files have been extremely beneficial for my translation, and much easier than finding material on tapes. I made sure each participant understood that her/his identity will be kept confidential, and that the recording is for my personal use only and that no one else will have access to it.

The following questions formed the basic structure I used for my interviews. Every interview and interviewee differs. However, I did add and drop questions based on the participant and the progress of the interview. The questions are crafted to gather information on the collective memory of those that live in the area and how they view the volcano due to past and present activity. The questions that I used as the structure for my interviews are:

1. How long have you and your family lived in this area?
2. Tell me a little bit about your life.
3. What are the things you do in a typical day?
4. What are the main dangers in your village/town?
5. Does the volcano have an impact on your life?
6. What is the relationship between your village and the volcano?
7. What did your ancestors say about the volcano?
8. How has the volcano affected your family and your village?

9. How dangerous is the volcano?
10. ***If so,*** how can you tell if something dangerous is about to happen?
11. What do you do if dangerous signs are coming from the volcano?
12. ***If not,*** how would you know if the volcano might become dangerous?
13. Will the volcano become dangerous in your lifetime?

In an ideal research environment, I would have liked to disconnect myself from the volcano in the beginning of the interview so that my first four interview questions would have been more effective. However, even in Ecuador when I showed up in a community without an escort wandering around by myself, people associated me with the volcano. When people I met agreed to introduce me to others, they would usually inform those who they asked to participate in my interviews that it was about the volcano. While this was a problem, I was able to work around it. Some people were likely influenced to speak about the volcano, even though they might not have done so if they had not heard that I was interested in the volcano. This did not negate the validity of my interviews; it just meant I had to conduct them in a different way. Of all my sites, I was probably least associated with Fuego Volcano. Here, people associated me with John, but I did not look or act like the visiting scientists they are used to, because I was not spending any time in the observatory. Therefore, most people seemed to assume that I was one of John's girlfriends who was visiting people.

I crafted question 4 to determine if participants perceive the volcano as a primary danger in their life. If the volcano was not mentioned in the answer, it shows that they view the risk of the volcano as lower than the dangers they mentioned. This question was more effective in Panímaché Uno because I was not as associated with the volcano as in other sites. However, some people were not swayed in the other sites and answered as they pleased. I found that thieves are a large problem in the Ecuadorian villages, and the roads are considered a problem in the rainy season in Panímaché Uno and La Morelia at Fuego. There was no consensus answer at Santiaguito. A few people replied that there were no dangers at all, while several responded that the volcano is the only danger.

Questions 5 -13 deal directly with the volcano, asking for the participants' perceptions of how the volcano affects their life, if at all, their history with the volcano, and their perceptions of the volcano. My goals were to discover if there is any mystical or spiritual significance attributed to the volcano with these questions, as well as to determine their views on the meaning behind volcanic activity, and any misconceptions to see how well they understand their respective volcano. Some of the questions I added during the field research are:

14. Who is the owner of the volcano?

15. Are there any good things that the volcano gives to the people here?

Question 14 was added due to stories that I heard relating to Santiaguito. I found that it also created interesting responses at Fuego. I crafted question 15 in Ecuador because I found that people usually only spoke of the negative effects of the volcano, when they also believed it had many positive impacts. The question was successful at

Cotopaxi and Santiaguito, but not at Fuego. Indeed, among women I had to drop the question completely. It seemed to confuse them and lead them to look at my contact for help which would disrupt the interview. If I was having a particularly good interview, or interviewing men, I would usually ask the question, sometimes leading to an interesting answer and other times none at all. When I interviewed the owner of *Finca* El Faro, the health inspector of Nuevo Palmar, and the teachers of Panímaché, I developed additional questions.

When tallying responses to the interview questions, I chose categories that best separated the significance of the responses. For example, question five yielded few diverging answers, therefore I only used the following four categories: yes, sometimes, no, and unknown. As with the other questions, I used the 'sometimes' category to signify when the respondent answered the question within a certain timeframe, instead of with a definitive 'yes.' For this question, some people responded by saying that the volcano only affected their lives when the ash falls on the village, or when a lahar blocks the road. People whose responses were coded as 'yes' responded with a definitive 'yes,' or by giving a long-term effect as an example showing that their lives were not only affected immediately after an eruption, but constantly.

Question 9 is such an important question that I wanted to make sure the variety of answers is shown. For this question, I used the following categories: extremely, dangerous, sometimes, little, and no danger. The 'sometimes' category has the same meaning here, in that it shows when the response was given for a specific time frame. Both the 'extremely' and 'dangerous' categories signify answers

saying that the volcano is always dangerous. The difference in this case is that people who were adamant about the definite danger of the volcano were categorized as 'extremely.' Those who seemed unsure about the danger were categorized as 'little,' and the rest responded that there is no danger.

B. Study Sites

i. Cotopaxi Region

In my Ecuadorian research site, *el campo* of Quisinche, I conducted ten interviews, followed by two in San Ramon and three in Ticatilín Bajo. I interviewed nine women and seven men, with one informal interview being split between a mother and son. All of the people in these pueblos are generally very poor, perhaps owning some land and animals for subsistence. At least two of the Quisinche subjects rented plots of land in the fertile ground in order to grow food for their animals. All of the residents I interviewed in this region were Mestizos and did not speak a native language other than Spanish to the best of my knowledge.

Rose plantations in the area are the largest source for local jobs in Quisinche. All of the women I interviewed work at home to take care of the children and animals, with the exception of two who also work in *tiendas*. The men of Quisinche that I spoke with work outside the home in the rose plantations, with the exception of one who is a student and travels to Quito two or three days a week. Any other work conducted off one's own property requires traveling outside the area. All of the teachers in the school come in from Latacunga every day. Ticatilín Bajo is extremely rural, and the men I interviewed there all worked on their land and with their animals.

The people I spoke with here revealed that the majority of their children left the region to find work and make a living for themselves. All of the interview subjects were born in the area with the exception of one man who moved to San Ramon to be the principal of the school.

ii. Santiaguito Region

The Instituto Nacional de Sismología, Vulcanología, Meteorología, e Hidrología (INSIVUMEH) is the government agency dedicated to geologic research in Guatemala. INSIVUMEH has observatories located at both Santiaguito and Fuego to observe and record the daily activity of the volcanoes. The observatory of Santiaguito, where I stayed with Adam, is located in a private coffee plantation called *Finca* El Faro. This makes it a difficult location to reach people, as Peace Corps volunteers are not allowed vehicles. Within the *finca*, it is difficult to find people who have lived in the area for a significant time, as many temporary workers come only for the growing season. With so many people coming and going, it is difficult for Adam to meet people, and to reach the people outside the *finca*. While I was staying at *Finca* El Faro I conducted twelve interviews. Of these interviews, ten were with men and only two with women.

Of the people interviewed, three lived inside *Finca* El Faro. The first is the owner of the *finca*, who spent half a week there and the other half at his other *finca* near Antigua, Guatemala. The second is a *finca* worker who had lived in this area all his life, as have his parents, and he has worked on this particular *finca* for ten years. The third is the teacher at the El Faro school, who lives inside the *finca* Monday-Friday and leaves for Las Marías on the weekends.

The other nine people interviewed live in various towns in the area. Three live in *Finca* La Florida, a small *finca* run by a group of families that has no vehicle access. Two live in *Finca* Patrocinio, which, although the most distant location I visited, is still at risk from the volcano because it is near one of the rivers. Two of the persons I interviewed are from Antiguo Palmar. Both had to relocate after Antiguo Palmar was destroyed by lahars in the 1980s and 1990s, but are both still living in the area, one in Las Marías and the other in Nuevo Palmar. In total, I interviewed two people currently living in Las Marías, and two in Nuevo Palmar.

Of the eleven, none of the interviewees worked in the home, which is most common among women in Guatemala. This is not to suggest that the majority of women do not work in the home in this area, but Adam does not have the opportunity to meet the women who do work at home. Instead he meets people through their occupations. When Adam asked for help finding people for me to interview, the majority of the people he spoke with thought of or suggested men. Both of the women I spoke with are teachers in the local schools. As for the men I spoke with, one owns a *tienda* and is president of the Community Committee for Development. Two work in the observatory and on *Finca* La Florida, while one of these men is also attending school to become a teacher. One is the owner of *Finca* El Faro. I also spoke with the health inspector for El Palmar. One of my interviewees was ninety-six years old and therefore retired, while the last four all worked and lived on *finca*s, three of them in leadership positions. There are two significant groups which I did not get sufficient access to within this location: women and 'ordinary' *finca* workers. I also did not have the opportunity to interview any indigenous people in the area.

However, interviews with those responsible for the *fincas* do give a unique perspective that I did not get to explore in any of my other research sites. There was ample opportunity to observe the 'ordinary' *finca* worker at Santiaguito, but the opportunities for participant observation with women were much more limited.

The owner of *Finca* El Faro is the only subject in this socio-economic class. The health inspector is more educated than most of the people in this area, and therefore is probably at a higher income level than the average resident in the area. Living and working on a *finca* is a poor life that is dependent on the weather. Even though three of these men have leadership roles that does not put them at a much higher income level. They all work in the fields like the other non-administrative *finca* workers. The teachers of Guatemala are not well paid and have been fighting with the government for higher salaries for years. Instead, the government reduced the number of hours required for school each day. It is likely that the INSIVUMEH observatory workers are also poorly paid. They are locals in the region who have been trained to observe the volcano, with little education required.

iii. Fuego Region

In my last research site around Fuego Volcano, I stayed in Panímaché Uno, which is a large village of about seventy families. The warm weather and friendly atmosphere all contributed to a generally congenial attitude. Therefore, in this area I visited every house and conducted sixty interviews. Of the total group, twelve were in La Morelia, a large town of 400 houses; four were from Sangre de Cristo, a small town of five families; and five were from Panímaché Dos, a town of about thirty families. According to the most recent available census data, very few indigenous

people live in these areas (INE 1994), and I did not have the opportunity to interview any.

I visited Panímaché Uno during coffee and sugarcane harvesting season, as well as cane field burning season. Therefore, six days a week the majority of the men were in the fields during the days. This gave me an opportunity to meet and speak with the women of Panímaché and La Morelia and made it more difficult to interview the men. I did speak with twenty men out of sixty interviews.

All of the forty women interviewed work in their homes, cooking, cleaning, raising children and a few animals. A few also have small stores out of their homes, with snacks, basic necessities, and rarely meat. It is obviously not common to work outside the home in this area, although even if it were, there are not many jobs. I met one woman who lives in La Morelia and is the teacher in Panímaché Dos, at least a one hour walk each way. Two of the men I spoke with are teachers in the school in Panímaché Uno, while all the others work on cattle, sugarcane, or coffee *finca*s in the area. A big complaint I heard was that there are very few jobs, and much of the current *finca* work is temporary/seasonal. This is different from the Santiaguito region, where there is a shortage of coffee workers, believed to be due to out-migration. The administrators at *Finca* El Faro believe all of the workers are moving to the United States.

In these regions, there is little diversity of socio-economic status. All the people are poor. Some are poorer than others, usually due to the number of offspring, and others might be slightly better off, shown by having a vehicle or other luxuries. Two of the men I spoke with have pick-up trucks. However, the people of Sangre de

Cristo are much poorer than those from other villages and are much more vulnerable to the volcano as the village is located very close in proximity to a volcanic *baranca,* which is a large ditch for volcanic drainage of lava and lahars. The two school teachers of Panímaché Uno are better educated than the people of this area, and come from Yepocapa, the capital city of the municipal district and a wealthier area in general. While not outside of Fuego's hazard zone, it is at a higher socio-economic level than Panímaché Uno and Dos, La Morelia, and Sangre de Cristo. Nevertheless, aside from the school teachers, who both had motorcycles, there is little economic variation among the people I interviewed.

Chapter IV. Results

A. Site-Specific Observations

i. Cotopaxi Volcano

In my first visit to the *barrio* Quisinche, it was immediately apparent how aware the people are of their environment here. While riding on the bus, my contact family informed me of the names of all the mountains, towns, and geological features along the way. Mario, a child of six years, named the mountains with confidence as we rode from the *barrio* to Latacunga.

I never saw Cotopaxi clearly, as it was always cloudy when I made it to Quisinche, but it was an ever present force in the lives of the people from this area. In every interview I conducted, the people were extremely aware of the presence of Cotopaxi Volcano in their lives. This was unexpected, considering the relatively dormant state of the volcano.

Of the ten interviews I conducted in Quisinche, all of the people are aware and thankful for the current state of tranquility of the volcano. However, all but two believe that the volcano will become dangerous again in their lifetime. Of these two, one is an elderly man in his seventies, and the other is a single mother who speaks of the volcano and the land around her with a certain passion and love, believing it to be a more protecting than threatening environment. The other eight people see Cotopaxi volcano as dangerous in the case of an eruption because of its size. I often heard that it is the largest volcano in Ecuador, which is not true. The highest volcano is

Chimborazo, however this is a completely inactive volcano and has been for a long time. Therefore, Cotopaxi is the highest volcano viewed as active in Ecuador.

When the people were not aware that I was interested in the volcano, usually the first threat mentioned as the greatest for the pueblos of Quisinche and Ticatilín Bajo was thieves. These communities, plus the community of San Ramon are located along a single road that leads to other towns and eventually to the volcano Cotopaxi in one direction, and to the city of Latacunga in the other direction. There is bus traffic for locals and tourist traffic along this road. Thieves apparently target household goods and farm animals. Households own packs of loud dogs to serve the purpose of announcing any and all visitors, so that thieves cannot sneak in quietly at night.

However, even if it was not mentioned as the most severe threat for the area, the people of Quisinche and San Ramon are acutely aware of the danger of the volcano should an eruption occur. There are several possible reasons for this. First, the village of San Ramon contains many boulders from an eruption of Cotopaxi 150 years ago. The boulders are all over the village and have been used for building materials. The Catholic Church in San Ramon was constructed of volcanic rock (Photo 1). Also, the biggest tourist attraction in this area is Chilintosa, a giant boulder over seven meters in height (Photo 2). These boulders, the church, and Chilintosa all serve to remind the people of the region of the danger that is possible. An eruption with blocks the size of Chilintosa today would have a very destructive impact. The people of Quisinche and San Ramon are aware of the danger that Cotopaxi is capable

Photos 1 and 2: Church made from volcanic rock and Chilintosa of San Ramon.

of and thus all the interviewees believe that in the case of an eruption their only course of action would be to evacuate.

The people living on the road of Ticatilín Bajo have very different views of Cotopaxi Volcano. I conducted interviews with three people in this very sparsely populated subsistence farming area. However, there is a stark contrast between their perceptions of the volcano and those I heard from the people of Quisinche and San Ramon. Indeed, all three respondents were very casual about the risk of Cotopaxi, and adamant that it was calm and had absolutely no impact on their lives. One man I spoke with was seventy-nine years old and insisted that he had never heard any stories of past eruptions from his parents or grandparents who all lived in the area. They are aware of the boulders of San Ramon, and see this as evidence that they would not be affected by the volcano, because there are no boulders in their area. These people live closer to the volcano than the other people I interviewed; however they view the volcano as unlikely to ever be dangerous for them in the future.

These very different responses raise questions because all of these people are in close proximity to the volcano and the boulders of San Ramon. It is possible, therefore, that the people of Quisinche and San Ramon have elevated perceptions of the risk of Cotopaxi due to the strong media attention given to other active volcanoes in Ecuador over the past four years. A month before I arrived in Ecuador, Tungurahua erupted, blocking the road in and out of Baños with a lahar. Volcanic activity has escalated in the recent past, and the media attention over these incidents has been intense. The communities of Quisinche and San Ramon are close to Latacunga, a medium-sized city, and therefore catch the news of what is happening outside their area. They also have televisions and radios, and are likely to hear or see the news themselves. However, Ticatilín Bajo is much farther away, and not likely to have the same access to the news as the other communities. Some of the houses in Ticatilín are less modern and without electricity. While there is an institute for the volcano further up the road toward Cotopaxi, there is very little traffic that would influence the people. Therefore it is possible that the media frenzy over other active volcanoes has heightened the risk perceptions of the people of Quisinche and San Ramon, while the people of Ticatilín have not yet been affected.

Visiting San Ramon, I could see that Cotopaxi also provided some benefits to the people in this region. The boulders are used for building supplies by some people, such as for the church of San Ramon. The people benefit from the fertile volcanic soil throughout the region, such as with the rentable land plots that families in Quisinche use for food for their animals (Photo 3). Ticatilín Bajo has potable water because of the institute nearby. There is some tourism in the area because of

Chilintosa and the boulder field. However, I never saw signs of governmental involvement with the local people of this region in regard to the volcano for either communication or education purposes.

Photo 3: Rentable plots of land in Quisinche.

ii. Santiaguito Volcano

Santiaguito is often obscured from view by clouds, hills, and Santa María, making it a hidden and sometimes forgotten threat. After leaving Cotopaxi, an area where people seemed to fear a century of past silence because of the unknown future, I was surprised to enter an area with a very active volcano that people seemed to ignore. Santiaguito erupts every fifty minutes, on average. The most common danger of the past several years are the lahars during the rainy season, especially when a lot of volcanic material (often from pyroclastic flows) has accumulated in the rivers. The lahars pick up this material, increasing the danger. However, Santiaguito also

produces ash eruptions and pyroclastic flows associated with dome collapses. The ash is a problem for agriculture and health as it is sixty percent silicate, which means it persists for a much longer time than ash with a lower silicate content (Photo 4), which could be dangerous for health or agriculture. Pyroclastic flows are usually only risks for those within 4 km of the dome, as Santiaguito's dome collapses have usually been small. However, there are high elevation coffee fields where people do work, at an elevation where people have been killed by a pyroclastic flow in the past. Santiaguito also produces lava flows that extend two or more kilometers south from the dome at highly active times, but the lahars are the most destructive force.

Photo 4: Ash from Santiaguito on a coffee plant in the San Andreas *finca.*

In the 1980s and 1990s, Santiaguito produced large lahars, which blocked the Río Nimá II and destroyed the town now referred to as Antiguo Palmar and caused the abandonment of several small fincas north of Antiguo Palmar. Because of this recent activity, one would assume that people in the vicinity of this town would be extremely aware of the danger of Santiaguito. However, after almost twenty years memory has faded and the only people who seemed very aware of the dangerous capabilities of Santiaguito were those who were directly affected by it. I interviewed two people who had lived in Antiguo Palmar. The first is a female teacher in her twenties who now lives in Las Marías. Her family did not leave Antiguo Palmar until 1995, which is surprisingly late, as the first eruption occurred in 1983. The other person is a ninety-six year old man who can also recount details from the aftermath of the 1929 Santiaguito dome collapse and pyroclastic flow. These two respondents recounted the terribleness of their entire town being destroyed. They both spoke of the pain and horror Santiaguito caused, and were adamantly against people moving back into the Antiguo Palmar region. The male spoke of the danger of the people working close to the volcano, while the female spoke of evacuation plans and the importance of moving the children out of danger first. Neither of these persons believes that Santiaguito gives anything good to the people in the region.

The two respondents from Antiguo Palmar show very strong emotions and feelings with regard to the volcano. However, even though several are close to this area that was destroyed, no one else in the region seems remotely affected or aware. Through participant observation it is apparent that others in the region who see the volcano every day, and those who are close by but cannot see the volcano, find the

volcano to be of little risk. The people in this region know of the destruction of Antiguo Palmar, and three interviewees even told stories from the 1902 Santa María eruption, but because they do not have first hand experience of that kind of devastation they do not imagine it happening to them.

Of the other interviews I conducted, I found that the majority of the people who seem to be most concerned about the volcano are in some sort of position of responsibility or are directly vulnerable. I spoke at length with the owner of the coffee plantation El Faro, whom I shall refer to as Miguel (not his real name). El Faro is located directly under Santiaguito. On the USGS hazard map, El Faro is located in the hazard zone with the greatest risk being ashfall, however Miguel has seen the rivers flood, pushing lahars out of the baranca and onto his land and crops. He has stopped planting coffee plants on the edge of the river gulch, knowing that the walls are slowly eroding away and that there is a possibility of a lahar flooding the river again. He worries about his crop, and his greatest fear is that, for one reason or another, he will not be able to fulfill his agreements with Starbucks and one day lose his contract. He does not necessarily believe that the volcano will cause this, but he worries about the possibility. He is glad that Santiaguito is not the size of Santa María or Fuego. While he is confused about the science of geological events, he does know that the greatest risk is lahars. He has an INSIVUMEH hazard map in his conference room, and he recognizes that the small everyday eruptions the volcano produces are a good sign of a regular and healthy volcano, knowing that if the cone becomes clogged, a much greater eruption would occur.

Miguel also believes there is something romantic about Santiaguito. He is attracted to it, and it has attracted business to him (Photo 5). He uses Santiaguito in his marketing, and it is the reason Starbucks chose his farm as a producer over another Guatemalan plantation. Starbucks executives have even flown over the dome during their visits to El Faro. Santiaguito creates a beautiful scene for the plantation, but it also provides fertile soil for the plants and rock which is used for building materials and the road. Miguel believes the ash also has a helpful effect for the coffee crop, because it produces a dryer atmosphere that protects the crop from fungi.

Photo 5: El Faro and Starbucks.

Miguel seems mostly concerned about his crop, but he is also responsible for many permanent and temporary workers. However, he does not have an evacuation plan for the people on his farm, and replied to the question by saying, "I guess everyone would just go up to my house." His house is at a higher elevation over the

farm and would be out of the lahar risk zone. However, his best coffee is produced in his high elevation San Andreas farm. This region is at risk for pyroclastic flows, and people have been killed here in the past, though not since Miguel bought the farm. During the harvest he has 200 workers in San Andreas, and while he is aware and conscious of the risk, he does not believe the workers are. He is not communicating the risks to these people either, but he believes they would work anyway and disregard the risk.

The health inspector of Nuevo Palmar informed me of the many health problems he has seen in the region due to either working near the volcano or past eruptions. While he believes the primary effect of the destruction of Antiguo Palmar was economic, there were many health problems when people were crammed into housing situations in Las Marías with no water. Perhaps the greater health effects are the chronic ones that affect the everyday *finca* worker, who may not realize that frequent exposure to ash is bad for his health. Even though the inspector is aware, there seem to be no communication of the health risks and no education programs set up. A common opinion is that the people would choose to work anyway. However, as they are not informed, they never have the opportunity to choose.

Permanent *finca* workers are in very different situations from those I have discussed so far. These men only have responsibility for their families. They do not own land, crops, or even their houses. They are given plantation housing, which Miguel complains that they will not take the responsibility for, and "would stare at a hole in the roof for two months until we (the *finca* administrators) have it fixed" even though any improvements would be reimbursed. The people do not believe the

volcano is dangerous, even though they may have been working in the area long enough to see the effects of violent eruptions. One interviewee who has lived around Santiaguito all his life and worked in El Faro when lahars flooded the rivers expressed his belief that the volcano is tranquil and does not present any danger to the farm or the people. His parents never told him any stories of the volcano, and he does not think it will become dangerous in his lifetime.

It seems unbelievable that anyone could believe the volcano poses absolutely no risk, but there are several people who feel exactly this way. It seems as though those who do not own their own property, who live on someone else's land, and who do not own their own houses do not take the risk of the volcano very seriously. If a permanent *finca* worker loses his house in a lahar, he would not lose any financial investment of his own. He may lose clothes and some personal belongings, which might be all he has, but unless the entire plantation is destroyed, he can wait for the *finca* to build him another house. However, even though he owns none of the land, he still sees benefits from the volcano for the people. The volcano produces construction supplies and good soil that provides jobs for the poorer people. Overall, the volcano is seen as a positive feature.

Something that I found at Santiaguito that I did not find at either Cotopaxi or Fuego volcanoes is a strong history of legends and myths surrounding the volcano. Everyone I interviewed in this area knew of Juanoj and his story as the supposed owner of the volcano. There are many stories and many different versions, as the memory of Juanoj has become confused in some people's minds. A version of the myth involves people giving money to Juanoj, bribing him to prevent eruptions from

Santiaguito. This began after someone who refused to pay was killed by an eruption. Instead of paying, it was believed that one large land owner in the area gave Juanoj his daughter, and therefore his daughter never married. People would see a very elegantly dressed person going to the house of this man, and they would say that this was Juanoj going to visit his bride.

One man who is from the area grudgingly admitted that he has family members who practiced a sort of mysticism in the past, and told stories of Juanoj, but could not clarify if he was a man, a god, or a demon. The young woman from Antiguo Palmar was not sure if he had at one time been a real person. Those people that I spoke with, who are currently practicing an evangelical religion, knew of Juanoj, but immediately denounced the stories as lies as only God owns the volcano or controls the volcano.

Why would one volcano have such a rich mythological tradition while Cotopaxi and Fuego seem to have none? Tungurahua, the most active volcano in Ecuador, has a strong religious mythological tradition which can be seen heavily in the artwork throughout the Cathedral in Baños (Photo 6). Perhaps Santiaguito and Santa María have been celebrated with such a tradition because of the long history of violent eruptions. In the 20th century, this volcano complex has threatened its communities with violent eruptions in 1902, 1929, 1983-1990s.

Photo 6: Tungurahua image in the art work of Baños Cathedral.

It also seems more complex than the average looking volcano because it is made up of more than one volcanic dome (Photo 7).

Photo 7: Dome complex of Santa María and Santiaguito.

There are ongoing debates as to whether Santiaguito and Santa María are the same volcano, and they are accompanied by four other domes which at some points in time were also active. The dome Brujo still produces fumaroles, even though it has not been active in the past ten years. Also, Santiaguito does not stand out in the Guatemalan landscape like other volcanoes. It is more mysterious, and is hidden behind the hills. One cannot see the volcano from Las Marías, which is only a kilometer away. Guatemala is known for Lake Atitlán from which one can see six volcanoes, or the city of Antigua which is towered over by Agua and Fuego. Therefore it might be more likely for people to develop stories to try to understand or explain a volcano that one cannot see while it is very close, a volcano that produces violent destructive eruptions, and a volcano that looks like it could erupt out of more than one dome at a time.

iii. Fuego Volcano

Because I spoke with so many people, I noticed immediately that it was much more difficult to speak with young women than any other group. With the exception of one seventeen year old female who I only spoke to casually, women in their twenties and thirties had much more trouble answering my questions than men or older women. They were much more likely to answer the open-ended questions asking for their opinions with phrases such as "saber" or "solo Dios sabe" meaning 'who knows' or 'only God knows' than to come up with their own response. One possible contributing factor is the prominence of the Evangelical Church in this area, combined with the general low status of women in a *machista* culture. Here, young women are simply not used to being asked their thoughts or opinions. Unlike the

Catholic Church, which tried to incorporate indigenous or pagan beliefs into their doctrine to make it easier to recruit followers, the Evangelical Church has tried to squash "pagan" ideas in Guatemala, some of which I saw with the myths surrounding Santiaguito Volcano. It seems as though young women are used to being told what to believe, and not until their children grow past adolescence and they are given the more revered status of a mother do they evolve past the "solo Dios sabe" phase. I did not encounter this problem at Santiaguito, most likely because I only interviewed two females who were both educated and working as teachers. None of the women I interviewed around Fuego worked outside of the home.

When I asked about the relationship between Fuego and the villages, the most common answer I received is that they are accustomed to the volcano. Fuego is one of the most active volcanoes in Central America. It has multiple eruptions daily, it rumbles and makes lots of noise, lava glows red after dark, and it threateningly towers over the villages. However, this happens every day and night, so the people barely look up when they hear a *rotumbo*.

In fact, because they are so aware, they are almost unaware. The first week I visited Fuego, there were many eruptions, lava, and degassing, but the volcano was mostly quiet and did not produce the large sounds called *rotumbos*. In my second week the volcano started changing. All of a sudden Fuego was making a lot of noise, with several *rotumbos* a day, and the eruptions and degassing became a lot more frequent. There was also an earthquake that week. I noticed these changes because it was all very new to me, and the change only made the situation seem scarier and more dangerous. However, the locals did not notice the change, even when probed in

interviews, and never mentioned the earthquake. They are so accustomed to the volcano that even when a definite and noticeable change occurs in the activity, they notice nothing, as though every event were the same.

As I noted earlier, the majority of my interviews here were conducted with women. I believe the women can be divided into two groups. Those who are under forty years old, or who have moved here only in the past ten years, are more likely to say that they have a happy life and do not consider the volcano dangerous. They are accustomed to the noise and do not believe they or their family have been affected by the volcano. They will most likely reply that 'solo Dios sabe' whether the volcano will become dangerous in the future. Overall, they will speak very little, but give the impression that the volcano has little or only periodic impact on their lives and that it should not be taken seriously. They do not know anything good that has come from the volcano. However, some complain about the ash slowly deteriorating the roofs on their houses, but they do not connect this with an impact on their lives. Some might also mention the problems with the road during the rainy season as the main danger in their life. This is not connected with the volcano, and a few spoke about how lahars block the road, stranding everyone inside the villages.

Women forty years and older give a very different account of their lives. First, they are most likely to say that they have a hard or difficult life. They remember the 1974 eruption, and therefore believe the volcano is dangerous and has a great capacity for more danger. They recount the details of what the land looked like, and their houses. They talk about the difficulty of building new houses because it is

necessary to dig sometimes one meter into the sand in order to reach hard ground (Photo 8).

Photo 8: House built after the 1974 eruption where volcanic materials had to be removed to reach a solid surface.

They have many stories about the hardships the volcano has caused. Surprisingly, when I asked for stories their ancestors or grandparents told them about the volcano, many women responded by telling me how many more people used to live in Panímaché Uno or Sangre de Cristo, but left because of an eruption and never came back. Perhaps they moved just down the road to La Morelia, but some left the area altogether. Now it seems as though the people who are left in Panímaché Uno and Dos, as well as Sangre de Cristo, are those who cannot leave because those who had the resources to move elsewhere already have done so.

The older women also made it clear that the volcano is the only danger in the area. They also speak about the road in rainy season as a problem, but I think they

see the road being washed out as a more normal part of life that they have to deal with every six months. The volcano is a different kind of danger because large eruptions are not regular and cannot be predicted. These women associate the deterioration of tin roofs with the volcano, as well as the boulders in La Morelia. They also spoke about the road becoming impassable due to lahars, and not being able to leave for Santa Lucia for food or supplies. One woman also spoke about the children being sick after the eruption because of the ash and sand particles in the air. Overall, as in Antiguo Palmar around Santiaguito, the people who lived through the eruption of 1974 have a much more acute vision of the danger of Fuego, whereas the younger women or people new to the village do not have that kind of awareness.

One dramatic difference between the men and women is that the men seem to be educated about the volcano by personal working experience and by hazard preparation programs. The men spoke to me openly about their experiences during and after the eruptions. They work six days a week either with sugarcane or coffee, and it is clear that the volcano is a source of more work for them. When the road is blocked off because of the lahars, the government does not send troops to help them; they have to wait till the lahar cools down and remove the hardened material themselves with shovels. There is a local community group for preparedness which was set up in the area by ConRed, a private geological hazards research group in Guatemala. The group is supposed to host meetings to educate and update the people of the town about the status of the volcano to keep people informed; however they are extremely inactive and have not held a meeting in the past year and a half. When meetings are held usually only men attend. John Lyons, the local Peace Corps

student, has shown volcano videos at the churches and in the schools, and this has been the only form of education recently.

In my interviews I always asked a version of this question: how can you tell if something dangerous is going to happen (with the volcano)? This question is important because it tests to see what kind of knowledge the people have about signals coming from the volcano or any misconceptions about its activity. Forty percent of respondents at Cotopaxi and 60% from Santiaguito replied with some ideas about how they could tell if the volcano's activity elevates, whereas only 22% described volcanic signs as a predictor at Fuego. However, in the four locations I visited around Fuego Volcano, the most common response was that they did not know how to tell if the volcano is becoming dangerous (38%). A quarter of respondents around Fuego said that INSIVUMEH, the governmental agency that monitors the volcanoes and other geological events, would inform them to evacuate. This implies that the people living around Fuego are very confused as to activity of the volcano and therefore cannot interpret the signals themselves. From one perspective this is not surprising, as Fuego is very active and determining when a dangerous eruption will occur is quite difficult. The frequency of the activity numbs them to the volcanic signals. Therefore they rely on the government to tell them when these types of events will happen.

Interviews from the other two sites show similar results, as 27% of the respondents from Cotopaxi and 20% from Santiaguito replied that a government agency or someone would inform them if the volcano's activity increases. Those from Santiaguito were also referring to INSIVUMEH. The Ecuadorians who

responded in this fashion were not necessarily referring only to the government, but also to media, family, and non-governmental organizations.

Table 4 demonstrates that a similar percentage from each site are taking no responsibility for their own well-being, and relying on someone else to alert them in case of dangerous volcanic activity.

Table 4: Results for Each Location for Questions 10 and 12: How can you tell if something dangerous is going to happen?

	Give Volcanic Signs	Gov/Someone Will Tell Us	Physically See	Unknowable	Unknown
Cotopaxi	33%	27%	7%	13%	20%
Santiaguito	60%	20%	0%	10%	10%
Fuego	22%	25%	0%	16%	38%

However, this is most likely due to the confusion surrounding the volcanic signals. The 60% from Santiaguito that gave volcanic signals as a response to this question are either educated or have lived in the area for a minimum of twenty-two years. They are also from or living in the areas closest to the volcano, and therefore have more daily exposure. Because there is less volcanic activity at Cotopaxi, it would seem to be easier for those who live there to interpret any new signals that begin as dangerous. However, 33% people responded that they did not know or could not know how to determine if the volcano is becoming dangerous. Combining the 'Unknowable' and "Unknown' responses with those relying on information from others, 60% of the respondents from Cotopaxi, 40% from Santiaguito, and 78% from Fuego reveal that they do not have the knowledge to determine the safety level of the volcano in their area.

Table 4 also illustrates that 25% of the respondents from Fuego trust the government to make these decisions for them. They see the scientists who come, and they have access to the INSIVUMEH observatory in Panímaché Uno, and therefore they believe that the agency is able to advise them. I do not believe this is the case for the people surrounding Santiaguito Volcano. The observatory for Santiaguito is in a private *finca* with doors closed to ordinary citizens. It is difficult for people to reach the observatory and for the observers to leave the plantation grounds. Therefore, people do not know the observers and are not familiar with the observatory. The people in the hazard zone for Santiaguito are unaware of what the observers are doing, any plans they might be making, or research they might be conducting. Therefore, there is no relationship between the people in the area of the volcano and the governmental observatory. The two respondents from Santiaguito who answered that they rely on INSIVUMEH for this information are both *finca* administrators who have radio access and regular radio contact with the observatory.

The Fuego observatory is quite the opposite. It is in an accessible location with open doors to those who wish to stop by. It is a regular occurrence to see students in the observatory office using the computer for homework assignments. Because of this open and available atmosphere, the people of the region have really grown to trust INSIVUMEH. This trust has allowed them to rely heavily on the agency, entrusting it with their lives, and admitting helplessness.

While there are no widely held myths across the populations, there are two interesting beliefs that exemplify the confusion some people feel about the volcano. The first is that there is gold or petroleum in the volcano. Enough people mentioned

this idea to show a rumor trend, although the majority of people never admitted this belief in conversation to me. One of the consequences of this idea, is that the people see the foreign scientists and government employees out of Guatemala City come to look at the volcano, take samples, and only stay for a few days. They believe that the visitors are studying the volcano in order to discover how to get the gold or petroleum out of the volcano. John Lyons was even asked in the beginning of his service in Panímaché Uno if he was there to finally get the gold out of the volcano. The other idea that I heard twice, once in Panímaché Uno and the other time in Sangre de Cristo, is that Germans own the volcano. It is possible that the question "Who is the owner of the volcano?" confused some people around Fuego and fooled them into believing that there really was an owner. However, the belief that Germans own the volcano derives from an influx of Germans moving to Guatemala during and after the Second World War and purchasing a lot of land, including coffee plantations. Everyone else who I dared to ask this question here either responded that the government or God owned the volcano.

B. Patterns of Perception

i. Communities and Government

This research identified valuable information on how communities would respond to help and what they need from their governments. Interview results reveal a strong dependence on outside sources, and a lack of knowledge at home. Based on this information, it is possible to draw conclusions about the reactions of these communities to government involvement in the future.

Out of eighty-four respondents, 69% replied that they would evacuate if there were dangerous signs coming from the volcano (Table 5).

Table 5: Results from all three sites: What do you do if dangerous signs are coming from the volcano?

	Evacuate	Stay, Take Cover	Nothing	Unknown
Cotopaxi	80%	0%	13%	7%
Santiaguito	70%	10%	20%	0%
Fuego	64%	14%	7%	15%
Total	69%	11%	10%	11%

Therefore, if people are alerted that the volcano is dangerous, as long as they believe it, they should be willing to evacuate to a safer location. In both the Cotopaxi and Santiaguito regions people were more likely to respond that they would do nothing, rather than take cover in their homes. People at Fuego were more likely to respond that they do not know what they would do, meaning either that they most likely wish to evacuate but cannot for some reason, or that they do not believe Fuego will be a risk for them in the future and therefore have not made plans. However, those at the other two locations who responded in this way were adamant about the low level of risk, and therefore did not need to consider any option.

No one responded that they did not know which course of action to take at Santiaguito, even when they openly admitted that they have not made plans. This might be due to the very diverse sample I interviewed in this area. Many of the people were educated or had lived in the area for a significant period of time. Therefore, even if they were not convinced that the volcano will be dangerous for

them, they are aware enough of the past to know the best options. The educated people were also the most likely to know the hazardous areas for Santiaguito. The *finca* administrators at *Finca* Patricinio were aware that the rivers are the danger zones carrying lahars in the rainy season. They keep track of volcanic activity on their own and are in contact with the Santiaguito Observers (Photo 9).

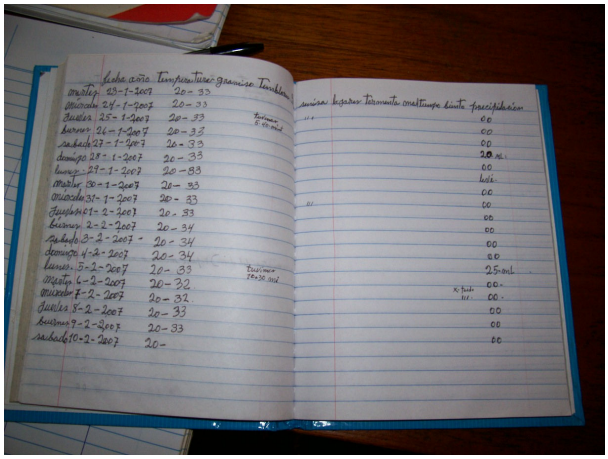

Photo 9: Log of activity of Santiaguito kept at *Finca* Patricinio.

However, even though their farm is located on one of the rivers, they know that the river is very deep at that point, and that it would take several large events of the scale seen in recent years for their farm to be affected. It has been affected by the volcano in the past, but the frequent lahars have caused erosion that has increased the depth enough to minimize the damage for *Finca* Patricinio. This knowledge, combined with neither of the administrators having lived in the area very long, made it easy for them to respond that they would take no action in the future.

Table 5 demonstrates that there is a strong willingness to evacuate at Cotopaxi. This seems surprising considering that all of the people I spoke with raise animals ranging from chickens to cows and alpacas. An evacuation of the animals would not be possible; they would be left behind. However, a great majority said that they would have to evacuate should Cotopaxi become dangerous. The respondents who said that they would not leave and would do nothing were from Ticatilín Bajo. They were resolute that Cotopaxi presents no danger for their *barrio*.

Of the thirty-five interviewees who said that the volcano has no impact on their lives, twenty-five responded that they would evacuate if the volcano gives dangerous signals (Table 6).

Table 6: Other responses of those who will evacuate.

Volcano Has No Impact on My Life	71%
Volcano Will Not Be Dangerous in Future	69%
Volcano Has Not Affected My Family	59%
Volcano is Not Dangerous	14%

Sixteen people said that they do not believe the volcano will become dangerous in their lifetime, but 69% of those people responded they would evacuate in this case. Additionally, 59% of those who replied that their volcano has not affected their family also said that they would evacuate in the case of elevated danger. Over half of all of the responses categorized the volcano as something that has not impacted them in the past and that they do not believe it will impact them in the future, but all responded that they would evacuate if the volcano became dangerous. However, only

1 respondent (14%) of those that replied that the volcano is not dangerous also said they would evacuate. It is easier for people to reply that the volcano has not affected their own life or the lives of their family members, but much more difficult to take the strong stance that the volcano is not dangerous. Therefore, few people responded that the volcano presents no danger, but those who did have strong convictions to support their answer and see little necessity to plan an evacuation in the future. This demonstrates that even though some people do not consider the volcano a risk, a strong majority of people will evacuate, rather than risk their lives should danger become apparent.

At Cotopaxi volcano I saw very little government effort taking place in the at-risk villages. There seems to be very little communication with the populations here, even though two of the three I visited have communication and media access. The people in the *barrios* of Quisinche and San Ramon would respond to governmental action, but they do need guidance and education. The people of Ticatilín Bajo would most likely reject any interference.

The people around Santiaguito do not view it as a great risk unless they have already been affected by a previous eruption. Since the population is transient, they do not recall much beyond 5 or ten years. They are not looking for government involvement and are largely unaware of current activities of the government. Unfortunately I was not able to conduct many interviews with the poorer, less-educated population in this region. Through communications with Adam Blankenbicker, interviews with others, and my own personal observation, I believe the poorer population would resist evacuation efforts, just as some did in the 1980s in

Antiguo Palmar. The *finca* workers, especially those there only temporarily, are not informed as to the hazard zone of the volcano or the health risks of the area. There are no programs established to inform them. As Lindell and Perry argue, people need to believe the hazard exists to take any sort of action, and as the plantation-working class is not even warned about possible risks, they do not believe there is a risk at Santiaguito (1993). Therefore, I believe they would strongly resist evacuation efforts.

Around Fuego Volcano the older population of the communities are relying on the government to tell them when or if they need to take action. A strong majority does not understand the signs from the volcano, probably because there are so many eruptive events, and cannot make assumptions about when dangerous activity is approaching. They have admitted this, however, and are waiting to be helped. The question then becomes, will the people respond when the government tells them to take action? However, the younger population, and people who are newer to the area are not as aware. They have heard the stories, but I am not sure that is enough to motivate younger families to evacuate when told. They believe that evacuating is the safest course of action, but will they believe an eruption is coming when they do not understand the volcanic signs? There does seem to be a strong trust for INSIVUMEH overall, so perhaps these people will react accordingly to INSIVUMEH recommendations.

In my research sites, 69% of the people I spoke with were willing to evacuate if the volcano was becoming dangerous. This is a significant majority because it includes people who believe the volcano has had no impact on their life (71%) and those who believe the volcano will not become dangerous in the future (69%). The

remaining 31% believe that evacuation would not be possible for them or unnecessary. In certain cases, such as Ticatilín Bajo and *Finca* Patricinio, they are most likely correct that an evacuation would not be needed. But for others, it shows that the people are uninformed and uneducated about the risk zones surrounding the volcano. The lack of government involvement confuses the people of Cotopaxi and Santiaguito. The governments have not developed a sense of trust among the people in these regions, and problems will arise when either the governments or the volcanoes become active. There is a great sense of trust of the government among the population around Fuego which results in a much more cooperative environment.

ii. Gender and Risk Perception

In three locations, I interviewed fifty-one women and thirty-seven men. The majority of my interviews with women are from the Fuego area, and I only conducted two interviews with women in the Santiaguito area. In some ways the responses of men and women are very similar, but there are some notable differences.

The first difference is that men were more likely to say that the volcano is dangerous or extremely dangerous in response to question 9. With thirty-five men responding, 72% stated that the volcano is either 'extremely' or 'dangerous.' Only 44% of women described the volcano in a way that fit these terms. Thirty-six percent of women did offer specific timeframes in which the volcano is dangerous, which is categorized in Table 7 as 'sometimes.'

Table 7: Response by Gender: How dangerous is the volcano?

	Extremely	Dangerous	Sometimes	Little	No Danger	N of Respondents
Females	12%	32%	36%	10%	10%	50
Males	23%	49%	14%	8%	6%	35

Only 14% of men described the volcano in these terms. Therefore, 20% of women categorized their volcano as having 'little' or 'no danger,' while 14% of men agreed.

The differences in responses are significant in that women were less able to show that they understood the long-term effects of the volcano. The females were more likely to name specific events, but the males I spoke with seemed to have a better understanding of how the volcano's eruptions affect the area and their environment over time. This shows, perhaps, a better understanding of natural processes, and how a volcanic event does not just have negative effects immediately following the event.

Males were also more likely to name more than one danger for their area in response to question 4. Of thirty-five men, 29% named more than one danger when asked for the main dangers in their area, whereas only 3 of fifty women (6%) responded with more than one danger. I made sure to phrase this question so that any number of dangers could be given.

There is no significant difference in the responses from men and women regarding the dangers in their villages (Table 8). Seventy-five percent of women and 70% of men reported the volcano as one of the main dangers or the principal danger. Fourteen percent of men gave different enough responses so that they did not fit into a common category, and were thus put into the 'other' category.

Table 8: Response by Gender: What are the main dangers in your village?

	Volcano	Thieves	Roads, Rain	Other	None	N of Responses
Females	75%	9%	8%	4%	4%	53
Males	70%	9%	2%	14%	5%	43

*Total is greater than the number of respondents, reflecting multiple responses from some subjects.

This diverse grouping of 'main dangers' or '*peligros principales'* was created by men from three different locations around Santiaguito and two different locations around Fuego.

While Table 7 reveals that women were more likely than men to describe the danger of the volcano in a specific timeframe, Table 9 shows the opposite when referring to the effect the volcano has had on one's family or village.

Table 9: Responses by Gender: How has the volcano affected your family or your village?

	Greatly	Sometimes	Little	None	Unknown	N of Respondents
Females	34%	26%	18%	18%	4%	50
Males	18%	42%	15%	24%	0%	33

Thirty-four percent of women described the volcano has having a long-term or lasting effect in very descriptive terms. Only 18% of men responded in the same way. However, 42% of men described the effect that the volcano has had locally or personally through specific events and within finite timeframes. This is greater than the percentage of women describing the danger of the volcano as 'sometimes' (Table

9), and the women describing the effect the volcano has had on their families (26%). Nevertheless, combining the results from these two categories, 'greatly' and 'sometimes,' shows that a majority of both men and women agree that the volcano has affected their families and villages in some way (60%).

Of the 18% of women who responded that the volcano had not affected their family or village, 89% are from the Fuego region while the remainder are from the Cotopaxi region. Nearly all of these 'no effect' women (89%) are under the age of forty. This is significant because in 1974 there was a strong ash eruption of Fuego that largely affected the communities I visited. Of the women who responded that the volcano has not affected their family, 77% are young women (under the age forty) from Fuego. The 1974 ash eruption either occurred before they were born or when they were very young, and therefore they are not likely to remember the details of the event. The remaining women reporting that they are unaffected by the volcano are one woman under forty who is much too young to remember an event at Cotopaxi, and a sixty year old woman from La Morelia who also does not believe Fuego has impacted her life and will not become dangerous in the future. However, she said that she would evacuate, if Fuego were giving dangerous signals, to Panímaché Uno— a village which is closer to the volcano and still in the hazard zone. Interestingly, she reasons that it is at a higher elevation and, therefore, safer.

Men who report being unaffected by the volcano are mostly from other locations than Fuego (Table 10).

Table 10: Males who said the volcano had not affected their family or village.

	Cotopaxi	Santiaguito	Fuego
Males	37%	50%	13%

One man from Fuego responded that the volcano has not affected his family, but he admitted that he has only lived in Panímaché Uno for nine years, and that the volcano has been quiet in this time. He believes that the volcano is dangerous, and will evacuate if necessary, but he does not believe there will be a dangerous eruption in his lifetime. However, he is the only male from Fuego who gave a response of having no effect. All other Fuego males, who have lived in the region much longer, have a strong consensus that the volcano has affected their families and village at least in some way. With a very active volcano like Fuego, it is understandable that such a large percentage would agree that the volcano has caused some effect on others.

The men from the Cotopaxi region who do not believe the volcano has affected their family or village were all from Ticatilín Bajo. These results from Cotopaxi again reaffirm the consensus of those who live in Ticatilín Bajo that Cotopaxi is calm and has not had any effect on their village in the past. It also highlights that 57% of the men from Cotopaxi *do* believe their families have been affected by the volcano that has not erupted in 100 years.

The men from Santiaguito who do not believe the volcano has affected their families represent 44% of the men I interviewed from that region. This group is made up of a *finca* worker from El Faro, a *tienda* owner from Las Marías, a *finca* administrator from *Finca* Patricinio, and a ninety-six year old man who lived in El

Palmar before it was destroyed. Las Marías and Finca Patricinio are near the volcano or a river, but located at such a distance where they would only be affected by a very large eruption or series of eruptions. The worker from El Faro does not view the volcano as a risk at all, does not believe it will become dangerous, and does not believe it has made any impact on his life, or the lives of his parents, who have also lived in the region for their entire lives. The ninety-six year old man from El Palmar, however, is not like the other respondents. He has been directly affected by the volcano multiple times. He told stories of the 1902 eruption of Santiaguito, and remembers the aftermath of the 1929 eruption. He lost the ability to farm on the same land because of the volcano, and was forced to move to a different location. However, he responded confidently that the volcano has not affected his family. Perhaps his response is more of a reflection of the current state of his family. He moved from Antiguo Palmar fifteen years ago and is currently experiencing health issues due to old age. It is possible that he was saying that no one died, and therefore was not affected bodily, or perhaps there was some sort of misunderstanding of the question.

Men were slightly more likely to respond that the volcano had not affected their family or village at all (24%) and less likely to say that the volcano had long-term effects on their family than women. Over half of the women interviewed answered either 'greatly' or 'none.' The difference could be attributed to women staying at home and nurturing the family, whereas the males act more as providers. In these small rural villages, the *machista* culture is very apparent. The women do not work outside the home but stay home and take care of the children and husbands.

The days are spent caring for the animals, preparing meals, washing clothes, and cleaning the house. The men work six days a week and handle the money. The men only give the women enough money for food and necessary items and do not involve their wives in the finances. One man admitted that his wife does not know how much money he makes, and that he did not know why he would tell her. Women generally spend extra money on the family, whereas men are more likely to spend extra money on themselves, purchasing such goods as beer or cigarettes. These examples do not suggest that men do not care, or are not involved in their families, but that there is a certain distance between males and females that might be explained by the patriarchal culture.

In some sense the men are members of the public sphere, whereas the women operate more in the sphere of the home. Women appear to be much more fatalistic about their environment, as 45% responded that they simply did not know, and 14% responded that they could not know, if a dangerous event were about to occur (Table 11).

Table 11: Responses by Gender: How can you tell if something dangerous is about to happen?

	Give Volcanic Signs	Gov/Someone Will Tell Us	Physically See	Unknowable	Unknown
Females	31%	10%	0%	14%	45%
Males	26%	40%	3%	16%	16%

They have resisted any responsibility or the possibility of being able to save themselves. Instead of believing the government or someone will let them know

when there is danger, they seem to accept their lack of knowledge and rely on their husbands to make the decisions.

Nevertheless, 69% of men do believe that there is some way they will be able to anticipate any danger. Of these men, an overwhelming 40% rely on the government or other sources to tell them when the level of danger is rising. However, in contrast to the women, the men take a more proactive approach and believe that they can tell for themselves, or that they will be able to find out. Of the women, 59% have no hope to know when they need to take action, whereas 69% of men will take action rather than resort to fatalism.

It is not surprising that the results show that a strong majority of each gender state that they believe the volcano will become dangerous in their lifetime (Table 12).

Table 12: Responses by Gender: Will the volcano become dangerous in your lifetime?

	Yes	No	Unknown
Females	62%	17%	21%
Males	56%	25%	19%

There is actually little difference between men and women as they attempt to predict the future. They differ when discussing how dangerous the volcano is and the effects on family, but men and women answered similarly in all categories on whether or not a dangerous eruption will occur in the future.

While men and women agree that the volcano is the main danger for their village and will most likely become dangerous in their lifetimes, they differ significantly as to effects of the volcano and the understanding of its signals. Men

were more likely to respond with long-term examples of the danger of the volcano (72% to 44%), showing that their work on the land has given them a better understanding of the effects the volcano has on the environment. Whereas women believe that there are more long-term effects on their families than the men (34% to 18%). Both genders agree that the volcano has affected their family (60%), but men were more likely to say that their family has not been affected at all, showing that women are more focused on the family. Men give more proactive solutions to interpret the signs of the volcano, with 69% believing they will either know or will be able to find out. However, women show a much more fatalistic approach to the volcano, with 59% believing they there will be no way to know if the volcano is becoming dangerous. Men were also more likely to reply that the signs from the volcano are unknowable, meaning that they cannot be understood, showing their reluctance to admit not understanding the volcano.

iii. Unknowable vs. Not Knowing

For questions 10 and 12, I developed two different categories describing similar responses. Often people stated that they 'did not know' in response to my questions. However, when I asked people how they would know if the volcano was becoming dangerous, I noticed that some people's responses were that they would not be able to know, or that what I was asking was actually unknowable.

There is a subtle difference in these responses, which I labeled as 'unknowable' and 'unknown,' but the difference is significant. Many people whose responses fit into the 'unknown' category, responded by saying that they had no idea how to know when the volcano was becoming dangerous. But other respondents

were saying that there was actually no way for them to know if the volcano was becoming dangerous. One person in Panímaché Dos clarified further, saying that they will not be able to know because there is no volcanic equipment to tell them. However, most others did not clarify this way, and simply stated that they cannot know, possibly because 'only God knows.'

The idea of something being unknowable is significant because if it cannot be known, then the respondent is not uneducated or uninformed, but rather just an ordinary human without supernatural knowledge. This removes liability from the individual because what is unknowable cannot be learned. It is also might seem easier for males in a *machismo* environment to tell a female researcher that there is no answer to the question she is asking, rather than admitting that he does not know the answer. Table 11 shows that an equal number of male subjects responded 'unknowable' and 'unknown.' Women, on the other hand, were much more willing to reveal their lack of knowledge by stating that they did not know.

The difficulty with this issue is that it is difficult to interpret the very common and colloquially used phrase 'solo Dios sabe.' Translated literally, this phrase means that 'only God knows' and therefore the information is unknowable. However, this phrase is used repeatedly and has become a common response when something is simply unknown to the person being asked.

Something being unknowable is a complex concept, because one is forced to determine if it is a lack of education that is the cause, or perhaps a lack of endurance. Most of the people in these regions are poorly educated and do not have sufficient background in science to understand the meanings behind the volcanic signals.

However, the people in these regions have also been living with the volcano for most of their lives, so perhaps the volcano is looked on as unknowable because it is something that has never made sense, and they have simply lost the patience to believe there is logic behind it.

iv. Proximity

The Mt. St. Helens case study by Lindell and Perry alleges that in the first week of April, less than a month after the volcano awoke, a significant increase occurred in the "perceived severity of the volcano threat and the change in perceived risk increased with proximity to the volcano" (1993). Therefore, those who lived closer to the hazard zones suddenly saw the volcano as more dangerous than they had a month before. Is proximity a concept that can explain people's perceptions of natural hazards? From the data received at my three sites, I examined the concept of proximity with the different communities I visited.

Of the three Cotopaxi locations I visited, only one is located inside a hazard zone (Figure 6). San Ramon is located in the high hazard zone for ash fall, and on the margin of the high hazard zone from lahars. San Ramon was affected by lahars several hundred years ago (Mothes 2007). Of the two people I spoke with here, both named the volcano as the principal risk in the area, both believe it is dangerous, and both would evacuate should danger become apparent.

Ticatilín Bajo is located just south of the lahar high hazard zone, and the people here do not believe that the volcano is a risk at all. They were very adamant that Cotopaxi is quiet and that they have never heard of activity in the past affecting their village. Of the four people I spoke with, none named it as a risk or said that they

or their family had been affected by it. None of these people believe that the volcano will become dangerous in the future. They were aware of the giant boulders that

Figure 6: Aerial view of Cotopaxi volcano and research sites.

exploded from Cotopaxi and landed in San Ramon, but as they do not have them in their area, they believe they are risk free unlike the town of San Ramon. Ticatilín Bajo is upriver and at a higher elevation than San Ramon, and closer in proximity to the volcano. However, they do not believe there is any volcanic risk for their town.

Quisinche is .5 km east of the high hazard zone for lahars. There has never been a lahar that entered Quisinche in history. However, 50% of the people I interviewed named the volcano as a principle risk for the village and 80% reported that Cotopaxi is extremely or dangerous. For the question, 'do you think Cotopaxi will become dangerous in your lifetime,' 20% said 'yes,' 40% said 'no,' and 30% responded that they did not know.

The people of Quisinche seem to have an elevated perception of risk for an area that is outside the hazard zone and has never been affected by a lahar or other volcanic activity. There is a strong amount of fear, but no environmental reason in their area to explain it. The people of Ecuador, though, have experienced an extremely active volcanic period at other peaks over the past four years, so perhaps this has aroused the fears of the people of Quisinche Bajo.

The people of Ticatilín Bajo seem to be greatly aware of their environment, as they live extremely close to what has been a destructive volcano in the past, and yet they are so aware that they are out of the danger zones that they have little fear of a hazard event. No one I spoke with mentioned being informed that they were safe; they just spoke about being safe, as if they knew it to be fact without having to be told. They feel secure in their area and showed an accurate knowledge of their risk level.

In San Ramon, the people seem to be aware of the possibility of danger in the future. The woman I spoke with in this area does not believe the volcano has impacted her life or the lives of her family members, but this can be explained by the amount of time that has passed since the last eruption of Cotopaxi. It may not be

affecting them now, but it is important that they view the volcano as dangerous and recognize that it could affect them in the future.

It is difficult to draw conclusions about perceptions relating to proximity at Santiaguito because of the diversity of the respondents Figure 7).

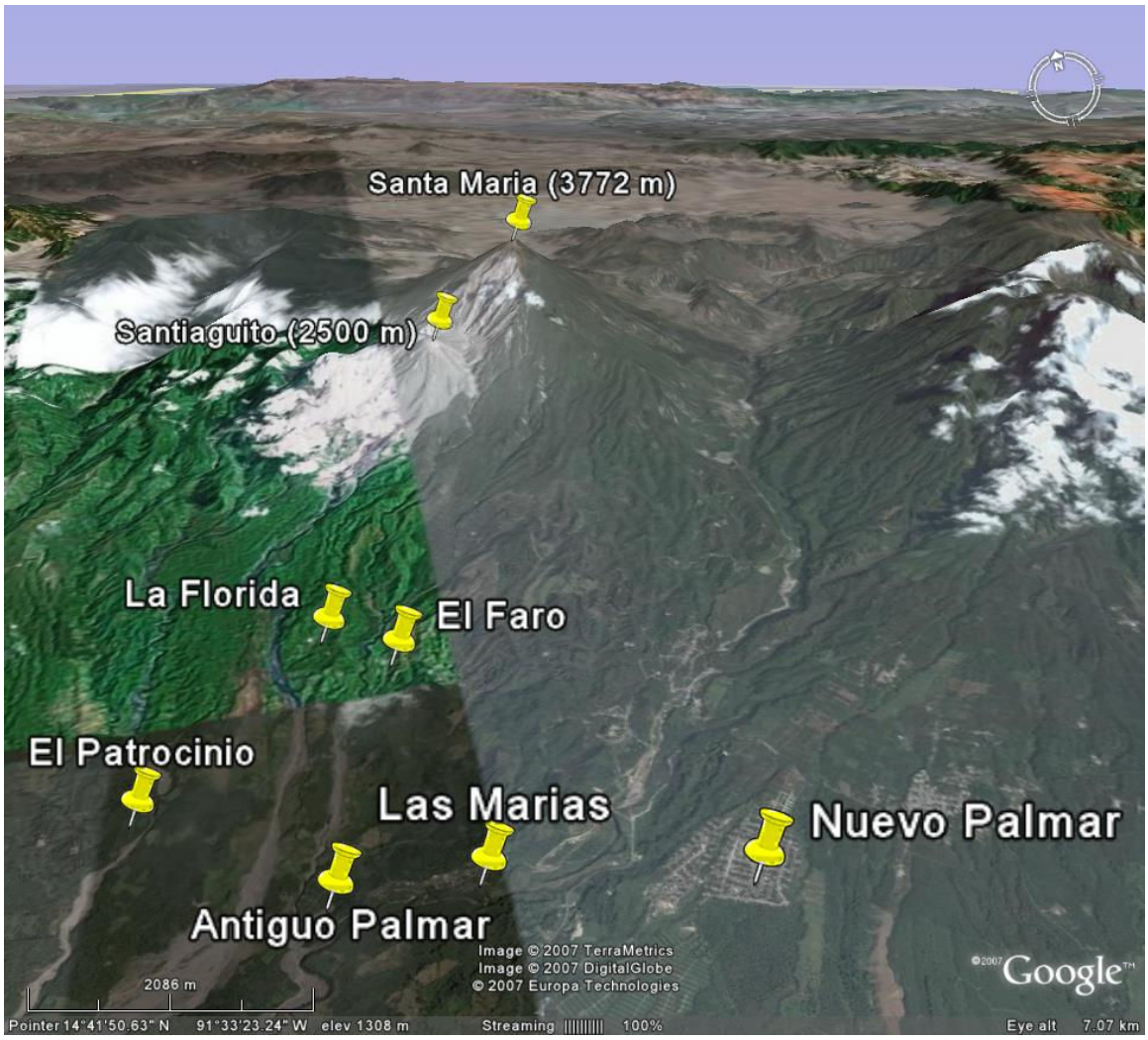

Figure 7: Aerial view of Santiaguito and Santa María volcanoes and research sites[2].

[2] Different shades of image come from various satellite images stitched together.

Many held educated positions in society, and therefore may not represent the majority of the people in this region. One item of significance, however, is that the two observers in the Santiaguito Observatory are both from *Finca* La Florida. The road to La Florida was blocked by a lahar, and now there is no road access into the *finca*. This explains the population drop from the 1994 estimate of 92 persons, to the seven families that now manage the *finca*. This community was directly affected by the volcano, and is the only one of the five communities around Santiaguito that is actually located inside the pyroclastic flow hazard zone. Therefore, it seems appropriate that the people here would take the volcano seriously enough for two of the men to seek jobs in the observatory. As for the other locations, I believe their perceptions are most likely explained by direct experience and land ownership rather than proximity.

All of the villages I visited at Fuego have experienced an eruption in the recent past, unlike some of the villages at my other two locations (Figure 8). However, some communities experienced more of the volcanic impacts than others. La Morelia is the furthest community from the volcano, but it is near the rivers and at a lower elevation than the other villages. The most respondents to say that the volcano is not dangerous are from Morelia (25%; see Table 13). Two of the other communities had no respondents who said 'no danger' and only 5% responded this way in Panímaché Uno. However, 41% of respondents from Morelia believe the volcano is 'extremely' or 'dangerous' and 25% believe it is dangerous within a specific timeframe.

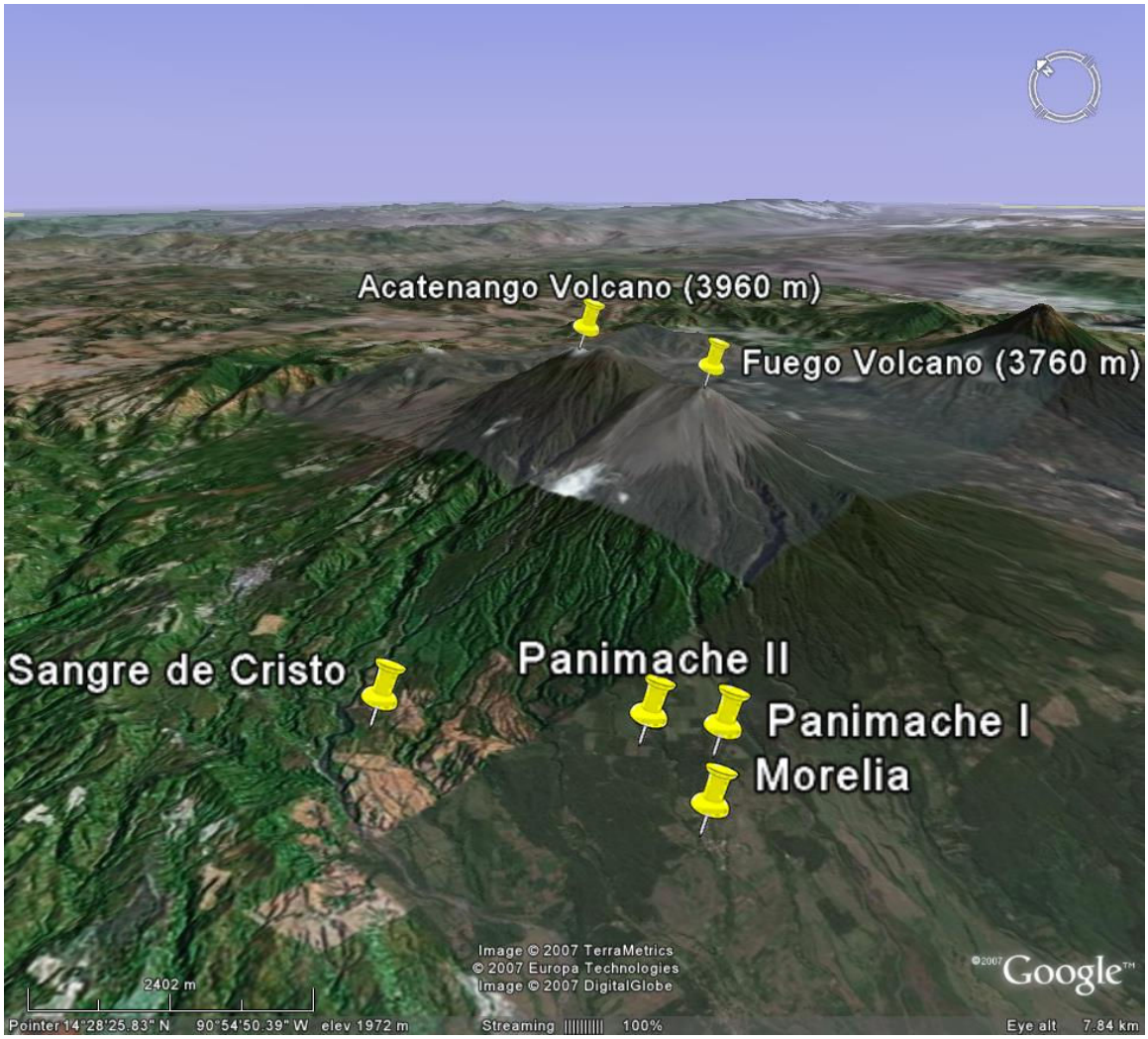

Figure 8: Aerial view of Fuego and Acatenango volcanoes and research sites.

Table 13: Responses by Village at Fuego: How dangerous is the volcano?

	Extremely	Dangerous	Sometimes	Little	No Danger
Panímaché Uno	3%	43%	38%	11%	5%
Panímaché Dos	40%	0%	60%	0%	0%
La Morelia	8%	33%	25%	8%	25%
Sangre de Cristo	25%	50%	0%	25%	0%

Sangre de Cristo is the community closest to a volcanic *barranca* and therefore the hazard zone. Table 13 shows that 75% of the respondents from Sangre de Cristo stated that the volcano is 'extremely' or 'dangerous.' During the interviews, they were aware of the severe risk that flows very close to their homes. They reported that the town used to be much bigger, but that after the 1974 eruption most people left and did not come back. Since then they have been given a radio to be in contact with INSIVUMEH and ConRed. However, the people here say that they are too poor to go elsewhere.

People were least likely to refer to the volcano as 'extremely' dangerous in Panímaché Uno (3%), whereas the people of Panímaché Dos either referred to the danger on a finite timescale (60%) or as 'extremely' dangerous (40%). In both locations, respondents were much more likely to report that Fuego is dangerous rather than having 'little' or 'no danger.' The respondents from Panímaché Dos seem to consider the volcano 'extremely' dangerous because they feel unprepared for a future eruption from Fuego. In Panímaché Dos, 100% of respondents believe that the volcano will be dangerous in their lifetimes, and 80% believe they will not be able to tell when the volcano is becoming dangerous, as the signs are 'unknowable' or 'unknown.' This creates an atmosphere of uncertainty and desperation. The respondents here also say they are too poor to move, and that the population was much larger before the 1974 eruption.

Overall, the responses from the Fuego region seem to be very similar. This coincides with the Lindell and Perry concept of proximity because, even though some of these locations are located further from the volcano than others, they are all in the

pyroclastic and lava flow hazard zone. The lahar hazard zones are marked around the rivers for Fuego. Therefore, even though Morelia is the furthest from the volcano, it is still located in one high risk zone and equidistant from another. The responses in this region support the theory that awareness of the hazard elevates with proximity, as the similarity of the responses shows a similarity of risk level.

These results reveal that extreme uncertainty can cause problems with Lindell and Perry's concept of proximity. The people of Quisinche Bajo are outside of the Cotopaxi hazard zone, however they view their village as very close to the volcano. Because the volcano has not erupted recently, and because there are no education programs in place to explain volcanic activity to the locals, the people view the hazard as a great risk. The uncertainty has created a great amount of fear among the village. However, the results from the other villages I visited around Cotopaxi and Fuego support the concept of proximity. The people of San Ramon are in a high risk zone and are aware of the possible danger from Cotopaxi. The people of Ticatilín Bajo do not believe themselves to be in any danger and their village is outside of the hazard zones. The communities around Fuego are all aware of the risk, even if they have different responses as to the future and the degree of danger, and all of these communities are inside the hazards zones. La Morelia, the furthest community from Fuego, had the highest percentage of residents to say that the volcano poses 'no danger' (25%). The interview results from these communities confirm that proximity is an issue that affects awareness.

Chapter V. Implications

A. Significance of Research

While there are some exceptions (Cronin 2004), the majority of natural hazard research is conducted as disaster research immediately following an occurrence, and risk perception knowledge of natural hazards is unknown. The 1975 Natural Hazard Assessment conducted by Gilbert White and Eugene Haas found that research efforts are sporadic event-based studies that are dominated by the technical science fields. The authors recommended more interdisciplinary research be conducted and that comprehensive longitudinal studies be created to combat the problem of hot spot disaster research. One of the key accomplishments of this report is that it began the process of communication across disciplines; however the recommendation for longitudinal studies was largely ignored. While this project is not a longitudinal study, it is one that can provide baseline data on risk perception that can be used comparatively after a disaster and for years to come. This research is valuable because how people behave before, during, and after a disaster is directly related to their feelings about the volcano and their environment during relatively peaceful times. A community's strong opposition to a mandatory evacuation can most likely be explained by their relationship with the land and the volcano.

The 1999 Assessment conducted by Dennis Mileti states the following:

> Societal factors, such as how people view both hazards and mitigation efforts or how the free market operates, play a crucial role in determining which steps are actually taken, which are overlooked, and thus the extent of future disaster losses. Because such social forces are now known to be much more powerful than disaster specialists previously thought, growing understanding of physical systems and improved technology cannot suffice. To effectively

> address natural hazards, mitigation must become a basic social value (Mileti 1999).

Mileti clearly states that social issues need to be considered when researching hazards. Ultimately, hazards are human events, and therefore social issues play a great role. Thus, qualitative research on people in high risk areas is a necessary contribution to quantitative work. Treating hazards as merely geological phenomena separates them from the social environment and ignores the human impact (Wisner 2005).

Collecting risk perception data is a step in understanding the social environment surrounding a hazard. It is clear from my research that the majority of people in these volcanic regions consider the volcano their only danger. While Peace Corps volunteers and governmental officials warned about crime in the cities and on the buses, this is not something that local people are worried about. The most commonly mentioned social threat was thieves around the Cotopaxi region and the Fuego regions, but 73% of respondents reported that the volcano was the main risk in their village. In other words, in spite of other hazards in the lives of the respondents, the overwhelming majority clearly identify the volcano as the most significant danger they face.

This type of research is necessary to be able to know how best to communicate risks to an at-risk population and to organize an effective evacuation. Poor communication with local people will result in chaos and confusion. Even the most successful and well-run evacuations have led to people suffering from extreme anxiety, such as that from Paricutín in 1943, where grief was the main cause of death (Scarth 1999). Without understanding an evacuation from the point of view of the

local population, others cannot learn from that process and perfect it for different populations in later events.

The research conducted for this project shows the variety of opinions in each location and how difficult it would be to organize the people in a given location without having some sort of baseline information for reference. A group can go to the community organization in Panímaché Uno and plan out an evacuation with the group leaders, but if that is all the planning they do they will later ask why their plan did not work. My results show that the men would meet about the plan and inform each other, but the women would not be included and the men would not necessarily inform their wives later on. Also, an evacuation plan is worthless if the population does not know when to put it into action. These results show that the majority of people do not believe they can determine when volcanic activity is increasing. Without knowing communication and education issues among the population, any other actions will be ineffective.

Theoretically, there is a lack of academic knowledge regarding risk perceptions of natural hazards, especially of hazards in the developing world. Conducting research of this nature increases the possibility of identifying new relevant questions because qualitative research is "grounded in people's actual experience" (Phillips 2002). Opening up the field to new questions that we have not even begun to ask is possible, due to the interdisciplinary nature of this research. The Peace Corps students that I worked with have backgrounds in geology and little experience with the social sciences. I gathered their perceptions, as well as brought a

new perspective into the field that through an interdisciplinary approach will hopefully have a practical and theoretical impact on natural hazard research.

B. Implications for Future Research

Does the awareness people have of the hazard zone they are living in adequately reflect the risk of the environmental agent? In my research, I found that the awareness level is exaggerated around Cotopaxi, low around Santiaguito, and confused and split among age groups around Fuego. However, this is a question that should be answered for as many areas as possible in developing countries. In industrialized countries, if the people are not aware of some risk, there is most likely a governmental agency that is watching out for them. However, the governments of developing countries do not have the resources to keep this kind of watch over problematic environmental zones. The people in the Cotopaxi risk zone are very confused because the government of Ecuador cannot or does not inform them of what the silence of the volcano means, when multiple volcanoes are erupting destructively elsewhere in the country. It is very important for research to assess the awareness level of people in risk zones so that communication in the future will be easier. This is baseline data that is needed before a hazard event occurs.

It is understandable when people are unprepared for a disaster event that occurs from a seemingly silent threat and they are left devastated. If a volcano like Cotopaxi were to erupt suddenly after 100 years, the at-risk populations would likely be caught unaware, no matter how much they say they worry about the volcano. What is less understandable is how people like those around Fuego might be caught unprepared for a large eruption when the volcanic activity is regularly high.

Is it possible for the at-risk population to become numbed to a risk that is so apparent, that they ignore the possibility of a catastrophic event? Walking down the road in Panímaché Uno, people do not look up at Fuego when they hear a large burst of sound. They do not acknowledge the almost hourly events that occur. I noticed a change in the volcanic activity from one week to the next while I was staying in the village, but the local people seemed unaware; they certainly did not seem as excited about it as I was. The people of the four communities I visited are largely acquainted with the high level of activity from Fuego, but it is difficult to understand how an apparent risk could become commonplace to the point of not considering the possibility for a larger event to occur. It is necessary to study populations living in environments with a constant elevated risk to see if the pattern of perception is similar to that in communities in low risk environments when the risk suddenly elevates.

In relation to hazards, the difference between what is knowable, but unknown, and what is unknowable needs to be further explored. Does the label 'unknowable' only refer to the respondent and his/her community, or is it possible that outsiders can understand what is unknowable to the respondent? Does the local population believe that scientists can understand what the locals deem 'unknowable?' Or would the locals reject an explanation given by an outsider? It would be interesting to know how a risk escalates from being unknown to unknowable, and the criteria required to determine the difference between what is considered unknown or unknowable.

C. Recommendations

One of my primary research goals for this project is to be able to use my findings to improve communication between scientists and the public to create

effective hazard mitigation and preparedness. I believe my results reveal many avenues that researchers can take to ameliorate both their fieldwork experience, and the experience of the host society. These recommendations have been developed based on my results and the significance that they carry for future work in the field.

1. *Researchers should not enter an area without knowledge of the language.*

Visiting scientists who cannot communicate with the local populations are not valuable to the local people. It is confusing for communities, especially those in developing countries who do not have much familiarity with other cultures, for people to enter their region and poke around their land without trying to speak to the people who live there. In Panímaché Uno, I made very significant relationships with a few nearby families. I was only there for a short time, but the people I met loved spending time with me and giving me food simply because I was one of the few people who came for a visit who could actually communicate with them. They complained about other visitors who came in without any Spanish skills and no capacity for communication.

Researchers visiting areas without acknowledging the local population create atmospheres of mystery. I believe the idea of there being gold or petroleum inside Fuego Volcano began because the people of Panímaché Uno believed that there had to be something inside the volcano that the scientists wanted, and no one had taken the time to explain their interests before. Granted, people who visit and only stay for a week cannot build real trust among the community, but by just attempting to communicate, one will create and atmosphere of openness to combat what seemed like secrecy in the past.

2. *Scientists should take the time to find out what the locals know.*

I think researchers long to find the one true example of the myth of primitive ecological wisdom. I was certainly hoping to find a community that could read their volcano like an open book. However, even as unlikely as this is, it is still important to gauge what exactly the locals do understand about their environment. The implications could range from unhelpful to tremendous. For instance, the fact that the majority of the people around Fuego openly admit that they cannot interpret its signals and completely rely on the government to let them know if they need to evacuate is extremely significant. Or one could find that the locals are extremely aware of the risk, and even though they are close to locations that are impacted by the volcano their specific town lies outside the hazard zone. The conclusion is that a researcher cannot really help a group of people unless they understand the people's level of comprehension of the issue.

3. *Government-involved education programs can help prepare local populations for hazard events..*

As Cotopaxi is currently viewed as an inactive volcano, even though there are still lahar risks, it is not a governmental priority for Ecuador, as other volcanoes are currently much more active. The lack of government involvement in this area has caused much confusion among the people. They hear about eruptions in other areas, and have no scientific or governmental guidance telling them the current state of Cotopaxi. Even a monthly oral report over the radio or television explaining the current activity, or inactivity, of the Ecuadorian non-dormant volcanoes would greatly improve awareness. As it is, the people have not heard anything about the status of

Cotopaxi for months or years, allowing them create an exaggerated or underestimated view of the risk.

The poorer populations around Santiaguito suffer from a lack of education on the volcano. The temporary workers of El Faro are significantly vulnerable as they are not aware of the hazard zones they might be entering or the possible health effects they face when arriving at the *finca* looking for work. Of the permanent residents, many communities are simply unaware of the danger of Santiaguito because there is little to no government presence or involvement. The observatory is obscured in a private *finca* where people have little access to or knowledge about it. People do not see the government offering them help or knowledge, and would therefore not be trusted in a time of disaster.

4. *Scientists and governments need to reach out to women with education programs.*

Women run the homes, cook the meals, and send the children to school in the mornings and to work in the afternoons. In developing countries, these are not nine to five workdays, five days a week. In Panímaché and most of the communities I visited in Guatemala, the men work from dawn to dusk, six days a week. It would not be difficult to find a community where there are no days for rest. Therefore, what is the value in only educating the men about hazards, when an event could very easily occur when the men are not at home? Do there need to be more female scientists in the field to explain the dangers to women? Educational programs could easily be conducted during the day when women are at home. These are certainly needed, not

only for education about volcanoes, but also for health risks associated with them and the best protection for children.

5. *Proximity needs to be considered when working with communities.*

My results support the concept that awareness levels of hazards increase with proximity to hazard zones, not just the source of the hazard itself. Communities who are close to a volcano but outside the hazard zone might actually view the volcano as far from their area or peaceful even though it is very active. It is important to take this concept into consideration when examining the perceptions people have of their environments.

6. *Scientists should not trust that "others" understand the locals.*

People always seem to believe that they understand other people. When I arrived in Guatemala, I was informed by a government employee in Guatemala City that the younger generation of Nuevo Palmar wanted to move back to Antiguo Palmar. This would be very risky because the site of Antiguo Palmar is just as dangerous as it was in the 1980s and 1990s. The only difference now is that the majority of the population has relocated to Nuevo Palmar. However, when I arrived in this region, I encountered no one who had heard of people moving back into Antiguo Palmar, and no one who wanted to do so. In fact, people were always telling me what other people think. The owner of *Finca* El Faro informed me that the people there do not understand the volcano; they only are concerned about finding work. The teacher of the school in El Faro stated that the people in the area do have knowledge about the volcano because they have lived there all their lives. I believe these ideas about what other people think tell you more about the people making the

claim, than about the people they are talking about. People project their own beliefs, interests, and concerns on others when they speak about them in this context.

7. *Governments should take more pro-active solutions to minimize human vulnerability.*

Before the 1877 eruption of Cotopaxi, the lahar zones were not densely inhabited. However, after the eruption people slowly began moving into these zones and today the population density has increased by more than 10%, with 150,000 people living in the lahar hazard zone (D'Ercole 1996). In order to prevent people from returning to the high hazard zone surrounding Arenal volcano in Costa Rica, the government built a lake in the previously inhabited region. People have not returned to this region and, therefore, less people are at-risk when Arenal erupts. This type of precautionary solution benefits the government and the people from the region. While it is expensive to find resettlement locations for communities, it is less expensive to only have to find them once.

Natural hazards affect people all over the world even when the risk is known. However, the benefits of scientific studies often do not reach those living in the hazardous regions because of a separation between the researcher and the research site residents. It is important, therefore, to enter high risk zones to speak with the people and ask them their views on the hazard agent. Risk perception before an event influences behavior during and after a hazard event occurs. People will not react when someone asks them to evacuate if they do not believe they are in any danger. People often believe they have a good understanding of the agent because they live near it, but when asked how to tell if the risk is elevating, many admit that they do not

know. This project is beneficial for future research in hazardous areas because it examines problems that may have profound effects on the communities during a hazard event, such as government interaction, hazard education, gender issues, and proximity.

VI. References

Bruce, V. (2000). *No Apparent Danger: The True Story of Volcanic Disaster at Galeras and Nevado Del Ruiz*. New York: Harper Collins.

Centre for Research on the Epidemiology of Disasters (CRED) (2000). Emergency Events Database, www.cred.be/. University of Louvain in Brussels, Belgium.

Cronin, Shane, *et al*. (2004). "Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu." *Bulletin of Volcanology* 66: 652-668.

Cutter, S. (2003). "The Science of Vulnerability and the Vulnerability of Science." *Annals of the Association of American Geographers* 93(1): 1-12.

D'Ercole, R. (1996). "Représentations cartographiques des facteurs de vulnérabilite des populations exposées à une menace volcanique: Application à la région du volcan Cotopaxi (Equateur)." *Bulletin de l'Institut français d'études* 25(3): 479-507.

Ecuador Explorer (EE). (2006) Map of Ecuador, www.ecuadorexplorer.com/html/basic_ecuador_map.html.

Ernst, W. (2001). "The Increasing Severity of Circumpacific Natural Disasters." *International Geology Review* 43: 380-390.

Global Volcanism Program (GVP) (2006). Smithsonian National Museum of Natural History, http://www.volcano.si.edu/world/.

Instituto Geofísico, Escuela Politécnica Nacional (IGEPN) (2006). "New Mitigation Tools For Cotopaxi Volcano." In proceedings *Cities on Volcanoes 4*, January 23-27.

Instituto Nacional de Estadistica, Direccion de Censos y Encuestas (INE) (2006). "Descripcion de los Censos Realizados por el INE." Guatemala City, October.

Instituto Nacional de Estadistica, Direccion de Censos y Encuestas (INE) (1994). X Censo Nacional de Poblacion y V Censo Nacional de Vivienda.. Guatemala City.

Instituto Nacional de Sismología, Vulcanología, Meteorología, e Hidrología (INSIVUMEH) (2003). Volcanic Hazard Map: Volcán Santiaguito, 1-5. Government of the Republic of Guatemala.

Janis, I. and L. Mann (1977). *Decision Making: A Psychological Analysis of Conflict, Choice and Commitment*. New York: Free Press.

Lindell, M. and R. Perry (1993). "Risk Area Residents' Changing Perceptions of Volcano Hazard at Mt. St. Helens." In *Prediction and Perception of Natural Hazards*, J. Nemec, J. Nigg, and F. Siccardi (eds). Boston: Kluwer Academic Publishers.

Mileti, D. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Washington, DC: Joseph Henry Press.

Mileti, D. (1993). "Communicating Public Earthquake Risk Information." In *Prediction and Perception of Natural Hazards*, J. Nemec, J. Nigg, and F. Siccardi (eds). Boston: Kluwer Academic Publishers.

Mileti, D. and H. Sorensen (1987). "Natural Hazards and Precautionary Behavior." In *Taking Care: Why People Take Precautions*, N. Weinstein (ed). New York: Cambridge University Press.

Mitchell, J., N. Devine, K. Jagger (1994). "A Contextual Model of Natural Hazard." In *Environmental Risks and Hazards*, S. Cutter (ed). Englewood Cliffs, NJ: Prentice Hall.

Mothes, P. (2007). Personal Communication with IGEPN scientist, April 24.

National Research Council of the National Academies (NRC). (2006) *Facing Hazards and Disasters: Understanding Human Dimensions*. Washington, DC: The National Academic Press.

NOVA (2002). Science Programming on Air and Online, http://www.pbs.org/wgbh/nova/volcano/team.html.

Orcher, L (2005). *Conducting Research: Social and Behavioral Science Methods*. Glendale, CA: Pyrczak Publishing.

Phillips, B. (2002). "Qualitative Methods and Disaster Research." In *Methods of Disaster Research*, R. Stallings (ed). California: Xlibris Corporation.

Rose, W. (1989). "Priorities of Current Hazard Study," http://www.geo.mtu.edu/volcanoes/santaMaría/haz.html.

Scarth, A. (1999). *Vulcan's Fury: Man Against the Volcano*. New Haven: Yale University Press.

Tobin, G. and B. Montz (1997). *Natural Hazards: Explanation and Integration*. New York: The Guilford Press.

Vallance, J., S. Schilling, O. Matías, W. Rose, M. Howell (2001). Volcano Hazards at Fuego and Acatenango, Guatemala. U.S. Geological Survey *Open File Report 01-431*. This reference is available on the web: http://vulcan.wr.usgs.gov/Volcanoes/Guatemala/Publications/OFR01-431/framework.html

Wisner, B., P. Blaikie, T. Cannon, I. Davis (2005). *At Risk: Natural hazards, people's vulnerability and disasters*. New York: Routledge.