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Perceptions of Risk for Volcanic Hazards at Vesuvio and Etna, Italy

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Abstract

There is a considerable body of work concerning citizens' perceptions of risk regarding volcanic hazards, with most studies conducted in the United States and New Zealand. No comparable study has been done in Italy, where millions of residents live in close proximity to Mt. Etna and Mt. Vesuvio. This study compared the survey responses of 516 participants at Etna and Vesuvio on topics such as salience of the volcanic hazard, various measures of risk perception, perceived control over eruption effects, perceived preparedness, confidence in government officials' efforts to protect them from the eruption hazard, self efficacy and sense of community. While residents at Etna appeared to have an objective and informed perspective concerning the volcanic hazard, those residents living in the highest risk areas at Vesuvio demonstrated high levels of fear and perceived risk concerning an eruption, but low levels of perceived ability to protect themselves from the effects of an eruption. These Vesuvio residents also demonstrated low levels of awareness concerning evacuation plans, and low levels of confidence in the success of such plans.

Keywords: Risk Perception, Volcanic Hazards, Vesuvio, Etna, Italy

Introduction

Over the past three decades a large body of research has focused on how at-risk populations adjust to natural hazards. Preparatory behaviors such as heeding evacuation warnings, storing emergency food, water and supplies, or learning the proper actions to take in an emergency situation will save lives and reduce injuries when a disaster strikes. There are a variety of factors that may be related to why an at-risk population may or may not take such self-protective measures, but certainly one of the most central is the public's perceptions regarding the level of risk posed by a particular hazard (Drabek, 1986; Perry & Lindell, 1990). Therefore, increasing our understanding of how individuals perceive the risks from natural hazards and of the factors related to accurate risk perception is an important area of study, as findings from such work can help to shape more effective community response through education programs and disaster planning.

Unfortunately, the link between perceived risk and subsequent preparedness has not always been found to be as direct or as predictable as we might expect (Mulilis & Duvall, 1995; Lindell & Whitney, 2000). One possible explanation for the inconsistent relationship between risk perceptions and taking self-protective measures is the fact that "risk perception" is an extremely broad concept that has been operationally defined in a variety of different ways, making comparison between studies difficult (Tierney, Lindell, & Perry, 2001). For example, in a review of 23 studies of perceived risk and preparedness for earthquake hazards, Lindell (2000) identified a number of different risk measures, such as participants' ratings of the likelihood of a quake or of its potential severity, open-ended items gauging the salience of the earthquake threat relative to other issues,

estimations of the probability of suffering personal injury or property damage in a potential earthquake, and ratings of fear or concern about the hazard.

Another possible explanation for the contradictory findings in the research on perceived risk and its link to preparedness is that the public's perceptions of risk for natural hazards are complex and not always accurate; unlike those of experts, laypersons' perceptions are often biased and may be influenced by a variety of social and psychological factors (Rohrman, 2000; Slovic, 1987). An example of such a bias is the common pattern that has been observed in past studies of risk perception where an at-risk population fails to personalize their risk or demonstrates a sense of perceived invulnerability or unrealistic optimism regarding the chances that they will suffer serious consequences from a disaster (Burger & Palmer, 1992; Mileti & Fitzpatrick, 1993; Weinstein & Klein, 1996).

Another widely studied influence on perceived risk is prior experience with the effects of a particular hazard. In their study of residents prior to and after the eruption of Mt. St. Helens, Perry & Lindell (1990) noted that after the eruption, perceptions of risk and feelings of personal vulnerability increased dramatically. Similar results have been reported in New Zealand (Becker, Smith, Johnston & Munro, 2001; Johnston, Bebbington, Lai, Houghton & Paton, 1999). However, other studies indicate that vicarious or benign exposure to hazard effects can create a "normalization bias" whereby an at-risk population grows accustomed to the hazard and downplays its potential threat (Johnston et al., 1999; Mileti & O'Brien, 1992).

Finally, drawing on the work from Health Psychology, Paton (2003) has suggested that other factors may also mediate the link among risk perception, intentions to take self-protective measures, and subsequent adoption of those measures. Two of these factors that are particularly relevant to the present study are self-efficacy and sense of community.

Self-Efficacy.

According to Bandura (1977, 1997) feelings of self-efficacy refer to specific beliefs about one's ability to accomplish certain tasks or confidence in one's ability to handle stressful events. He stated that self-efficacy beliefs are positively related to factors such as optimism, motivation and perseverance, and are negatively related to anxiety, depression, and vulnerability to stress. While self-efficacy is commonly seen as being domain-specific, Schwarzer (1994) proposed the concept of "generalized self-efficacy", defining it as global confidence in one's coping ability across a wide range of stressful situations.

Paton (2003) has argued that self-efficacy is an important variable that should be considered within the context of natural hazards research, since it has been linked to both perceived risk and adoption of hazard adjustments in a variety of past studies. For example, Kallmen (2000) showed that measures of both general and personal risk for a variety of societal hazards were negatively correlated with a general measure of self-efficacy. Likewise, stronger feelings of self-efficacy have been linked to an increased likelihood of adopting self-protective measures (Bishop, Paton, Symes & Nancarrow, 2000; Paton, Johnston & Houghton, 2001), as well as to decreased psychological vulnerability in the aftermath of a volcanic eruption (Miller, Paton & Johnston, 1999).

Sense of Community.

McMillan & Chavis (1986) described those with a strong sense of community as possessing feelings of belongingness and attachment to a place, or a sense of shared history and connection with other members of their community. This bond to one's community has been found to have a variety of positive psychological consequences. For example, Davidson & Cotter (1991) found that a stronger sense of community was associated with greater feelings of subjective well-being, including less worry and higher levels of perceived self-efficacy. According to Prezza & Costantini (1998), people are more likely to develop and follow through on solutions to their problems and to feel greater self-confidence when there is a stronger bond to their community. A strong sense of community has also been found to reduce perceptions of risk regarding the incidence of crime in urban neighborhoods (Kim, Mackin & Schweitzer, 1997).

In the context of hazards research, sense of community has typically been studied in relation to either the adoption of hazard adjustment measures or to psychological vulnerability in the aftermath of a disaster, and the results of this work have been inconsistent. Those with stronger community ties were found to be less likely to heed evacuation warnings for an approaching hurricane (Riad & Norris, 1998). In contrast, studies involving risks posed by environmental degradation (Bishop et al., 2000) and hazardous waste (Bachrach & Zautra, 1985) indicated that stronger community bonds were reflected in greater involvement in community response and feeling less vulnerable following a disaster event, yet Paton, Millar & Johnston (2001) found that sense of community was unrelated to vulnerability following a volcanic eruption. Additionally, trust or confidence in government officials' ability to protect citizens from potential hazards can result in a reduced sense of personal responsibility for one's own safety, thereby affecting both perceived risk and adoption of preparedness measures (Paton et al., 2003). For example, a study of New Zealand residents showed that after being provided with hazard information, residents actually became less concerned about volcanic hazards (Ballantyne, Paton, Johnston, Kozuch & Daly (2000).

Volcanic Hazards & Perception of Risk

According to Perry and Lindell (1990), of the many natural hazards which threaten human populations, volcanoes are distinguished by several unique characteristics. Volcanic eruptions may produce a number of diverse effects including earthquakes, pyroclastic flows and surges, lava flows, ash and pumice fall, flooding or mudflows, gas release, and tsunamis. Some of these effects may last for weeks to months, representing a chronic, long term problem for the affected communities. Long intervals between eruptions can contribute to public ignorance of or complacency about the potential threat.

Furthermore, volcanic areas are often places of great natural beauty, rich farmland, and bountiful recreational opportunities, encouraging both settlement and tourism. The positive aspects of living in volcanically active areas further complicates how citizens perceive risk, since the perceived benefits of residing in these areas may work to outweigh the risks posed by a potential eruption. Tourists pose another challenge to a community's hazard education efforts and emergency planning, since these short term visitors are unlikely to be familiar with the local hazards or to be aware of the proper actions to take in the event of an eruption.

The vast majority of work on public perceptions of risk concerning volcanic hazards has been conducted in the United States at Mt. St. Helens (Perry & Greene, 1983; Perry & Lindell, 1990; Saarinen & Sell (1985) and Mt. Shasta (Perry, 1990), or in New Zealand at the Ruapehu volcano

(Becker et al., 2001; Johnston et al., 1999; Miller et al., 1999). Other work has been done on the Caribbean Island of Martinique (D'Ercole, Rancon & Lesales, 1995) and in Japan (Yoshii, 1992). A search of the literature in psychology and related disciplines revealed that no studies similar to these have been done in Italy, where two active and potentially dangerous volcanoes lie in close proximity to populated areas. Therefore, the present research was designed as an exploratory study to expand the existing body of work on citizens' perceptions of risk for volcanic hazards, focusing on samples of residents living in close proximity to Italy's two major volcanoes: Vesuvio and Etna.

Background on Vesuvio and Etna

Vesuvio.

Vesuvio, located in close proximity to the city of Naples in the Campania region of southern Italy, is most famous for its explosive Plinian eruption in 79 A.D. which destroyed and buried the Roman cities of Pompeii and Herculaneum. Other catastrophic subplinian eruptions of Vesuvio occurred in 472 and 1631. Vesuvio's last eruption occurred in 1944, taking 24 lives and causing damage from lava flows and ash fall in communities closest to the crater, but since then the volcano has experienced its longest state of quiescence in almost 400 years (Scandone, Giacomelli & Gasparini, 1993). Approximately 3 million people now live in greater Naples, Europe's most densely populated metropolitan area. Almost 600,000 of these reside in the "Zona Rossa" or Red Zone, an area defined in the local emergency plan that is likely to experience the most devastating effects from Vesuvio, particularly pyroclastic flows and lahars, in the event of a future subplinian eruption. Other areas surrounding Vesuvio are designated as the "Zona Gialla" or Yellow Zone and "Zona Blu" or Blue Zone. Communities in the Yellow Zone are further from Vesuvio and may be exposed to fallout hazards from the eruptive column, depending upon the direction and speed of prevailing winds during the eruption. The Blue Zone is an area that is exposed to hazards from mudflows and floods resulting from syneruptive or posteruptive remobilization by heavy rainfall of loose pyroclastic material deposited by the wind-dispersed eruptive column.

In 1995, Italian civil protection authorities approved a volcanic emergency plan calling for a total evacuation of the residents of the 18 communities located within the Red Zone in the event of increased activity at Vesuvio. Residents of each town are to be sent to a designated host region in another part of Italy, and this evacuation is estimated to require two weeks to complete. In addition, the government is offering cash incentives toward the purchase of a new home to residents who permanently move out of Red Zone communities and relocate in less risky areas (Arie, 2003; McGuire, 2003). The emergency plan for the Red Zone is presently in the process of being reviewed and updated.

Etna.

Mt. Etna, located in the Catania region of eastern Sicily, is the largest volcano in Europe and it produced large eruptions in the 12th and 17th centuries. Smaller eruptions are more frequent and Etna has erupted 15 times in just the past 30 years; however, only 14 people lost their lives during the 20th century as a result of eruptions of this volcano (Behncke, 2004). This is due to the fact that Etna's eruptions tend to be effusive, rather than explosive. Lava flows pose the greatest risk for property damage or loss, but most of the surrounding communities are located far enough from the summit to allow for diversion of the lava flows by means of artificial barriers or to alert the at-risk population of impending danger (Barberi & Carapezza, 2004). Nevertheless, several smaller communities on the slopes of the mountain, some of which have been destroyed and rebuilt in the past, remain at considerable risk from the effects of an eruption. During the summer of 2001 and again from October, 2002 – January, 2003 eruptive activity at Etna produced a damaging

earthquake and lava flows which destroyed ski resorts and tourist shops near the volcano's summit forcing the evacuation of residents from some nearby towns. Ash falls also created disruption of air traffic in the area (Behncke, 2004; Di Marco, 2002).

Goals of the Present Study

The level of risk and the extent of residents' prior exposure to volcanic hazards differs considerably between Italy's two largest volcanoes. At Vesuvio, the catastrophic potential of a major eruption will require that the entire at-risk population be evacuated, yet only a small percentage of the total population in this area is old enough to have had any direct experience with a previous eruption. In contrast, while the risk of such a catastrophic eruption at Etna is much less than at Vesuvio, residents in this area have regularly and recently been exposed to the effects of eruptions.

The purpose of the present study was to compare various aspects of risk perception between residents at Etna and Vesuvio, and to determine how factors such as self-efficacy and sense of community might be associated with risk perceptions. Additionally, local officials in both the Campania and Catania regions provided a great deal of support and assistance to us as we conducted the study, and it was their hope that information gathered from this research could be used to help them design more effective methods for educating and motivating the public to take the volcanic hazards in these areas more seriously.

There were three general hypotheses in the present study. First, given the more recent volcanic activity at Etna, it was expected that the volcanic hazard would be more salient to these residents and that they would perceive the risk of an eruption to be greater than residents close to Vesuvio. Second, it was hypothesized that those residents who displayed higher levels of self-efficacy would view their risk from potential eruptions as lower. Finally, it was predicted that those residents who felt a stronger bond to their community would view their risk as less serious and would express less concern regarding the possibility that their community's would suffer serious consequences from a potential eruption.

Method

The research study was conducted during May, 2003 and a total of 2,000 surveys were distributed: 1500 in the vicinity of Vesuvio, and 500 in the towns closest to Etna. A total of 516 usable and complete surveys were returned, representing an overall response rate of 26%. Two different sampling procedures were used to distribute and collect these surveys, and for this reason, description of the recruitment procedures will be discussed separately for each sample.

Participants and Procedure, Sample 1

A total of 400 surveys were distributed personally by the researchers: 300 to residents of 21 communities in metropolitan Naples within close proximity to Vesuvio (all of the 18 Red Zone communities and 3 Yellow Zone cities: Nocera Inferiore, Nola, and Poggiomarino) and another 100 to residents of 4 towns in eastern Sicily near the base of Etna: Linguaglossa, Nicolosi, Santa Venerina, and Zafferana. The number of surveys distributed in each city or town was proportional

to that community's population. The researchers recruited participants from diverse venues in the center of each town: shops, cafes, markets, social clubs and political organizations. In some cases, surveys were given directly to those who agreed to participate in the study, but in several places a few surveys were left with someone in charge so that clients of the business or members of the club or organization could complete a survey later that day.

All interested volunteers received a packet containing a letter of introduction from the researchers, the survey measure, and a plain envelope in which the survey could be sealed and returned anonymously once completed. Participants were told both in person and in the letter of introduction that the study concerned their perceptions of the town in which they live, their awareness of environmental problems facing their town, and their feelings regarding how much they could do to help solve those problems. No mention was made of the fact that the true focus of the research was on perceptions of risk from volcanic hazards.

Within 48 hours of distributing the survey packets, the researchers returned to each venue where surveys had been left and collected all completed surveys. A total of 174 (43.5%) completed surveys were returned: 145 were from Vesuvio residents and 29 from Etna residents, representing response rates of 48.3% and 29%, respectively.

Participants and Procedure, Sample 2

An additional 1600 surveys were distributed with the aid of local government officials in Naples and Catania: 1200 in the towns near Vesuvio and 400 in the towns at Etna. Volunteers from local civil protection agencies visited middle and high schools in each town and distributed surveys to children in randomly selected classrooms. To avoid having predominantly male heads of household complete the surveys and so as to obtain roughly similar numbers of male and female respondents, girls were instructed to have their mother fill out the survey and boys were asked to have their father complete it. Surveys were then to be returned to the classroom anonymously in sealed envelopes, where volunteers collected them several days later.

The researchers carefully explained the recruitment protocol to the volunteers, who were also advised not to inform the teachers or the students about the actual focus of the study. A total of 362 completed and usable surveys were returned, for an overall response rate of 23%. Of these, 222 were from Vesuvio residents and 120 from Etna residents, representing response rates of 18.5% and 30%, respectively. It should be noted that 102 additional surveys were returned from Vesuvio area schools but were unusable. Many of these had been filled out by minor children under the age of 18. In one unusual case, 32 surveys from one town had evidently been fraudulently completed by the same person. Because of these problems, we were dubious as to how well the recruitment protocols had been carried out by the volunteers, and this led to our decision to at least initially keep data from the two samples separate.

Survey Materials

A 50 item risk perception questionnaire was developed from a previous study of earthquake risk perceptions by one of the authors (Davis, 1989), and the choice of variables to include in the survey was also guided by the recent theoretical work of Paton (2003) and past empirical research on

perception of natural hazards (e.g. Becker et al., 2001; Lindell & Whitney, 2000; Paton et al., 2001; Perry, 1990). Among the items included were:

- * *salience of the hazard* – the tendency to mention volcanic hazards as a problem relative to other concerns, and the amount of time spent thinking about the threat;
- * *risk perception* - ratings of both the likelihood and severity of future eruptions;
- * *personal vulnerability to the hazard* – ratings of the likelihood that a future eruption will affect one's self and your family, as well as the severity of those effects;
- * *anxiety about or fear of the hazard*;
- * *domain specific feelings of self efficacy* – feelings of control regarding ability to protect one's self and/or their family in the event of an eruption;
- * *trust in officials* – confidence in government's level of preparedness and in the ability of government officials to provide accurate information about potential eruptions.

Additional demographic questions included sex, age, highest level of education achieved, and marital status. All of these measures were reverse translated from English to Italian and back into English to insure accuracy of the translation.

In addition to the above-mentioned measures, two standardized psychological scales were included in the survey. First, the 10 item General Self-Efficacy Scale (GSES) - Italian Version (Sibilia, Schwarzer & Jerusalem, 1995) was included. This scale is a translated version of the original German language General Self-Efficacy Scale by Jerusalem & Schwarzer (1992). This scale measures self-efficacy as a general personality disposition and has been translated into 29 languages; for a discussion of its psychometric properties and equivalence across languages see Scholz, Gutierrez-Dona, Sud & Schwarzer (2002). Second, the 18 item Italian Scale of Sense of Community (ISSC) developed by Prezza, Constanti, Chiarolanza and Di Marco (1999) was used. It is a translated and slightly modified version of the English language Sense of Community Scale by Davidson & Cotter (1986) which measures sense of community using one's city or town as the frame of reference.

Results

The 174 participants in Sample 1 ranged in age from 18 to 83 years ($M = 37.08$, $S = 14.09$) and regarding education level, 23% had not completed high school, 61% were high school graduates and 10% had a university degree; 6% failed to report their education level. Males comprised 49% and females 51%, and with regard to marital status, 47% were single, 47% were married, and 3% were divorced or widowed. For the 362 residents in Sample 2, ages ranged from 18 to 57 years ($M = 37.98$, $S = 9.25$) and regarding education level, 35% had not completed high school, 49% were high school graduates and 11% had a university degree; 5% failed to report their education level. Males accounted for 34% and females 66%, and for marital status, 15% were single, 79% were married, and 5% were divorced or widowed.

Except for these demographic differences between the two samples, statistical results showed that on the survey measures themselves, response patterns of the two groups were virtually identical on the vast majority of variables. Therefore, for greater clarity of presentation, the results are discussed for the entire sample ($N = 516$). Although our sampling procedures were not able to generate a random sample of area residents, a comparison of the sample's demographic data with Italian census data for these regions showed that our sample closely reflected the population in terms of gender and age, while in terms of education level, the sample contained higher numbers of people who had graduated from high school and lower numbers of those who had either not completed high school or had earned a graduate degree than would be expected in the general population.

The 516 returned and usable surveys were divided into one of three groups on the basis of the location of the city in which the respondents resided. Residents from the 4 towns in eastern Sicily comprised the “Etna” group (N = 150). Residents of the 18 communities located within the Vesuvio “Red Zone” (which are to be evacuated in the event of a potential eruption) formed the “Vesuvio Red” group (N = 286). Finally, residents of three cities close to Vesuvio but not within the Red Zone, were categorized as the “Vesuvio Yellow” group (N = 80).

Salience of the Hazard

In order to measure the salience of the volcanic threat among the participants, one of the initial items on the survey was the open-ended question: “list three major problems facing the city you live in.” The three most commonly-mentioned problems, and the percentage of respondents who mentioned each one, are presented in Table 1. Additionally, the percentages of those who mentioned the volcano as a problem facing their city are included to demonstrate the salience of the volcanoes versus other community issues.

Table 1. The Most Frequently Mentioned Community Problems

Etna	Vesuvio Red	Vesuvio Yellow
Lack of Social Life (35%)	Public Services (45%)	Public Services (41%)
Public Services (34%)	Crime/Delinquency (35%)	Traffic & Parking (29%)
Etna (16%)	Traffic & Parking (26%)	Pollution (28%)
	Vesuvio (7%)	Vesuvio (0%)

The three most frequently mentioned problems reported by residents in each area are listed and the percentage of those who mentioned each one. Percentages for those who mentioned the volcano as a problem are included for comparison.

As the data indicate, in relation to social problems such as crime, dissatisfaction with public services, lack of social outlets, traffic, and pollution, mention of the volcano hazard as a problem was relatively low. However, among Etna residents, the volcano was the third most commonly mentioned problem; in the Vesuvio Red Zone the volcano was the 9th most commonly mentioned issue (of a total of 12 problems) while at the Vesuvio Yellow Zone, the volcano was not mentioned by even one resident.

Another survey item, presented much later in the questionnaire measured hazard salience by having respondents rate the amount of time they spend thinking about the possibility of an eruption. A rating of 1 indicated “almost never” and a 5 “almost always”. Results of a one way ANOVA and subsequent post-hoc analysis using Tukey’s HSD test revealed that while there was no significant difference between the Etna and Vesuvio Red groups, these groups reported spending significantly more time thinking about an eruption than those in the Vesuvio Yellow group. See Table 2 for a summary of these data.

Risk Perception & Feelings of Personal Vulnerability

A series of Likert scale items assessed respondents’ risk perceptions. These included rating the likelihood of a volcanic eruption within the next 5 years, of their town being affected by such an

eruption, and of being injured or of suffering some property damage in an eruption. Two other questions asked them to rate the severity of consequences that such an eruption would cause for their town, as well as for themselves and their families. Mean ratings on these items among the three groups were compared using a series of one-way ANOVAs and these data are presented in Table 2.

Table 2 . Hazard Salience, Awareness, Likelihood & Severity Estimates.

Frequency of Thinking About the Possibility of an Eruption?	MEAN	SD	
Etna	2.59	1.09	F (2,5 09) = 18.58 , p < .001 (4)
Vesuvio Red Zone	2.58	1.22	
Vesuvio Yellow Zone	1.72	.80	
Likelihood of an Eruption in the Next 5 Years?	MEAN	SD	
Etna	3.87	.94	F (2,511) = 78.70, p < .001 (1)
Vesuvio Red Zone	2.65	1.06	
Vesuvio Yellow Zone	2.54	1.01	
Likelihood of Effects on Your Town?	MEAN	SD	
Etna	2.80	1.05	F (2,510) = 74.96, p < .001 (2)
Vesuvio Red Zone	4.03	1.12	
Vesuvio Yellow Zone	2.89	1.14	
Likelihood of Injury to Self of Family?	MEAN	SD	
Etna	1.79	.90	F (2,509) = 92.77, p < .001 (3)
Vesuvio Red Zone	3.38	1.35	
Vesuvio Yellow Zone	2.21	1.21	
Likelihood of Property Damage?	MEAN	SD	
Etna	2.64	1.06	F (2,505) = 72.53, p < .001 (2)
Vesuvio Red Zone	3.80	1.14	
Vesuvio Yellow Zone	2.56	1.04	
Severity of Consequences of an Eruption for Residents of Your Town?	MEAN	SD	
Etna	2.85	1.14	F (2,507) = 116.20, p < .001 (2)
Vesuvio Red Zone	4.17	.99	
Vesuvio Yellow Zone	2.65	.98	
Severity of Consequences of an Eruption for You and Your Family?	MEAN	SD	
Etna	2.63	1.07	F (2,505) = 143.71, p < .001 (2)
Vesuvio Red Zone	4.13	.97	
Vesuvio Yellow Zone	2.57	.98	

Note: Ratings were made on a 5 point scale, with higher numbers indicating higher levels of frequency, likelihood or severity.

Pattern of significant differences as determined by post-hoc analysis using Tukey's HSD test:

- (1) Etna residents differ significantly from Vesuvio Red and Yellow Zone residents.
- (2) Vesuvio Red Zone residents differed significantly from Vesuvio Yellow Zone and Etna residents.
- (3) All three groups were significantly different from one another.
- (4) Vesuvio Red and Etna residents differ significantly from Vesuvio Yellow residents.

Significant differences were found on all of these measures. Subsequent post-hoc analysis using Tukey's HSD Test revealed the specific patterns of the differences between the groups. Regarding the likelihood of an eruption, Etna residents expressed the highest expectation of a future eruption,

with no differences between the Vesuvio groups. However, on four other items, a consistent pattern was observed such that residents of the Vesuvio Red Zone expressed significantly higher likelihood ratings concerning the possibility of their town being affected or of suffering property damage in a future eruption and rated the potential consequences for their town and for themselves and their families as significantly more serious; there were no significant differences between the Etna and Vesuvio Yellow groups. Finally, when rating the likelihood of being injured in a potential eruption, all three groups differed significantly, with Vesuvio Red Zone residents again the highest, while Etna residents gave the lowest ratings concerning their chances of being injured.

Participants were also asked to rate the extent to which various eruption effects (earthquakes, lava flows, ashfall, mudflows and pyroclastic flows) might cause problems for their community, and the results of these analyses are presented in Table 3. Significant differences were found for all five of these items. In general, results indicated that Vesuvio Red Zone residents considered the risk posed by each of these threats as significantly higher than did the other two groups, except for earthquakes; in this case, Etna and Vesuvio Red Zone residents rated quakes as a more serious threat than Vesuvio Yellow Zone residents.

Table 3 . Ratings of Severity of Eruption Effects and Fear of Eruption.

Extent that Earthquakes pose a Problem?	MEAN	SD	
Etna	3.56	.95	F (2,496) = 12.94, p < .001 (4)
Vesuvio Red Zone	3.49	1.10	
Vesuvio Yellow Zone	2.85	1.01	
Extent that Lava Flows pose a Problem?	MEAN	SD	
Etna	2.81	1.17	F (2,488) = 49.66, p < .001 (3)
Vesuvio Red Zone	3.41	1.25	
Vesuvio Yellow Zone	1.85	1.21	
Extent that Ash Fall poses a Problem?	MEAN	SD	
Etna	3.45	1.19	F (2,492) = 19.50, p < .001 (2)
Vesuvio Red Zone	3.99	1.08	
Vesuvio Yellow Zone	3.24	1.04	
Extent that Mud or Debris Flows pose a Problem?	MEAN	SD	
Etna	1.59	.96	F (2,466) = 110.16, p < .001 (3)
Vesuvio Red Zone	3.38	1.27	
Vesuvio Yellow Zone	2.18	1.20	
Extent that Pyroclastic Flows pose a Problem?	MEAN	SD	
Etna	2.04	1.24	F (2,472) = 125.24, p < .001 (2)
Vesuvio Red Zone	3.88	1.28	
Vesuvio Yellow Zone	1.99	1.26	
How afraid are you of the possibility of an eruption?	MEAN	SD	
Etna	2.89	1.16	F (2,513) = 35.08, p < .001 (2)
Vesuvio Red Zone	3.86	1.33	
Vesuvio Yellow Zone	3.11	1.15	

Note: Ratings were made on a 5 point scale, with higher numbers indicating that the effect represents a more serious problem for the community if there is an eruption.

Pattern of significant differences as determined by post-hoc analysis using Tukey's HSD test:

- (2) Vesuvio Red Zone residents differed significantly from Vesuvio Yellow Zone and Etna residents.
- (3) All three groups were significantly different from one another.
- (4) Vesuvio Red and Etna residents differ significantly from Vesuvio Yellow residents.

Finally, participants were also asked to rate their level of fear regarding the possibility of an eruption. These data are also presented in Table 3. Again, Vesuvio Red Zone residents reported significantly higher levels of fear, while Etna and Vesuvio Yellow Zone residents did not differ significantly from one another.

Perceived Preparedness and Confidence in Officials

Several survey items required respondents to rate their perceptions of how prepared they are to deal with an eruption as well as their confidence in government officials' levels of preparedness and ability to provide accurate information about an impending eruption. These data are presented in Table 4.

Table 4 . Perceived Preparedness and Confidence in Government by Group.

Preparedness of self and family?	MEAN	SD	F (2,508) = 56.16, p < .001 (1)
Etna	2.91	1.02	
Vesuvio Red Zone	1.90	.93	
Vesuvio Yellow Zone	2.04	.94	
Preparedness of government officials?	MEAN	SD	F (2,505) = 55.10, p < .001 (1)
Etna	2.98	1.05	
Vesuvio Red Zone	1.94	.95	
Vesuvio Yellow Zone	2.14	.98	
How confident are you in government officials' ability to provide accurate information?	MEAN	SD	F (2,507) = 2.74, p > .05
Etna	2.40	1.03	
Vesuvio Red Zone	2.34	.99	
Vesuvio Yellow Zone	2.64	1.06	

Note: Ratings were made on a 5 point scale, with higher numbers indicating higher levels of perceived preparedness and confidence.

Pattern of significant differences as determined by post-hoc analysis using Tukey's HSD test:

(1) Etna residents differed significantly from Vesuvio Red & Yellow Zone residents.

As the data indicate, significant differences were found on two of the three items. On the items asking participants to rate their own level of preparedness for eruptions, as well as that of their government officials, the same pattern emerged: Etna residents rated their own and their government officials' level of preparedness significantly higher than the two Vesuvio groups. However, with regard to their confidence in government officials' ability to provide accurate information about an eruption, there were no significant differences among the three groups.

Self Efficacy

One survey item asked participants to rate the amount of control they feel they have over their ability to protect themselves from the effects of a potential eruption. This measure represents a more traditional, domain-specific measure of self-efficacy as defined by Bandura (1977). Ratings were

made on a 5 point Likert Scale, with higher numbers indicating a higher degree of self-efficacy concerning protecting one's self from potential eruption effects. These ratings were compared among the three groups, and results of the ANOVA and post-hoc analyses revealed that there were significant differences among all three groups such that Etna residents expressed the highest level of self-efficacy, while Vesuvio Red Zone residents reported feeling the least amount of control. Scores on the 10 item General Self-Efficacy Scale were then calculated, and means for the groups were compared using a one way ANOVA. Unlike the results for the specific measure of self-efficacy, no significant differences were found among the groups on this scale. These data are presented in Table 5.

Table 5 . Self-Efficacy Compared by Group.

How much control do you feel you have to protect yourself/family from an eruption?	MEAN	SD	
Etna	3.79	1.13	F (2,512) = 44.14, p < .001 (3)
Vesuvio Red Zone	2.63	1.33	
Vesuvio Yellow Zone	3.31	1.16	
Pattern of significant differences as determined by post-hoc analysis using Tukey's HSD test: (3) All three groups were significantly different from one another			
General Self-Efficacy Scale Scores	MEAN	SD	
Etna	27.68	4.68	F (2,511) = 2.24, p > .05
Vesuvio Red Zone	27.16	4.64	
Vesuvio Yellow Zone	28.35	4.59	
General Self-Efficacy Scales scores may range from a low of 10 to a high of 40 points, with higher numbers indicating higher levels of self-efficacy. No significant differences among the three groups were obtained.			

Sense of Community

To assess respondents' level of attachment to their community, scores of the Italian Scale of Sense of Community were calculated for each participant, and means for the three groups were then compared using a one way ANOVA and Tukey's HSD test. These data are presented in Table 6. A significant difference was found, such that Etna residents demonstrated a significantly higher level of attachment to their communities than the two Vesuvio groups, $f(2, 513) = 25.55, p < .001$, while the Vesuvio groups did not differ significantly from one another.

Table 6 . Sense of Community Scale Scores by Group

Sense of Community Scale Scores	MEAN	SD	
Etna	51.15	7.19	F (2,513) = 25.55, p < .001
Vesuvio Red Zone	45.67	8.05	
Vesuvio Yellow Zone	48.15	6.90	
Sense of Community Scale scores may range from a low of 18 to a high of 72 points, with higher numbers indicating a stronger bond to the community. (1) Etna residents differed significantly from the Vesuvio Red and Vesuvio Yellow residents.			

Self Efficacy, Sense of Community & Their Relation to Perceived Risk

In order to determine whether the measures of self-efficacy and sense of community used in the study were related to the residents' perceptions of risk, a series of correlations were calculated among these measures and this was done for the entire sample, as well as separately for each of the three groups. Table 7 shows correlations between the Self-Efficacy measures and various aspects of risk perception; Table 8 shows correlations between Sense of Community and the same series of measures.

Table 7. Correlations Between Self Efficacy and Other Measures

	GSES Scores	Likelihood of Eruption	Likelihood of Effects (town)	Likelihood of Personal Injury	Likelihood of Property Damage	Severity of Consequences for Town	Severity of Consequences Self/Family
Self Efficacy							
Etna							
Vesuvio Red	+ .27**	-.11	-.18*	-.16*	-.10	-.16	-.17*
Vesuvio	+ .18**	-.10	-.16**	-.20**	-.12	-.18**	-.17**
Yellow	+ .05	-.04	+ .06	-.16	-.16	-.02	-.11
Total Sample	+ .19**	+ .08	-.28**	-.34**	-.26**	-.32**	-.34**
GSES Scores							
Etna							
Vesuvio Red		+ .03	-.03	-.14	-.05	-.01	-.09
Vesuvio		-.04	+ .01	-.07	-.03	+ .13	+ .08
Yellow		-.02	+ .04	-.05	+ .12	+ .03	-.04
Total Sample		-.02	-.04	-.10*	-.05	+ .01	-.04

	Fear of Eruptions	Frequency of Thinking about Eruptions	Perceived Preparedness (Self)	Perceived Preparedness (Government)	Confidence in Government	Sense of Community Scale Scores
Self Efficacy						
Etna	-.29**	-.04	+ .33**	+ .08	-.01	+ .20*
Vesuvio Red	-.19**	-.07	+ .41**	+ .28**	+ .30**	+ .10
Vesuvio Yellow	+ .01	-.02	+ .32**	+ .23*	-.03	-.06
Total Sample	-.30**	-.07	+ .47**	+ .33**	+ .17**	+ .21**
GSES Scores						
Etna	-.28**	+ .05	+ .40**	+ .16	+ .11	+ .05
Vesuvio Red	-.06	-.13	+ .19**	+ .01	+ .11	+ .06
Vesuvio Yellow	-.01	-.22	-.01	+ .12	+ .16	+ .06
Total Sample	-.13**	-.10*	+ .22**	+ .08	+ .12**	+ .06

* indicates significance of $p < .05$; ** indicates $p < .01$

As shown in Table 7, the single item, domain-specific measure of self-efficacy was significantly associated with several of the likelihood and severity ratings, but for the most part this was only true within the Etna and Vesuvio Red groups. The general pattern of these correlations showed that residents with a higher degree of confidence in their ability to protect themselves from a potential eruption rated the likelihood that an eruption would affect their town, the severity of consequences from such an eruption both for the community and personally, and the level of fear of eruptions as lower. The self-efficacy measure was also positively correlated with perceptions of self-

preparedness among all three groups, and with perceived self-preparedness and perceived preparedness of government officials only within the two Vesuvio groups. Finally, this measure was significantly, positively related to Sense of Community among Etna residents, such that those residents with stronger community bonds tended to rate their ability to protect themselves from eruption as higher. This pattern was not observed among Vesuvio residents.

In contrast, scores of the General Self-Efficacy Scale (GSES) were unrelated to estimates of the likelihood or severity of potential eruptions across all three of the groups. The only significant findings here were that Etna residents with higher GSES scores expressed lower levels of fear regarding an eruption, and that at both Etna and in the Vesuvio Red Zone, GSES scores were positively related to perceived self-preparedness.

With regard to the Sense of Community Scale, as the data in Table 8 illustrate, correlations between community attachment and ratings of likelihood and severity were observed almost exclusively among residents of the Vesuvio Red Zone, despite the fact that residents of this area had the lowest levels of sense of community among the three groups. For these Red Zone residents, stronger bonds with the community were negatively associated with the perceptions of the likelihood of an eruption, the possibility that an eruption would affect one's town, one's chances of being injured, and on ratings of how serious the consequences of an eruption might be for both the community and themselves. However, sense of community was significantly, positively related to ratings of self-preparedness and government preparedness within all three groups, and was positively related to confidence in government officials' ability to provide accurate eruption information in the Etna and Vesuvio Red groups only.

Table 8. Correlations Between Sense of of Community and Other Measures

	Likelihood of Eruption	Likelihood of Effects (town)	Likelihood of Personal Injury	Likelihood of Property Damage	Severity of Consequences for Town	Severity of Consequences Self/Family
Sense of Community						
Etna	-.14	-.07	-.11	-.14	-.02	-.10
Vesuvio Red	-.21**	-.17**	-.12*	-.06	-.21**	-.12*
Vesuvio Yellow	.04	-.24**	-.16	-.20	-.03	-.17
Total Sample	.00	-.26**	-.25**	-.21**	-.25**	-.26**

	Fear of Eruptions	Frequency of Thinking about Eruptions	Perceived Preparedness (Self)	Perceived Preparedness (Government)	Confidence in Government
Sense of Community					
Etna	-.10	-.11	+.23**	+.30**	+.21*
Vesuvio Red	-.02	-.05	+.13*	+.20**	+.14**
Vesuvio Yellow	+.06	-.12	+.30**	+.29*	-.11
Total Sample	-.13**	-.07	+.28**	+.32**	+.16**

* indicates significance of $p < .05$; ** indicates $p < .01$

Awareness of and Confidence in Evacuation Plan: Vesuvio Red Zone

Because of the extremely high level of risk that exists for residents who live within Vesuvio's Red Zone, and because of the existing plan to evacuate all of these individuals in the event of a future eruption, a survey item asked residents whether they were aware of the evacuation plan for their city or town, and for those who said that they were aware, a follow-up question asked them to rate their confidence that the plan would be successful. Of the 286 Red Zone participants, only 25% said they were aware of the evacuation plan for their town. Of these, 61% expressed either "a little confidence" or "no confidence at all" in the plan. In contrast, only 15% stated that they had either "a lot of confidence" or "complete confidence" in the plan's success.

Further analyses were conducted to determine whether those who were aware of the plan differed from those who were unaware in terms of variables such as age, years of residency, Sense of community, education level, or gender. Of these, only age differed significantly between the two groups. Those who were aware of the plan were significantly older ($M = 40.31$, $SD = 12.08$) than those who were unaware of the plan ($M = 36.51$, $SD = 11.02$); $t(269) = 2.36$, $p < .05$.

Discussion

The results suggest that residents of the three areas that were compared in this study did, as hypothesized, differ with regard to how they perceive the risks posed by the volcanic hazards in their midst. From the pattern of results, it is possible to construct a profile for each of the three study areas.

At Etna, where the population has had numerous and recent experiences with the effects of eruptions, the salience of the threat is relatively high. When asked to list the most serious problems facing their communities, the volcano was the third most commonly mentioned issue. Approximately 47% of Etna residents think about the possibility of an eruption "often", "very often" or "almost always", indicating that for many, the hazards facing them are quite apparent. Furthermore, while these residents rated the likelihood of an eruption within the next five years as significantly higher than did those at Vesuvio, which is in all probability an accurate perception, they also tended to be less concerned about the possible severity of consequences of such an eruption. They feel that they have control over their exposure to the eruption's effects, they rate their own preparedness and that of their government officials as fairly high, and they have relatively strong bonds to their community. It would seem that residents of the towns surrounding Etna are displaying realistic and objective patterns of risk perception that most government officials in at-risk areas could only hope for. It is likely that this positive state of affairs is attributable to the government's success in protecting citizens during Etna's 2001 and 2002-2003 eruptions.

In the Yellow Zone cities near Vesuvio, a very different picture emerges. Although these towns could experience some of the effects of an eruption of Vesuvio if conditions are conducive to it, they are farther from the volcano and from its most destructive eruptive effects. This is reflected in their survey responses: not one resident sampled in these cities spontaneously mentioned the volcano as a problem, and 43% of them report that they think about potential eruptions "almost never", with another 47% saying they do so "sometimes". Although they rate the probability of an eruption within the next five years similarly to their neighbors in the Red Zone, they rate the likelihood of their town being seriously affected or of suffering personal injury or property damage much lower than those residents in the more dangerous Red Zone communities.

It is within the Red Zone communities surrounding Vesuvio that the most disturbing pattern of results was observed. Despite the fact that none of these towns is more than 7 or 8 km from Vesuvio, and that two of them, Pompei and Ercolano are built atop the buried ruins of their ancient Roman counterparts, only 7% of residents mentioned Vesuvio as a problem facing their community. However, this result seems less indicative of denial or lack of awareness of the hazard than it is of the realities facing the communities of metropolitan Naples. For residents of these cities dissatisfaction with public services, traffic, crowding, crime, and unemployment are undeniable problems that are confronted on a daily basis. Illustrative of this is the fact that while we were collecting data in the Red Zone towns, the area had been without trash collection for more than a week due to problems at the local dump. Piles of trash cluttered city streets, and in some areas citizens were setting these enormous piles of rubbish ablaze to try and dispose of them. Our data collection at area schools was delayed for several days because of school closures caused by the trash emergency. We do not believe that this particular event was the cause of the low levels of salience concerning the volcano hazard; we mention it to illustrate what many residents told us informally was a typical aspect of life in their communities.

While Red Zone residents did not have the volcano hazard in mind when they thought about problems facing their communities, they did readily acknowledge the volcanic threat when asked specifically about it. In fact, they report thinking about the possibility of an eruption as often as the residents at Etna, with approximately 20% stating that it is on their mind “very often” or “almost always”. In their ratings of the likelihood and severity of consequences of a future eruption on their town, of suffering property damage or injury, and of their fear of the possibility of an eruption, Red Zone residents were significantly higher than those in the other groups.

However, along with their higher levels of perceived risk, Red Zone residents rated their ability to protect themselves in the event of an eruption far lower than residents in the other groups; 50% of Red Zone residents said they had either “no control” or “a little control” over protecting themselves from an eruption. Likewise, 83% rated their level of preparedness for an eruption as “none” or “a little”. As Paton (2003) points out, high levels of fear concerning a threat, coupled with low levels of perceived control over one’s exposure to hazard effects has been associated with lower levels of hazard adjustment. This suggests that when Vesuvio does become active, residents of the Red Zone communities may not be well prepared to deal with such a crisis. Supporting this assumption is the fact that among residents of the Vesuvio Red Zone, 75% said they were not aware of any evacuation plan for their community and of those who were aware of the plan, only 15% expressed “a lot” or “complete” confidence in its success. It is distressing that so few of the Red Zone residents are aware of the evacuation plan for their community, since it has received a great deal of publicity over the past 8 or 9 years; however, it is not surprising that those who are aware of the plan express little faith in its ability to protect them. The plan has been severely criticized by some scientists and local politicians who do not believe the idea is feasible (Arie, 2003; McGuire, 2003). Red Zone residents also expressed very low levels of confidence in the preparedness of their government officials to deal with an eruption (77% expressed “little” or “no confidence”, while no one in the Red Zone stated that they had “complete confidence”). Likewise, only 16% of residents expressed strong confidence regarding the ability of government officials to provide adequate information about potential eruptions.

Given the pattern of results among Red Zone residents, it seems that officials at Vesuvio are challenged with the task developing more effective strategies to inform the public about measures that are being taken to ensure their safety. They must also find a way to balance convincing the public that the government can protect the region’s citizens, while simultaneously trying to devise methods of increasing people’s sense of personal control and responsibility regarding their own safety if evacuation plans are to be successful here.

The predicted relationship between Self-Efficacy and various measures of risk perception was only partially confirmed. While the specific survey item asking residents to rate their ability to protect themselves from volcanic risk was, as expected, negatively related to perceived likelihood, perceived severity of effects, and fear levels, these relationships were only observed among the Etna and Vesuvio Red Zone participants. Furthermore, we found few meaningful links between the General Self-Efficacy Scale and the various risk perception measures. It would appear that self-efficacy relates to risk perceptions only when a more domain-specific measure of the construct is used.

With regard to the issue of sense of community, we did obtain the predicted, significant relationships between this measure and assessments of risk: a stronger sense of community was associated with lower levels of perceived risk regarding the likelihood of experiencing eruption effects or the severity of consequences of such as eruption. However, these findings applied only to residents of the Vesuvio Red Zone. This is interesting given the fact that it was these residents who expressed the lowest levels of community attachment of the three groups. Nevertheless, this finding supports other work that has found a negative link between sense of community and feelings of fear or vulnerability to risk (Davidson & Cotter, 1991; Kim et al., 1997; Prezza & Constantini; 1998). It is interesting to note, however, that those Red Zone residents with a stronger sense of community, were no more likely to be aware of the evacuation plan for their community than those who were not as attached to their community. This raises the question as to whether having stronger community bonds actually contributes to behavioral adjustment to the hazard.

One limitation of this study that must be addressed is that unlike many of the past studies conducted in the U.S. and New Zealand on response to volcanic hazards, we did not include any measures of residents' actual levels of preparedness for a volcanic eruption. The reason for this omission stemmed from the fact that Italian civil protection authorities do not encourage citizen preparedness in terms of individual actions such as storing supplies, food, etc. Rather, they are focused on predicting potential eruptions and simply evacuating those at greatest risk. Therefore, a number of behavioral adjustment questions that were originally to be included in the survey were removed after discussions with the Italian authorities. Perhaps it is this official strategy for dealing with the volcanic hazard that contributes to residents' high levels of fear and feelings of having little control over protecting themselves from an eruption, especially within the Vesuvio Red Zone.

In conclusion, we believe that in order to more closely compare the results of this work with those of past studies conducted in other countries, a major focus of future studies at Vesuvio and Etna should be to include more items related to residents' levels of knowledge about the specific details of the evacuation plans that are in place for their community and to explore their behavioral intentions to follow through on such plans. Such a focus might also be useful to civil protection officials in these areas as they attempt to develop mitigation strategies that will prove successful given the unique characteristics of residents living in these high risk areas.

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