

The role of individual well-being in risk perception and evacuation for chronic vs. acute natural hazards in Mexico.

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Abstract:

This paper examines how situational and cognitive measures of well-being associated with chronic and acute hazardous conditions affect perception of risk. The research was conducted in two disaster sites in the state of Puebla, Mexico; risk perception from chronic exposure to volcanic eruptions of Popocatepetl was investigated in San Pedro Benito Juárez, and risk perception from acute exposure to a flood/mudslide event was explored in Teziutlán. The research employed structured questionnaire surveys in both communities to collect information that included demographic information (e.g., age, sex, affinity to place, etc.), evacuation history, hazard belief systems, social networks, and physical and mental health related to hazard exposure. While well-being scores were worse for Teziutlán residents than for people in San Pedro Benito Juárez, with few exceptions it was in the chronic hazard site of San Pedro Benito Juárez and not in Teziutlán that individual well-being predicted risk perception. The results of this research can be used to tailor risk communication and educational policies differently for acute disaster vs. chronic hazard settings, as well as identify subpopulations for specific kinds of support or education.

Keywords: disaster | risk perception | risk evacuation | Mexico | geography | well-being | natural hazards

Article:

Introduction

This paper examines how situational and cognitive variables associated with chronic and acute hazardous conditions affect perception of risk. Risk perception from chronic exposure to

volcanic eruptions of Popocatepetl was investigated in San Pedro Benito Juarez, Puebla, Mexico, and risk perception from an acute exposure to a flood/mudslide event was explored in Teziutlán, which is also in the state of Puebla, Mexico.

Perceptions of risk and attitudes towards natural hazards have been the focus of considerable research (Slovic, 2000). Individuals' perceptions of natural hazards – i.e., “the range of judgments, beliefs and attitudes” that individuals hold (Taylor, Stewart, & Downton, 1988)--may either contribute to or detract from effective response. Concomitantly, mitigation and preparedness policies are influenced by perception. Since response to any warning message is closely related to perception of risk (Tobin and Montz, 1997, Tobin et al., 2005 and Whiteford and Tobin, 2004, chap. 11), the assumption has been that more accurate perceptions of risk will usually lead to rational behavior in the face of hazard and its aftermath, with the corollary that decisions people make regarding natural hazards are directly linked to the amount of information they have acquired such as through educational programs (Carlino et al., 2008, Dobran, 2008, Ronan et al., 2000 and Ronan and Johnston, 2001). Major factors that have been considered in risk perception include prior experience, political economic contexts, and individual attributes like gender and religion, but not aspects of individual well-being.

Factors in risk perception

In practice, there are many situational constraints on perception and behavior. Indeed, cognitive and situational factors can work individually, in combination, in sequence, or even back and forth to influence response (Frazier et al., 1986 and Slovic and Weber, 2002). Although there is no simple relationship, it is not unusual to find that individuals exhibit various degrees of cognitive dissonance with regard to their behavior in hazardous environments (Burton, Kates, & White, 1993). This can be related to degree of prior experience. For example, the National Research Council (1991) in Colombia in 1985 and Newhall and Punongbayan (1996) in the Philippines, showed that limited local experience with volcanic hazards was associated with poor perception of the risk, which led to inappropriate responses. As a proxy for degree of prior experience, in this paper we compare a chronic hazard population with an acute disaster population in terms of risk perception; the argument being that those residing in chronic hazardous environments are more likely to have disaster experience than those living in an area where only one event had occurred in recent time.

In a recent review of the literature on volcanic risk perception, Gaillard and Dibben (2008) describe ways individual behaviors and perceptions of risk vary according to macro variables like political and economic contexts, the history of experience with hazards or evacuations (see

also Tobin & Whiteford, 2002), and relationships between communities at risk, government institutions and officials. Some scholars have looked at micro factors for risk perception, such as livelihood (Lane, Tobin, & Whiteford, 2003), religious beliefs (Chester & Duncan, 2009), gender (Bateman & Edwards, 2002), and socioeconomic status (Elliot & Pais, 2006) for transforming abstract notions of risk into concrete personalized assessments of risk (Mileti & Fitzpatrick, 1993). However, these studies have generally omitted analysis of the association of risk perception with measures of individual well-being such as mental health status, physical health status, social networks and recent life changes.

Evacuation behavior

Research on evacuation behavior has included the role of family (Chester, 1993, Lindell and Perry, 1992 and Whiteford and Tobin, 2004, chap. 4) including the presence of young children (Dash and Gladwin, 2007 and Gladwin and Peacock, 1997, chap. 4), the need for childcare (Alway et al., 1998 and Fothergill, 2004), and the ways children themselves coped with the stress and emotional difficulties produced by the disaster (Ronan et al., 2000). Additionally, cultural or religious beliefs (Blong, 1984 and Chester and Duncan, 2009), fear of theft of goods left behind (Lindell & Perry, 1992), physical clues like ash and minor eruptions (Lindell & Perry, 1992), the volcano being dormant for some time (Punongbayan et al., 1996), having income sources from where they are evacuated (Cola, 1996), and quality of amenities in shelters (e.g., Inhorn and Brown, 1997 and Tobin and Whiteford, 2002) contribute to the willingness or reluctance to evacuate.

Although perception of risk is not sufficient for predicting successful evacuation, it is an important variable in determining the effectiveness of proposed evacuation projects. Employing forced evacuations can save lives, but in the long-term may introduce additional problems such as diminished faith in the military or negative political fallout for community leaders. As with risk perception, research has not addressed individual well-being as a factor in evacuation, although some attention is being given to people's function limitations for disaster response and evacuation (e.g., Kailes & Enders, 2007).

Definitions of acute and chronic hazards

An acute hazard is a sudden-onset event with a limited duration (typically weeks or less) and not regularly repeated, although variation exists in the degree to which an event can be considered acute. A chronic hazard is an event that is of unforeseen duration (e.g., volcanic activity) or that is regular/repeated (e.g., yearly floods). Event quality is an ecological feature of hazards that

describes duration, intensity and predictability, such that hazards of varying types are usefully compared in these terms because of the variation in how different disasters are experienced (Couch and Kroll-Smith, 1985 and Kroll-Smith and Couch, 1991; Shultz, Espinel, Galea, & Reissman, 2007, chap. 4).

Risk perception in Puebla, Mexico

Perceptions of risk of Popocatepetl volcano

Reguillo (2000) has argued that the problems experienced while trying to evacuate communities located near Popocatepetl volcano are related to two cultural views of risk: the perspectives held by the emergency management agency (i.e., Protección Civil) and the perspectives held by community members. Community members tend to hold a peaceful and caring image of the volcano (Hernandez, 2004, Reguillo, 2000 and Vera Cortes, 2005). Popocatepetl is regarded as a protective entity and provider of rains and agricultural fertility and is generally not seen as a danger to nearby communities. Vera Cortes (2005) states that meteorological conditions such as nature of rain fall – too much or too little, occurring at the wrong time – and frost and hail have a great impact on a households' well-being, and are seen as indications of what family members will do, such as migrate, and whether next year will be a good year or bad one. The elderly, who survived the last major volcanic eruptions of 1919–1927, are instrumental in this process of maintaining a spiritual connection with the volcano, and are the main transmitters of the rituals and beliefs associated with the volcano (Vera Cortes, 2005). A common belief among this group is that previous volcanic eruptions were more severe and yet did not produce permanent damage to the people or their communities; thus, they see little reason to worry about current volcanic activity. As found elsewhere (Whiteford & Tobin, 2004, chap. 4), recent evacuation around Popocatepetl was also dependent on the presence or absence of young children; those families with young children were more likely to evacuate than those without (Tobin, Whiteford, Jones, & Murphy, 2007).

Analyzing the relationship between perception and the information available to members of communities in the risk zone, Lopez-Vazquez (2009) found that perception towards Popocatepetl was influenced by hazard knowledge stemming from previous experiences, government programs and the media. However, despite the information provided to communities, a high percentage of the population did not feel prepared to deal with an eventual volcanic eruption and had not developed preventative strategies (Lopez-Vazquez, 2009).

Cruz-Reyna and Tilling (2008) present an analysis of the volcano alert system that employs a series of volcanic warning stages resembling traffic lights (Cruz-Reyna & Tilling, 2008). The idea behind that project was to standardize diverging perceptions of risk and to ensure proper preparedness and evacuation strategies. Even though the traffic light alert system has been incorporated by community members and government authorities without major complications, studies have found that understanding regarding each of the light stages vary. As Patiño Terreros (2005:3–4, our translation) indicated: for some of the authorities the green light means normality, while for most of the people in the different regions it means volcanic inactivity, the yellow light, on the one hand is alert for authorities and on the other it is prevention for the people, and finally, the red light for the authorities is alarm and for the people it is alert.

Their study also found that only a small proportion of the population was able to identify the correct meaning of the signs used to indicate evacuation routes, evacuation transportation, and shelters. In summary, understanding of risk communication in volcano communities near Popocatepetl varied by role (authorities vs. lay people), age/experience, and exposure to information from government and media.

Perceptions of risk in the Sierra Norte of Puebla

Other work has covered risk communication strategies in the Sierra Norte of Puebla to prepare community members for landslides. Following landslides and flooding in the region and much of eastern Mexico in 1999, Alcantara-Ayala (2004) and Alcantara-Ayala, Lopez-Mendoza, Melgarejo-Palafox, Borja-Baeza, and Acevo-Zarate, (2004) examined the difficulties of transmitting information on preparedness and evacuation strategies among populations with different beliefs and for whom Nahuatl may be the primary language. Their research indicates that structural factors in the region, including marginalization from public services, inadequate living conditions, and water and food insecurity, not only frame perceptions of risk, but determine individual possibilities for action.

Similar to the case of Popocatepetl, research on communities in the areas at risk for mudslides has looked at how risk perception can be influenced by economic activities related to the hazards. For example, Saldaña Tellez (2003) found that since most community members depended on agricultural for their livelihoods in rural areas of the region, the rainfall that contributed to the creation of mudslides was not perceived negatively, but was actually desired for cultivation. A positive view of heavy rainfall was also supported by religious beliefs and assumptions that God would protect the communities (Alcantara-Ayala, 2004 and Saldaña

Tellez, 2003). These results prompted us to consider further the role of well-being in risk perception in the more urban environment of Teziutlán.

Study sites and risk communication policy

Two study sites were selected to represent communities impacted by chronic and acute natural hazards, respectively, San Pedro Benito Juárez and Teziutlán, both in the state of Puebla, Mexico.

San Pedro Benito Juárez

The town of San Pedro Benito Juárez is located in the municipality of Atlixco in the state of Puebla, approximately 11.5 km east of the volcano Popocatepetl (Fig. 1). In 1996, San Pedro Benito Juárez had a population of 4,340 individuals living in 817 households, according to the local health center's census, and has been subjected chronically to varying degrees of hazards from Popocatepetl. The town is the closest population to the cone, is in the direction that the cone is slanted, and is prone to ash fall, volcanic bombs and pyroclastic flows, although ash more often falls to the east and the major lahars have run to the east side as well. The volcano has been relatively quiet over the last 100 years; however, it entered a new phase in 1994 when an eruption triggered the evacuation of 75,000 residents in the region. Eruptions have continued since then, and a large event in 2000 necessitated a second formal evacuation. While these two major eruptions and evacuations have occurred, suggesting that this could be an acute hazard, we defined this as a chronic hazard for our study since the level of damage resulting from the two eruptions is relatively low, there are constant ash plumes and vapor, regular pyroclastic flows, and occasional volcanic sonic explosions. That there has been more than one eruption – and many more than one warning/alert – helps us justify the selection of this setting as a chronic hazard.

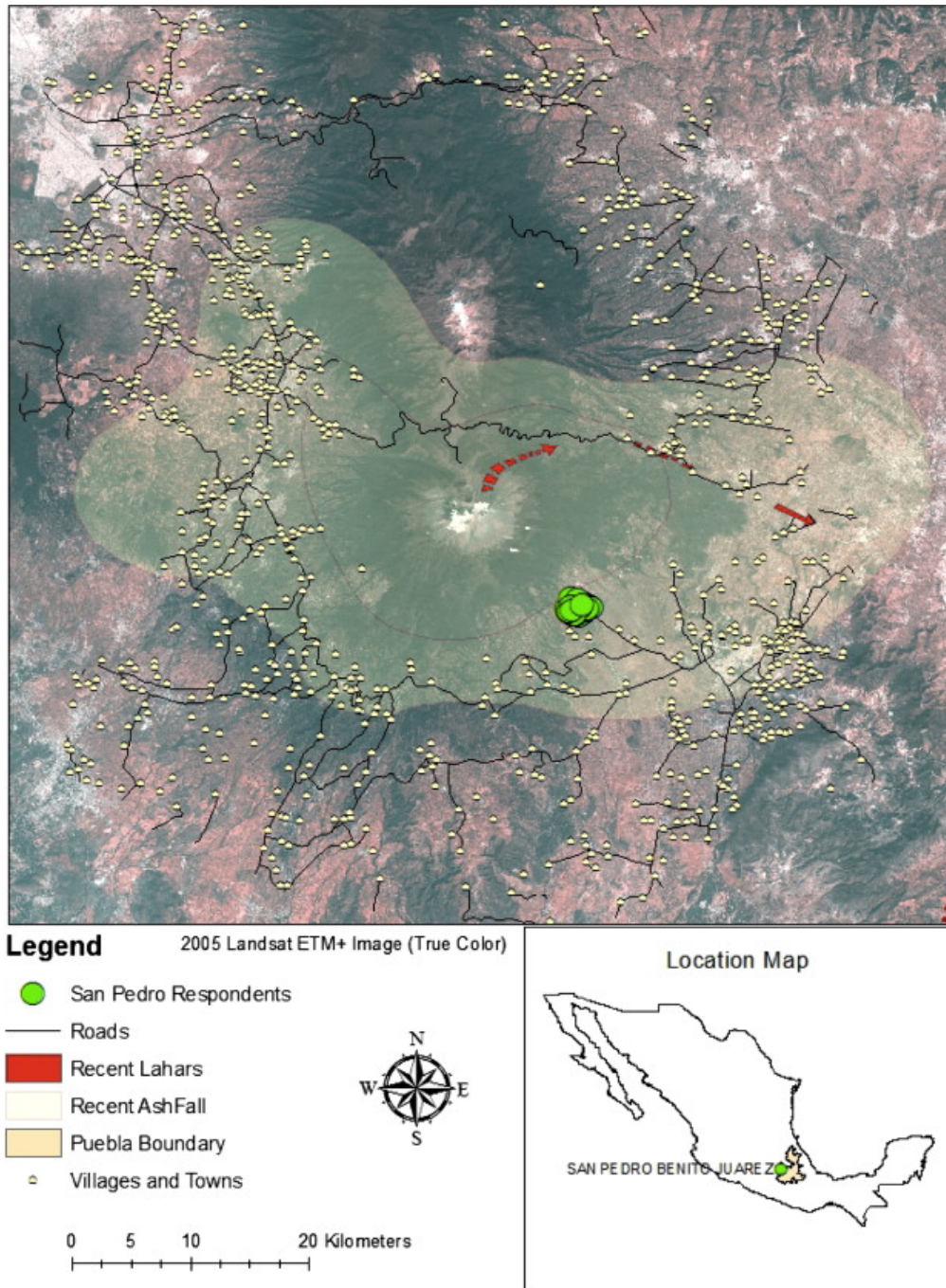
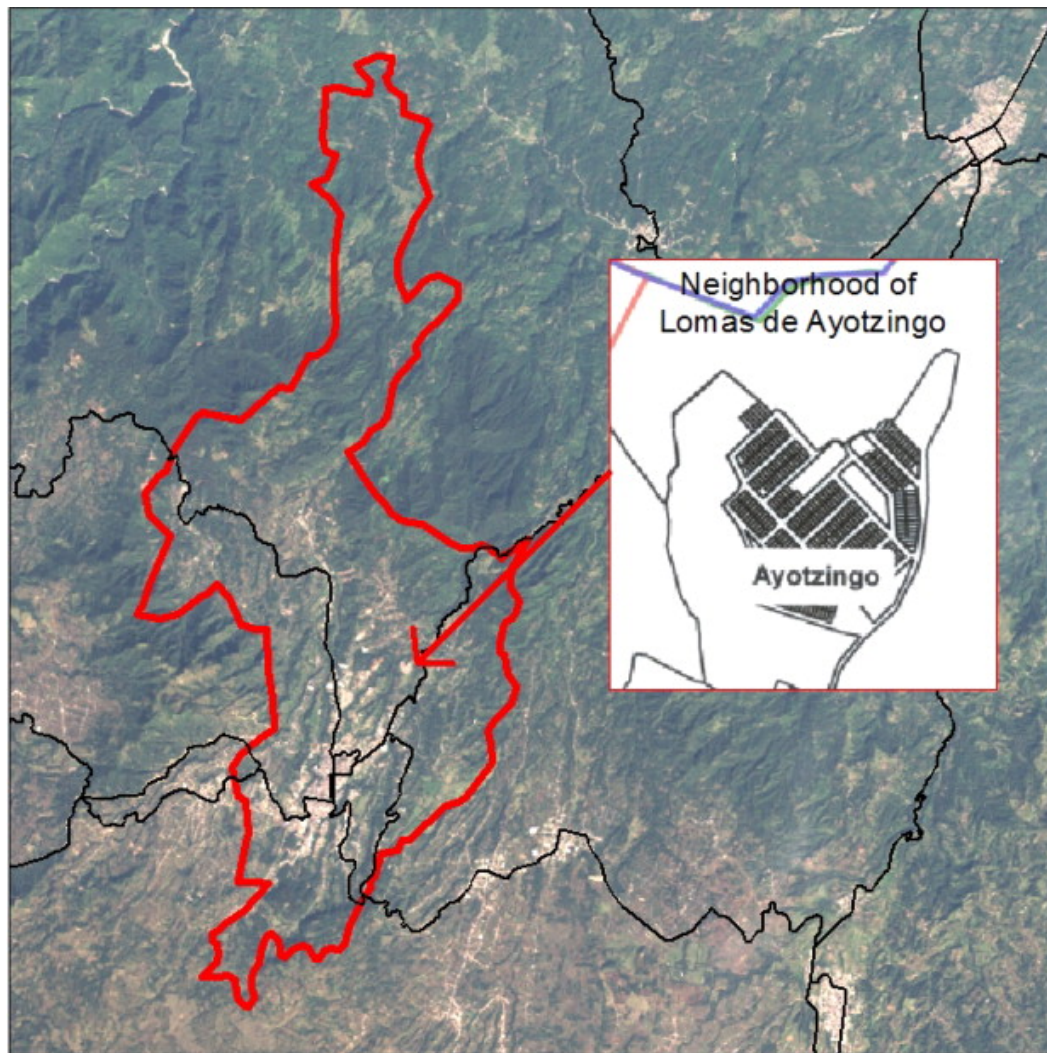


Fig. 1. San Pedro Benito Juárez in Relation to Volcano Popocatepetl.

The people of San Pedro Benito Juárez rely primarily on agriculture, cultivating corn, beans and squash and raising livestock. Community members also engage in a variety of other pursuits such as producing and selling charcoal, commerce of agricultural and animal products, remunerated employment in nearby cities, and migration to the United States (see Gendreau & Giménez, 1998 and Tobin et al., 2007 about emigration from San Pedro Benito Juárez to the US).

Teziutlán – Ayotzingo

Teziutlán is a mining and factory town of approximately 60,000 people located on and around steep hillsides in the northeast portion of the state of Puebla in the Sierra Norte (Fig. 2). In the fall of 1999 many communities in the Sierra Norte suffered floods and landslides that in all took the lives of more than 350 people and destroyed the homes of 200,000 individuals along Mexico's Gulf Coast. It was the country's worst disaster in 4 decades (Murphy, Baker, Hill, Perez, & Norris, 2001). The landslides occurred after a year's worth of rainfall fell in three days. Rain is ubiquitous in Teziutlán, but nothing like this had been recorded here before; this was an extreme and sudden-onset event. Many Teziutlán neighborhoods were severely affected (including La Aurora, Huehueymico, Colonia Juarez, Aire Libre, San Sebastian, Xoloco, Xoloateno, Mexcalcuautkam Atoluca, and La Gloria) which culminated in some residents being relocated to Lomas de Ayotzingo where the Instituto Poblano de la Vivienda (Puebla Institute of Housing) had purchased 3.5 hectares of undeveloped agricultural land and built for the relocated residents. The people interviewed for this study live in the Ayotzingo resettlement, which is situated on hillsides and, although probably safer than some of the landslide areas, is probably less safe than the hilltops or gentle slopes.



Notes:
 2005 LandSat ETM+ Image (True Color)
 Lighter colored areas indicate urbanized areas

Legend

- Mexico Highways
- ▭ Municipality of Teziutlan



Fig. 2. Teziutlan, Puebla, and Study Site Lomas de Ayotzingo Neighborhood.

Methods and data

Many factors influence risk perceptions in disaster-prone regions. The objectives of this study were to determine how perceptions of risk vary between chronic and acute exposure to natural

hazards as well as to identify and measure aspects of individual well-being associated with risk perception in chronic and acute disaster settings.

Research design and sample

Two survey instruments were utilized in this study. First, a short questionnaire was undertaken to collect basic demographic information from 294 households. Of these, 155 were randomly selected households in San Pedro Benito Juárez and 139 were households in Ayotzingo that had participated in a prior study concerning impacts of the landslide. These households contained a total of 1,412 individuals (746 from San Pedro Benito Juárez and 666 from Ayotzingo). A second, more detailed impact and well-being survey was administered to 200 individual participants—one randomly chosen adult (based on most recent birthday) per household from 61 randomly selected households in San Pedro Benito Juárez and 139 households in Ayotzingo based on a convenience sample from the 176 individuals who participated in a 2000–2002 study by one of the researchers when around 234 households existed in Ayotzingo (see Norris, Murphy, Baker, & Perilla, 2004)--due to funding and time limitations, data collection was stopped at 139, though a higher response was likely. This resulted in an overall response rate of 79 percent, although we were actually not refused by anyone. Teziutlan’s (Ayotzingo’s) prior experience with interviews is unlikely to have decreased the quality of people’s responses, and probably served to provide us with high response rates (see Jones, Murphy, Perilla, Perez-Vargas, & Norris, 2010). The random sample in San Pedro Benito Juárez produced similar average values for general demographic data when comparing household level vs. individual level characteristics, except for the cases of rate of marriage and average age, both of which are lower for the household level. In Teziutlán, where we attempted to re-interview participants from a prior study (Norris et al., 2004), some differences were found between the households and respondents; there was an over sampling of women and a higher percentage of married individuals and older individuals in Teziutlán. The two sites were compared for differences in demographics of the respondents (Table 1). Several differences are apparent. Respondents in San Pedro Benito Juárez are younger, have less formal education and have more people born in the community than Teziutlán.

Table 1. Demographics of study sites.

Characteristics	Household Level San Pedro Benito Juárez/Teziutlán	Respondent Level San Pedro Benito Juárez/Teziutlán
Average age	46/39 ($p = .000$)	43/47 ($p = .041$)
% Born in city of residence	98/58 ($p = .000$)	98/46 ($p = .000$)
% Females	56/55	58/70

Characteristics	Household Level San Pedro Benito Juárez/Teziutlán	Respondent Level San Pedro Benito Juárez/Teziutlán
% Married or cohabitating	66/61	53/60
Average years of education	5.3/6.9 ($p = .000$)	5.4/6.5
% Catholic	No Data	57/90 ($p = .001$)
Average number of close family living outside the country	No Data	2.2/.7 ($p = .000$)
% Employed in agriculture	83/2 ($p = .000$)	85/2 ($p = .000$)

Notes: · Calculations for both household and respondent levels include all adults 18 years and up.
· No statistical comparison made between household and respondent levels.

Variables and measures

Survey questions were arranged into nine variable groups, including demographic, evacuation data and beliefs toward the hazard (either volcano or flood/mudslide), household conditions, recent life changes, closeness to people, material possessions and resources, physical health traits, depression symptoms, and post-traumatic stress. In terms of the dependent variables (risk perception and evacuation experiences), several questions were asked about past evacuation experience and likelihood of evacuating again; four risk perception questions and one evacuation behavior question were asked—concern about living near a hazard, perception that the hazard posed a risk to life during eruptions/landslides, whether the hazard continues to pose a risk to health, whether they are generally attentive to or concerned about health, and whether they would evacuate in the future (English translations of the questions provide the titles of Table 6, Table 7, Table 8, Table 9 and Table 10).

For measures of well-being (posed as the independent variables), standard psychological scales were used to assess post-traumatic stress symptoms (17 items) adapted from a modified version of Schedule K of the World Health Organization’s Comprehensive Interview Diagnostic Inventory 2.1 (World Health Organization, 1997); depression symptoms (20 items) from the CES-D, including subscales of negative affect and lack of positive affect (Radloff, 1977); physical health symptoms (20 items) from the Physical Symptoms Checklist (Leventhal, Hansell, Diefenbach, Leventhal, & Glass, 1996) including subscales for heart (3 items), respiratory system (5 items), muscles (5 items) and physical stress/level of energy (4 items), plus a question about being limited in capacity due to physical symptoms; living conditions (10 items) from Ecological Stress Scale (Riad & Norris, 1996); perceived support (22 items) from the Provisions of Social Relations Scale, including subscales for support perceived from friends vs. family vs.

mate/partner (Turner & Marino, 1994); and the number of 26 listed consumer items owned plus the number of rooms in their house (excluding kitchen, since many kitchens are separate and less permanent structures) served as measures of wealth. Significant differences between the variable groups were determined using the Kruskal–Wallis test for nonparametric independent samples, and variables associated with risk perception measures were identified using bivariate correlation analysis (Pearsons R; tests using Cronbachs alpha produced the same results).

Survey results

Evacuation behavior and beliefs toward the eruption/mudslide

A series of questions was asked related to evacuation histories, experiences in the shelters, and future evacuation plans (Table 2). In San Pedro Benito Juárez, respondents were asked if they evacuated during the 1994 and 2000 volcanic eruption events. In Teziutlán, they were asked if they evacuated in 1999 as a result of the mudslide and secondly, if they experienced any additional evacuations at other times as a result of flooding and/or hurricanes. While the rates of evacuation were comparable between the two sites, significantly fewer respondents in San Pedro Benito Juárez suggested they would evacuate next time if an event threatened.

Table 2. Evacuation behavior, experiences and expectations in study sites.

	San Pedro Benito Juárez	Teziutlán	Significance (<i>p</i> -value)
Reporting having ever evacuated to a shelter (San Pedro Benito Juárez, <i>n</i> = 56 for 1994 or 2000; Teziutlan, <i>n</i> = 130 for 1999 or another time)	50	45	–
If ever evacuated (<i>n</i> = 28; <i>n</i> = 58), felt good about at least one evacuation experience	71	69	–
Tried to convince anyone outside their household to evacuate in 1994 (<i>n</i> = 53) or 1999 (<i>n</i> = 130)	45	50	–
Authorities tried to convince them to evacuate in 1994 (<i>n</i> = 56) or 1999 (<i>n</i> = 129)	41	33	–
Think they will evacuate next time there is a strong eruption/mudslide (<i>n</i> = 54; <i>n</i> = 132)	70	84	.034
Would evacuate if someone from household wanted them to evacuate (<i>n</i> = 48; <i>n</i> = 134)	75	94	.000

“- “ not significantly different at *p* < .05 using Kruskal-Wallis test for nonparametric independent samples.

Significantly more respondents from Teziutlán believe that it is dangerous to live close to an area prone to a hazard (i.e., mudslides) and stated that they have been affected by a disaster, and believe that the hazard poses a health risk to them and their families, compared to what San Pedro Benito Juárez respondents believe in association with volcanic eruptions (Table 3). More San Pedro Benito Juárez respondents have been told about previous eruptions from their elders than Teziutlán respondents have been told about prior flood events.

Table 3. Beliefs toward the eruption/mudslide.

Variable	San Pedro Benito Juárez	Teziutlán	Significance
	Percent	Percent	<i>p</i> -value
The eruptions (<i>n</i> = 57) or mudslide (<i>n</i> = 136) affected them or their family in any way.	19	74	.000
Their life or the life of any person close to them was in danger during any of the eruptions (<i>n</i> = 57) or mudslides (<i>n</i> = 135).	21	84	.000
They believe that eruptions (<i>n</i> = 57) or floods/mudslides (<i>n</i> = 133) represents a risk for their health or the health of their family?	53	90	.000
They have tried climbing the volcano (<i>n</i> = 57).	35	NA	NA
They think it is possible for there to be another eruption (<i>n</i> = 55) or mudslide/flood (<i>n</i> = 131) during their lifetime.	75	76	–
Their parents or grandparents told them about any previous strongeruptions (<i>n</i> = 56) or mudslides/floods (<i>n</i> = 135).	70	22	.000

“–” not significantly different at $p < .05$ using Kruskal-Wallis test for nonparametric independent samples.

Variation in independent variables between sites

The predictors for risk are shown in Table 4. The results suggest more negative and worse conditions for Teziutlan in virtually all categories, with higher numbers of physical symptoms, depression symptoms and post-traumatic stress symptoms as well as significantly higher numbers of recent life changes, poorer household conditions, and a greater number of household items. Perceived support is comparable, except for spousal support, which is lower in Teziutlán.

Table 4. Differences between study sites for scaled predictors of risk perception.

Variable (scale range in parentheses)	San Pedro Benito Juárez	Teziutlán	Significance
	Mean	Mean	<i>p</i> -value
Total number physical symptoms (0–20)	5.3	6.9	.008
Cardiovascular problems (0–3)	.6	0.9	.022
Muscular skeletal complaints (0–5)	1.9	2.2	–
Respiratory problems (0–5)	1.1	1.2	–
Strength and level of energy (0–4)	1.2	1.6	.025
Number of depression symptoms (0–20)	7.0	13.0	.000
Lack of positive affect	3.5	6.2	.000
Negative affect	3.5	6.8	.000
Number of post-traumatic stress symptoms (0–17)	2.9	7.0	.000
Intrusion	1.0	2.3	.000
Arousal	1.0	2.7	.000
Avoidance	.8	2.1	.000
Functioning	.3	.6	.014
Perceived support (0–22)	1.5	1.5	–
From friends (1–2)	1.2	1.4	.038
From family (1–2)	1.6	1.7	–
From spouse/partner (1–2)	1.9	1.5	.002
Recent life changes (0–9)	1.1	1.5	.031
Household conditions (0–10)	5.6	8.3	.000
Number of household items (0–26; wealth)	8.2	11.4	.000

“–” not significantly different at $p < .05$ using Kruskal-Wallis test for nonparametric independent samples.

Physical and mental health symptoms

The total number of physical health symptoms was significantly different between the two sites. Similarly, the average number of symptoms of recent depression was significantly higher in Teziutlán than in San Pedro Benito Juárez, with relatively equal differences existing for both negative affect and lack of positive affect. Symptoms of post-traumatic stress nine years after the 1999 mudslides/resettlement were also significantly higher on average in Teziutlán than in San Pedro Benito Juárez seven years after the second and last eruption/evacuation in 2000. Mental health differences would intuitively be expected since Teziutlán residents lost family, friends or property and had to relocate permanently while San Pedro Benito Juárez residents did not. However, those in San Pedro Benito Juárez could live in constant fear of a major eruption. In any case, we report differences so that the reader can take this into account when thinking about the results of our analyses in Table 6, Table 7, Table 8, Table 9 and Table 10.

Table 5. Material possessions.

Example Household Items (<i>n</i> = 58; <i>n</i> = 139)	San Pedro Benito Juárez	Teziutlán	Significance
	Percent	Percent	<i>p</i> -value
Washing machine	24	53	.000
Dining room tables	71	80	–
Compact disc	40	43	–
Microwave oven	7	20	.022
# of Rooms not counting kitchen (<i>n</i> = 55; <i>n</i> = 134)	15	14	–
Receives economic support from family or friends outside the country (<i>n</i> = 57; <i>n</i> = 130)	53	9	.000
Grows crops (<i>n</i> = 58; <i>n</i> = 133)	88	2	.000

“–” Not significantly different at $p < .05$ using Kruskal-Wallis test for nonparametric independent samples.

Table 6. Are you concerned about living where an eruption/flooding-landslide can occur?.

	San Pedro Benito Juárez (<i>n</i> = 57)	Teziutlan (<i>n</i> = 135)
	Pearson's <i>R</i>	Pearson's <i>R</i>
<i>Demographics</i>		
Civil status (married/single)	.357	-.171
<i>Evacuation behavior/beliefs</i>		
Feel good about shelter	.444	–
Eruption/mudslide affected you or your family	.303	–
Life in danger during eruption/mudslide	–	.266
Risk for personal and family health	–	.200
<i>Symptoms of post-traumatic stress</i>		
Total PTSD symptoms (excluding functioning symptoms)	–	.212
Intrusion symptoms	–	.203
Arousal symptoms	–	.174
Avoidance symptoms	–	.172
<i>Physical health symptoms</i>		
Symptoms or conditions interfered with daily activities	–	.201
Muscular problems	.312	–
Total physical symptoms	.283	–
<i>Household conditions</i>		
	–.303	
<i>Material possessions and resources</i>		
Number of rooms	–.402*	–

All *R*-values significant at .05 level or less, except * which indicates .01 level or less. Correlation coefficient obtained using Pearson's bivariate correlation with two-tailed significance.

Table 7. Do you believe that your life or the life of someone close to you was in danger because of the eruptions/flooding-landslides?.

	San Pedro Benito Juárez (<i>n</i> = 57)	Teziutlán (<i>n</i> = 135)
	Pearson's <i>R</i>	Pearson's <i>R</i>
<i>Demographics</i>		
Evacuated at least once	.323	–
Age	–	–.181
<i>Evacuation behavior/beliefs</i>		
Try to convince someone outside your house to evacuate	.323	–
Eruptions/mudslide affect you or family	.293	.233*
Eruption/mudslide can represent a risk for health	.404*	–
Worried about living close to eruption/mudslide	–	.266*
<i>Recent depression symptoms</i>		
Negative affect	.315	–
<i>Number of symptoms of post-traumatic stress</i>		
Arousal symptoms	.341*	–
Total PTSD symptoms (excluding functioning symptoms)	.390*	–
Functioning symptoms	.376*	–
Intrusion symptoms	.486*	–
<i>Physical health symptoms</i>		
Muscular problems	.314	–
Total physical symptoms	.342*	–
Respiratory problems	.317	–
Strength/level of energy	.299	–
<i>Household conditions</i>	–.641*	–
<i>Recent life changes</i>	.322	–

All *R*-values significant at .05 level or less, except * which indicates .01 level or less. Correlation coefficient obtained using Pearson's bivariate correlation with two-tailed significance.

Table 8. Do you think about your health?.

	San Pedro Benito Juárez	Teziutlán
	Pearson's <i>R</i>	Pearson's <i>R</i>
<i>Demographics</i>		
Age	–	.190
<i>Evacuation behavior/beliefs</i>		
Convince others outside house to evacuate	–.273	–
Belief that another eruption/mudslide during lifetime	.331	–
<i>Post-traumatic stress symptoms</i>		
Arousal symptoms	–	.268*
Total PTSD symptoms (excluding functioning symptoms)	–	.221
Functioning symptoms	–	.202
<i>Physical health symptoms</i>		
Cardiovascular problems	–	.168
Muscular problems	–	.200
Total physical symptoms	–	.251*
Respiratory problems	–	.210
Strength and level of energy	–	.231

All *R*-values significant at .05 level or less, except * which indicates .01 level or less. Correlation coefficient obtained using Pearson's bivariate correlation with two-tailed significance.

Table 9. Do you think that an eruption/flood-landslide could put the health of you or your family at risk?.

	San Pedro Benito Juárez	Teziutlán
	Pearson's <i>R</i>	Pearson's <i>R</i>
<i>Evacuation behavior/beliefs</i>		
Would evacuate if someone from house wanted you to	.390*	–
Evacuated in 2000 (San Pedro Benito Juárez)/other time in Teziutlán	.401*	–
Try to convince others outside house to evacuate	.438*	–
Believe that life in danger during eruption/mudslide	.404*	–
Would evacuate next time there is a strong eruption/mudslide	.374*	–
Someone other than authorities tried to convince you to evacuate	–	.182
Worried about living close to eruption/mudslide	–	.200
Affected by eruptions/mudslides	–	.177
<i>Number of symptoms of post-traumatic stress</i>		
Total PTSD symptoms (excluding functioning symptoms)	.365*	–
Arousal symptoms	.340*	–
Avoidance symptoms	.276	–
Functioning symptoms	.286	–
Intrusion symptoms	.360*	–
<i>Recent depression symptoms</i>		
Negative affect	.267	–
<i>Physical health symptoms</i>		
Muscular skeletal complaints	.305	–

All *R*-values significant at .05 level or less, except * which indicates .01 level or less. Correlation coefficient obtained using Pearson's bivariate correlation with two-tailed significance.

Table 10. The next time there is an eruption/landslide predicted, do you think you' ll evacuate?.

	San Pedro Benito Juárez (n46–54)	Teziutlán (n = 132)
	Pearson's <i>R</i>	Pearson's <i>R</i>
<i>Evacuation behavior/beliefs</i>		
Would evacuate if someone from house wanted you to	.468*	.334*
Evacuated in 2000 (San Pedro Benito Juárez)/other time in Teziutlán	.374*	–
Evacuated in 1994 (San Pedro Benito Juárez)/1999 in Teziutlán	.399*	–
Flood–landslide/eruption could put the health of you or your family at risk	.374*	
Belief that another eruption/mudslide during lifetime	.629*	–
<i>Number of symptoms of post-traumatic stress</i>		
Total PTSD symptoms (excluding functioning symptoms)	–	.227*
Arousal symptoms	–	.221
Intrusion symptoms		.218
<i>Recent depression symptoms</i>		
Negative affect	.292	–
<i>Physical health symptoms</i>		
Cardiovascular problems	–	.212

All *R*-values significant at .05 level or less, except * which indicates .01 level or less. Correlation coefficient obtained using Pearson's bivariate correlation with two-tailed significance.

Perceived support and recent life changes

With respect to perceived support, Teziutlán respondents reported having slightly more support, trust and appreciation from friends than did San Pedro Benito Juárez respondents, while San Pedro Benito Juárez respondents reported more support from spouse/partner than Teziutlán. No difference was observed in the level of perceived family support. In terms of respondents' life changes in the last 6 months (e.g., move, conflict, death in the family), Teziutlán had a higher average score than did San Pedro Benito Juárez, although the average number of events per person is only around one out of nine possible events.

Household conditions

Respondents from both communities were asked questions regarding the general nature of their household conditions (e.g., availability of food, water, and space; each measured on a 1–4 Likert scale). There were significantly more problems reported by Teziutlán respondents. In Teziutlán, respondents described more space scarcity, problems with heat, lacking private places, and fear of criminal activity--all possibly related to living in small high-density housing. In San Pedro Benito Juárez, respondents reported a higher percentage of problems with electricity and sanitary conditions, possibly associated with lack of infrastructure in the rural area. Despite differences being significant for these individual items on the scale, no specific condition presented a difference of more than 0.6 between the two sites, and most items had spreads around 0.2 points.

Material possessions and resources

As a surrogate measure for overall wealth, survey respondents were asked how many of each type of 26 material possessions that they currently own as well as two questions related to dependence on agriculture and number of family members abroad (Table 5). The material possessions list included shower, electric/gas water heater, wood water heater, refrigerator, electric/gas stove, washing machine, electric sewing machine, manual sewing machine, electric coffee maker, blender, electric iron, bed with mattress, couch/sofa, dining room table, cassette recorder, compact disc player, radio not part of stereo, television, bicycle, motorcycle, car/pickup/jeep, microwave oven, TV video game console, satellite dish/cable, and computer.

Four items are included in the analysis to distinguish wealth differences between the two communities. Washing machines are relatively expensive in Mexico and lack of ownership would tend to separate out those unable to afford them against doing laundry by hand (these sample populations would generally not have included people able to afford domestic help). The middle stratum above washing machine owners would be distinguished by lack of ownership of a

microwave oven due to the high cost of microwaveable prepared foods. Although not essential, dining room tables are a necessary item that we expect most except the poorest would own, and compact disc players are a luxury item that is a first priority for any household when sufficient disposable funds are accrued. Table 5 shows that the two communities are similar in terms of wealth as indicated by ownership of tables and compact disc players, but that over twice as many people in Teziutlán have washing machines and microwave ovens as do those in San Pedro Benito Juárez.

Analysis and discussion

The four measures of risk perception included the following: concern about living close to a hazard; perceived danger from hazards; perceived health risk from hazards; and, being attentive to or concerned about health in general. Each of the four perception measures was tested for significant correlations (at $p < .05$) against the hypothesized independent variables.

Concerns about proximity to hazard

As shown in Table 3, more Teziutlán respondents (79 percent) reported to be worried about living in a region prone to landslides as compared to San Pedro Benito Juárez respondents (43 percent) who worried about living close to an active volcano. In Table 6, our measures—primarily focused on well-being—were correlated with concern about living near a hazard. What is noticeable is the contrast between the two research sites; in general, mental health factors are more important in Teziutlán while other traits stand out in San Pedro Benito Juárez.

These findings might be explained in terms of three conditions prevailing at each site. First, the negative view in San Pedro Benito Juárez towards shelters ($-.444$) probably stems from a previous bad experience of shelters combined with a perception of limited options. Residents of San Pedro Benito Juárez have few alternatives to shelters in the event of another eruption. Second, in San Pedro Benito Juárez, greater impact of eruptions is correlated with greater expressed concern about living in close proximity to the hazard. This is understandable. However, in Teziutlán all respondents were relocated—thus similarly affected by the mudslide—hence, there is little variation among their high levels of stress. Third, in San Pedro Benito Juárez, household conditions (e.g., less space, limited privacy, food and heat problems) are negatively correlated with concerns over living close to a hazard. Similarly in San Pedro Benito Juárez, those with fewer material possessions had greater concerns about living near a hazard. This third possible explanation may also be an artifact of the difference between relative urban affluence and relative rural poverty.

Perceived danger to life from hazard

Approximately 21 percent of San Pedro Benito Juárez respondents perceived that volcanic eruptions had constituted a danger to them or their family, which is significantly less than the 84 percent of Teziutlán respondents who had perceived danger to life from landslides and flooding. In a worst case scenario, in reality, more people could die in the case of an eruption of Mt. Popocatepetl than would die from landslides in Teziutlán. Nearly all variable groups/scales resulted in significant correlations with perceived danger in one of the two sites, but once again, the difference between the two sites was striking (Table 7).

In Teziutlán, only those who worried about living close to the mudslide, younger people, and the most highly impacted expressed higher levels of belief that their lives or those of someone close to them was in danger. In San Pedro Benito Juárez, however, there were many significant differences amongst the population. It is likely that poverty in San Pedro Benito Juárez is playing a role with household conditions being highly correlated with belief in danger. In San Pedro Benito Juárez, higher levels of evacuation, greater impact experience, and concerns about the volcano are all associated with a belief that the hazard poses a threat to the life of someone and/or the life of loved ones. It also indicates that the chronic hazard site, but not the acute site, produces an association between perceived risk of life and degree of post-traumatic stress and depression.

Generally attentive to or concerned about health

People may also perceive risk in terms of their general concerns about health. We first looked at general attentiveness to health prior to looking into whether health concerns were associated by people with the hazard. The difference for general attentiveness to and concern for health is not significantly different between the communities. In San Pedro Benito Juárez, 86 percent of respondents indicated that they were attentive to and concerned about their health and their families' health, and 92 percent in Teziutlán. It would be expected that generally caring about health would correlate with a number of variables associated with demographic variables (e.g., age and gender), beliefs, mental health symptoms, and health symptoms. Significant correlations were observed in four of the variable groups: demographic characteristics, evacuation data and beliefs toward the eruption/mudslide, mental health symptoms, and health symptoms (Table 8), as described below.

In Teziutlán, those respondents with health issues expressed greater concern in general about their health. It is probable that the extreme event, that is the mudslide or relocation, had precipitated high levels of stress symptoms in some respondents. Respondents, having been through the trauma of a severe event and then forced to relocate, experienced high levels of arousal (general concern) symptoms, whereas, in San Pedro Benito Juárez, there may be a lack of variation in answers because respondents have limited access to resources. Again, poverty may be playing a role. However, those who believed that another event is possible may see health problems in the future. In Teziutlán, future events were not perceived as problematic because the problem had been “solved” since all respondents had relocated.

Perceived health risk from hazard

When asked about health risks emanating from the hazards, approximately 53 percent of San Pedro Benito Juárez respondents and 90 percent of Teziutlán respondents report that the hazard represents a health risk to themselves and/or their families. Again, largely for San Pedro Benito Juárez and not Teziutlán, nearly all variable groups resulted in significant correlations with perceived health risk, with the exception of the demographic characteristics, material possessions, closeness to people, and number of recent life changes (see Table 9).

The results shown in Table 9 indicate high levels of association between a number of variables and an individual’s perceived risk of the hazard to family health. It is probable that the chronic nature of the volcano hazard in San Pedro Benito Juárez is evoking a variety of responses. However, there is consistency in these responses. Those who evacuated, those who would evacuate again, those who would encourage others to evacuate, and those who believe that the volcano is a danger to health are much more likely to believe that the volcano presents a health risk. Similarly, high levels of mental health and physical health problems are also correlated with greater concerns about health. In contrast, there are few significant differences in Teziutlán because nearly all respondents (90 percent) perceived health risks from the hazard. Given the extreme nature of the mudslide experience, it is not surprising that so many residents responded affirmatively to this question. Table 8 and Table 9 are related; respondents in Teziutlán perceive health as a problem, but it is not necessarily related to the mudslide, whereas in San Pedro Benito Juárez there is a greater range of response with some associating health conditions with the hazard. This could be connected with ash falls which invariably lead to health problems (such association has been well-documented, see for example Horwell & Baxter, 2006).

Likelihood of evacuating next time

As with the above results, the two sites exhibit considerable differences in the factors that predict whether or not residents plan on evacuating for the next eruption or flooding/landslide. In Teziutlan, only half as many (16 percent) plan on not evacuating as in San Pedro Benito Juárez (30 percent). However, the small number of respondents in Teziutlan makes it relatively hard to achieve statistical significance for the predictive factors. Nonetheless, again, the difference between the two sites is striking.

In Teziutlan, it is higher levels of post-traumatic stress and higher levels of some physical health symptoms that predict plans to evacuate, although these correlations are only at the .05 level and the R-values are moderately low. In the chronic site of San Pedro Benito Juárez, one mental health measure (termed “negative affect,” an aspect of depression that has to do with low motivation and efficacy) does show up as a predictor, with greater negative affect predicting plans to evacuate. The main predictors in San Pedro Benito Juárez are prior evacuation and risk perception. The risk perception measures were whether the hazard/disaster could present a risk to health in the future, and whether respondents believe it likely in their lifetime that there will be another eruption/landslide. The latter is by far the strongest predictor. This is important for disaster management officials—risk perception begets evacuation—but, once again, it is in the chronic hazard site that this kind of perception might be translated into action. In Teziutlan, no such relationships exists (although we have already mentioned the low variation in likelihood of future evacuation), and this means that other avenues would need to be tried to convince the remaining holdouts to evacuate in that site. Perhaps one avenue would be through family—both sites had moderate predictors in whether the interviewee would evacuate if someone in their household wanted them to evacuate. This is the only predictor variable that the two sites shared in common.

Traits, conditions and resources

Demographics

In general, the people in both communities are similar in terms of gender breakdown, marital status, and education. However, some key differences were identified. Nearly all San Pedro Benito Juárez respondents live in the same location in which they were born, where significantly more Teziutlán residents have immigrated from outside their birth city. In San Pedro Benito Juárez, agriculture is dominant and nearly all the population works on farms. In contrast, there is little farming in Teziutlán and respondents are mostly employed in their homes doing piecework for textile factories or are laborers, employees, or store workers. In addition, the religious breakdown is significantly different with almost half of the San Pedro Benito Juárez respondents being evangelical, while Teziutlán is virtually all Catholic. However, even with these differences, demographic variables do not correlate significantly with perceptions of risk in

either site, also indicating that age, religion, gender, marital status, and education may not vary between these cases of acute and chronic exposure to risk.

Mental health symptoms

Teziutlán respondents exhibited two to three times as many post-traumatic stress and depression symptoms as San Pedro Benito Juárez respondents. This makes sense because the mudslide in Teziutlán represented an imminent threat to those in its path. The acute and sudden nature of the event could not reasonably have been anticipated. In comparison, San Pedro Benito Juárez respondents are more used to the volcano and accept the hazard as a normal part of life. That is not to say that people exposed to chronic risk do not suffer from mental health problems and those who have been more affected do in general exhibit symptoms. In San Pedro Benito Juárez, perceived danger and perceived health risk are correlated with stress and depression symptoms, which are not seen in the Teziutlán population. Thus, those respondents in San Pedro Benito Juárez who perceive danger and risk to their health exhibit more mental health symptoms. However, although acute exposure to hazards will result in more stress and depression symptoms than chronic exposure to hazards, the chronic exposure appears to produce a subset of people who are more concerned about the hazard than are fellow villagers and this may be either cause or consequence of mental health status.

Physical health symptoms

There is no difference in physical health symptoms between these two disaster events. However, there are significant differences between how risk is perceived between the two communities. For example, health worries are positively correlated with physical health symptoms in Teziutlán, but not in San Pedro Benito Juárez. The opposite was found in San Pedro Benito Juárez where there is a clear pattern that health worries are positively correlated with the other measures of risk perception (i.e., proximity to the volcano, perceived danger, and perceived health risk). This suggests that physical response to hazards varies between the communities depending on their perception of risk. In Teziutlán, respondents who worry about health exhibit more health symptoms, where San Pedro Benito Juárez respondents who worry about living close to the volcano and the danger and potential risks associated with the volcano exhibit more health symptoms.

Household conditions

In San Pedro Benito Juárez, there is a clear pattern that household conditions play a role in risk perception. San Pedro Benito Juárez respondents who have poor household conditions clearly

perceive more risk in terms of proximity, perceived danger, and a threat to their health, a trend that was not reported in Teziutlán. This indicates that household conditions play a role in how risk is perceived. If household conditions were to improve in San Pedro Benito Juárez, then perceived risks would probably advance.

Material possessions and resources

In general, Teziutlán respondents appear to have more possessions than do San Pedro Benito Juárez respondents, indicating a higher standard of living in Teziutlán. However, a significant proportion of San Pedro Benito Juárez respondents receive additional support from outside the country as compared to Teziutlán respondents. The difference in affluence does not appear to significantly affect how each community perceives risks associated with disaster exposure-- although it may indirectly affect risk perception through the influence of affluence on household conditions.

Closeness to people and recent life changes

In both these variable groups, there did not appear to be significant differences between the communities in terms of general characteristics nor in terms of perceived risk perception. Further work is now being undertaken to look at social relations more carefully through the study of social networks to determine how these affect hazard perception and response.

Conclusion

As a result of this study, key differences were identified between San Pedro Benito Juárez and Teziutlán respondents that include specific demographic characteristics, physical and emotional health, household conditions, and material possessions. In addition, clear patterns have emerged to identify variable groups associated with risk perception.

This study shows:

- A definite difference between these sites, categorized as chronic and acute, in terms of perception of risk.
- More health symptoms (physical and mental) were reported in the acute site than the chronic site. However, in three of the risk perception measures, these symptoms are correlated with perceived risk in the chronic site, but not the acute site.

- We noted the association of household conditions with perceived risk in the chronic site, but not in the acute site. Economic conditions appear to be worse in San Pedro Benito Juárez (the chronic site) than in Teziutlán (the acute site), although the measure of material possessions as a proxy for wealth did not correlate with risk perception in either site.
- Although the literature suggests a variety of demographic variables to be important, for risk perception and evacuation, specifically religion and gender, this study did not replicate those results in either the chronic site or the acute site.
- Chronic vs. acute hazard site differed in terms of predictors of intended future evacuation, with post-traumatic stress symptoms being significant in Teziutlan the acute site, but mainly prior experience and risk perception as major predictors in San Pedro Benito Juárez the chronic site.

Policy applications may flow from this work. For instance, there is already a significant literature on public policy and disasters focusing on the development and assessment of adequate, and in some cases culturally specific, programs to inform populations at risk on prevention and evacuation strategies. Alcantara-Ayala et al., 2004 and Alcantara-Ayala, 2004 and Lopez-Vazquez (2009) have addressed these issues in and around Teziutlán and Popocatépetl. Communication problems have been studied to develop standardized systems of knowledge transmission (Alcantara-Ayala, 2004, Cruz-Reyna and Tilling, 2008 and Lopez-Vazquez, 2009). Researchers have proposed different mechanisms not only to transmit information, but also to engage community members in activities during emergencies (Alcantara-Ayala, 2004). For instance, after the 1994 eruption of Popocatépetl, the National Center for the Prevention of Disaster (CENAPRED) brought together civil defense officials from the states of Puebla, Mexico, Morelos, Tlaxcala, and Mexico City to create a series of informative and operative programs (Cruz-Reyna and Tilling, 2008 and Marcial, 1996) that identify jurisdictional and agency responsibilities, areas of risk, organization of evacuations, and a system of alerting the population. Currently, various measures have been implemented by local and state government authorities in Mexico to inform the population of possible risks and the actions that might be needed in the event of a future disaster such as emergency booklets and radio messages in Spanish and Nahuatl (Alcantara-Ayala, 2004), and signs indicating evacuation routes.

Policy guiding forced and voluntary evacuations has been identified as one variable in increasing vulnerability among already disenfranchised and poor populations (Whiteford & Tobin, 2004, chap. 4). Whiteford and Tobin (2009: chap. 8) asserted that forced evacuation is particularly detrimental for vulnerable populations because it divides communities, uses fear tactics to initiate the evacuation, and often unfairly targets people with limited resources. However, before any specific policy recommendations can be made, confirmation by additional studies differentiating chronic and acute conditions are necessary.

Some insights for emergency management can be drawn from our research on well-being in acute disaster vs. chronic hazard settings. Emergency management could target those who perceive a low level of risk because of their high levels of well-being, as well as people with strong economic ties to where they live, and past experience of the population. Also, many who are most willing to respond to warnings (i.e., those who perceive high levels of risk) often have fewer resources and worse living conditions plus more mental and physical problems—all of which may affect their ability to participate in disaster preparation, mitigation or response activities. Finally, differences between the two sites suggest that a distinction between these two types of settings is useful for tailoring public awareness and evacuation efforts.

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