

## Cross-Cultural and Site-Based Influences on Demographic, Well-being, and Social Network Predictors of Risk Perception in Hazard and Disaster Settings in Ecuador and Mexico

By: Eric C. Jones, Albert J. Faas, [Arthur D. Murphy](#), Graham A. Tobin, Linda M. Whiteford, Christopher McCarthy

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### **Abstract:**

Although virtually all comparative research about risk perception focuses on *which hazards* are of concern to people in different culture groups, much can be gained by focusing on *predictors of levels* of risk perception in various countries and places. In this case, we examine standard and novel predictors of risk perception in seven sites among communities affected by a flood in Mexico (one site) and volcanic eruptions in Mexico (one site) and Ecuador (five sites). We conducted more than 450 interviews with questions about how people feel at the time (after the disaster) regarding what happened in the past, their current concerns, and their expectations for the future. We explore how aspects of the context in which people live have an effect on how strongly people perceive natural hazards in relationship with demographic, well-being, and social network factors. Generally, our research indicates that *levels* of risk perception for past, present, and future aspects of a specific hazard are similar across these two countries and seven sites. However, these contexts produced different predictors of risk perception—in other words, there was little overlap between sites in the variables that predicted the past, present, or future aspects of risk perception in each site. Generally, current stress was related to perception of past danger of an event in the Mexican sites, but not in Ecuador; network variables were mainly important for perception of past danger (rather than future or present danger), although specific network correlates varied from site to site across the countries.

**Keywords:** Comparative analysis | Disasters | Cross-cultural research | Emergency response Resettlement | Latin America | Risk perception

### **Article:**

This exploratory research is part of a larger effort to understand the role of social networks in various aspects of disaster mitigation and recovery. Our prior research and engagement with the literature on responses to natural disasters suggested greater care and detail was required in studying the roles of relationships and social support in hazard mitigation. In this study of hazards experienced by people in Ecuador and Mexico, we examine how the structure and composition of social networks are associated with risk perception in different affected sites, while taking into account other influences found to affect risk perception. Although insights from social network analyses are relatively new to disaster and hazard studies—and still unexplored in the study of risk perception—our effort can be seen as building on research on the “culture of response” (e.g., Dyer and McGoodwin 1999) that investigates how people in different places respond differently to similar hazards or disasters. Specifically, we explore how disaster-affected communities differ in the role of demographic variables, individual well-being factors, and social influences on risk perception. Because there is a lack of research on social networks and risk perception—especially comparative research on social networks and risk perception—our study is necessarily exploratory.

In addition to inter-societal and individual differences in risk perception there are differences between communities that can produce different pressures for individuals responding to hazards and disasters. We think that differences in the experience of the same hazard at different sites may lead people to form different senses of risk, especially when actually faced with a disaster, since disasters often result in relocation of individuals and/or communities. For this study, we interviewed relocated and non-relocated populations faced with volcanic hazards and landslides. This study seeks to go beyond measuring variation in risk perception to identifying possible mechanisms for that variation.

A review of the comparative research on disaster-related political economic change, psychological impacts, and social support showed relatively little variation in post-disaster social support between societies or between cultural groups within societies (Jones and Murphy 2008). However, the review found moderate variation cross-culturally for mental health consequences of disasters and also high variation in post-disaster political dynamics, including elections and responses by governments and elites. We posit that risk perception is affected by all three of these sets of variables. For example, high social support (in this case, network density) could be associated with high tendencies toward conformity, and thus one’s risk perception would depend on those around them; poor mental health status can create fearfulness; and variation in political economic strategies of elites (e.g., protecting private resources vs. protecting public goods and services; cf. Blanton et al. 1996) could make people more (or less) worried about hazards, depending on their position in society and what they might stand to lose in a disaster. It is important to understand which *outcomes* tend to vary cross-culturally and which do not, plus which *factors* vary in predicting these outcomes in different contexts.

We are interested in how societies structure vulnerability. A framework that we use to understand who is vulnerable in the face of disaster includes how infrastructure, land, investment potential, and control over labor are accumulated and maintained by elites, as well as how individuals and households engage these larger economic and political processes (Jones and Murphy 2009). At the macro level for risk perception, this approach would involve how governments and media mitigate risks, portray various risks, and respond to disasters. At a more micro level, this includes how people perceive the conditions in which they live and how they

choose to live with those perceived risks. We use this approach because it reminds us that hazards are not just individually experienced, they are constructed, encountered, and marked through living in communities. In this study, we compare several communities in two countries in terms of levels and correlates of risk perception. We review the cross-cultural literature on risk perception, although this literature primarily focuses on levels of perceptions and the hazards with which they are associated, rather than predictors of risk perception.

## **Understanding Risk Perception Cross-Culturally**

Cross-cultural research on risk perception has focused almost exclusively on which kinds of risks (e.g., technological, environmental, epidemiological) are prominent in each country and how perception of these risks varies across different demographics. These comparative studies have surveyed the general population and their perceptions about a variety of hazards, but they have generally not examined variation in exposure to specific hazards or disasters. We want to understand whether (and why) people already exposed to a hazard perceive risk associated with that hazard. We engage the comparative literature on risk perception in order to build upon it and to expand its domain. We primarily rely on literature involving two or more systematically studied societies or populations of different cultures, although some important theoretical contributions are noted from reviews and studies of single cases.

The two general approaches to the cross-cultural study of risk perception—the psychometric approach and the cultural approach—are primarily distinguished by their respective methodologies and are theoretically quite complimentary rather than being competing theories of human nature. The psychometric approach treats risk as individually subjective and takes into account technical and social/psychometric criteria for measuring risk magnitude and acceptance (Fischhoff et al. 1978). One critique that might be leveled at this approach is that it is under-socialized—that relationships are insufficiently addressed. The primary focus is on the cognitive constructs of risk perception in individuals and the patterns of distribution of these perceptions within and between populations. In the studies that have involved two or more countries and focus on generalized constructs of risk, such as voluntariness, controllability, and novelty, two broad risk factors have emerged: the degree to which risk parameters are perceived to be unfamiliar and involuntary by those exposed (i.e., unknown risk), and the degree of fear and perceived severity/catastrophic potential (i.e., dread risk; Goszczynska et al. 1991). To wit, these scholars have been interested in whether people are worried about the unknown aspects of hazards or about their magnitude/extremity.

On the other hand, the cultural approach in disaster research generally treats risk perception as a process of implementation of norms, values, and cultural practices within a group of people (Douglas and Wildavsky 1982; Heimer 1988; Johnson and Covello 1987; Rayner and Cantor 1987; Schwarz and Thompson, 1990; see also Cvetkovich and Earle 1991). Basically, the interest is on culturally distinct subgroups or groups (including whole nations) and how beliefs and practices regarding risk are instituted and reflected by people in those groups. Again, though, the interest in this field has been on what a general population perceives as hazardous rather than on risk perception for a given hazard a specific population has faced. The critique that might be leveled at this approach is that it is over-socialized—that specific relationships are ignored since the society organically distributes thoughts and behaviors.

In studies replicated in the United States, Hungary, Norway, and Poland (Englander et al. 1986 for Hungary; Teigen et al. 1988 for Norway; Goszczynska et al. 1991 for Poland), respondents rated several dozen hazards. The cognitive structure of risk was similar for each (i.e., relative importance of unknown risk and dread risk), and the mean degree of perceived risk across all categories was 46.1 for the United States, 38.1 for Poland, 32.4 for Norway, and 27.7 for Hungary. Americans were most concerned about risks associated with chemical substances and new technologies. Scores were highest for narcotics and psychoactive drugs in Norway. Hungarians were more concerned with the risks associated with cigarette smoking, alcohol, and road accidents. The authors in each case speculated, but could not ascertain, that this variation could be due to variations in geography, socioeconomic variables, political trends, and demographics between the countries. Some of the variation could be explained by the greater frequency of particular hazards, such as new technologies and chemical substances in the United States, but others, such as traffic accidents and smoking, could not. Englander et al. (1986) suspected that this may be due to over-reporting on dangerous accidents outside of Hungary and underreporting dangerous accidents inside Hungary. Goszczynska et al. (1991) suggested that having and reporting more incidents of accidents and negative events influenced risk more than did social, economic, and cultural backgrounds. More specifically, they argued that larger countries are more likely to have a greater number of accidents, hazards, and extreme events, and reporting these events is less likely in countries with constraining media policies, such as Hungary before the Soviet Union's *perestroika* (also suggested by Englander et al. 1986). Goszczynska et al. (1991) also found in Poland that lay urban dwellers were more likely than their lay rural counterparts to rate technological hazards, tourism, and certain recreational activities (things urban dwellers were exposed to more often) as hazardous, but that technicians' ratings did not vary between rural and urban areas, presumably because they relied more on technical information they had in common and less on external indicators of risk. We do not look at the role of media in our study, although all of our sites have relatively low print media circulation and all but one of our sites have fewer televisions than would be found in most urban areas.

Research using both the psychometric and cultural approaches conducted in Australia, New Zealand, and Germany found that Australian groups have a higher acceptance of sport-related risks (e.g., car racing or skiing), unhealthy private behaviors (e.g. smoking, overeating), and conventional technologies (e.g., airports, coal power plants) than do Germans, but Australians gave more negative evaluations than did the Germans to risk-exposed occupations (even those of high social benefit, e.g., firefighting), environmental pollution, and a large-scale technology such as nuclear energy (Rohrman 1994). Analysis did not reveal any significant differences in sources of risk except earthquakes for New Zealand, nor differences in overall sense of dread, controllability, and potential risk outcomes between the Australian, New Zealand, and German groups. Rohrman found that, within Australia, fear of health impacts is higher for risks with acute rather than chronic effects; risk acceptance was higher for occupational risks and for risks associated with private activities, while greater societal benefit is seen for risky occupational activities than private recreational ones. Rohrman also found that people self-identifying as "ecologically oriented" and "feminist" (based on issue-based attitude scales) had higher ratings on all riskiness scales as well as feelings of anxiety, and their benefit judgments and risk acceptance were lower than other subgroups. Technologically oriented respondents reported the lowest risk ratings, identified more benefits, and were more willing to accept risks. The

judgments of the “financially oriented” group were in between the extremes. Perhaps owing to socially conservative vs. liberal attitudes, engineers and technology students gave the lowest acceptance ratings to consumption risks (e.g., smoking, tranquilizers, and overeating) while the ecological and feminist groups yielded the highest scores (Rohrman 1994). Our own samples are relatively homogeneous along these axes and are composed of peasant farmer families or day laborers, including factory workers in one site, and thus we have reduced some influences of individual background factors.

A study of risk perception in Japan, China, and South Korea found that Chinese citizens had the highest tolerance for risk (Zhai and Suzuki 2009). Earthquakes ranked high as the primary risk in each country and hazards such as global warming, cancer, fire, and car accidents were considered higher-order risks, whereas other infectious diseases and technological hazards were considered lower-order risks.

The comparative studies above demonstrate that populations in different countries vary in terms of *what* they find risky. Moreover, risk perceptions tend to vary in terms of the degree to which people experience dread or fear and not knowing or not having control. However, comparative studies thus far have addressed concerns of the general population—not disaster-affected subpopulations—and have reported relatively little on what factors are associated with risk perception. A few of the above studies, as well as many single-country studies, do focus on the variables associated with intra-community variation in risk perception, which allows countries to be compared more systematically. The following are several demographic variables implicated in variation in risk perception, though largely from single-country studies, not comparative studies.

### *Age*

The perception of risk was associated with age more in China and South Korea than in Japan (Zhai and Suzuki 2009). Armas and Avram (2008) conducted a study of earthquake risk perception in Bucharest, Romania, and found that age was negatively correlated with ability to predict events and positively associated with the potential impacts on life and personal security (see also Armas 2006; Dwyer et al. 2004; Ngo 2001).

### *Gender*

In Zhai and Suzuki’s (2009) findings, Japanese women overall had higher mean risk scores than men, whereas the results were the opposite in China and South Korea. In a study in Taiwan, Ho et al. (2008) also found that gender was a good predictor of disaster attitudes among disaster victims, as males perceived a lower level of potential and economic impacts and had a lower sense of dread than female victims. Similarly, Armas and Avram (2008) in their single-country study found that women exhibited a greater degree of confidence in the capacity to predict earthquakes than men, a higher level of dread, greater preparedness (likelihood of storing emergency reserves), and greater confidence in mitigation strategies than men. Thus gender is an important variable to control for in our cross-site and cross-national comparisons.

### *Education*

The perception of risk was more influenced by level of education in China and South Korea than in Japan (Zhai and Suzuki 2009). Armas and Avram (2008) found that education was negatively associated with perceived severity of disaster outcomes in Romania.

#### *Population Density*

Armas and Avram (2008) also found that willingness to relocate was highly correlated with residential density (number of apartments per floor), and people in duplexes and detached houses were less likely to be willing to relocate. This could be because of a desire to seek more comfortable and less dense living conditions, as suggested by the authors, but it might also partly be a proxy for home ownership such that people who owned properties were less willing to move and those who rent might be more likely to relocate.

#### *Religion*

Religious subjects generally perceived greater possible disaster impacts and had an overall greater level of concern with potential disasters than did non-religious respondents (Armas and Avram 2008). This is intuitively reasonable for participants in millennialist faiths or movements, but less so for religious subjects who might use their faith to mitigate concerns about extreme events—in the field, we certainly heard people say their deity would protect them, or that their deity has reasons for whatever it allows to happen to them. However, we do not have sufficient variation in our variable of denominational affiliation within some research sites for correlation with risk perception. Virtually all participants in all of our samples self-identify as Catholic, although analyses were conducted when variation was sufficient.

#### *Well-being*

In a recent study, Tobin et al. (2011) considered the relationship of mental health, physical health, and household conditions to risk perception in chronic and acute hazard settings, in addition to the role of demographic factors and evacuation beliefs and behaviors. Their results were presented for the same two Mexican sites discussed here; the current paper takes up the role of well-being in comparative fashion—comparing Mexico and Ecuador.

In summary, several sociodemographic factors plus cultural context are expected to play roles in risk perception, although there has been insufficient research on the more social aspects of risk perception. We work toward what we see as an important effort to account for real, situated relationships, interactions, and mutual and unidirectional influences on risk perception.

### **Social Factors in Risk Perception**

People's relationships have been found to play important roles in individual and community recovery from disasters (e.g., Hobfoll 2002), which in turn could reasonably be expected to influence risk perception after the experience of disaster. What influences do other people have on our perceptions of risk? Tobin et al. (2011), in a study of many factors of risk perception in a disaster setting, called for further research on social aspects of risk perception. Research in the past decade has only begun to address this question, albeit through case studies and not cross-culturally. A study in Malawi on perception of health risks (HIV/AIDS) found that network

effects are mediated by gender, marriage, and geographic region but generally can be characterized on the one hand as people seeking information from their networks and, on the other hand, that having many people in your network concerned about a risk can increase your own concern with the risk (Helleringer and Kohler 2005). In a short pioneering piece on social networks and risk perception, Scherer and Cho (2003) studied perceived risks from a hazardous waste cleanup site and found that the strength of ties between actors predicted similar risk perceptions but did not predict similar attitudes about a control question about belief in science.

Recent efforts to address this domain of networks and risk perception have even included computer modeling. Kitchovitch and Liò (2010) sought to add social network impacts in an existing model of risk perception in order to study possible reduction in risky behaviors once at least some members of a social network are made aware of them. Regarding network structure, such studies generally consider only network density and size and the strength of ties between actors in the network. We have chosen in this manuscript to test a number of theoretically relevant network measures because the findings from these few studies beg further inquiry about the nature of social influences on risk, and whether such results hold up cross-culturally—particularly in the context of extreme community events.

We hypothesize that the nature of personal networks may predict individual adjustment post-disaster, and here we extend this general hypothesis to the examination of risk perception. Specifically, we investigate whether risk perception is associated with aspects of the content of personal networks: sociodemographic variation, receiving or providing different types of support, who is perceived as a potential helper, and with whom interaction occurs. We also examine personal network structure to explore connections between risk perception and number of relations, network density, various forms of network centralization, and the presence of subgroups in the network.

Community recovery from disaster depends in part on individuals feeling that they are part of a strong network and can thus overcome adversity (Hall et al. 2003; Hobfoll 2002; Reissman et al. 2004; Tobin and Whiteford 2002). However, dense networks of strong ties might create redundant feedback loops not conducive to the introduction of new information regarding evolving risk conditions. Relatedly, when an individual's network does not include different subgroups, the potential exists for restrictive norms to limit a person's choice of how and from whom to seek help (Avenarius 2003; Unger and Powell 1980; cf. Avenarius and Johnson 2004 as an example of a disaster study). However, the presence of subgroups might present a vulnerability to opinion leaders in the development of risk perception. Density, because it is associated with trust within the network (Buskens 1998), but not between individuals from different networks, could be expected to have a negative association with perceived risk. Our goal in this manuscript is to better understand predictors of risk perception that vary cross-culturally, particularly social network structure and content.

## **Methodology**

In Mexico, we collected data from April to August 2007 in San Pedro Benito Juárez, and from April 2008 to March 2009 in Ayotzingo. In Ecuador, we interviewed in the five sites between April and December 2009. First, we administered a half-hour preliminary sociodemographic

survey to a random sample of households at all sites. The data from this questionnaire were used to establish the distribution and basic attributes of the each reference group and provided the basis for the random sample used in subsequent surveys.

The sociodemographic survey was followed by a 90-minute well-being and personal network survey. We administered the second survey to a randomly selected adult in each study household. *Well-being* included scales covering economic status and employment status, mental health, health, and household conditions. *Personal networks* involved the interviewee naming several individuals and then reporting on the relationships between those people in order to understand the kind of influences and support the interviewee has. We asked participants to “Please list the people you know by sight or by name with whom you have had contact, or could have had contact if you needed to, in the past 2 years (we would like you to list 45 names)” (after Bernard et al. 1990; McCarty 2002; McCarty et al. 2000). We then asked the interviewee for basic demographic information about a randomly chosen pre-selected sequence of 25 the named individuals (those corresponding to the same 25 numbers on each list of 45) since a random subsample of ~20–30 individuals from the larger list of individuals (~40–60) named by a respondent provides accurate structural representations or measures of a personal network (McCarty and Killworth 2007; Chris McCarty, personal communication). Interviewees were also asked to indicate the presence and strength of interactions between individuals in the random subsample of people they named.

### **Measures of Dependent Variable of Risk Perception**

Risk perception questions were used to understand whether people are concerned about the past, present, and future nature of the hazard. The well-being data covered disaster experiences and household disaster impacts, including health, economic, psychological, and social effects. Data on risk perception were collected by asking respondents if they were concerned about living where another disaster event could happen (**Currently Concerned**) and if they believe that their or their family’s lives were in danger because of a specific disaster event (**Perceives Past Threat to Life**), another disaster event could happen during their lifetime (**Expects Future Event**), and if they have plans for evacuating if another event occurs (**Plans to Evacuate**). We also created a five-point overall risk perception variable that combined these three measures plus desire for future assistance from an institution in evacuating.

### **Independent Measures**

#### *Site-Based Characteristics*

In order to measure the effects of different site types in our sample, we developed four variables to account for site-based variation in risk perception: (a) urban vs. rural; (b) resettled vs. non-resettled; (c) low- vs. high-impact sites; (d) Mexico vs. Ecuador.

#### *Sociodemographic Variables*

To account for demographic attributes already known to be relevant for risk perception (Dash et al. 1997; Peacock and Ragsdale 1997; Peacock et al. 2005), respondents were asked about household wealth (number of rooms in house), as well as their age (10 ordinal categories), gender, civil



status (married or as-if married, single/widowed/divorced), second language spoken, occupation (whether or not they farm), religion, years of education (4 ordinal categories), number of close kin living abroad (typically United States for Mexico and Spain or United States for Ecuador), and whether an institution or a benefactor helped them after the extreme event.

### *Well-being*

Our survey employed commonly used scales to assess post-traumatic 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), including the post-traumatic stress symptoms (17 items) and measures of functioning as a result of the post-traumatic stress (4 items); depression symptoms from the CES-D (20 items; Radloff 1977); health symptoms (24 items) excerpted from the Physical Symptoms Checklist (Leventhal et al. 1996); household living conditions (10 items) using the Ecological Stress Scale, measuring such things as discomfort with temperature and lack of food or space (Riad and Norris 1996); perceived support from the Provisions of Social Relations Scale, including subscales for perceived support from friends (7 items), family (7 items), and spouse (8 items; Turner and Marino 1994); and Recent Life Events (9 items consisting of moves, changing households, conflict, estrangement).

### *Network Content*

We collected demographic variables for 25 of the network members (referred to as *alters* in social network analysis) named by each interviewee—the interviewee for focal individual is known as *ego* in social network research. We calculated average age, as well as percentage of each network constituted by each the following: females in network, higher/same/lower socioeconomic status relative to interviewee, bilingual (as a measure of ethnicity), religion, very/somewhat/not close to ego emotionally, having given and/or received material support, informational support, emotional support, and work/labor with ego.

### *Network Structure*

In addition to the demographic and socioeconomic composition of the network and the incidence of support exchanges, we created ratio measures of network structure. To create networks for each ego, we asked them whether each of individuals in their network interacted with one another a lot, some, or little/none. Delphi-based EgoNet 2.0 ([www.mdlogix.com](http://www.mdlogix.com)) was used in Mexico and the Java-based EgoNet (<http://sourceforge.net/projects/egonet/>) was used in Ecuador to collect and analyze the data to produce the following measures: **Components**, or the number of sets of alters in which each alter is tied to every other alter directly or indirectly (where each set is totally disconnected from the others), is a measure of disconnected subgroups; Normalized average degree (i.e., **Density**), or the mean for all alters of the direct ties between them and other others, implicates the roles of homogeneity (everyone knows everyone) but also varied potential paths for transmission of information and opinion about risk (lots of ways to get from A to B); **Average betweenness**, or the mean for all alters of the proportion of times each alter lies on the shortest path between all pairs of alters in the network, can show the importance of bridging or unique paths through a personal network for influencing aspects of risk perception; **Degree centralization**, or the extent to which the network has only one or a few people who know most

people, can be important for information/opinion gatekeeping and influence on respondent's risk perception; **Betweenness centralization**, or the extent to which the network is dominated by a few alters that lie on the paths to all other alters, can highlight the role of networks with one or very few unique bridging people that tie together the respondent's personal network; **Isolates**, or the number of isolated alters with no ties to any alters in the network, shows us how fragmentation or disconnectedness in a network is associated with risk perception; **Dyads**, or the number of times two alters are connected but neither is connected to any third alter, is another measure of fragmentation.

## Analysis

We approached the analysis with an interest in describing differences between sites in terms of (1) demographic and contextual factors; (2) level of perceived risk; (3) testing the relationship between sociodemographic and contextual variables and risk perception in each site; (4) testing the relationship between well-being variables and risk perception in each site; and (5) testing the relationship between network variables and risk perception in each site in order to understand how risk perception might vary across social and cultural contexts. In this article we limit examination of intra-site variation to reporting the extent to which a variable was associated with a risk perception variable in each site. Mann-Whitney U tests were calculated for the relationship between binary against ordinal or interval variables, and Pearson's chi-square for binary against binary variables, with significance set at  $p < 0.05$ .

## Sites

Because cross-cultural research is concerned with finding which phenomena and causal factors differ across societies and cultural contexts and which are relatively universal, the challenge is to find countries and samples that do not widely differ on too many contextual factors. When studying disasters or risk perception cross-culturally, finding comparable samples in different countries becomes a major challenge since no two disaster experiences are alike, plus hazardous conditions are often dissimilar.

We chose the State of Puebla, Mexico, and the provinces of Chimborazo and Tungurahua, Ecuador, both Spanish-speaking Latin American contexts, because of important similarities and differences. Notwithstanding a general cultural similarity in language and colonial history, a major difference in context is that Ecuadorians have a much lower expectation of the capabilities and desirability of intervention by National Guard-type forces, whereas Mexicans have seen the intervention by these forces as more normal and acceptable (at least prior to subsequent government warfare with drug mafias in northern Mexico).

In Tungurahua and Chimborazo Provinces in Ecuador, we chose to vary the sites by degree of impact from the eruptions of the stratovolcano, Mt. Tungurahua: "low impact" involved occasional volcanic ashfall; "high impact/evacuated" involved chronic heavy ashfall, occasional rock fall from eruptions, evacuation in 1999, and two evacuations in 2006; and "high impact with resettlement" involved houses destroyed by lahars, evacuation in 1999, two evacuations in 2006, temporary housing for years for some people, and eventually resettlement in 2008. In Mexico, we chose a minor disaster that involved chronic volcanic eruptions and evacuations in 1994 and 2000, and a major disaster involving landslides in 1999 that were too sudden for evacuation and that resulted in resettlement of around 300 households in 2000. One Mexican site

was non-agricultural, and one Ecuadorian cite was partially agricultural. The other sites were dominated by agriculturalists. Table 1 provides further description of the sites in terms of some of the contextual similarities and differences.

**Table 1**  
Selected characteristics of study sites

Site (Country)	Disaster impact	Settlement pattern	Disaster type	Pop	% Male/female	% Occupied houses	Time since last evacuation
Penipe Viejo (EC)	Low, not evacuated	urban village	Volcano	710 <sup>c</sup>	50/50	79	not applicable
San Pedro Benito Juárez (MX)	Low, evacuated	rural village	Volcano	3,512 <sup>a</sup>	44/56	78	7 years
Pillate (EC)	High, evacuated	rural village	Volcano	193	49/51	80	3 years
San Juan (EC)	High, evacuated	rural village	Volcano	172	53/47	88	3 years
Pusuca (EC)	High, resettled	rural village	Volcano	161	48/52	93	3 years
Penipe Nuevo (EC)	High, resettled	urban village	Volcano	1,405	50/50	98	3 years
Ayotzingo (MX)	High, resettled; dozens of deaths	urban neighborhood	Flood	1,609 <sup>b</sup>	45/55	98 <sup>b</sup>	9 years

All data original based on study samples, unless otherwise noted.

<sup>a</sup>Centro de Salud de San Pedro Benito Juarez, 2005, unpublished archives

<sup>b</sup>Centro de Salud de Ayotzingo, 2008, unpublished digital spreadsheet

<sup>c</sup>Instituto Nacional de Estadísticas y Censos (2001)

**Penipe Viejo** is a small township that also serves as the county administrative seat of Penipe County in Chimborazo Province, Ecuador. Penipe sustained moderate ashfall during major eruptions in 1999 and 2006, and occasional light ashfall in the interim and ensuing time periods that has caused minor damage to buildings, crops, roads, and utility infrastructures, as well as

presented some public health risks. Penipe was never evacuated for any of the eruptions, as it lies well beyond the extents of prior lahars and pyroclastic flows that pose the risk of death or injury. Penipe has served as a base of emergency response operations during the major eruptions, and several local buildings were repurposed as shelters for nearby evacuees. The eruptions affected Penipe economically, politically, and demographically, especially since the 2008 resettlement added 285 houses to the township's previously existing 190 households. Though there is some small agricultural production at the margins of town and, to a lesser extent, some animal husbandry, most Penipeños make a living from small businesses in town (e.g., restaurants, stores, trades) or wage employment in the larger city of Riobamba.

**Penipe Nuevo** is a resettlement community built as an extension of the urban center of Penipe Viejo; it is the new part of town. Beginning in late 2007 and continuing into mid-2008, the Ecuadorian Ministry of Housing and Urban Development and Samaritan's Purse, a multinational, Evangelical Christian disaster relief organization, constructed 185 and 100 homes, respectively, on the southern edge of Penipe's municipal center. These 285 houses were granted to villagers displaced from more than a dozen villages in the northern parishes of Bilbao, El Altar, and Puela after the major eruptions of Mt. Tungurahua in 1999 and 2006. At least five deaths resulted in this area (United Nations Office for the Coordination of Humanitarian Affairs 2006). Resettlers were predominantly small-holding agricultural producers who found themselves without land, productive resources, or employment opportunities in the resettlement. Though some have sought limited employment in nearby Riobamba and even fewer have created small businesses in the resettlement (usually small convenience stores), the majority of the residents of Penipe Nuevo still travel daily to their lands in the high-risk zone in order to produce food for household consumption and, now to a lesser extent, for market. Chronic ashfall in the high-risk zone has greatly diminished the productive capacity of soils and fruit trees in the region and created a health hazard for both humans and livestock.

**Pusuca** is a resettlement community of 45 households approximately five kilometers south of Penipe Nuevo. The rural resettlement was largely built by Fundación Esquel, an Ecuadorian non-governmental organization. Resettlers in Pusuca hail from the same villages as those in Penipe Nuevo. However, unlike in Penipe Nuevo, each household in Pusuca was provided a little more than one half hectare of land for agricultural production and/or livestock, and there are additional communal plots of land for cooperative agricultural production. Although some resettlers in Pusuca, like those in Penipe Nuevo, have sought wage employment in nearby cities, agricultural production is the primary economic activity of nearly two-thirds of households in Pusuca—some of them farm in Pusuca, and many continue to farm in the high-risk area from which they were relocated.

**Pillate** and **San Juan** are two adjacent villages in Tungurahua Province, to the north of Penipe and directly across the River Chambo from the western flanks of Mt. Tungurahua. The two communities of approximately 40 and 30 households, respectively, are just three kilometers west of the volcano and well within the high-risk zone. They were evacuated for both eruptions in 1999 and 2006, and the villages suffered immense damages as a result of heavy ashfall, incandescent material, and tremor-induced landslides. In spite of this damage, approximately 70% of the former residents of these communities returned to live in and rebuild the villages after each eruption. Like their neighbors in the northern parishes of Penipe County, their homes

sustained significant damage in the major eruptions, and the productive capacities of their soil and fruit trees have been greatly reduced by continued chronic ashfall.

**San Pedro Benito Juárez** is an agricultural village of approximately 850 Nahuatl and Mestizo households that lies on a fracture zone on the southeastern flanks of Mt. Popocatepetl, directly west of the city of Puebla, Mexico. The village is also known for high rates of migration to urban centers in Mexico and the United States. The village is the closest of its neighbors to the crater of the volcano, and it lies in one of the areas most likely to be hit by lithic projectiles and pyroclastic flows, although ashfall and prevailing winds more commonly flow to the east and northeast of the volcano. Despite its proximity to the volcanic hazard, the community's residents have the reputation for being resistant to evacuation. An eruption in December of 1994 deposited ash over a wide area and led to the evacuation of San Pedro Benito Juárez and neighboring villages. This was the beginning of a new eruptive phase for the volcano and meant that area residents were increasingly at risk with the subsequent mild-to-moderate activity. In December of 2000, Popocatepetl erupted again, more powerfully than before, resulting in a second evacuation, though many villagers chose to remain (Tobin et al. 2007). Those who chose to leave often said that they did so only because their children were frightened. People say they do not evacuate because of one or more of the following: "nothing will happen," "whatever happens is God's will," "we can't afford to leave our animals behind," or "I was born here, I'll die here."

**Ayotzingo** is a resettlement of just over 300 houses. Families relocated from various neighborhoods in the mountain city of Teziutlán (pop. ~50,000) after flooding and landslides destroyed significant parts of the city in 1999. Teziutlán is located on the eastern slopes of the Sierra Madre approximately 250 km northeast of Puebla, Mexico. More than 400 people lost their lives and more than 200,000 lost their residences (Garcia2000) along the Mexican Gulf Coast. In Teziutlán, entire sections of the city were washed away, causing millions of dollars of damage. As part of the recovery, approximately 350 families were given plots and building materials in Ayotzingo, a state-funded resettlement community several kilometers away from town, between 4 and 12 months after the disaster, although at first they had cold water only and no electricity (Norris et al. 2004, 2005). As an indication of community isolation, the commute to Teziutlán and back is a bus ride that can cost one-fourth of a day's wage, an expense which keeps visiting to a minimum.

## **Results and Discussion**

For presentation, we divide our risk perception questions in terms of how respondents perceived what happened during the most recent disaster at the time of research, what their level of concern is about current risk, their expectations about whether or not future events will occur, and their plans for evacuation in the case of reoccurrence of an extreme event.

### **Levels of Risk Perception**

Table 2 shows the percentages of people answering yes to the four risk perception questions in each of the study sites. All sites have been exposed in some fashion to a hazard—although actual degree of impact varies—and three of the populations are from disaster-induced resettlements. There is relatively low variation across all sites for expectations about what will happen in the

future. San Pedro Benito Juárez, despite being the low-impact site in Mexico, ranked lower for current concern about risk but still relatively high for what is expected to happen in the future. Residents of San Pedro Benito Juárez tended to minimize the risk present in past eruptive events, often claiming that authorities overreacted in evacuating the area, and that risk from the volcano had subsided, leaving no further cause for worry.

**Table 2**

Comparison of study sites in levels of perceived risk, percent answering yes

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>	<b>Overall perceived risk (0–5)*</b>
Penipe Viejo (EC)	56%	22%	93%	71%	3.8
Urban					
Low impact, not evacuated					
San Pedro Benito Juárez (MX)	21%	40%	73%	71%	3.4
Rural					
Low impact, evacuated					
Pillate (EC)	77%	55%	91%	84%	4.2
Rural					
High impact, evacuated					
San Juan (EC)	70%	77%	90%	79%	4.4

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>	<b>Overall perceived risk (0–5)*</b>
Rural					
High impact, evacuated					
Pusuca (EC)					
Rural to rural resettlement					
High impact, resettled	92%	45%	100%	83%	4.2
Penipe Nuevo (EC)					
Rural to urban resettlement					
High impact, resettled	87%	62%	88%	72%	4.2
Ayotzingo (MX)					
Urban					
High impact, resettled	84%	80%	76%	85%	4.3

\*Kruskall-Wallis:  $\chi^2 = 37.52$ ,  $df = 6$ ,  $p = .000$

The low-impact volcanic sites of San Pedro Benito Juárez and Penipe Viejo registered lower perceived past threat, although the latter saw a majority remembering that they feared for their lives or the lives of others when the event occurred. Furthermore, in the aftermath of major volcanic events, Penipe has been transformed by the construction of the resettlement community (Penipe Nuevo), whose presence and daily negotiation of hazards in the high risk zone have helped to create a greater “culture of risk awareness” in the otherwise low-impact site.

Considerable variation between sites exists for current concern, with a minimum of 22% in Penipe Viejo and a maximum of 79% in Ayotzingo. Again, Penipe Viejo, as a low-impact site outside the high-risk zone, was expected to have generally low risk perceptions, whereas Ayotzingo, whose residents suffered the most devastating disaster event in our sample, could be expected to continue to be concerned about the prospect of another similar event, even years after the disaster.

Although residents experienced a disaster 9 years prior to our interviews in the Mexico sites, high-impact Ayotzingo still had elevated levels of risk perception that were similar to those at the Ecuador sites that had experienced eruptions only 2 years before our interviews. In terms of more general comments about human nature, we note in Table 2 that people aren't as concerned about living where something could happen again, although they believe that possibility to be very real—this gives us some indication that it is somewhat common to ascertain risk yet not be highly concerned by it. In all cases, a higher percentage of people in each site are more likely to evacuate than they are to be concerned currently about living where it could happen again. In all but Ayotzingo (an infrequent flood event, unlike the chronic volcanic locations at the rest of the sites), fewer people plan on evacuating than anticipate another event occurring.

Table 2 in many ways suggests there is some uniformity to risk perception regardless of rural-urban setting, relocation/non-relocation, and the country or cultural context, as long as the hazard has had a large impact. Nonetheless, this does not mean risk perception works in the same way in each place. Table 2 has been organized to put the lowest exposure to risk (from our perspective) at the top and the highest exposure to risk at the bottom, with evacuated sites separate from resettled sites. The three relatively urban sites are the first one and the last two in the list.

We next conducted Mann-Whitney U tests to evaluate the difference in overall perceived risk (scale 0–5) between different site types in our sample: (a) urban vs. rural; (b) resettled vs. non-resettled; (c) low vs. high impact sites; (d) Mexico vs. Ecuador (Table 3). Urban sites had significantly higher rates of past and present risk perception than did rural sites, though there was no significant difference for future perspective. Similarly, resettled sites had significantly higher rates of past and present risk perception than non-resettled sites, but there was no significant difference for rates of perception that a future event is likely. This trend in findings continues when we test rates of perception for low and high disaster impact sites. Again, we find that high-impact sites have significantly higher rates of past and current risk perception, as well as plans to evacuate, but no significant difference for expecting it to happen again. Finally, when we test by country, we find a somewhat more nuanced pattern—Ecuadorian sites have a significantly higher rate of past and future risk perception, while Mexican sites have a significantly higher rate of current risk perception. For the overall perceived risk scale, significant differences are noted between resettled and non-resettled ( $p = 0.000$ ), low impact and high impact ( $p = 0.000$ ), but not between rural and urban ( $p = 0.198$ ) or Mexico and Ecuador ( $p = 0.827$ ).

**Table 3**

Relationships between site type and rate of risk perception (Mann-Whitney U)

	Perceives past threat to life	Currently concerned	Expects future event	Plans to evacuate



Site type	Mean rank	Sig.	Mean rank	Sig.	Mean rank	Sig.	Mean rank	Sig.
Rural	200	.000	210	.011	218	.308	222	.852
Urban	245		238		210		220	
Non-Resettled	181	.000	196	.000	216	.653	216	.331
Resettled	258		247		212		224	
Low Impact	145	.000	166	.000	208	.399	205	.047
High Impact	252		245		215		227	
Mexico	210	.001	247	.002	194	.000	227	.272
Ecuador	240		212		229		217	

In general, it makes sense that urban sites have a higher rate of past risk perception because two of the three urban sites are also resettlement sites that were heavily impacted. Urban and resettlement sites have higher rates of current risk perception than their rural and non-resettlement counterparts despite the urban and resettlement sites now being spatially removed from the risks they faced in the past. They may be additionally preoccupied by a new set of urban risks. We also know that people from both resettlement sites in Ecuador continue to rely heavily on agricultural production and animal husbandry in the hinterland near or within the volcanic high-risk zone, which could contribute to their comparatively heightened perception of current risk. That high-impact sites would have a higher past and current risk perception than low-impact sites should come as no surprise. In some way, this translates to future action, as people at higher-impact sites do not perceive greater likelihood of an event, but they are more likely to evacuate in the future. Finally, the country-level results are more challenging to explain. Past impact being higher for Ecuador than Mexico could be explained by the fact that all but one of the five Ecuadorian sites were recently affected and continue to experience ashfall, but Mexico having a higher rate of current risk perception may be due to the loss of life that was involved and the higher proportion of the sample that was relocated. Beyond level of impact, it is possible that other well-being and social network factors account for some of this variation, which we test below.

### **Sociodemographics and Risk Perception**

When we look at possible correlates of these risk perception questions in each site, we find considerable variation. Tables 4, 5, and 6 present the variables that were correlated at  $p < 0.05$  ( $t$ -test; Mann-Whitney U) with each of the risk perception questions for each site. In these tables,

only significant results are presented; thus, some of the variables described above were analyzed, but do not appear in the tables. Table 4 covers sociodemographic, behavioral, and contextual variables; Table 5 covers social support, mental health, physical health, household conditions, and recent life events; and Table 6 covers variables concerning the content and structure of personal networks. In Ecuador, reported perception of risk is very high for most sites for most questions, which may mean there is excessively low variation in the dependent variable of risk perception. Nonetheless, there are many correlations in Tables 4, 5, and 6, and they are generally different for different contexts.

**Table 4**

Significant relationships between sociodemographic variables and risk perception (yes/no), by site (Mann-Whitney U for ordinal variables; Chi-square for dichotomous variables;  $p < .05$ ; italic variables show negative correlations)

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
Penipe Viejo (EC)				
Urban				
Low impact, not evacuated	–	–	– <sup>a</sup>	# rooms in house
San Pedro Benito Juárez (MX)		married		
Rural				
Low impact, evacuated	institution or boss helped them	<i># rooms in house</i>	any close kin living abroad	–
Pillate (EC)		gender		
Rural				
High impact, evacuated	gender	<i># rooms in house</i>	– <sup>a</sup>	–
San Juan (EC)				
Rural				
High impact,	–	–	– <sup>a</sup>	–

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
evacuated				
Pusuca (EC)				
Rural to rural resettlement				
High impact, resettled	–	–	– <sup>a</sup>	education
Penipe Nuevo (EC)				
Rural to urban resettlement				
High impact, resettled	<i>married</i>	–	<i>age</i>	–
Ayotzingo (MX)		# rooms in house		
Urban		# close kin living abroad		
High impact, resettled	<i>age</i>	<i>worked outside the area</i>	–	–

<sup>a</sup>indicates insufficient variation in risk perception variable

**Table 5**

Significant relationships between well-being variables and risk perception, by site (Mann-Whitney U,  $p < .05$ ; no negative associations occurred)

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
Penipe Viejo (EC)				
Urban				
Low impact,	–	physical symptoms	– <sup>a</sup>	–

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
not evacuated				
San Pedro Benito Juárez (MX)	PTSD symptoms			
Rural	PTSD functioning symptoms			
Low impact, evacuated	physical symptoms			
	negative household conditions	physical symptoms	–	–
Pillate (EC)	–	negative household conditions	– <sup>a</sup>	PTSD symptoms
Rural				
High impact, evacuated				
San Juan (EC)	PTSD symptoms recent life events	PTSD symptoms		
Rural		PTSD functioning symptoms		
		recent life events		
High impact, evacuated		depression symptoms		
Pusuca (EC)	–	PTSD functioning symptoms	– <sup>a</sup>	–
Rural to rural resettlement				
High impact, resettled				
Penipe Nuevo	recent life events	PTSD symptoms	perceived	perceived

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
(EC)			support from family	support from partner
Rural to urban resettlement		PTSD functioning symptoms		
High impact, resettled		depression symptoms		
Ayotzingo (MX)	-	PTSD symptoms		
Urban		PTSD functioning symptoms		
High impact, resettled		depression symptoms		

<sup>a</sup>indicates insufficient variation in risk perception variable

**Table 6**

Significant relationships between network content and network structure variables against risk perception, by site (Mann-Whitney U,  $p < .05$ ; italic variables show negative associations), columns supplying yes/no values

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
Penipe Viejo (EC)	-	% alters received material support	-	-
Urban				
Low impact, not evacuated		% very close ties		
San Pedro Benito Juárez (MX) <sup>b</sup>	<i>% not close ties</i>	% alters invited ego to work	% not close ties	% alters invited ego to work
Rural	% very close ties	% alters invited by ego to work	<i>% somewhat close ties</i>	% alters invited by ego to work

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
Low impact, not evacuated	% alters gave ego material support			
	% alters gave ego emotional support			
	<i>degree centralization</i>			
	<i># dyads</i>			
Pillate (EC)	-	% ties with women	-	-
Rural		<i>density</i>		
High impact, evacuated		average betweenness centrality		
			- <sup>a</sup>	
San Juan (EC)	-	% alters invited ego to work	-	-
Rural				
High impact, evacuated				
			- <sup>a</sup>	
Pusuca (EC)	<i>% ties with women</i>	% alters received material support	-	
Rural to rural resettlement	% alters gave ego emotional support	% alters received emotional support		
High impact, resettled	% alters received emotional support	% alters gave emotional support		
			- <sup>a</sup>	
Penipe Nuevo (EC)	% alters invited ego to work	% not close ties	degree centralization	% Evangelicals
Rural to		% ties with higher		

	<b>Perceives past threat to life</b>	<b>Currently concerned</b>	<b>Expects future event</b>	<b>Plans to evacuate</b>
urban resettlement		economic class		
High impact, resettled				
Ayotzingo (MX) <sup>b</sup>				
Urban				
High impact, resettled	% somewhat close ties	<i>% ties with higher economic class</i>	–	–

<sup>a</sup>Indicates insufficient variation in risk perception variable

<sup>b</sup>We did not ask about ego giving support to alters in the two Mexico sites

In general, as seen in Table 4, sociodemographic predictors are not as stable and strong as the cross-cultural literature reviewed above suggests, and they are virtually nonexistent in the low-impact site of Penipe Viejo in Ecuador. Nonetheless, patterns in sociodemographic predictors exist, including the potential roles of age, civil status, occupation, wealth, evacuation experience, and having family living outside the country. Being a farmer was not significantly associated with any of the risk perception measures.

Two of the variables that are strongly correlated in the literature but seem to play very relatively little role in risk perception in both countries studied here are gender and education. Pillate is an exception, where being female predicts both higher current concern and higher perceived past threat. Women are responsible for childcare and the household economy much more than men in all of the study sites, so it makes sense that they would be more sensitive to the ways in which the household was affected by past disasters, though it is difficult to speculate as to why this would be the case in one site only. In general, men speak of the ways in which crops and animals were affected, while women speak of family members, health, and issues of the home when assessing risk. There were a couple of marginal associations with gender for risk in other sites, but for this exploratory research we only reported cases for which  $p < 0.05$  (and not  $p = 0.05$  or greater).

Regarding age, younger respondents were more likely to say the event would happen again in the resettled site of Penipe Nuevo, and they were also more likely to perceive that life was threatened in Ayotzingo, the urban resettlement resulting from displacement of thousands of people and dozens of deaths. Certainly, those who were younger when the event happened could have experienced greater fear or stress during the event. While younger people are not significantly more concerned than older people about currently living where it could happen again, their past experiences have taught younger urbanites that hazardous events are possible, so they would not rule it out for the future.

Being married seems to have mixed impacts. Marriage may serve as a buffer to past impact. In the urban resettlement of Penipe Nuevo, marriage is negatively associated with perception of past risk. Although both married and single people overwhelmingly perceived past threat to life in Penipe Nuevo, married people were less likely than single people to perceive past threat, particularly when relocated out of direct harm's way. On the other hand, marriage may produce higher concern in the present owing to family responsibilities—especially in rural areas. In the rural non-resettled site of San Pedro Benito Juárez, married people were equally likely to be currently concerned as not, but only 20% of single people expressed current concern about living where the event might happen again.

The geographic reach of one's life was tested for influence on risk perception, with the assumption that greater diversity of information would influence risk perception. The two measures here were having worked outside the area and having family abroad. Having worked outside the area predicted lower concern about current risk, such that people with wider geographic networks and experiences in other places feel they have options in the case of another extreme event. The second measure of geographic reach of one's life—having any closely related kin (siblings, parents, children) living abroad—predicted higher values in the current concern about the risk (urban, relocated Ayotzingo), and expectations that it will happen again (rural, evacuated, low-impact San Pedro Benito Juárez). Both are Mexican sites with more frequent international emigration than in Ecuador. This second association of family abroad with current and future concerns suggests that families from outside the site effect an increase in risk perception, perhaps owing to reduced insularity of information or concern resulting from lack of physical proximity. For the overall risk perception scales, a positive Spearman's rho correlation occurred in San Pedro Benito Juárez for number of family members living abroad ( $r = 0.363$ ,  $p < 0.01$ ), and marginal positive values also resulted for Pusuca and Ayotzingo ( $r = 0.303$  and  $0.172$ , respectively,  $p < 0.1$ ), again suggesting that Mexico has a different experience in this regard.

Wealth (number of rooms in house) also predicts a mixed relationship with perception of risk. In the Mexican resettled urban site, higher wealth is associated with greater perception of current threat, and in the Ecuadorian resettled urban site, wealth was positively correlated with plans to evacuate in the future. On the other hand, wealth in two rural, non-resettled sites predicted lower perception of current threat. Wealthier people potentially stand to lose more material possessions and productive assets in a disaster; nonetheless they typically have more resources for coping with hazards and disasters. Also, recent research in our Ecuadorian sites suggests that the wealthy may have political incentives to minimize public perceptions of risk in their sites so as not to destabilize or displace their political and economic bases of power in the community or region (Faas 2012). In addition to family living abroad, the only other sociodemographic variable that predicted level of overall risk perception was wealth (number of rooms in house:  $r = 0.362$ ,  $p < 0.05$  for Penipe Viejo but  $r = -0.405$ ,  $p = 0.001$  for Pillate). The difference in direction between these two variables indicates that wealthier people in the relocated setting had heightened concern, but those with greater wealth who were still living in a risk zone were minimizing their perceived risks.

In the least-impacted evacuated site of San Pedro Benito Juárez, people who received help from an institution were less likely to perceive past threat, suggesting that the receipt of help may



reduce the perceived strength of a past threat. We treated institutional support as contextual factor that takes on a demographic quality (similar to infrastructure) rather than being an orientation post-event (such as mental health or perceived support) and therefore we include institutional support in Table 4 instead of Table 5.

### Well-being and Risk Perception

In Table 5, which covers the possible influences of mental health (including subscales of post-traumatic stress symptoms and associated functioning, as well as subscales of depression), perceived support, physical health, household conditions, and recent life events, we see a few patterns. First is the predominant role of physical health in perception of past and present risks in the lower-impact sites (especially San Pedro Benito Juárez).

Second, social support appears only relevant in Ecuador. In terms of perceived support, family or spouse/partner support increased people's perception in Penipe Nuevo (where friend support also had a positive marginal association) that the event will happen again and that they plan to evacuate; family support increased current concern in the evacuated site of San Juan.

Third, post-traumatic stress and depression are dominant throughout as predictors of risk perception, but especially for current concern as well as for perceived levels of past threat in the rural evacuated sites. In Ayotzingo, post-traumatic stress remains a dominant predictor of perception of risk in both present and future. Tobin et al. (2011) also arrived at this conclusion using a version of the same Mexico dataset analyzed for the current manuscript. The specific subscales of intrusion and arousal are good predictors of perception of past and present risks, especially in the Mexican samples (older events), although in this manuscript we do not report the results for subscales of depression or post-traumatic stress. Otherwise, the number of post-traumatic stress symptoms predicted overall risk perception (our cumulative scale) separately in each site in both countries, except Pillate. Correlations for the overall scale were moderate, with R-squared values indicating that post-traumatic stress explained between 10% ( $p < 0.05$ ) and 28% ( $p < 0.01$ ) of the variation. Problems with day-to-day functioning ability, as a result of post-traumatic stress symptoms, also were associated with increased overall risk perception significantly in four of the seven sites (San Pedro Benito Juárez and Ayotzingo at  $p < 0.5$ ; San Juan and Penipe Nuevo at  $p < 0.01$ ); and marginally in a fifth (Pusuca,  $p < 0.1$ ).

Fourth, poor household conditions increase perception of either past or present threats in two of the three rural non-resettled sites. Similar to Armas and Avram (2008), whose research in Romania found that residents of high-density apartment complexes were more favorably disposed to relocating than were homeowners, it is likely that respondents with negative household condition scores experience more overall stress (risk-related or otherwise) in their current living situations. Moreover, household and economic stresses may themselves be perceived as part of an array of risk factors.

Finally, more stressful recent life changes or events (moves, changing households, conflict, estrangement) in two Ecuadorian sites predict higher levels of perceived past threat, and higher levels of current concern at one Ecuadorian site. In these cases, it is possible that respondents are drawing causal connections between past disaster events and recent life events.

Generally, well-being is highly relevant for current concern and selectively relevant for past and present. It was not surprising to find that future risk had relatively few predictors, since the respondents in all sites frequently claimed that they, as well as variously described experts, were unable to predict the future. Many also cited competing claims about future potential risks, often saying that “while [authorities] say there is a danger, no one can really know, only God.” Additionally, what can be said about the lack of a role for well-being and social support in affecting thoughts about the future? Although household conditions and perceived support have the least impact on people’s perception of their own future behaviors, it is worth noting that our questions about the future ask about (1) whether or not a hazardous event will occur and (2) plans to evacuate, whereas our questions about past and current risk ask about the extent to which respondents were at risk during these timeframes. Stress and support may contribute more to perceptions of past and present experiences, while not factoring into one’s assessment of future events.

### **Social Networks and Risk Perception**

In addition to the non-network variables just presented, we examined several network variables for their association with the suite of risk perception questions. In general, personal network composition played a bigger role than did network structure, although we did use a few more network composition measures than structural measures.

Because other research has found significant relationships between network structures and the type of support people were able to access in disasters (e.g., Hurlbert et al. 2001), we expected structural variables to contribute meaningfully to variation in risk perception. Instead, we find that it is the content of respondents’ social networks (primarily support exchanges) that is more associated with variation in risk perception for most of our analyses. The importance of these support exchanges suggests, as mentioned earlier, that shared cultural/cognitive models of past disaster events may be emerging in the denser networks and where support is exchanged more frequently, contributing to the reinforcement of collective memories of past events, current concerns, and future scenarios.

Having a higher percentage of females in one’s personal network was negatively associated with perception of past impacts in the rural Ecuadorian resettlement site of Pusuca and positively associated with perception of current risk in the high-impact site of Pillate. Having a higher number of females in a personal network has been proposed by other scholars as a deterrent to disaster recovery—specifically, mental health (e.g., Norris et al. 2004). When disasters occur, it is a confirmed generalization that women’s networks and access to resources are more adversely impacted than are those of men. However, because percentage of females in personal networks is negative in a high-impact rural resettlement site and positive in a high-impact rural evacuation site—and the two sites are otherwise very similar culturally and sociodemographically—it is possible that the resettlement itself is the mitigating factor. We know from a related study in the same Ecuadorian sites (Faas 2012) that women were promoted to leadership positions in the Pusuca resettlement and played a central role in establishing the cohesion of the new community. It is therefore possible that women continued to have marginal access to resources in the high-impact evacuation site, fostering the development of a higher risk perception in highly female networks, whereas similarly composed networks in the resettlement are associated with recovery and resilience and therefore lower perception of past risk.

As with sociodemographic and well-being predictors, we see few correlations with future-oriented risk perception. However, in Ecuador, the expectation that it will happen again is significantly associated with degree centralization for urban resettled Penipe Nuevo. This positive association of a centralized network with the perception of future risk suggests the presence of opinion leaders in these networks. Degree centralization has the opposite relationship with perception of the past, decreasing it in San Pedro Benito Juárez, nonetheless similarly suggesting another role for opinion leaders in one's network. However, coupled with the negative relationship with number of dyads, it appears that decentralized and fragmented networks may be more of an effect than a cause of high perceived past threat.

Work exchange—or asking neighbors to work in your fields for you and vice versa—is always associated with increases in risk perception. In the urban relocated site of Penipe Nuevo, perception of past threat was higher with work exchange. Also higher were current concern and plans to evacuate in San Pedro Benito Juárez, with a similar increase in current concern in another rural evacuated site, that of San Juan in Ecuador. Interestingly, work exchange tended to be reciprocal in the cases where it was associated with risk perception. Work exchange is more frequent in rural areas owing to the needs of smallholder agriculture. It is possible that, in the rural sites, working closely with someone exacerbates existing perceptions of risk; alternatively, reciprocal relationships might be part of a suite of social support practices and collective approaches to disaster recovery and coping with chronic hazard.

In the Mexican site of Ayotzingo, having a wealthier personal network was associated with decreased current concern, whereas it was associated with increased current concern in the Ecuadorian site. Reduced wealth means reduced options for dealing with the hazards or with disaster recovery, and thus would increase concern. Why this is not the case in Penipe Nuevo may have something to do with the fact that people are still in the throes of deciding how to proceed—whether to continue farming via a daily commute, whether to move back into the high-risk zone, whether to invest in the small town of Penipe, or whether to move elsewhere for work or farming, such that those with more resources might feel they have more to lose while things are still a bit unsettled.

Received social support (emotional, material, informational) plays a major role in perception of past threat and current concern. It appears to some extent that for past threat, ego receiving support is more relevant, whereas for current threat, ego giving support is more relevant. That said, it is really in Pusuca and San Pedro Benito Juárez that these relationships exist, along with material support for Penipe Viejo's current concern.

In addition to received social support (as measured through individual relationships rather than by typical social support scales), it is clear that the degree to which someone feels close to the people in their network is implicated in risk perception and expectations. That said, it is difficult to discern immediate patterns, since close ties, somewhat close ties, and no close ties all exhibit both negative and positive associations throughout Table 6. Finally, despite low variation in religious affiliation of network members in all the sites except San Pedro Benito Juárez, having more evangelical Christians in one's network was associated with having plans to evacuate in the relocated urban site of Penipe Nuevo.

Overall, the results presented in Table 6 point out the relevance of content and some structural network factors for what happened and what is happening (past- and present-oriented perceptions), and relatively little role for network factors in what they perceive to be possible (future-oriented perceptions). More focus research must now be undertaken using social network analysis but with the specific goal of using more standard risk perception measures from both psychometric and cultural approaches to risk perception to explain variation in what people are concerned about, how they are concerned about it, and why.

## Conclusion

We proposed that the comparative method would give us insight into: (1) differences between countries in risk perception; (2) inter-site differences in risk perception, and (3) differences in risk perception based on disaster type. Regarding overall levels of risk perception for specific hazards that people have already experienced and may realistically experience again, relatively little variation exists between the two countries. There is some interesting variation across some risk perception questions about the past, present, and future in terms of the variables associated them, and these often vary considerably across the sites. Most of the relevance of our tested independent sociodemographic, well-being, and network variables appears to concern the perceived effect of the event or disaster, or the concern about living where it might happen again. Other risk perception questions, however, particularly those relating to future behavior, show less variation. The differences between the two countries are worth exploring further, and of course an increase in the sample sizes and the number of sites might help sort out what is site-related, what is country-related, and what is disaster-related.

Comparing Tables 3, 4, 5, and 6, we generally note the lack of association of measures of risk perception with variables known to make a difference in somewhat more general forms of risk perception in non-disaster contexts (e.g., age, gender, education, religion). Nonetheless, site characteristics such as urban vs. rural, resettlement vs. non-resettlement, high impact vs. low impact, and country do appear to be associated with variation in risk perception and to be related to which kinds of variables predict risk perception in each site. We must also remember that the variation is fairly low in the risk perception measures in Ecuador, suggesting that being exposed to a disaster or major hazard is a totalizing experience. There is also the possibility that our yes/no technique biases the answers toward yes when a Likert scale or larger set of possible responses might produce greater variation (then again, it might not). This is worth considering in future work.

We have identified several empirical and methodological factors that may inform future research on risk perception. First, looking beyond macro contexts of nation and disaster types, we have found that social network content plays a significant role in risk perception, though the results remain somewhat ambiguous since the results presented here are based on binary recognition (or non-recognition) of past, present, and future risks, but not the cognitive content of risk perceptions. Our findings suggest that, where support exchanges are more frequent and there is a common experience of past disasters, risk perception tends to be higher, at least for the past. As we noted, this suggests the emergence of shared cognitive or cultural models (a collectivization of memory or a redundant feedback loop of information in a dense network) of past events that

may be contributing to the perception of current and future risk in ways that are not obvious in our current data. Future research might then explore correlations between qualitative constructs of risk and social network content. Secondly, though we did not find as many relationships between personal network structure and risk perception, there is still potential for the analysis of personal network structure and its relation to qualitative constructs of risk.

Finally, our research has identified a range of contextual variables that contribute meaningfully to variation in risk perception among disaster-affected peoples. Specifically, we have found significant evidence for the influence of recent life events, household conditions, and, importantly, mental health variables such as recent depression and post-traumatic stress, both of which may be dependent on past disaster experiences. Overall, our research shows that a host of context-specific factors contribute to risk perception, and analytical attention to these factors could contribute meaningfully to future cross-cultural research on risk perception.

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