

Living With the Throat of Fire: The Role of Trust in Impending Volcanic Disaster



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Abstract

This paper examines different aspects of trust in Baños de Agua Santa, a small tourist destination in Ecuador that sits at the base of the active Tungurahua Volcano. Through a methodology that includes constructing a timeline of eruptive, political, and social events, and conducting a thematic analysis of statements compiled from interviews, newspapers, journal articles, and films, I aimed to answer the question *What factors influenced citizen trust of governmental and scientific authorities, and how did this trust impact perceived certainty of the volcanic hazards?* I coded seventy-one statements into three broad categories (Trust, Certainty, Agency) and then further into subcategories. I found that the subcategories of Competence, Credibility/Reliability, and Care were the most frequently referenced dimensions of trust and posit that because the scientists in the region did not perceivably demonstrate these desired characteristics of trust they received the bulk of the blame for the rampant uncertainty and the disruption to citizen livelihoods.

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Preface

The streets of Baños are covered in art. When I arrived for a quick getaway in February 2016, everywhere I turned there was some reference to “la Mama” Tungurahua, the 5023 meter colossus that dominates the physical and cultural landscape of the town. She turns up in their electronic musical festival, the religious paintings, hostel names, and clubs, but in the combined three weeks that I spent there in February and again in April, I only was able to lay eyes on the actual volcano for about five minutes from the bus window before she was covered by the persistent blanket that characterizes the Andean cloud forests. I had read about this place so much and thought that I had an idea of how integrated into everyday society this volcano had become, but it ultimately became impossible to avoid the topic of the eruptive activity that began right after I left in late February (and stopped before I returned). The landscape is covered in scars from landslides and lahars, and the multiple hot springs within the city are constant reminders of how close the city actually sits to the mountain that is translated literally to mean “throat of fire.”

In 1999, long before I knew Tungurahua existed (but old enough to know that I was terrified of volcanoes and would never, ever, get anywhere near one) the Tungurahua Volcano awoke after nearly seventy years of quiescence, prompting a mandatory mass evacuation in Baños and the surrounding villages on the *faldas*, the flanks of the volcano. While this evacuation was successful in removing thousands of people in a short amount of time, it ultimately resulted in a united citizen front forcing their way back into their city. The main monitors of all things seismic in Ecuador, the Instituto Geofísico de la Escuela Politécnica, the geophysical institute associated with the polytechnic university in Quito (IGEPN), rapidly set up a volcano observatory known as the OVT (Observatorio del Volcán Tungurahua). There were not eruptive patterns established with the organization (they were only founded in 1983) and uncertainty as to how destructive this eruption could be was high (Presentación - Instituto Geofísico – EPN, 2017). Citizens responded to this uncertainty with strong distrust toward authorities, especially the scientists. Almost seventeen years after the initial eruption, my experience piecing together Tungurahua’s complex social history began.



Fig. 1. A map of Baños in relation to the volcano found in the city center.

My investigation is guided by the following question: *how do decision-makers utilize scientific information to negotiate domestic needs while balancing risk and uncertainty?* Through my situated context of Baños de Agua Santa, Ecuador, I explored the question *What factors influenced citizen trust of governmental and scientific authorities, and how did this trust impact perceived certainty of the volcanic hazards?* I begin by discussing risk and governance and then contextualizing them in hazardous landscapes. Next I address communication frameworks in these regions and the results that different dissemination strategies have on risk perception and preventative action measures taken by communities. This leads into a discussion of trust and the introduction of my situated context: Baños de Agua Santa and the Tungurahua Volcano. After presenting and discussing the results of my study, I will finally examine the implications of this situation on the larger risk governance theme. I argue that scientists in this region were not perceived to exhibit the residents' desired components of trust (care, competence, and credibility) and, because of this, received the bulk of the blame for the uncertainty that interrupted citizen livelihoods, despite the fact that they do not make the decision to evacuate areas. In this situation, decision-makers prioritized human life over

economic prosperity, but only to the point of tangible economic collapse; uncertain risk bore weight in their initial governance of the town, but when faced with the more pressing reality of loosing the industry they had worked so hard to create and maintain, the certainty of economic downfall overshadowed uncertainty of eruption.

Background

An Introduction to Risk

Everyday we are all faced with risks of various sizes and certainties. Risk is defined as “an uncertain (generally adverse) consequence of an event or activity with respect to something that human beings value” (IRGC 2012). Some are mundane, like eating junk food, while others, like travelling by car, hold more serious costs. According to Starr (1969), risks come in voluntary and involuntary forms and the public is 1,000 times more willing to accept voluntary risks than involuntary. The dangers associated with something like skiing, where each person is in charge of their own decision to ski, are much more palatable than war, where few people choose it and many are subjected to it. Post-industrial regions have grown safer and healthier, yet Americans in particular have become more preoccupied with risk (Slovic 1993).

Starr (1969) continues to discuss risk in terms of risk-benefit analysis, upon which Fischhoff (1978) elaborates. Risk and benefits are related in that a reduction of risk often results in a reduction of benefits. This means that generating money, enjoyment, or contribution to human health could be sacrificed to manage risk, and that forces decision-makers and citizens to balance the benefits against costs very carefully (Fischhoff et al. 1978). Fischhoff and colleagues (1978) additionally propose a grid system that describes how people perceive risk in their everyday lives. In their diagram, each axis is a continuum. The x-axis begins on the left with “not certain to be fatal/common” and ends with “certain death/catastrophic” on the right. The y-axis ranges from “involuntary to voluntary” and “uncontrolled to common.” Items such as vaccinations are common and more involuntary than mountain climbing, which falls in the opposite quadrant. Humans are constantly looking to accept larger risks for activities with higher benefits, and the Fischhoff study provides a way of thinking about and categorizing these risks, but does not provide a framework with which to navigate them.

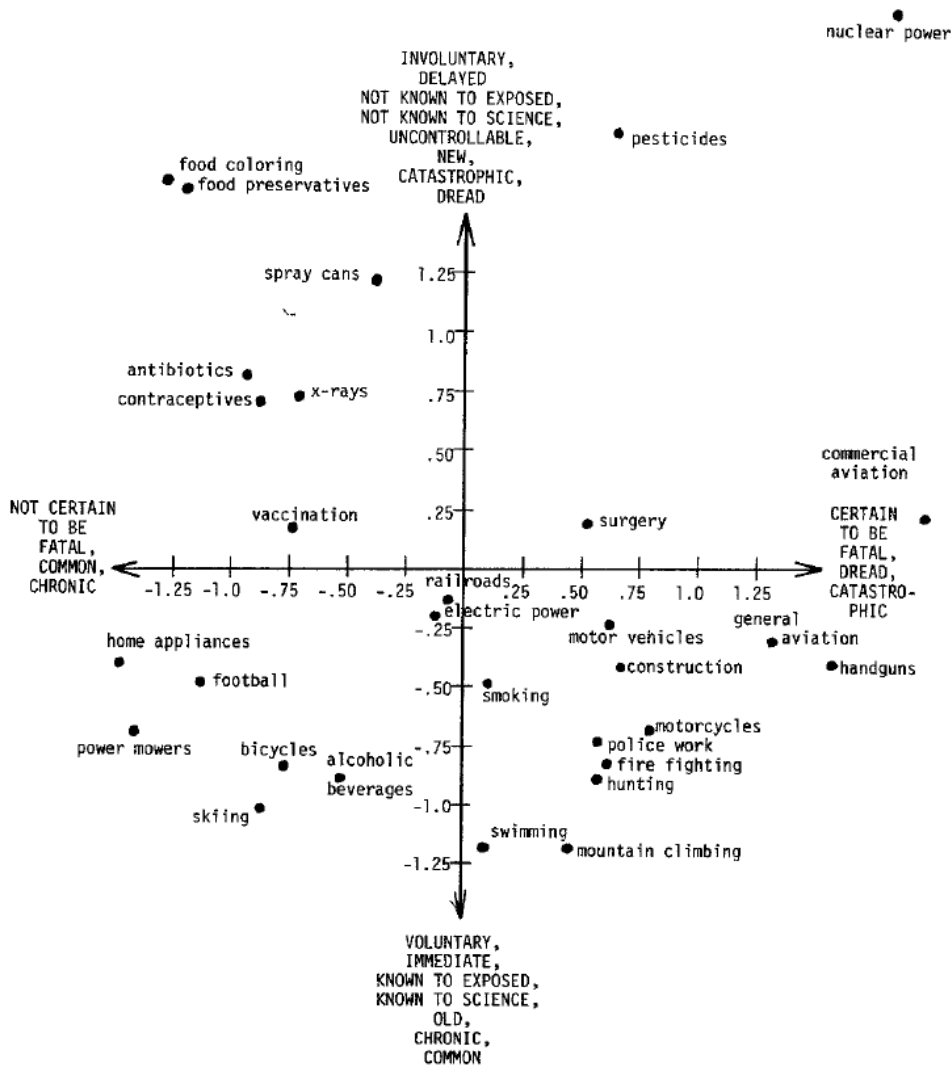


Fig 2: Fischhoff's system for categorizing risk. From Fischhoff et al.1978.

This sorting ultimately ignores the subjective nature of risk perception but does provide a beginning base off of which others have elaborated. It does not draw any distinction between expert and layperson perceptions, nor does it take into account the value-laden nature of judging risk. Later studies along the same vein addressed the ideas of positive and negative feelings toward the source of the risk, socio-political factors that amplify risk (Kasperson et al. 1988), and the general emotional component associated with identifying and reacting to risk (Slovic 2015). Nevertheless, with these ideas of how risk is perceived we are able to move on to how it is managed.

Risk Governance refers to how risk is handled at an institutional and policy level. It includes the processes that guide decision-making with the goal of reducing or controlling

hazards (Renn et al. 2011). The aim of risk governance is to allow society to benefit from new objects and experiences while minimizing the detrimental consequences from risks that accompany these opportunities (IRGC 2012). Stakeholders past the traditional executive, legislative, and judicial branches such as science, industry, and non-governmental organizations (NGOs) are represented in this structure; these entities add additional values, perceptions, and political interests to the decision-making processes involved in risk management (Renn et al. 2011).

The International Risk Governance Council (IRGC) created a framework for risk governance that includes five steps: Risk Pre-Assessment, Risk Appraisal, Characterization and Evaluation, Risk Management, and Risk Communication (2012).

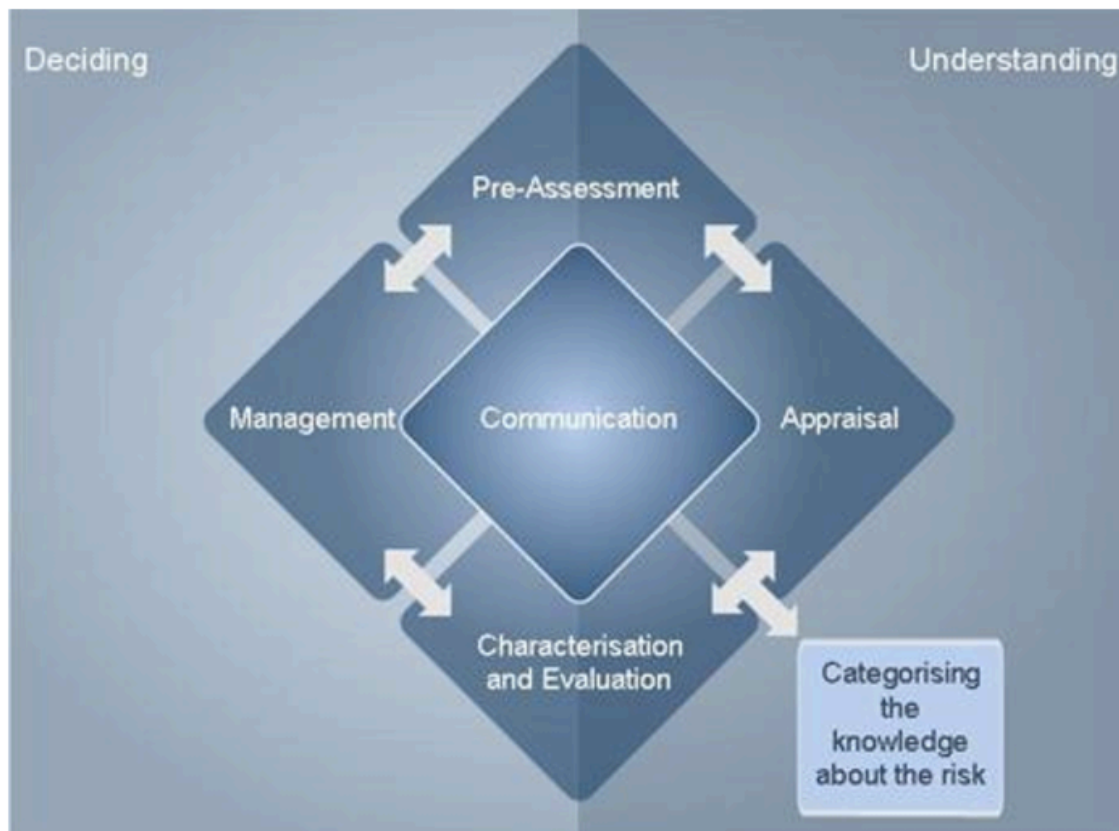


Fig. 3: Risk Governance framework from IRGC (<https://www.irgc.org/risk-governance/irgc-risk-governance-framework/>)

Pre-assessment discusses early warning and presenting the risk in a way that provides a formal definition of the problem and the possible solutions; it can be looked at as the baseline for how similar events should be handled. Appraisal combines a scientific risk assessment with a concern assessment, the physical mechanisms with the perceptions of the risk. Evaluation takes Appraisal

and fits it into the larger social values, economic needs, and political considerations. Evaluation serves to judge whether the risk is acceptable, tolerable, or intolerable by the public.

Management involves designing and implementing plans to avoid, reduce, transfer, or retain risk. Finally, Communication allows for stakeholders to understand each other's perceptions, delegate tasks, and "empowers stakeholders and civil society to understand the risk and the rationale for risk management" (IRGC 2012). Communication is key at all stages of this framework. This framework can be applied to all kinds of risk including technological, social, and natural hazards.

Risk and Governance in Hazardous Landscapes

There is a certain amount of inherent risk that accompanies living in areas that experience geophysical hazards. These natural hazards are often referred to as disasters, but the definition of disaster varies slightly across disciplines. It generally includes destruction, disruption to normalcy, a connection to time, and is linked to "dysfunction or overstrain" in society (Vacano et al. 2014). Disasters can be further categorized into natural, technological, social, and socio-natural, but for the purpose of this paper I will be specifically focusing on natural disasters. It is important to note that hazards and disasters are not the same thing. Hazards are potentially harmful events or processes while a disaster is the function of the "magnitude, potential occurrence, frequency, speed of onset, or spatial extent" of this hazard (Wisner et al. 2011). It is possible for hazards to lead to disasters, though this is not a guaranteed sequence.

On Fischhoff's chart, natural hazards including hurricanes, earthquakes, tsunamis, volcanoes, floods, fire, and drought could be largely categorized as involuntary with the potential to be catastrophic. People regard these natural hazards in a similar manner as technological risks like vaccines or pesticides. The risk to inhabited regions from natural hazards is increasing, despite being on the trajectory of becoming an objectively safer and healthier global society (Paton 2008). As population growth and economic development encourage settlement and infrastructure, the potential for more loss in the face of natural hazards grows. Weighing this risk against the benefits is still important, but when people appraise risk from natural hazards, they additionally consider personal experience and trust in authority. Confidence in personal knowledge of, or experience with, a hazard increases trust in one's own judgment over authorities, especially when they have lived in this type of region for many years (Wachinger et al. 2013).

People do not just stay away from risky landscapes. These areas often come with extreme economic and cultural draws. Volcanic regions, in particular serve as “magnets” to human settlement (Perry and Lindell 1990). These landscapes offer “visually spectacular” scenery, the “spectacle” of eruption, thermal springs, and outdoor adventure opportunities that draw in millions of people each year (Sigurdsson and Lopes-Gautier 2000). Volcanic soil supports more than 10% of the world’s population; its fertility allows for cash crops, fruits, and hardwood forests to flourish (Ping 2000). The production of these resources, however, necessitates that people also move into these areas to tend to the crops, thus placing them at risk. Similarly, coasts offer lucrative fishing industry, but also subject workers to the possibilities of hurricanes, floods, or tsunamis, depending on the location. Locals are able to learn how to interact with the hazards that accompany these regions, but tourists often represent an additional vulnerability because they likely do not interact with this geography on a daily basis and do not know the intricacies of the warning systems (Bird et al. 2009). Continuous living with a hazard encourages understanding of evacuation protocols and warning systems, and interactions with local decision-makers, which can increase overall safety. It also, however, allows for people to form opinions about the hazard that may be grounded more in experience and less in the current science. This reliance on personal experience is an important consideration when governments manage risk in their communities.

Risk governance in regions prone to hazards has shifted over the years. In 2005, the United Nation’s Hyogo Framework for action became the “global blueprint for disaster risk reduction” (DRR), ensuring that DRR be a national and local priority for natural disaster events (Staal 2017; “Hyogo Framework for Action (HFA) - UNISDR” 2017). It sought to enhance early warning systems, reduce the underlying risk factors, build a culture of safety and resilience, and strengthen disaster preparedness at all levels (“Hyogo Framework for Action (HFA) - UNISDR” 2017). Ten years later, the United Nations prepared the Sendai Framework for Disaster Risk Reduction 2015-2030, which represented a shift from disaster management to disaster *risk* management. The goal of this publication was to focus on “preventing new risk, reducing existing risk and strengthening resilience,” which includes similar priorities to Hyogo, but with an additional emphasis on technological disasters (UNISDR 2015). With the change in focus to risk management, however, came many recommendations for people-centered measures that included participatory processes tailored to the individual community needs, promoting public

awareness, and training workers and volunteers in disaster response (UNISDR 2015). The Sendai Framework allows for stakeholders to be directly involved in the governmental management of risk and has somewhat less of a focus in preparedness and more of an emphasis on resilience at all stages of a disaster.

Other frameworks have slightly different priorities than those crafted by the United Nations. Sixteen years prior to Sendai, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) published guidelines for volcanologists regarding professional conduct in volcanic crises and the protocol going forward. They decided that life safety is the most important matter and also required scientists to make it clear to decision-makers and the public that a zero risk scenario is not attainable. They also needed to increase transparency in methods, trade-offs, and expectations (Haynes et al. 2008). The IAVCEI prioritized life safety over quality, ultimately neglecting the social factors at play in all stages of disaster management. More recently these guidelines have begun to include ideas about scientists being conscious of the distinct cultural needs of their locations, but they still are not encouraging the type of participatory governance that the United Nations promotes ("IAVCEI Guidelines on the Roles and Responsibilities of Scientists Involved in Volcanic Hazard Evaluation, Risk Mitigation, and Crisis Response" 2017). These frameworks all demonstrate similar concepts of risk governance, but while the IAVCEI emphasizes expert conduct to prioritize people, the Hyogo, and especially Sendai, Frameworks invite stakeholders into the planning stages to learn their perspectives and implement them into policy.

Moving into a collaborative relationship allows for all stakeholders to grasp an understanding of the community level of acceptable risk during a disaster event. This is a newer approach than the idea of objective risk explained to an uninformed and unaware public (Barclay et al. 2008). While this idea is more inclusive, it is much easier said than done. Few volcanologists push for involvement from decision-makers or the general public in the process of crafting "expert" judgment; "inclusivity does not yet give a formalized voice to non-scientific opinion when forecasting the impact of volcanic hazards" (Barclay et al. 2008). Fischhoff (1995) discusses the benefits of simply asking if the public wants to give an opinion and define their reality. This method of collaboration also allows for the scientific body to present their position and helps to foster a relationship of mutual respect (Fischhoff 1995).

Risk Communication, Perception, and Preventative Action

The way that risk is communicated can have large implications for the way that a hazard is perceived and the resultant action. In Paton’s (2008) discussion of risk communication and natural hazard mitigation, he states that risk management has become more controversial as we become more concerned with it, and the relationships between lay people, experts, and decision-makers are often strained and unproductive. Those in decision-making or expert roles often judge the lay public for acting perceivably irrationally, which fuels an aggressive relationship between these groups. Risk communication often is more focused upon the messages being transmitted than the relationship between citizens and authorities, when the latter should be included in the models (Paton 2008). There is a positive relationship between believing the source of information and taking mitigation action and this belief extends outside of official information transmitters into family members and friends; we do not see one single source as a universally “best” source of information (Haynes et al. 2008).

The Protective Action Decision Model (PADM) is one example of a model focused upon transmitting messages well and describes how communication of environmental hazards influences preventative action.

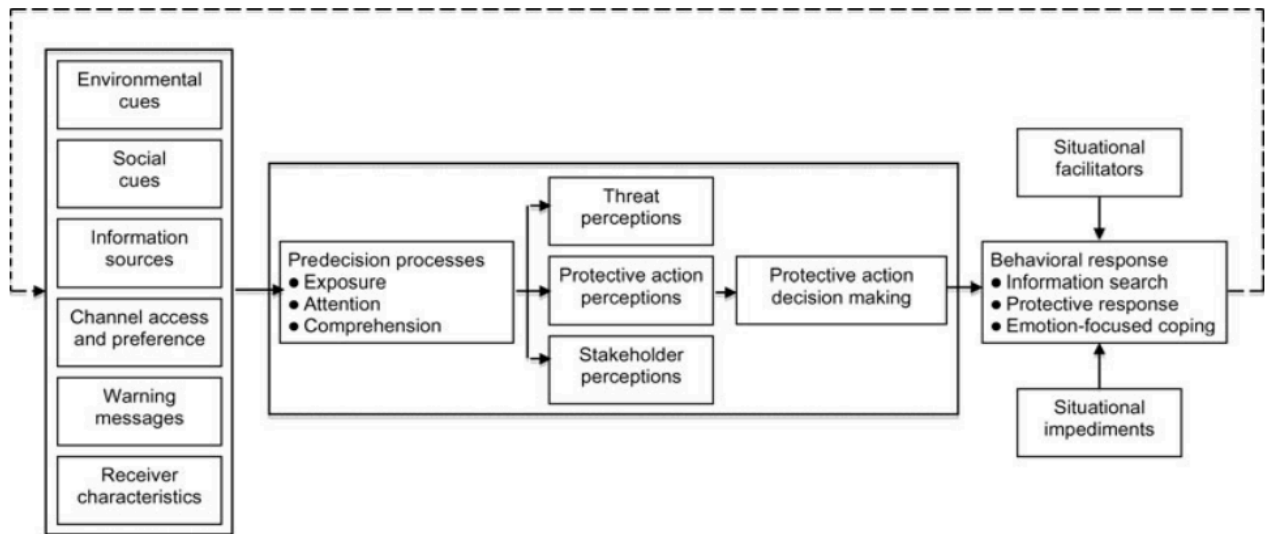


Fig. 4: Lindell and Perry’s protective Action Decision Model flow of information (2012).

This model begins by discussing sources of information including environmental/social cues and warning messages. Environmental cues are sensed directly by the self, and signal that there is a threat. Social cues, on the other hand are perceived by other people and passed along. Warnings are transmitted through a channel to the receiving body and are interpreted based upon the

physical, psychomotor, cognitive, economic and social resource traits of the receiver. A warning message transferred audibly to a person who is hard of hearing will not elicit the same response as it would from someone who has normal hearing. Likewise, two people may receive the same message, but if one does not have the economic resources to retrofit their house for an earthquake, for example, the message will not be received or implemented in the same way (Lindell and Perry 2012).

The next step in this model refers to predecision processes, which include exposure, attention, and comprehension. These signify core beliefs about the threat, potential protective actions, and any other relevant stakeholders in the situation. The perceptions of the threat, actions, and stakeholders serve as the basis for any decision making in the context of environmental hazards. The ideal outcome of an influx of information would be protective action, but if the information was uncertain or unclear, the person may continue to search for clarification until they are satisfied. If emotion-focused coping results, then the person is treating their emotional response to the warning message instead of taking preventative action toward the cause, which Lindell and Perry (2012) identify as a situational impediment rather than a situational facilitator. This model is based off of the assumption that risk perception is correlated with preventative action, but having a high level of risk perception does not necessarily denote risk-mitigating behavior, a phenomenon known as the “risk perception paradox” (Wachinger et al. 2012). While PADM includes social and environmental influences, and separate appraisals of threat and action decisions, it does not take into account factors inhibiting preventative action in even the most risk-aware groups.

Credibility is intertwined with any information source. If a group issuing the warning is perceived as completely credible, people may unquestioningly follow their recommendations and skip all of the middle steps of the PADM. This could be extremely useful in time-sensitive situations like evacuations, but in a case where the perceived credible source abuses power, this lack of cognitive decision-making could potentially result in disastrous consequences. When trust levels are somewhere in between, people will often double check information they hear from authorities with other people that they know well and already trust, delaying a response (Haynes et al. 2008).

Issues of credibility and certainty extend into communicating volcanic hazards to communities. With people cultivating livelihoods in these areas, it becomes especially important

that they do not get caught in the information-seeking phase of the PADM. However, the uncertainty of these situations makes it incredibly difficult to communicate risk (Stirling 2003). The combination of technical scientific knowledge and accepted/understood vernacular is often difficult, especially when the information is being passed directly from the scientists to the community, stakeholders, or decision-makers. The more people this information passes through, the more likely it is to be “distorted, misrepresented, or misunderstood” which ultimately puts more lives at risk (Barclay et al. 2008).

There is disagreement as to what the role of the risk analysts should be as they address environmental uncertainty in hazardous areas. It is often unclear as to whether it is their job to only develop estimates or also include social values. When the “choice of definition affects the estimated riskiness...they cannot escape some responsibility” (Fischhoff 1995). Even in cases where it is decided that the local government or emergency managers are those who are going to determine the actual risk to this particular society, the definitions and recommendations from the analysts directly impact the society; they are held to some amount of accountability. Telling people what they need to know, however, requires understanding the population and what matters to them. People often base their decisions off of cost-benefit analysis, which further emphasizes the need for collaborative interactions between planners and residents, so as to develop a common idea of acceptable risk in each individual context and build trusting relationships between the citizens and authority figures (Barclay et al. 2008).

Trust

Communication becomes much easier when the decision-makers are trusted. Risk communication cannot be expected to be effective if the public does not trust the information source (Slovic 1993). While it is difficult to quantify, generally doctors, environmental/consumer organizations, and quality media are highly trusted sources of information, whereas government officials, departments, and industry are distrusted (Haynes et al. 2008). Trust can be used as a “shortcut to reduce the necessity of making rational judgments based on knowledge by selecting trustworthy experts whose opinions can be considered as accurate,” and when the communicator is considered an expert, information is accepted more easily (Wachinger et al. 2012; Haynes et al. 2008). There is, however, a clear limit to trust after which the degree of certainty decreases; uncertainty, then, can be used as a functional equivalent for distrust (Earle and Cvetkovich 1995,

as cited by Haynes et al. 2008). Distrust displays the skepticisms of the population but is not an entirely negative state as it can still lead to taking preventative action.

Trust can reduce uncertainty when people are faced with unfamiliar or infrequent environmental hazards (Paton 2008). In an analysis conducted by Wachinger et al. (2012) trust in authorities and experts and personal experience with the hazard were the two most influential factors on risk perception. This trust refers to how reliable the individuals providing the information are perceived, and confidence in protective measures. Trust determines decisions to act when less information is directly available in uncertain situations; it is inversely related to experience with the hazard, meaning that lower levels of experience often result in higher levels of trust (Paton 2008). Trust is much easier destroyed than built, a concept known as the Asymmetry Principle. Slovic (1993) argues that this occurs because negative, or trust-destroying, events are far more visible than the positive, trust-building events. Negative events are usually specific occurrences such as accidents or lies, but positive events are more imprecise. This, combined with the psychological tendency of distrust to fuel further distrust, creates situations in which it is very difficult to restore trusted relationships (Slovic 1993).

Trusting authorities too much can also have detrimental impacts on risk perception and mitigation action. With too much trust in governing bodies, people tend to then underestimate their risk because of such a strong belief in the government's ability to mitigate it and a subsequent reduction in willingness to partake in preparedness actions (Wachinger et al. 2012). Negative feelings toward authority lowers trust levels, which ultimately increases risk perception and potentially, though not definitely, preparative action. Many believe that it is the government's job to "alleviate residents from the burden of taking protection for themselves," but this kind of blind trust in others does not help to encourage self-efficacy, which is an important trait to have when preparing for a disaster (Wachinger et al. 2012). While risk perception and preparedness are not consistently related, trust and preparedness actions are inversely correlated; when levels of trust in governmental authorities are low, people feel that they have no choice but to act to protect themselves (Wachinger et al. 2012). This is especially true when governments take a more hands-off approach that puts pressure on individuals and communities to act for themselves.

When faced with uncertainty, the baseline level of trust in decision-makers and experts dictates how willing a population is to heed advice from these entities. In uncertain situations,

conclusions about the quality of information are not objective but rather based on the “appraisal of the quality of information, and therefore trust in its source, [which] rests with the degree to which it is consistent with the needs and expectations of those seeking it” (Paton 2008). Issues need to be presented in a way that is relevant and accessible to the community, which requires some basic knowledge of the plight of the residents. If emergency managers adopt a more precautionary attitude when dealing with uncertainty, they risk the accusation of creating a false alarm, which undercuts their credibility. If they react too far in the opposite direction and are more relaxed in their management, they risk subjecting their community to avoidable consequences (Haynes et al. 2008). Cultivating trust in hazardous landscapes is a delicate process that can be catastrophic if taken lightly.

Situated Context

Problems with trust, authority, and uncertainty come to light in the situation at Volcán Tungurahua, in central Ecuador. This volcano is located in the southern part of the eastern chain of the Ecuadorian Andes, 140 kilometers south of the Quito, the capital of Ecuador, and thirty-three kilometers east of the capital of Tungurahua province, Ambato. It is renowned for its steep sides and frequent eruptive episodes (Mothes et al. 2015). Tungurahua has had four major historical eruptive cycles from 1641-56, 1773-81, and 1916-18 before the current phase, which began in 1999 (Hall et al. 1999). The beginning of this eruptive cycle was characterized by frequent small explosions, lava fountaining, the generation of incandescent ballistics, localized and widespread ash falls, and rain-generated lahars. The eruptions in August 2006, however, additionally produced pyroclastic flows, some of which made it to the base (Mothes et al. 2015). These hazards pose direct risk to Tungurahua’s immediate neighbors, including small farming villages on its flanks and the tourist town of Baños de Agua Santa, a city of 20,000 located at the northern base of the volcano.

Baños is an attraction for both domestic and international tourism. It is marketed as the “Gateway to the Amazon” because it is the last heavily populated area in the Andean cloud forest before dropping down into the Amazon. Thermal springs are a large draw inside the city, and the surrounding area provides infinite ecotourism opportunities (Government of Baños de Agua Santa). Religious tourism dates back to the city’s founding in the 1500s and numerous shrines to the Virgin of Baños can be seen around town. Although secular tourism has only been around

since the mid twentieth century, it is the main driver of the town. In 1999, 95% of the community's economic prosperity was from tourism (Lane et al. 2003).

In September 1999, after a long period of dormancy, the volcano started showing signs of reawakening through swarms of small earthquakes and hydrothermal changes. The Geophysical Institute established a permanent and continuously staffed observatory, the OVT, in the sector Guadalupe, 13 kilometers N/NW of the crater (Mothes et al. 2015). Through monetary support from the international community including the Governments of Canada, Japan, the European Union, and the Netherlands, and loans from the Ecuadorean National Government through the Inter-American Development Bank, IGEPN finances new projects to increase early warning systems and enhance natural risk management (Presentación - Instituto Geofísico – EPN 2017). Since the increase in activity in 1999, they have accumulated various instruments to collect seismic and infrasound data, SO₂ gas emissions, ground deformation data, thermal imagery, and acoustic-flow-monitors (AFM) for lahars at just the Tungurahua site alone (Mothes et al. 2015).

On October 16, 1999, the president of Ecuador called for an evacuation of all high-risk areas near the volcano, including Baños, displacing 26,000 people (Tobin and Whiteford 2002). At the time, no one knew when they would officially be allowed to return and this order ultimately remained in effect until September 2000 (Le Pennec et al. 2005). People relocated to the larger neighboring cities of Ambato and Riobamba but these shelters were ill equipped to deal with this mass influx because of the national economic crisis, and they remained in squalor for months (Lane et al. 2003). A group called el Hermandad Baneña (Brotherhood Baneña) was created and led by citizens who wanted to return to their houses and their industry. They met with the Governor of Tungurahua Province on January 4, 2000, demanding that the Baños-Ambato road be reopened, the hazard zone be demilitarized, and for a return of the displaced residents of Baños. The Governor opposed and the next day thousands of citizens mobilized and successfully took back their town from the military occupants. One person was left dead and many members of the military were taken hostage, but resettlement began (Lane et al. 2003). The citizens reestablished their old lives as best as they could without the normal bustle of the tourism industry and in the continued forecast of a potentially deadly eruption.

After signing an agreement with the Governor of Tungurahua late in the day on January 5th, the city was completely demilitarized and more people were able to return uninhibited. The responsibility for citizen safety was cast upon those who organized the return. In March, the

Governor relented further and allowed for the resumption of some basic services, including the city's hospital (Lane et al. 2003). The reopening of these offices, however, ultimately ended up forcing some people to come back under the mandated evacuation to ensure job security, a twist that essentially negated what remained of the evacuation order. The town continued to operate on these limited services and eruption remained an illusive threat until September 5, 2000 when the risk level was downgraded to a yellow alert, the second lowest level, and the evacuation was lifted.

The detrimental effects on the tourism industry resulted in a strained relationship between the citizens of Baños and the scientists. There was widespread fear that Baños would disappear from the global tourism map entirely, and they faced the challenge of convincing the rest of the world that Baños was safe to travel to. One member of the tourism industry stated, "We know that if Baños is not reactivated within at the latest...by the end of January that Baños will disappear from the world tourist scene" (Lane et al. 2003). Tobin and Whiteford (2002) additionally found that Baños returnees were the demographic that was least worried about the evacuation initially, so it made sense that they also had the lowest perception of risk moving forward. In hopes that it would stop deterring people from coming to the city, the residents tried to eliminate all reporting on the volcano by targeting the source of this information, the OVT. Some community members threatened the OVT with machetes and fire as retribution for the local economic crisis. This was not the last time the scientists were targeted as false reporters; later, in 2006, right before the largest eruption to date, the Governor of Tungurahua demanded that the IGEPN stop reporting and mandated that all questions be filtered through him first. Scientists complied, rerouting all questions to the governor's personal cell phone, though within twenty-four hours he was overwhelmed and reinstated their reporting power (Mothes et al. 2015). Citizens and government officials blamed the scientists for the local economic crisis, even though they did not make the call to evacuate the residents.

To try and calm the tensions between the citizens and scientists, Colonel Rodriguez from Civil Defense instituted the *vigía* program. This network of citizen volunteers began working with the scientists to monitor additional areas of the volcano and assist with communication between the scientists and the towns. They were recruited as civil defense volunteers either because they were already involved with civil defense or because they had previous contact with scientists because, for example, monitoring equipment was placed on their farmland (Stone et al.

2014). The need for intermediaries between the scientists and the lay public is extremely important in developing trust in volcanic crises and this was a vacancy that the vigías were able to fill (Haynes et al. 2008). The tumultuous relationships that were established during the initial phase of Tungurahua's current eruptive cycle set the stage for this study.

Methodology

I conducted my research in two parts. The first involved chronicling thirteen years of Volcán Tungurahua's current eruptive period and the second was a thematic analysis of public opinion of trust. This type of study was necessary due to time and monetary constraints limiting travel back to Ecuador for more formal interviews. Regardless, it provides first-hand accounts and leaves space for qualitative and basic quantitative analysis. Through this methodology I explored the factors that influenced trust of the various authority figures, and how this trust (or lack thereof) influenced perceived certainty of the hazards. These sentiments often served as the emotion behind the events depicted on the timeline and through the coincidences and gaps in events I hoped to be able to draw connections between feelings of (dis)trust and action.

Timeline

The timeline consists of three main categories: scientific observations, governmental declarations of risk/national changes, and citizen action. I used the program TimeGlider to create the timeline and began by establishing an objective sequence of events from the documents provided by the IGEPN. I decided to use the annual publications because they included broad characterizations of the year's volcanic activity in addition to the largest and most important events. These papers were very technical and in Spanish and were focused on just the objective events of the volcano. They did not include any recommendations for risk alert changes to authorities. I focused on the years 1999-2012 because those were the years that reports were digitally published and available directly from the Institute. In my final timeline, however, I relied more heavily on chunks that focused on main eruptive episodes (1999-2001; 2006). From 2006-2010, there were not annual reports available, so I substituted the monthly publications for those years. In addition to the reports, I read academic journal articles written by the same monitoring scientists, which not only clarified the progression of instrumentation and observation on Tungurahua, but also illuminated the scientific point of view on the social and governmental situations at the time. The scientific portion of the timeline includes all potentially

hazardous seismic/volcanic events, activity changes, and recommendations made from the scientific community.

The governmental and social portions of the timeline largely relied upon newspaper articles and academic publications as sources (Lane et al. 2003, *El Comercio*, various years). The Ecuadorian government (national and provincial) was responsible for changing risk alerts, while local Civil Defense carried out evacuations and directly interacted with the citizens and scientists in the community. This timeline additionally includes important national events such as the switch from the Ecuadorian sucre to the US dollar because these events had social and economic ramifications on the situation in Baños. The societal component largely shows the mobilization of citizens and interactions between citizens, scientists, and governmental officials and became important in my analysis of agency later on.

This timeline is meant to temporally situate social movements with eruptive events. This time period is categorized by so many different events and complications that having a way to view them visually became a necessity throughout the research process. In addition to providing a different way to conceptualize the sequence of events, the timeline also provides context for the statements I gathered about trust in the second part of my methodology, namely demonstrating instances of agency and bold acts of distrust.

Trust Analysis

The second part of my methods included conducting an analysis of trust inspired by the categories outlined by the study of trust in volcanic crises on Montserrat by Haynes et al. (2008). While in Montserrat, Haynes and colleagues conducted interviews, surveys, and participant observations to investigate the general attitudes of the public, scientists, and authorities in this landscape characterized by shifting volcanic activity. Based on a literature review and the first phase of their study, they identified eight key attributes of trust: those that fell into the “general trust” category, Competence, Care, Fairness, Openness, Value Similarity and those that more closely aligned with skepticism, Credibility, Reliability, and Integrity (Haynes et al. 2008).

For my analysis I used three overarching categories, the first of which refers to general trust as defined by the statements from the Haynes et al. study. I additionally included degrees of certainty and agency as their own separate categories. Uncertainty and trust are strongly related, especially in natural hazard situations, and trust can reduce uncertainty, thus easing the complexities that people are unable to process (Wachinger 2012). According to the Protective

Action Decision Model, uncertainties prolong the information-seeking stage of preparedness, but a source perceived to be extremely credible has the power to override these concerns and promote immediate action (Lindell and Perry 2012). According to Haynes et al. (2008), credibility is an important component of trust. Agency refers to the feeling of self-efficacy in taking personal steps toward mitigating risk. I included agency as its own category because when authorities are perceived as providing the necessary resources, citizens are more likely to trust them, but then less likely to take their own preventative actions because they perceive their preparedness needs as already complete (Paton 2008). I explored how sentiments of trust coincided with demonstrations of self-efficacy as shown on the timeline. These three categories are closely intertwined and hold importance for risk governance. I sorted statements into these categories that I gathered from interviews, newspaper articles, documentaries, and several key papers with interview components.

Table 1: Example statements for each category.

Statement Analysis Examples	
Group 1: Trust	
Competence	The scientists do/do not have the necessary skills and experience to monitor this volcano.
Credibility/Reliability	The information that they share is accurate.
Integrity	Their decisions are not influenced by others.
Care	They are looking out for all interests of the citizens.
Fairness	The decisions they make are fair to everyone.
Openness	All information about the volcano is provided to the public.
Value Similarity	We have the same idea of how safe/hazardous the volcano is.
Group 2: Certainty	
Certainty	We worry about the state of the volcano. We are sure an eruption will not affect us.
Group 3: Agency	
Agency	I have the means necessary to prepare for an eruption. I do not have the support I need to prepare.

Interviews

I visited Baños from February 9-13 and April 16-24, 2016 and during this time conducted semi-formal and unstructured interviews with citizens. Due to the national earthquake crisis, the

geologists with whom I had set up contact were unavailable for interviews. I conducted four semi-formal interviews, which were recorded, and four informal interviews, which were not. Of the recorded interviews, one was unusable due to a device issue. I took notes during and after all interviews and of daily observations. I found my subjects based upon word of mouth and happenstance, and all were given the opportunity to retract any information they shared with me at any time during our meeting, and to choose whether they were comfortable being recorded. I asked open-ended questions pertaining to demographics, their life in Baños, their experience with eruptions, and relationship with scientists (see Appendix A). I then transcribed these interviews. Two informal interviewees were quoted and included in this analysis.

Newspaper and Film

To find newspaper articles and films in Spanish, I used headlines that I encountered in a physical archive in Baños entitled *Erupciones Volcán Tungurahua: Volcanes, Cordilleras, y Montañas: Baños-Turismo todo el Año*. I searched these headlines (e.g. *La Guerra en Baños*), which turned up similar articles that were digitally published. These articles served as a basis for additional publications. I used the database LexisNexis to search key terms used in newspaper articles originally published in English (e.g. Tungurahua, Volcano, Eruption). To find films I searched Baños and Volcán Tunugrahua on YouTube and chose the top results that were not just videos of the eruptions. These films featured people talking about the events. When people were mentioned by name, I would then search for that name and watch the suggested videos.

I carefully read through the interview transcripts and articles and watched the films, then sorted quotations and sentiments into the aforementioned categories. Some statements could be argued to fit into more than one category, but all were only used once. If sources had very similar statements, I included those “repeats.” Using Excel, I evaluated the frequency with which each type of statement occurred, about whom the statement was said, and the distribution of certain versus uncertain statements. I additionally analyzed these statements for thematic similarities and differences, and how the relationships between the different actors changed over time.

Results

Timeline

My timeline can be viewed in full [here](https://goo.gl/zb8qaa) (https://goo.gl/zb8qaa). The size of the text is directly related to the magnitude of the event. Events in orange are eruptive activity, blue

represents action by community members or government officials, such as threatening to attack the OVT with machetes, and red designates changes in official risk alert and broad governmental events (e.g. overthrowing the president). The activity of Tungurahua fluctuated over the thirteen years but hazards usually consisted of rain-generated lahars, ashfall, lava fountaining, harmonic tremors, and in the case of larger eruptions, pyroclastic flows. The activity generally occurred in swarms with a period of a lot of activity followed by low activity. Tungurahua experienced four eruptions that ranked on the Volcanic Explosivity Index (VEI) scale, which is logarithmic, and ranges from 0-8. There were two VEI 2 events in July 2006 and February 2008, respectively, which are “explosive” on the scale, and two VEI 3 events in August 2006 and December 2010, which are classified as “cataclysmic” (Volcanic Explosivity Index (VEI) 2017). The timeline also demonstrates that there was much more citizen action in the beginning of the eruptive period and it tapered off toward then end. There was a small spike right before the 2006 eruptions as the threat to the tourism industry was perceived as high, but mobilization remained low after. The government at large generally declared risk alerts through the National Risk Administration, but the President and local Civil Defense also designated situations as emergencies.

Most of the language of the technical reports remained objective, current, and consistent throughout the thirteen years of reporting. There were, however, some notable differences. In mid 2000, the scientists wrote a reminder that there can be periods of calm between eruptive activities, citing the eruptions of 1916 as an example. At the end of 2001, the report concluded with a plea. The scientists wrote: *“Por otra parte, este proceso educativo debe ser parte de la cultura y el diario vivir de los habitantes que viven en la ciudad de Baños... Con ello se lograría minimizar el riesgo ante una gran erupción,”* saying that this educational process should be part of the culture and daily life of the habitants of Baños to minimize the risk from the volcano before a large eruption (“Resumen de La Actividad Del Volcán Tungurahua Durante El Año 2001” 2001). This statement became a staple of these reports and was one of the only instances of mentioning the need for a volcanic culture to develop in this region.

Trust Statements

I compiled a total of seventy-one trust statements from twenty-one sources. I ultimately included five interviews, five Ecuadorian newspaper articles, six newspaper articles originally published in English, three academic publications, and two Ecuadorian documentaries.

Statements referring to both the positive and negative aspects of each factor were included in the category because all mentioning indicated some level of importance.

Table 2: Distribution of types of sources from which statements were extracted. Total of 21 sources.

Types of Sources	Percentage
Interview	23.81
Academic	12.28
English Newspaper	28.57
Ecuadorian Newspaper	23.81
Ecuadorian Documentary	9.52

Trust was the most referenced category at 36 statements, followed by Certainty (29) and, finally, Agency (6). 50.7% of these statements fell into the original categories proposed by Haynes. Competence was the most frequently used category (36.1%), followed by Credibility/Reliability (25%), and Care (16.7%).

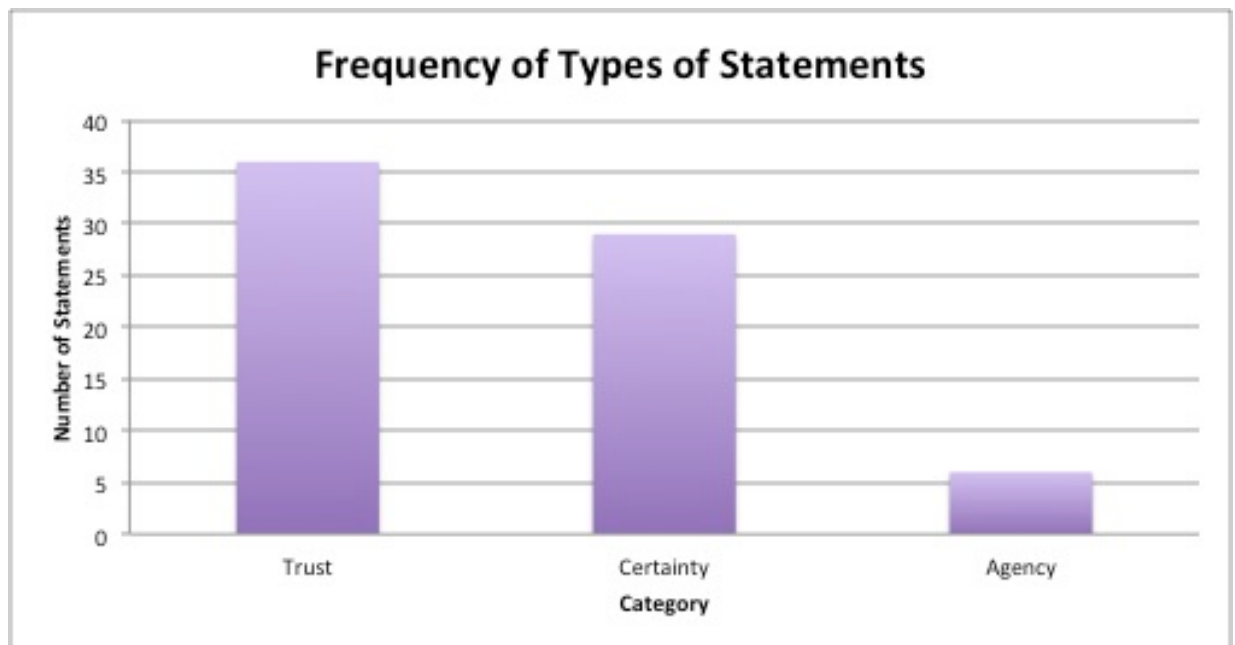


Fig. 5: Number of statements in each category. Total of 71 statements.

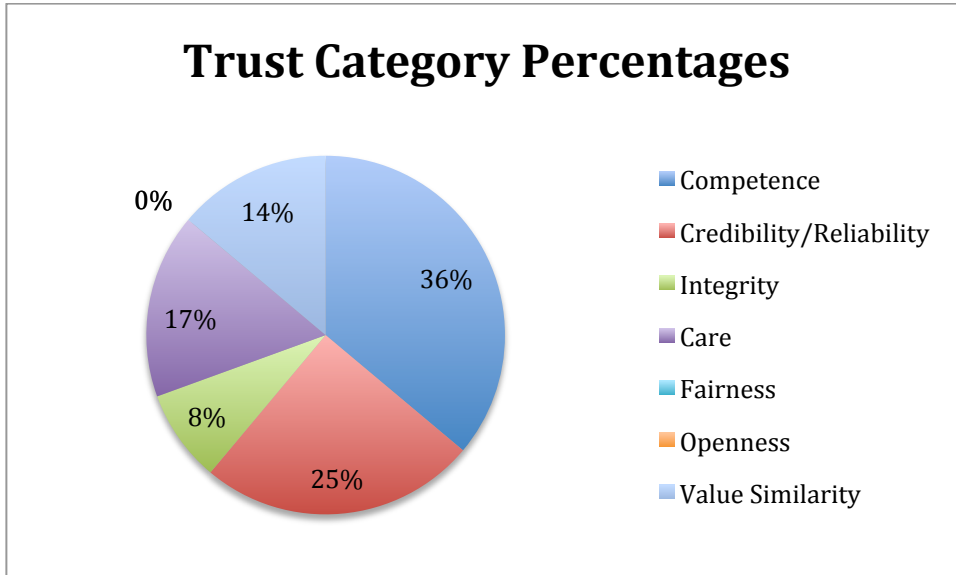


Fig. 6: Distribution of statements in the general Trust category.

The majority of the statements in the Trust categories were in reference to scientists (41.67%). 19% referred to general authorities, and 17% to the Vigías. Additional sources of trust outside of the science, authority, citizen triangle, were faith in la Virgen de Baños (the protector of the city) and distrust toward the media.

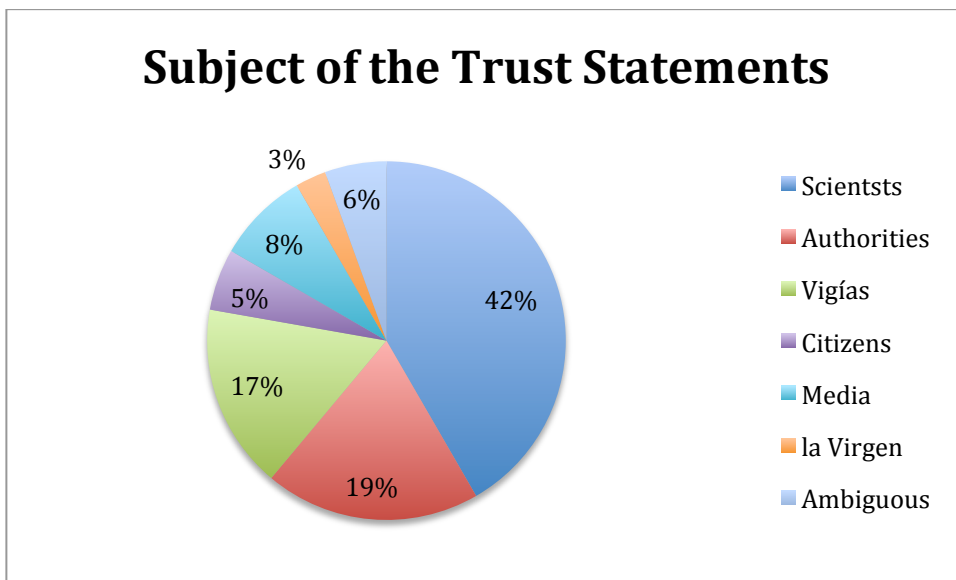


Fig. 7: Breakdown of the different subjects referred to in each trust statement.

40.8% of all of the statements fit into the Certainty category with a fairly even split between uncertainty and certainty (51.7% and 48.3%, respectively). Agency was a theme in 8.5% of the statements.

Thematic Analysis

Competence

Of the twenty-one sources that I included in this analysis, six emphasized competence in their discussion of the situation in Baños. These statements mainly focused upon the skills and knowledgebase of the monitoring scientists, but also briefly included the government and vigías as trusted sources because of their skills. When referencing the past, the competence of authority figures, including both the scientists and governmental officials, were spoken of in a very negative light. At the onset of eruptive activity in 1999, there was agreement that no one really understood what was going on. The potentially catastrophic effects of an explosive eruption were not discussed by my sources, but instead they focused upon the fact that the scientists, in particular, were perceived to only have textbook experience dealing with eruptions and this experience was not specific to Tungurahua. “*Faltó la verdad*,” described one villager, a misrepresentation or lack of truth (Calvache 2000). This statement was taken while the official evacuation order was in effect and, for the purposes of this project, is a rare account of a current sentiment, not one stated as a reflection after the event. While people were hesitant about the knowledge the scientists actually possessed, some did acknowledge the change as time went on. “Now they are more prepared,” said one interviewee. “They have more experience, not just... a lot of knowledge when you study, but you get... more knowledge with experience[ing] things,” (Interview Oscar 4/20/16). It is important to note, however, that this particular interviewee was a child during the actual events; the majority of his conscious life was spent with this activity and in Patate, a municipality closer to the OVT than to Baños.

Scientists gained knowledge, but that was largely due to the investments of the government, according to some. “They [the government] invest money in the latest technology to, to, to see how bad it’s going to be, like the increasing amount of sulfur in the air, the seismography, the other facts,” (Interview Oscar 4/20/16). Prior to this investment, however, was the sentiment that they “didn’t have any records about what to do in this situation,” which is why the town was asked to evacuate in 1999 (Interview Henry 4/18/16).

Governmental authorities were not the focus of this category; they seemed to be viewed on a more similar level to the citizens in terms of information possession and were not held accountable for hardship. The government, however, was directly responsible for the abysmal state of the shelters, largely because of prolonged high levels of inflation, the abrupt change to the US dollar from the Ecuadorian sucre in March 2000, and the military coup to overthrow the president (January, 2000) that competed for broadcast time (Lane et al. 2003). Blame was placed on those who provided the empirical data that influenced the evacuation decision, not upon those who made the actual declaration.

Finally, the *vigías* were a prevailing theme in this section, and were commented on by both citizens and scientists. Early on, scientists felt that they “needed the help from local observers on the other flanks of the volcano,” thus acknowledging their own shortcomings when it came to monitoring all sides (Stone et al. 2014). The OVT’s location on the NW side of the volcano does not provide any ability to observe the SE flanks, which prompted Gorki Ruiz, a volcanologist with IGEPN to profess the benefits of having this group. He stated that their “work is important because it provides information...[The *vigías*] confirm with the instruments and notify the authorities so they can evacuate to nearby towns,” (Rodriguez 2010). The implementation of the *vigía* program was widely received as positive, and none of the statements that I came across acknowledged the fact that the scientists admitted vulnerability in disclosing this breach in monitoring.

While the overall trend was that the scientists gained competence over time, there are always outliers. After a long informal conversation with a taxi driver in Baños who was part of the return in 2000, it became clear that not everyone had grown to accept scientific influence in town. When asked about the scientists and their interactions in Baños, his speech accelerated as he listed off scientists. “*Patricia Mothes—¡incompetente!*” he exclaimed (Personal Communication 4/23/16). Patricia Mothes, one of the volcanologists who has been involved with Tungurahua from the start, incompetent. Competence, it appears, is largely subjective and not based on credentials or what would be thought of as fitting an objective definition.

Credibility/Reliability

This category was quite similar to competence in that it mainly focused upon the perceptions of scientists and other information-bearing agencies. Scientists were originally thought of as liars “because we couldn’t have the information,” due to the lack of monitoring

equipment on the flanks in 1999 (Interview Oscar 4/20/16). This equipment was quickly installed, however, because of Baños' prominence in the international tourist scene. Just as scientists were seen as incorrectly reporting information, newspapers were viewed as unreliable because of their tendency to exaggerate the state of the volcano (Interview Henry 4/18/16).

One of my interviewees mentioned a person in town who calls himself a scientist even though he is not, emphasizing the fact that not everyone reporting about the volcano is credible or reliable (Interview Jill 4/18/16). This man has lived in Baños his entire life (upwards of seventy years) and opened a small museum about the volcano in his garden shed. He is incredibly enthusiastic, but definitively not a scientific source of information regarding Tungurahua's eruptive activity. The three hour conversation that I had with this man did not glean any specific information about the volcano, but more vague references to the laws of nature and assurances that Baños has never been harmed by volcanic activity because "*nacieron juntos,*" Baños and Tungurahua were born together (Personal Communication 4/21/16).

Vigías were often viewed as more credible than the scientists because they were people who had interacted with the volcano for longer. They were seen as a credible source because of their role of being intermediaries between citizens and scientists and offering commentaries on the status of the volcano. They had access to instrumentation and the knowledge-base of the monitoring scientists, something the other citizens did not have. In this discussion, it is important to note, "instruments aren't always reliable, so as perfect as a machine could be, it could fail," (Stone et al. 2014). Reliability can be extended to inanimate objects in a way that competence cannot.

Integrity

The only discussion of integrity was from my conversation with Oscar in which he cited the media as exaggerating the state of the volcano and tarnishing the public's view of what is actually going on. He felt that "the media role's a real important role in the perception of the people that are going to see the news...It would be nice if people would be more careful and more conscious," (Interview Oscar 4/20/16). He specifically referenced news shows airing footage that was an exaggerated representation of the current eruptive state. This outdated information could be seen as trying to manipulate the tourism industry, for better or worse. Oscar and Henry both emphasized choosing sources with care, such as getting status updates directly from the IGEPN because this information is the most accurate, as it was transferred through

fewer sources. IGEPN releases objective information about the state of the volcano that is not influenced by industry or ratings. While reliability simply implies that the information is accurate, integrity draws on the added dimension of motivation, which further relates to the aspect of care.

Care

The concept of care was most evident in discussions of all authority figures and was generally negative. Oscar currently feels that officials are here to help, but people felt very differently in the past (Interview Oscar 4/20/16). Upon remembering the return, citizen joy over their reunion with the town was shrouded by the sadness that they felt when remembering the disregard that the authorities had toward the Baneños while they were away from their homeland: “...tristeza al recordar el desinterés y olvido en el que las autoridades de turno mantuvieron a los Baneños durante el tiempo que estuvieron lejos de su tierra natal,” (*El Telégrafo* 2016, author’s translation). Another citizen stated that he does not rely on the government because “no one in Ecuador trusts the government...the leaders are corrupt and take all the money for themselves, even the money for the alarms to warn people,” (Prochnau and Parker 2000). The military, similarly, was unwelcome, living in peoples’ houses among their valuables. This imagery was propagated by the media and served as motivation to return to the city (Pinto 2006). The feeling of being taken advantage of by the military, who were allowed to live in Baños while the citizens were not, did not exude positivity. Finally, on a much more positive note, one barista in town specifically pointed out Patricia Mothes, the scientist referred to as incompetent earlier, as producing radio broadcasts that made her feel safe, but she did not elaborate as to what, specifically, about these programs made her feel cared for (Personal Communication 2/11/16). The interviews that I conducted seemed to emphasize current feelings about authority while the articles focused much more heavily on the past pain of feeling forgotten and uncared for.

Value Similarity

Value similarity largely referred to the lack of relationship between scientists and citizens and how the implementation of the vigía program helped to rectify this disparity. Stone et al. (2014) largely focused on the perception of scientists being of an elevated status and how the vigías helped to connect the communication between scientists and citizens. One community

member stated “Scientists are somewhat higher than us, and they think that they know more than this, but the vigías are people like us and feel too. The scientists only go to talk, not with feelings, like the vigías,” (Stone et al. 2014). Vigías themselves also found it useful to be able to have relationships with scientists outside of monitoring; this program humanized the scientists for these select citizens, which began to percolate into society at large.

An additional component of value similarity is more along the lines of value *dissimilarity*. One citizen expressed gratitude toward the authorities for providing eruptive information, but they were quite disinterested in this particular information because their strong faith in the Virgin of Baños led them to feel that they would always be safe (*El Comercio* 2014). With so much focus on empirical evidence, the fact that Ecuador at large is a very faith-based society was somewhat forgotten and not mentioned in scientific perspectives’ publications.

(Un)Certainty

Certainty (or lack thereof) was the most prevalent theme across all sources. High levels of certainty coincided with the faith community of Baños. This city is largely centered on the idea of the Virgin of Baños as the protector, and she, among other things, will protect the city against the volcano. “*Están seguros de la protección de la Santísima Virgen de Agua Santa y están convencidos que nada malo les pasará incluso por efectos del proceso eruptivo del volcán Tungurahua,*” insisted one citizen; they are sure of the protection from the Virgin of Baños and convinced that nothing bad will happen to them as a result of the eruptive processes of the volcano (Pinto 2006, author’s translation). The president of Ecuador in 2001, Gustavo Noboa, sent out a national radio broadcast in which he appealed to the Christian populations: “I think if we are all Christians, Mama Tungurahua will hear the prayers of this village and will grow calm,” (*The Ottawa Citizen* 2001). While this plea is not as certain as the previous usage of “they are sure,” it provides evidence of differing levels of certainty in the religious community.

Faith also extended outside of the religious community and was directed toward a strong belief in the volcano, for some. “*No temerle al volcán. Pues, la Mama Tungurahua es su amigo,*” a reporter observed about an inhabitant of a farm on the slopes of the volcano; this woman did not fear the volcano but looked at it as a friend (Tragedia Volcán Tungurahua 2006). She had lived with Tungurahua for so long that she felt she had developed a sort of friendship with “la Mama” and this friend was not going to destroy her livelihood because she had not done so in the past. This is consistent with an observation made by Perry and Lindell (1990) during their studies

of Mt. St. Helens. They found that “those who have spent their lives on the slopes of peaceful volcanoes tend to conceptualize the mountain as part of a nurturing and supportive, rather than threatening, environment. Based on such experience, residents are often reticent to heed natural warnings...that may signal the onset of an eruption” (Perry and Lindell 1990). This is one instance in which seeing an environmental cue for one’s self did not result in threat perceptions or a protective response. Past experiences help to solidify current perceptions and often people become trapped in their old way of thinking, even if the environmental cues start exhibiting different behavior.

Uncertainty continued to manifest itself throughout the eruptive process of Volcán Tungurahua, but was especially noticeable when people discussed the beginning of the eruptive cycle. “At the beginning we were more nervous because we didn’t know [know] what to expect,” explained Oscar, and was echoed by Henry: “People used to be really scared...Ecuadorians are still scared, they’re like chickens to come here,” he explained (Interview Oscar 4/20/16; Interview Henry 4/18/16). “*La incertumbre es el enemigo,*” explained one citizen; “uncertainty is the enemy” (LATV Ecuador 2006, author’s translation). This further exemplifies the fact that uncertainty was rampant in the areas around the volcano. Uncertainty manifested itself as fear in the younger generations; they did not yet share the friendship that the older inhabitants had with the volcano. “*Nosotros siempre teníamos miedo,*” remarked a child from the sector el Salado, “we were always scared” (LATV Ecuador 2006, author’s translation). He grew up in, and was evacuated from, El Salado, a region on the outskirts of Baños frequently plagued by lahars.

The citizen insecurity was additionally represented in the communications amongst the scientists. A *New York Times* article illuminated the fact that scientists in the Institute had differing stances on the timescale of the event, but upon reading the actual statements from the scientists, the ideas become convoluted because of the certainty with which they stated their arguments (*The Associated Press* 1999). Patricia Mothes released that “all indications are it could happen within a week or 10 days...When the smoke and ash emissions stop, that indicates the conduit has finally closed and then the energy will release violently in eruption,” (*Calgary Herald* 1999). While the exact events may be unclear, the progression is one about which the scientists were able to communicate with some certainty. Theo Toulkeridis, a volcanologist with IGEPN, stated in an interview that his data are clear, regarding the activity. This sense of clarity and knowing is not necessarily the widespread belief, or it was not constant over time (LATV

Ecuador 2006). When information comes from multiple scientific voices, however, confusion increases, levels of credibility, trust, and confidence decrease, and further statements could ultimately be “interpreted as a sign of incompetence” (Barclay et al. 2008).

One of the largest instances of uncertainty in the scientific reports was centered on the seismic activity in a region called Pisayambo about 35 km north of Tungurahua beginning in 2003 and continuing into 2004. Earthquakes in this region often coincided with an increase in volcanic activity at Tungurahua, and this new development was not something that the monitoring scientists had encountered previously. They used a lot of language such as “we postulate” or “it could” indicating the uncertainty surrounding this new type of activity (Resumen Anual de la Actividad del Volcán Tungurahua 2003). However, while this new relationship was deemed potentially causal beginning in August, in November, volcanic activity coincided less directly with the seismic activity, indicating the difficulties and uncertainties associated with developing new patterns. There are many instances of scientists expressing worry, talking about potentials, and essentially being unable to rule out further explosions. Issues of certainty were frequent throughout the publications on Tungurahua, thus indicating its importance in this period.

Agency

This category was not as widely mentioned as the others, but still represents an important component of citizen mobilization and action taken in response to the trust of authority. Oscar emphasized choice of location in his statements, arguing that people choose to live by an active volcano and that they need to learn to be prepared because of that. He spoke of bottom-up preparation including planning evacuation drills. For him, getting prepared was a requirement, not an option: “They have to give a damn because something happens and there is a bigger eruption or something is around we know where we have to run, you know, because what else can you do?” (Interview Oscar 4/20/16). Stone et al. (2014) pointed out that with this motivation, communities are able to bypass official decisions with self-evacuations. Over time, they have developed a “sense of agency and capacity...where they are able to preempt official decisions and thus more quickly respond to changes in the level of risk.”

The timeline demonstrates some basic instances of agency or empowerment among the residents of Baños as well as by the authorities. Most of this action was driven by a desire to protect livelihoods and occurred at the beginning of the activity. The biggest instance was of the

3000 people coming together to return to town, but on a smaller scale, groups would threaten to chase out the scientists, quiet the media, or petition the government to change risk alerts. Often this mobilization was in response to a risk change and was voicing discontent with these decisions. Residents demonstrated that they felt they had the capacity to be involved in the decision-making processes, in much of the same way as Stone et al. (2014) noted that they felt they could bypass official decisions and evacuate. By the end of the analysis period, I did not find any reports of community or individual action, perhaps indicating that this degree of agency had become engrained in the culture and was no longer newsworthy.

On the opposite end of agency falls the insinuation that this is all by divine will. All statements regarding the Virgin of Baños and her protection could have also been categorized here. If citizens are putting their faith in divine hands, they are sacrificing all senses of agency that they have in this situation. It shows a complete lack of self-efficacy. Those statements were ultimately not included in this category because the sentiment behind them was more closely related to certainty.

Discussion

My timeline demonstrates the events of the current eruptive period, while the trust statements provide the sentiment behind these actions. At the beginning of the activity, most events were unnoticeable without scientific monitoring equipment. These phenomena were not something that the average citizen was aware of, so when the call was made to evacuate Baños the reason was not something that the citizens had been able to see or make sense of for themselves. “No one knew about it,” described one interviewee. “Even the authorities, they didn’t [know] what to say because they hadn’t had any studies or any recordings” (Interview Oscar 4/20/16). For all the citizens and authorities could tell, the volcano was presenting as it always had and was not going to be a danger to their livelihoods, yet they still complied with the initial mandatory evacuation. These “invisible” indicators required full reliance on the scientists and authorities to have the best interests of the citizens in mind. Unlike authorities, scientists did not have the benefit of being fully immersed in the local culture and were perceived as unfamiliar with the town and volcano; they were the ones who were met with dissent. This is consistent with Fishhoff’s (1978) sentiment that “the public will resist even the best-laid plans if they feel that policy makers have not adequately considered their desires.”

The relationship between compliance with the evacuation and trust in the government still remains unclear. I did not come across any explicit statements about the government during this time period, so why citizens did not resist this initially could be due to any number of reasons. If the authorities did not actually know what to do, as Oscar stated above, then citizens and authorities had similar levels of uncertainty. The scientists were also experiencing extreme levels of uncertainty, but they had access to technology and information that the others did not, thus elevating their status slightly, as quoted in the Value Similarity section (“Scientists are somewhat higher...” (Stone et al. 2014)). As the balancing of uncertainty became such a prevalent theme in this analysis, it is very possible that the uncertainty about the eruptive status of the volcano at this particular time outweighed any perceived threat to the tourism industry. This scenario seems more likely than solely trust in the government because benefits, costs, and value trade-offs are so entrenched in hazard mitigation (Slovic 2015). The trade-offs involved with safety and the tourism industry arose several months later when the detrimental effects of evacuation began to fully set in.

Worry decreased over time and citizen unrest rose. Lane et al. tracked feelings of worry and perception of risk in various communities, and demonstrated that the reported degree of worry between June 2000 and January 2001 in all interview groups decreased over this time period. The vast majority of those that returned did so because of the economic hardship they faced away from Baños, but it was not just the citizens who suffered from the rapidly declining industry (Lane et al. 2003). The local, provincial, and national governments all benefitted from a thriving industry. With this mutual desire to restore tourism to Baños, the government and frustrated citizens were united over a very strong similar value that the scientists did not share, thus catapulting them further into a mistrusted out-group. The provincial government restored basic services in March 2000, despite the unchanged eruptive status, after which they became even more aligned with the citizen agenda. Citizens and government had the same level of acceptable risk, an important component of value similarity (Haynes et al. 2008).

For scientists, the risks were very concrete hazards: lahars, pyroclastic flows, and in more rare cases, lava flows. Citizens and authorities may well have acknowledged these hazards, but more pressing for them was their complete intertwinement with place because of their reliance on tourism. Evacuation led to fear that Baños would be removed from the global tourism map, which would throw many people into economic destitution (Lane et al. 2003). This risk was

stronger than any stemming from the volcano and the scientific community acknowledged this, though perhaps not very publicly. Hugo Yepes, the director of IGEPN stated: “You Americans have to understand that this is not a land of opportunity... We cannot expect people to lose everything. The degree of fatalism here is much higher. The people do not have a choice but to stay,” (Prochnau and Parker 2000). Yepes demonstrates care and shared value in this statement, important trust components from the perspective of the citizens, yet the community remained weary of scientific input, potentially because this sentiment was only published in an American newspaper. If the scientists were, in fact, in agreement with the citizens, then the governmental officials who were maintaining the evacuation order were those who were directly going against citizen wishes and should have been receiving the blame for their suffering. Understanding the position of the citizens did very little if there was not action or acknowledgement accompanying it. “Disasters, and fear of disasters also generate a strong desire for... someone to be held accountable,” and in Baños, the easy answer was the scientists (Waugh and Strieb 2006).

After the implementation of the vigía program in mid 2000, ideas about the scientific community began to shift. Residents had “more confidence in the vigías because...they know the behavior of the volcano” and “are people like us,” (Stone et al. 2014). At large, residents may have still felt uneasy about the scientific population, but they had a baseline level of trust in the community members who worked directly with the scientists; the vigías helped to ease some of the inter-group tensions. The implementation of this program helped to calm some of the distrust regarding the scientists’ perceived lack of practical experience and began to integrate them into the community. This is consistent with the Haynes et al. (2008) observation that the most trusted information source about volcanoes is friends and family, and the vigías were now familiar sources with objective information. Had the scientists and citizens perceptively understood the trade-offs each were navigating, the vigía program may not have been necessary for its bridge building but simply for the value of having extra eyes monitoring the volcano or as a way to bypass the official communication structure. Vigías emphasize that value similarity is still important, even if it was not shown to be the most imperative factor in my analysis. They additionally encompassed ideas of care and competence that the scientists did not exhibit because of their stronger ties to this specific place. Furthermore, Waugh and Strieb (2006) describe the necessity for personal familiarity over institutional contact in emergency management, a component that the vigías embodied well.

While the current literature (Stone et al. 2014, Mothes et al. 2015) suggests that the vigías were instrumental in rectifying the situation in Baños because of the value similarity component of trust, my study did not yield the same results. Vigías were extremely important in mending the trust relationships in Baños, but the statements I analyzed focused much more heavily on competence, credibility, and care as the driving components of trust. Addressing the noted deficiencies in understanding the local way of life and the specific patterns of Tungurahua could be precursors to the concept of value similarity.

Much of my analysis focuses on the original evacuation of Baños and the slopes and the implications that it had on the disaster management and trust relationships of the region during the initial eruptive years. The actual reporting on Tungurahua's status in relation to citizen perceptions was much less frequent in the years following. Activity continued to increase, but there was not an officially ranked eruption until July 14, 2006. Immediately prior to this, the governor of Tungurahua demanded that the IGEPN cease all reporting about the volcano because the preoccupation with keeping a bustling tourism industry remained a pressing concern (Mothes et al. 2015). Just one day after the reporting ban was lifted, Tungurahua experienced its biggest eruption to date, sending pyroclastic flows down the Vascún valley, right on the outskirts of Baños. The flow stopped two kilometers above the El Salado hot spring, a popular tourist attraction. Just one month later, on August 18, 2006, Tungurahua produced an even larger eruption. This event generated pyroclastic flows down the Palitagua and Juive Grande valleys, which destroyed fifteen houses, killed five people, and interrupted power supply in Baños. The local civil defense chief made the decision to evacuate Baños on August 16, the same day that the two pyroclastic flows occurred, and managed to get everyone safely out of the city before the eruption; this evacuation, however, was not entirely successful because it either did not reach or did not convince the people in these valleys that they needed to leave. The 2006 events demonstrate two polarized reactions to the eruptive activity. On one hand it shows the more distant provincial governor still subscribing to the older ideas of needing to protect the tourism industry at all costs, but on the other hand it exhibits local people agreeing with the official recommendations and taking preventative action by evacuating, a large positive change from the previous evacuation.

Tungurahua remained moderately active until June 2008, when it produced another VEI 2 (explosive) eruption comparable to that of July 2006. Baños was not evacuated, but there was a

lahar that descended Vascún valley and destroyed El Salado, two houses, two bridges, and killed two people. Two years later, a red alert and evacuation order were issued to Baños on the very same day that a VEI 3 (severe) eruption occurred. The articles that I encountered about these later events did not mention citizen perception; they focused upon the eruptive events themselves. This demonstrates a large shift over time, from complete mistrust and feeling wronged, to cooperative successful evacuations for violent events. Integrating Tungurahua as an erupting volcano into the cultural landscape of the town took time, but through this period scientists were able to gain the volcano-specific experience that the citizens originally desired. Whether they actually became viewed as more competent is hard to determine, but they were listened to, and more lives were saved than lost. Navigating uncertainty in such high-stakes situations is certainly difficult, but learning how the volcano functioned over time and having intermediaries know and accept the outsiders on a personal level helped to calm the tensions between the community and scientists, moving toward a mutual prioritization of safety over economic prosperity. The change in attitude over time shows that trust relationships in this volcanic crisis were malleable, and that gaining experience remains an important part of risk governance, both for acquiring information and building trust.

This study has several limitations, the largest of which being the usage of sources based on reflections on past events rather than current perspectives. A longitudinal study based on interactions with the same residents would produce much more complete results. The statements that I included are by no means comprehensive as I was limited to those that are available online, so locally published opinions were not used for this study. It does, however, open up interesting ideas as to how to address issues of trust in this particular uncertain landscape, demonstrating documented needs that can be applicable to other similar circumstances.

Implications

The struggling trust relationships in Baños provide concrete examples of how to approach volcanic crises in Ecuador with the Cotopaxi Volcano to the north. Baños can serve as an example of how to navigate uncertainty and create strong relationships between communities and scientists. It additionally demonstrates the benefits of participatory approaches to risk governance that may be successful in different settings threatened by natural hazards. Finally,

this study could have much broader implications and extend into the realm of climate skepticism and governance.

Cotopaxi

Cotopaxi is Ecuador's second tallest volcano and most well known, located about fifty kilometers south of Quito, and thirty-five kilometers northeast of the town Latacunga. Cotopaxi is characterized by violent explosive eruptions, most notably in 1877 when pyroclastic flows descended all sides of the cone and lahars traveled over 100 kilometers to the Pacific Ocean and into the Amazon basin (Global Volcanism Program 2013). Because of its wide-reaching eruptive nature, as of 2015, when the volcano became active once again, 325,000 people lived in areas that could be affected by mud and rock flows from Cotopaxi (BBC News 2015). As with Tungurahua, lahars are one of the biggest threats with Cotopaxi as they can reach Latacunga and the other surrounding towns within thirty minutes (Kitson 2015). At the onset of a new eruptive episode, people were panicked and scared as President Correa declared a state of emergency and prohibited all media except official sources (IGEPN) from publishing information about the volcano, an effort meant to prevent panic or have people adopt a false sense of security (BBC News 2015). Finally, the city of Latacunga's largest tourist draw is climbing Cotopaxi, but with a closed National Park, tourism dropped and the local industry suffered (Kitson 2015).

This uncertain progression is extremely similar to Tungurahua's reawakening in 1999 and the later governance is comparable. In 2006, the Governor of Tungurahua also halted reporting on the state of the volcano, but he included official sources in his ban, something President Correa kept active. The intentions behind this reporting freeze, however, were quite different. Correa looked to decrease panic and keep official information as the primary source (a potentially helpful effort, assuming that the official sources were perceived as credible) while the Governor was ultimately trying to protect the tourism industry over the people (Mothes et al. 2015). Even though Correa allowed for official sources to continue reporting, people still felt that they were not receiving needed information and that the government was deliberately hiding the true eruptive status from them; it was not effective at quelling the panic (Schreiber 2017).

Perhaps most importantly, however, is the implementation of a vigía program at Cotopaxi as was done with Tungurahua. This happened much faster here, starting just five months after activity began rather than two years later. As a response to the uncertainty as to whether Cotopaxi was going to produce a VEI-4 (Volcanic Explosivity Index, "cataclysmic") eruption as

it did in 1877, and the factors adding to the uncertainty such as hearsay, bad information, overdependence on poorly maintained social media, and low levels of knowledge about volcanoes, the vigías help to monitor and communicate to their towns as well as the IGEPN and ECU-911 (Ecuador's national integrated emergency services) about what is actually happening with the volcano. The information that they provide “compliments the ongoing IG-EPN monitoring and also serves to strengthen their capacities as community leaders and guides during volcano crisis” (Bedón et al. 2016). With forty-four volunteers just at Cotopaxi (seventy-three nationally) the vigías are helping residents of affected areas feel safer and more informed much quicker than at Tungurahua (Bedón et al. 2016). The early implementation of this program helps to skip the distrust and neglect that the residents of Baños felt and instead jumps right into healthy collaboration between residents, scientists, and government officials where the citizens can feel cared about by authorities and can also find the capacity to trust the scientists because their fellow residents have heavy involvement in the monitoring process.

Collaborative Risk Governance

The success of the vigía program at Tungurahua and later at Cotopaxi demonstrates the positive components of instituting participatory risk governance in hazardous areas. The Sendai Framework states that “participation of relevant stakeholders at appropriate levels” is necessary to strengthen disaster risk governance and that “inclusive, accessible and non discriminatory participation” should be available at an “all-of-society” level (UNISDR 2015). Essentially, participatory governance should not be exclusive to just the main stakeholders, but that all groups involved, regardless of how peripherally, should be given the space to be involved. The vigía program shows specifically how engaging citizens in the scientific monitoring and reporting of activity helps to promote a trusting society. The regions around Tungurahua valued competence, credibility, and care from the authorities they worked with, and referenced the scientists much more than the other authoritative bodies. If implementing more participatory measures helps to encourage feelings related to the categories strongly associated with trust (care, fairness, openness), the risk governance of the specific area could be much stronger. Clearer disaster risk management helps to promote sustainable development and foster resilient communities, a goal for societies outside of high natural hazard risk, as well (UNISDR, 2015).

The Katla volcano in southern Iceland provides an excellent example a volcanic region that could have benefitted from collaborative risk governance. Here, approximately 1,200 people

live within the jökulhlaup hazard zone, yet many still stated that they would not evacuate if an order were given (Bird et al. 2009). This community, comprised largely of farmers, was uncomfortable leaving their livestock, and furthermore they did not feel they could successfully complete all evacuation procedures in the allotted time. Rather than risk driving on the road through the valley susceptible to jökulhlaups, they felt safest and healthiest staying put, despite the recommendations of local officials (Bird et al. 2009). This situation is just one instance in which a more collaborative approach could have been used in emergency planning. Had both locals and emergency planners been able to understand the benefits and costs as perceived by the other group, evacuation routes could have been reworked to appease both parties, and perhaps more people would feel safe evacuating. This was not a case of people misunderstanding the technical risk, but appraising it differently than the officials calling for evacuation.

At Mt. Merapi in Indonesia, local communities believe that the mountain is “home to a powerful spirit kingdom” and hold a strong spiritual attachment to the volcano (Donovan 2009). They, too, are very reluctant to move in the case of eruption, but for different reasons than those around the Katla volcano. Their hesitance is a case further rooted in geomythology, or the study of oral histories and local knowledge, not one of the tense practicalities in Iceland. Stories of this volcano are much more prevalent in this area than current scientific knowledge. At the time of publication, there was still no official risk map for the volcano and “local people were not prepared to respond to scientific-based warnings,” (Donovan 2009). Understanding each community’s unique preoccupations is incredibly important when trying to effectively communicate and implement risk-reduction measures in these landscapes.

Tungurahua, Katla, and Merapi all demonstrate the necessity of understanding the community being affected by a volcanic hazard when evacuation is imminent and this can also be applied to other natural hazards. Hurricane Katrina ravaged New Orleans in 2005 and despite a mandatory evacuation, more than 100,000 residents stayed behind (Eisenman 2006). Factors often influencing non-compliance with evacuation orders include surviving past hurricanes, optimism about the outcome, being a racial/ethnic minority, crime, fear of losing property, and a lack of credible information source on the disaster. Additionally, evacuation is expensive and lack of finances was a huge barrier to evacuation with Hurricane Katrina because it struck right before pay-day (Elder et al. 2006). Staying behind ultimately resulted in devastation. There is high uncertainty with these sort of climatic events as well, and it remains difficult to convey this

uncertainty to people who are entrenched in their beliefs about their positive past experiences with hurricanes. Many people who did try to evacuate did not know what to do, where to go, or have the means to leave; even if travel vouchers were provided, if citizens did not know where to procure them this handout was not at all helpful for the communities that actually needed them (Eisenman 2006). Participatory risk governance in extremely varied demographic regions requires much more consciousness of keeping all groups involved to avoid common cultural and racial biases. Keeping all of the community involved helps more people to understand the problem, know what their resources are, and ultimately stay safer in disaster situations.

Climate Governance

Broader still, the problems associated with communicating uncertainty extend past acute natural hazards and into the realm of climate change. With climate change contributing to more frequent and more intense storms, the resilience-promoting aspects of disaster risk reduction become increasingly important on a practical economic level (ICCG 2017). With climate change characterized as “the ultimate ambiguous situation given its complexity and perceived uncertainty” it is difficult to reach diverse audiences with scientific data alone, especially with rampant distrust in the government and scientific communities (Nisbet 2009). Distrust in science is especially prevalent in the politics of climate change and Fischhoff (1995) argues that this is due to having so many expert sources of information. Citizens “might get the impression that scientists are completely confused or that one scientist’s guess is as good as any others’... There is considerable overlap in the probability distributions of those scientists who are most and least concerned about greenhouse warming, yet the debate is sometimes interpreted as though ‘anything goes.’” The scale of climate change, however, extends far further than a localized volcanic or weather event, which makes governance much more difficult and this distrust is extremely deep-seeded and politicized.

The Protective Action Decision Model’s information source section addresses personal beliefs like denial. After the environmental and social cues, warning messages, and issues of access, is the category of “receiver characteristics.” Beliefs and behaviors of the receiver will completely alter the continuation of the message. With this in mind, when talking to a climate denier with the goal of convincing them to take preventative action, it is important to acknowledge that a message that states the importance of taking precautionary action will probably not make it past the initial stage. This person will be exposed to an idea that conflicts

their own and will then either become stuck in the information-seeking aspect of the PADM or dismiss the idea entirely. The PADM is meant to address stages of disaster for large numbers of people in events that unfold over a period of months or years, but seems more effective in its application to evacuation in Baños than with the prolonged years of climate change (Lindell and Perry 2012). The climate problem offers a time in which it will be imperative to tailor a message to specific groups in order to obtain the desired mitigation action and that necessitates knowing and understanding these communities.

Nisbet (2009) suggests that recruiting “influential peers” to deliver carefully framed messages would be an effective way to help reach all audiences and encourage them to view climate change as a problem that needs to be addressed. This very idea was practiced in Baños and Cotopaxi with the vigías with success, but still does not quite address the scale of the problem. While the risk governance in Baños does not match the scale of the climate problem, these issues still mirror one another. Concerns of government distrust and corruption that were underlying many of the problems in Baños have become increasingly worrisome in the current political climate of the United States. Political leaders have been prioritizing economic development, effectively denying the risk that climate change presents, just as government officials in Ecuador tried to stifle the science in favor of promoting tourism. Distrust in an information source will ultimately have the same effect as negative receiver characteristics: the message will not be absorbed. On a small scale, Nisbet’s communication plan offers a solution that could be effective on a community level and perhaps adding all of these communities together could enact larger positive change. Addressing the specific uncertainties and criticisms associated with concerns of credibility or competence with science, and if there are problems with feeling left behind or uncared for in policy-making, may also assist in guiding people to the conclusion that climate change is something about which they should care. Just as with the evacuations in Baños, people will not feel like they need to take action to protect themselves if the value trade-offs do not fall in their favor, and decision-makers or other authority figures will not know how to properly care for these populations unless they become immersed in them.

Conclusion

This study aimed to address the complexities associated with navigating uncertainties in the volcanically active region around Volcán Tungurahua. Risk communication, perception, and

trust in authority all connect to form the motivation to take preventative action in these high-stakes situations. In Baños, relationships with authorities, especially the scientific community, were strained for years. The residents and government did not feel that the information was credible, that the scientists were competent, or that they were being cared for, and this discontent was evident for several years after the initial evacuation. The implementation of the vigía citizen-science program helped to build a bridge between these groups by having already trusted residents work with the scientists to monitor the volcano. This group was then able to advocate for the scientists' reports and relate to them as normal people. By the time Tungurahua reached its peak eruptive status, the remaining dissent was mostly from governmental leaders who were concerned about the tourism industry suffering.

Citizen livelihoods, especially those that relied on tourism were always at the top of the value trade-offs relating to the volcano; staying in Baños meant uncertain danger, but leaving was certain economic decline. This different appraisal of risk between the citizens, government, and scientists stands at the heart of this project. All parties understood the harm that leaving the area created, but this was not necessarily heard or acknowledged by everyone. Instead of blaming those who called for evacuation, citizens jumped straight to the information source. Their preoccupations with the competence and credibility of the scientists calmed over time as the scientific presence remained constant. The strides that this region made in participatory risk governance have already been replicated with another volcano. With this bridge, the Cotopaxi area will hopefully be able to skip the trust-building state that Baños needed, and jump straight to collaborative and trusting relationships between all stakeholders.

There are still people who feel violated and hurt by the events of 1999, and the pain of this injustice will likely not go away. Through studying their sentiments, I found that in order to be trusted, one must show that they deserve it in their merits and experiences, but they also must demonstrate that they care about the people with whom they are interacting. These experiential and human factors ultimately make it possible to enact positive, live-saving change.

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All official reports from IGEPN can be downloaded here: <http://www.igepn.edu.ec/informes-volcanicos/tungurahua>

Appendix A: Rough Interview Structure

- I. Demographics
 - a. Where are you from? (¿De dónde es usted?)
 - b. How old are you? (¿Cuántos años tiene?)
 - c. What is your job? (¿Cuál es su trabajo?)
- II. Baños
 - a. How long have you lived in Baños? (¿Cuánto tiempo ha pasado en Baños?)
 - b. Why did you move here? (¿Porqué se mueve a Baños?)
- III. Tungurahua
 - a. Have you experienced an eruption or evacuation? (¿Ha experimentado una erupción o evacuación?)
 - b. How does volcanic activity affect your business or daily life? (¿Como la actividad se le afecta?)
 - c. What do you see as the main risks the volcano presents? (¿Cuales son los riesgos más grande del volcán para usted?)
- IV. Communication
 - a. How and how often do you hear about the status of the volcano? (¿Cómo y cuándo oye sobre la situación del volcán?)
 - b. Are there resources in town that provide information about risk? (¿Hay recursos en la ciudad que provee información sobre riesgos?)
- V. Citizens/scientists
 - a. What do scientists do to interact with citizens? (¿Qué hacen los científicos para interactuar con la comunidad?)
 - b. Do you trust them? (¿Tiene confianza en ellos?)
 - c. Are you familiar with los vigías? (¿Conoce los vigías del volcán?)

Appendix B: List of Trust Statements

Competence:

Interview, Oscar 4/20/16

- Even the authorities they didn't know what say because they hadn't had any studies or any recordings.
- They (authorities) invest money in the latest technology to, to, to see how bad it's going to be.
- All the people understand better how volcanoes work, at least here in Ecuador, and they can compare the range of suffering there.
- Now they are more prepared, they have more experience not just, because you get a lot of knowledge when you study, but you get, I know personally with every job you get more knowledge with experience things.
- You go to any part of the world and say "okay, I've been dealing with this volcano for 15 years, I've studied science for that long, so here I am, I know what I'm talking about."

Interview, Henry 4/18/16

- He didn't have any records about what to do in this situation so he asked [us] to evacuate in 1999.
- We are not that familiar with them but we know that they are always in touch with the scientists.

Stone et al. 2014

- We felt that we needed the help from local observers on the other flanks of the volcano". (Scientist 2)
- ...more confidence in the vigías because it is they who are living in the community with us, they know the behaviour of the volcano.

Rodriguez 2010

- Gorki Ruiz, volcanologist Geophysics Institute said Carlos Sanchez's work is important because it provides information. "It indicates when heavy rains generated by these flows. Then confirm with the instruments and notify the authorities so they can evacuate to nearby towns."

Nature 2014

- At this time, evacuees had a very limited trust of scientists and scientific information, and were proud of their communities close to the volcano – despite the risk.

Tragedia Volcán Tungurahua

- Faltó la verdad

Personal Communication, Carlos 4/23/16

- Patricia Mothes--incompetente!

Credibility/Reliability

Interview Oscar

- If they say it's time to go, you must listen to them because they studied for it.
- They didn't look good, the science, because they look like they're lying but they were just, I believe, it was because we couldn't have information, no one was prepared.
- So after they got experience with the same volcano they said "ok, actually the process goes really high but it comes down."

- Being Baños such a touristic town so they have more attention to be more prepared.

Interview Henry

- Most of the time yes, we trust them [scientists].

Interview Jill 4/18/16

- I only know this doctor was on the risk management committee. Once I thought about calling him when I wanted to know what the situation was.
- He'll call himself a scientist, but he's not.

Stone et al. 2014

- It's a long process, we have to see results and when there are results, people gain trust".
- Instruments aren't always reliable, so as perfect as a machine could be, it could fail, therefore, what I believe, is that it is very important to have the commentaries given by the vigías.

Integrity

Interview Oscar

- So the media role's a real important role in the perception of the people that are going to see the news.
- It would be nice if people would be more careful and more conscious and going to those kind of sources where you can have real information about what is going on.

Interview Henry

- Newspapers and the tv channels are really bad things in this situation because they are always exaggerating about the situation

Care

Interview Oscar

- They are here to help us so we have to trust them.

Pinto 2006

- Las imágenes de ingreso de miembros del Ejército a nuestro domicilio, que se proyectaron a través de la televisión no solo en el país sino al mundo, motivaron que mi padre Jorge Villacís encabece "la guerra" para regresar.
- "La gente que dejó más cosas de valor en sus casas, al ver las imágenes temieron perder sus bienes", indicó con nostalgia.

El Telégrafo 2016

- Tristeza al recordar el desinterés y olvido en el que las autoridades de turno mantuvieron a los bañeros durante el tiempo que estuvieron lejos de su tierra natal.

Prochnau and Parker 2000

- Romo does not count on the government for help. "No one in Ecuador trusts the government," he says. "The leaders are corrupt and take all the money for themselves, even the money for the alarms to warn the people."

Personal Communication Noni 3/11/16

- Patricia Mothes, I always hear her on the radio. She makes me feel like everything is going to be okay.

Value Similarity

Stone et al. 2014

- The unique position of the *vigías*, as members of the community, allows them to act as intermediaries between the scientists and public, benefitting from dimensions of trust such as value similarity and credibility
- ...the *vigías* are people like us.
- Scientists are somewhat higher than us, and they think that they know more than this, but the *vigías* are people like us and feel too. The scientists only go to talk, not with feelings, like the *vigías*.

El Comercio 2014

- "Me agradecían la información, pero me informaban que la población de Baños estaba muy protegida por el manto protector de la Virgen de Baños".

UNISDR Science and Tech. Case Studies 2014: Stone et al.

- "The scientists are people who we can talk to and this shows a growth in trust. We now know what they think, what they do, not only talking about the eruptive process but also about our lives and how we live" -vigía

Certainty

Interview Oscar

- No one knew about it and then we were pretty scared.
- Of course at the beginning we were more nervous because we didn't know what expect.
- They said "ok, actually the process goes really high but it comes down."
- So following those patterns we hope and we believe that we can be away with not much risk if the nature gives us a chance and showing us and warning us that it's increasing.
- I will stay here.
- Of course my mom is always worried because she hasn't been here every time.
- You can be prepared up to some point, but you will never be prepared for something like—because unpredictable, you know.
- If it is, like, huge explosions or like a, without any time or warning, something really bad could happen.
- Make us understand that it's nature so we can't control, we don't have control over it.

Interview Henry

- Because people used to be really scared, especially.
- Because Ecuadorians are still scared they're like chickens to come here

The Associated Press 1999

- On Oct. 22, Alexandra Alvarado, a scientist from the Geophysical Institute in Ecuador, said Tungurahua would explode at any moment, while Patricia Mothes, an American volcanologist at the institute, predicted that the eruption would come within a week to 10 days.

Pinto 2006

- Están seguros de la protección de la Santísima Virgen de Agua Santa, y que están convencidos que nada malo les pasará, incluso por efectos del proceso eruptivo del volcán Tungurahua.

Prochnau and Parker 2000

- Scientists and volcanologists worry that Tungurahua's year 2000 show could match the worst volcanic disasters of the last century

- The sure ruin of leaving a job or a home is more threatening than all the power of the mountain.
- "You Americans have to understand that this is not a land of opportunity," he says. "We cannot expect people to lose everything. The degree of fatalism here is much higher. The people do not have a choice but to stay."

Calgary Herald 2006

- "But we cannot rule out more explosions." -Hugo Yepes, IGEPN

St. Louis Dispatch 2006

- "There is more potential for it to do very big things. We see that there is a fault in the volcano and it is very unstable," institute head Hugo Yepes said.

The Ottawa Citizen 2001

- "I think if we are all Christians, Mama Tungurahua will hear the prayers of this village and will grow calm. We have to ask Mama Tungurahua to let us live in tranquility, to grow calm," Mr. Noboa told villagers in a speech broadcast on state radio.

Calgary Herald 1999

- 'All indications are it could happen within a week or 10 days," Geophysical scientist Patricia Mothes said.

Nature 2014

- "When the smoke and ash emissions stop, that indicates the conduit has finally closed and then the energy will release violently in eruption," Mothes said.

Tragedia Volcán Tungurahua

- La incertumbre es el enemigo.
- No temerle al volcan, pues la mama tungurahua es su amigo--- yo estoy amistad con Mama Tungurahua.

Calavache 2000

- La unica solución es para evacuar la gente paraque hay mucho mayor chance de salvar la vida de la gente. -Hall (Scientist)
- Nosotros siempre teníamos miedo. Child from el Salado
- Los datos son muy claros. (Dr. Theo Toulkeridis)
- El volcán no va a esperar
- Estamos capacitando.

Misc Print Article found in Baños

- La gente no sabe si seguir al líder local o al regional, nacional, turístico o científico. -A scientist

Agency

Interview Oscar

- people getting prepared for themselves
- They have their own...they know where to go where they have to have a damn because something happens and there is a bigger eruption or something is around we know where we have to run, you know, because what else can you do?
- we live here, we decide to live here by a volcano so we need to have some, to learn how to deal with it.
- It starts with the same people. The people want to get prepared by themselves.
- okay, we're going to be doing those drills so you and everyone should know what to do.

Stone et al. 2014

- Self-evacuations demonstrate is a sense of agency and capacity possessed by the communities, where they are able to preempt official decisions and thus more quickly respond to changes in the level of risk.