

Chapter 2

Modeling Social Networks and Community Resilience in Chronic Disasters: Case Studies from Volcanic Areas in Ecuador and Mexico

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Abstract A social network framework was used to examine how vulnerability and sustainability forces affect community resilience through exposure, evacuation and resettlement. Field work, undertaken in volcanically active areas in Ecuador and Mexico, involved structured questionnaires and ethnographic studies of residents and their social networks, and interviews with government officials and political leaders. Networks were categorized into: (i) closed networks—everybody interacts with everybody else; (ii) extended networks—relatively closed cores with ties to more loosely connected individuals; (iii) subgroup networks—at least two distinct groups that are usually connected; and (iv) sparse networks—low densities that have relatively few ties among individuals. Additionally, it was found that

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people with less dense networks in the least affected site were better adjusted to chronic disasters and evacuations, while those with more dense networks had better mental health in the most affected sites.

Keywords Chronic disasters • Social networks • Community resilience • Ecuador • Mexico

2.1 Introduction

Understanding social networks can help explain much of human behavior and social phenomena (Kadushin 2012). How people are connected and interact, how they support each other (or not), and how individuals play different roles within a network can significantly impact decision-making and eventual outcomes. Sociologists, anthropologists and others have focused on the significance of social networks for some time, but it is only recently that attention has been devoted to such networks in the context of natural disasters and community resilience. Indeed, research suggests that turning to social networks may enhance individual and group recovery from hazard exposure, evacuations, and community resettlement (Ibañez et al. 2004; Hurlbert et al. 2001), and international resettlement policies explicitly refer to the need to avoid destroying ‘social capital’ by preserving social networks (World Bank 1990; Cernea 2003). This study applies methodological developments in personal networks in such disaster contexts (McCarty 2002).

Hazards research has focused on human vulnerability and sustainability (Wisner et al. 2004) advancing our appreciation of the interplay of environmental, social, economic and political forces (Tobin 1999). The picture is complicated, however, in chronic disaster settings. A concern of our research has been to address this—exploring how exposure to chronic hazards has a cascading and cumulative effect on the recovery, coping ability, and sustainability of people who live in exposed, evacuated, and resettled communities, and in this regard, to examine the extent to which social networks mitigate or exacerbate community resilience (Tobin et al. 2010a). It is argued that chronic exposure to on-going disasters may influence social network structures, which in turn may shape individuals’ abilities to adapt to the hazardous conditions.

Natural disasters still exert a significant toll on society; even though the global death toll from natural disasters has been declining relative to population (other than notable exceptions of major events such as the recent Japanese tsunami or the Haitian earthquake) losses continue to climb (Economist 2012). With 3.4 billion people now residing in hazardous areas, exposed to landslides, violent storms, floods, earthquakes, and volcanic eruptions such studies can add to our ideas regarding mitigation strategies and may ultimately enhance community resilience (Dilley 2005).

In this chapter, we expound on some of the findings we have discovered in our research focusing here on the general outcomes. The specifics on methods, disaster context, and results are described in detail elsewhere as cited in several references.

2.2 Study Sites

Our research has been conducted in Ecuador and Mexico around two active volcanoes and a landslide/flood area. The primary focus in Ecuador was Tungurahua Province, about 120 km south of Quito, an area that has been affected by ongoing ash falls and pyroclastic activity associated with Mount Tungurahua since 1999. The continuing eruptions have had severe impacts on agricultural practices, on economic and business activities, and on the health and well-being of many living in the shadow of the volcano (Lane et al. 2004). There have been several evacuations of populations, some long-term, which have led to high levels of stress associated with leaving homes, possessions, livelihoods, friends and familiar surroundings. In many cases, individuals have experienced a decline in their health (Whiteford et al. 2009). These physical, economic and emotional losses have been exacerbated by a loss of faith in both the local and national political leadership and by a struggling national economy (Tobin et al. 2011).

The research has extended over the last 12 years, and has investigated concerns in number of communities situated around the volcano. Discussed here are: (i) *Penipe Viejo*: *Penipe Viejo* has been affected notably through ash falls but has not been evacuated. It has served as a base for emergency response operations during major eruptions and several local buildings have been converted to shelters for evacuees from the high risk zone to the north. The on-going disaster, however, has affected *Penipe* economically, politically, demographically, and in terms of health and well-being (Whiteford et al. 2010); (ii) *Penipe Nuevo*: *Penipe Nuevo* is a newly constructed resettlement community built as a new section in *Penipe*. It consists of 285 houses, constructed by the Ministry of Housing and Urban Development and a multinational, faith-based NGO, Samaritan's Purse. The resettlement is an urban resettlement populated by smallholding rural agriculturalists displaced from a number of northern parroquias in the wake of the 2006 eruptions; (iii) *Pusuca*: *Pusuca* is a resettlement community, built by the NGO, Fundación Esquel 5 km south of *Penipe*. It comprises 45 houses occupied by smallholding rural agriculturalists displaced primarily from *Puela*, and a few residents from *Bilbao* and *El Altar*. (iv) *Pillate* and *San Juan*: *Pillate* and *San Juan* are two small communities of approximately 35 households each. The communities have suffered extensive damages as a consequence of heavy ash falls and landslides and been evacuated on several occasions. In spite of this, approximately 70 % of the residents have returned to live in and rebuild the communities (Jones 2010).

In Mexico, two study sites were selected, one, San Pedro Benito Juárez, which has been directly affected by the volcano Popocatepetl, and Teziutlán which has been impacted by a landslide and flood. San Pedro, a community of 4,340, is located approximately 11.5 km east of Popocatepetl. The town is the closest population to the cone and is prone to ash fall, volcanic bombs and pyroclastic flows. While the volcano has been relatively quiet over the last 100 years, 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 evacuation (Tobin et al. 2007). Teziutlán a community of 60,000, experienced a mudslide in 1999, following heavy rains and flooding, that forced the evacuation and eventual relocation of many residents to a new community, Ayotzingo, which is a neighborhood within the municipality of Teziutlán, where the Instituto Poblano de la Vivienda purchased four hectares of land on which to build starter homes for relocated families (Alcantara-Ayala et al. 2004).

2.3 Methods

Three questionnaire surveys were conducted in each community along with in-depth interviews and focus groups to collect information about adaptations to the hazards and stresses of resettlement. A socio-demographic survey was used to gather basic data on the community characteristics and this was followed by the network and well-being surveys administered to a random selection of one participant per household from the socio-demographic survey (Table 2.1). To determine networks, participants (ego) were asked to list 45 contacts (alters) from which 25 were randomly selected and classified according to sex, age, socioeconomic status relative to interviewee (ego), ethnicity, number of household members, degree of emotional closeness to ego (higher, lower), whether affected by the hazard, last contact with interviewee, and whether social, personal, financial or material support had been provided by them to ego or vice versa (Jones et al. 2013). Finally, the interviewee indicated how much each of the people in their personal network interacted with one another from the interviewee's perspective.

Survey questions were arranged into several 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 stress. In terms of the dependent variables (risk perception and evacuation experiences), several questions were asked about evacuation experience and likelihood of evacuating again; four risk perception questions 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, and whether they are generally attentive to or concerned about health.

Table 2.1 Community type and number of survey participants in surveys

Community	Hazard type	Socio-demographic	Well-being/network
<i>Ecuador</i>			
Penipe Viejo	Exposed-ash	53	44
Penipe Nuevo	Resettlement	116	99
Pusuca	Resettlement	42	40
Pillate	Evacuated-returned	54	48
San Juan	Evacuated-returned	37	30
<i>Mexico</i>			
San Pedro	Evacuated-returned	155	61
Teziutlán/Ayotzingo	Resettlement	139	139

The social network framework was used to examine how such traits affect hazard exposure, evacuation and resettlement outcomes (Tobin et al. 2010b). Four main network types were identified recognizing that in reality these points lie along one or more continua:

- a. Tight/Closed Networks: nearly everybody interacts with everybody else forming a tight, often dense group, likely with high cultural homogeneity;
- b. Extended Networks: relatively closed cores but with some ties or bridges to more loosely connected individuals;
- c. Subgroup Networks: at least two distinct groups or cores—these may or may not be well-bridged or connected; and
- d. Sparse Networks: relatively few ties among individuals and few bridges—low density.

The role of social networks in resilience and recovery efforts can be highlighted through these four types (Fig. 2.1) based on participants from San Pedro. Figure 2.1a shows a tight/closed network; the individual has few contacts outside the community, but all are of relatively equal socio-economic status and constitute close ties or somewhat close relationships. In contrast, the extending network shown in Fig. 2.1b illustrates a network with contacts that spread beyond the local community, although there is no connectivity among subgroups. This individual also has several contacts with relationships that are not considered close. The network in Fig. 2.1c, shows greater connectivity (bridging) among the different subgroups, all contacts are considered close or somewhat close and are of similar socio-economic standing. Finally, Fig. 2.1d illustrates a sparse network where the participant has few close contacts and limited connectivity.

It was hypothesized that participants with networks composed of strong subgroups and relatively robust bridging would be more successful than those with closed or extremely sparse (disconnected) networks in accessing appropriate information and resources.

In considering disaster impacts, therefore, support mechanisms as provided through such networks may prove crucial. For example, if resources are not

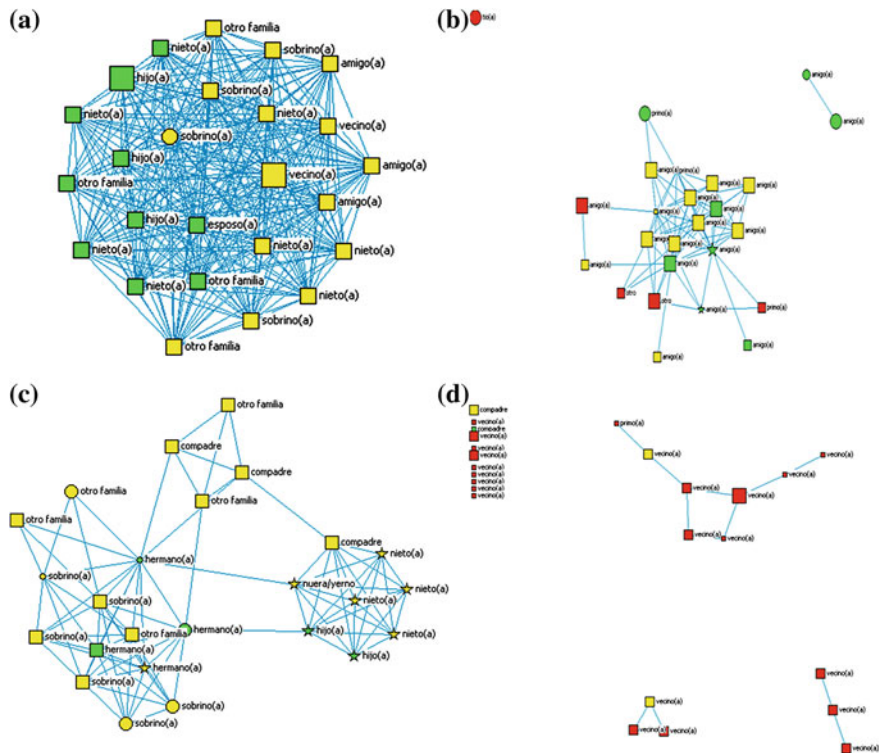


Fig. 2.1 Personal networks: **a** Tight, **b** Extending, **c** Subgroup, **d** Sparse (from Mexico). Key: Symbols *Square*—Community; *Circle*—Region; *Star*—Outside Region/International. Size: *Large*—Better off than Ego; *Medium*—Same as Ego; *Small*—Worse off than Ego

available locally, then strong outside connections may be essential to support the local community. Similarly, close ties with those from higher socio-economic levels may be advantageous under such conditions.

2.4 Results

Over the past decade or so, all the study communities, whether exposed or resettled, have faced considerable hardships with socio-economic conditions progressively deteriorating in a cascade of impacts as the disasters have intensified. In Ecuador, the destruction of basic crops and livestock from ash falls has culminated in a modified agricultural landscape, altered economic conditions, and compromised human health and welfare. Recovery has been varied reflecting differential resilience capabilities, with most households worse off than prior to the disaster. For example, residents who evacuated their homes for long periods often experienced poorer health and faced greater economic challenges than those who

remained in place, whereas those who evacuated on several occasions, and for short periods, had fewer health problems than those who either did not evacuate or stayed away from home for longer periods. The long-term consequences have been, and continue to be, severe (Whiteford and Tobin 2004).

The conditions are similar in Mexico where chronic conditions have served to exacerbate problems in both evacuated and resettlement communities. Ash has contaminated water and food, harvests have declined, and fertilizers are now needed to increase crop yields particularly for fruit trees. Also, stock animals and pets have been lost because feeding of such became difficult during evacuations (Tobin et al. 2012). At the same time, more respondents from the resettlement site, Teziutlán, believed that it is dangerous to live close to the hazard and stated that they had been negatively affected by a disaster. In comparison with San Pedro Benito Juárez respondents, more believed that the hazard poses a health risk to them and their families. Overall, significantly more problems were reported by the Teziutlán resettlement site respondents, including issues with living space, problems with heat, lack privacy, and fear of criminal activity—all possibly related to residing in small high-density housing.

Results show that disaster recovery in Ecuador and Mexico has been significantly impacted by social network type and that these play different roles depending on the prevailing conditions in the community (Table 2.2). Evacuated, exposed and resettlements present specific challenges and should not necessarily be considered as simply hazard prone.

Table 2.2 Social networks by community

Study Site	Tight	Extended	Sub-groups		Sparse	Total
			Connected	Not connect		
Penipe Viejo	13	11	10	6	4	44
Penipe Nuevo	37	22	22	9	9	99
Pusuca	17	14	7	2	0	40
Pillate	29	7	9	3	0	48
San Juan	15	5	7	3	0	30
Total	111	59	55	23	13	261

2.4.1 Mexico Networks

In general, our results suggest that medium density, sub-group networks (type c) with good bridging or connectivity to different sub-groups were better adapted to the demands of the disasters and evacuations than those with denser networks and limited bridging (Murphy et al. 2010). On the other hand, participants with sparse or open/weak networks (type d) may not have sufficient social influence to act in emergency situations and hence were often more vulnerable and showed lower

levels of well-being. Indeed, those networks with tight/close ties, such as found in types a and c, provided greater support mechanisms fostering reciprocal relationships amongst their contacts. Those participants within such networks reported more sharing, including that of materials, labor, tools, and food, than other networks. Disaster context and patterns of resettlement, however, demonstrate degrees of variation in these findings.

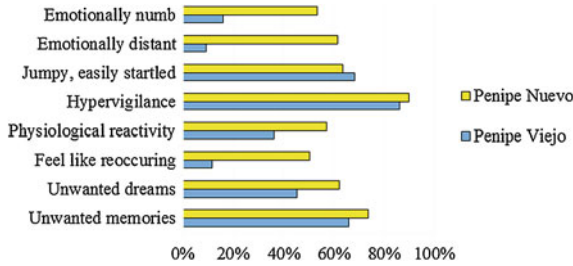
Conflicting results are found regarding network density. In many circumstances, dense networks are highly advantageous providing important support within communities, but in San Pedro Benito Juarez they predicted higher symptoms of stress and depression. Understanding the nature of such relationships may further complement our understanding of network structures and their changes. For instance, 94 % of respondents who provide or received labor with their network members reported reciprocal labor activities. In very few cases did someone give or receive labor on others' fields and not experience reciprocation. Where there are differences in socio-economic status between the participant and the contacts, there often exists a patron-client relationship which permits less wealthy individuals to have access to the support provided by the richer ones.

Nevertheless, networks that incorporate subgroups (type c) that extend well beyond the local community often provide additional benefits. Tight, dense networks generate multiple and often reciprocal benefits, but they do not offer a diversity of resources or information. For instance, if all a person's contacts reside in the same community, as in type a, then material support may be limited especially if the network consists of persons of equal economic status. Persons with well-connected sub-groups outside the disaster area have distinct advantages that may facilitate recovery. This is apparent in the case of San Pedro where remittances sent by migrant workers working in Mexico City or the USA played an important role in supporting the local economy. Having networks that extend beyond the community, therefore, can be important and enhance resilience.

Other personal traits of networks were found to predict impacts and emotional and material well-being. Those personal networks with higher proportions of older people and females in their networks received greater emotional and material support (the opposite was found in Ecuador). In addition, geographic distance was negatively correlated with frequency and the strength of contact; not surprisingly there was greater or stronger contact amongst those closer individuals. In San Pedro this was especially important since all the community was impacted by the volcano and individuals relied heavily on material support from outside the community. The balance, then, between geographic distance and the significance of sub-groups within a network needs to be addressed more fully.

Respondents' perceptions and awareness of the disasters were also correlated with social networks. Participants with sub-groups and networks with high levels of linkages, type c, demonstrated a moderate awareness of the hazards, but at the same time exhibited strong well-being and tended to participate in the evacuations. In contrast, those with dense networks had greater concern regarding the risk and more concerns that the events will recur. This may reflect the perceived lack of support available from outside the community.

Fig. 2.2 Incidence of some PTSD symptoms in Penipe Viejo and Penipe Nuevo



2.4.2 Ecuador Networks

It is clear that the chronic conditions associated with the eruptions of Mount Tungurahua have had a profound bearing on all communities in the region. The impacts appear to be cumulative with conditions for many individuals getting significantly more difficult. For example, household conditions, physical health, stress levels were all worse in the resettlement and evacuated communities than in the exposed, non-evacuated community. In part, this appeared to be related to social networks and differences were evident between Ecuador and Mexico. Those dense personal networks with strong ties and close relationships tended to be associated with greater levels of support and hence recovery, than those with looser networks. More support, such as food and supplies, emotional support, and information, was reported as having been provided in these networks.

The dissimilarities between established and new communities can be highlighted by looking at Penipe Viejo, Penipe Nuevo and Pusuca. Respondents in Penipe Nuevo exhibited significantly higher levels of stress and depression than those in Penipe Viejo (Fig. 2.2), although they also reported higher levels of support. Also, those social networks with higher densities and where ties were closer were negatively correlated with stress and depression in Penipe Nuevo, which suggests that more dense networks with close ties are related to lower depression levels in this site. In Pusuca, however, increased closeness was correlated with higher levels of stress and difficulties in functioning.

In the resettlement communities, it is possible that traditional support networks had broken down as individuals relocated and that new connections had not been fully established. In the resettlement community of Penipe Nuevo, for example, new residents had, for the most part, come from a number of different communities and probably did not know each other prior to relocation. An exception was the other resettlement site, Pusuca, where the new site was inhabited largely by residents from one community, which suggests that resettlement strategies may play significant roles in maintaining sustainability and fostering resilience.

Those networks with only a few unique connections, such as found in type b, were especially important with individuals receiving higher levels of support (material, emotional and informational) than those with more complex networks. Such relationships were not found in exposed or evacuated communities. Also,

males received more support in the resettlement communities than females, whereas there were no significant differences in the other communities between males and females. Support from families differed amongst the communities. Evacuated individuals cited the highest levels of family support, followed by those in the exposed community. Again, it appears that social networks had been negatively impacted by the resettlement and it may take time before new relationships are constructed.

2.5 Conclusions

Social networks influence impact and well-being and can have significant repercussions for communities prone to disasters. This research started with the hypothesis that residents with social networks comprised of strong subgroups and relatively robust bridging would be more successful than those with closed or extremely sparse (disconnected) networks in accessing varied and appropriate information and resources. The results from Mexico and Ecuador indicate that the structure of networks is indeed important in disaster recovery, but that its mechanism depends on context. We must also consider the degree to which network structure is a product of the chronic hazards themselves. Overall, social networks serve important purposes in disaster environments and appear to influence levels of vulnerability and resilience. However, continued analysis and follow-up research will determine if differences among research sites is a result of the nature of the events or variations in cultural, historical, political and economic contexts in which the hazards occur.

It is anticipated that a full understanding of social networks will enhance hazard response and facilitate community resilience. For instance, when reflecting on the lasting outcomes of the eruptions, Ecuadorian respondents spoke of the displacement and dissolution of their communities. They reported that their communities were tight-knit and organized prior to 1999, but that since then, and especially after 2006, resettlement and migration have severely disarticulated their communities. Taking different social networks into account when responding to further eruptions, then, may assist the transformation of disaster survivors to safe environments.

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