

Measurement of social networks for innovation within community disaster resilience

Table S1. Results of the analysis of the eleven selected case studies.

Author	Research interest	Conceptualisation			Operationalisation				Key findings
		Conceptual framing	Network variable	Network narrative	Network approach	Network definition	Network analysis		
							Network level	Network characteristics	
Nakagawa and Shaw, 2004	Examine the role of social capital in post-earthquake rehabilitation and reconstruction programs in Kobe, Japan and Gujarat, India.	Implicit reference to resilience: Social capital, leadership and a tradition of community activities encourage participation in reconstruction programs and are the most effective elements in enhancing collective action	Independent: Influence of community networks to encourage participation within rehabilitation events post-disaster. Networks categorised into the three types of social capital	Social capital: Social networks as a source of social capital. Different networks confer different types of social capital on their members.	Descriptive: Interviews with key stakeholders, including government officials, NGOs and academics. Social capital questionnaire for communities, based on integrated questionnaires	Social relation: connections within and between community groups, collective decision making, and links to formal organisations	Individual: Community members. Subgroup: Community groups.	Actor: Group affiliation (age, employment, gender, religion, caste). Tie: Bonding, bridging, and linking.	At every stage of the disaster cycle, the communities played the most important role among other concerned stakeholders. Communities with social capital are found to be efficient in rescue and relief. Social capital is not the sole factor determining speedy and satisfying recovery - strong leadership inside the community is also essential for any collective action. Leadership is an important issue in any community-based activity and in development projects.

		and disaster recovery.	(bonding, bridging, and linking) for modelling.		for the measurement of social capital. Secondary analysis of related studies, articles and documents.	Scale: Local / Community.			
Minamoto, 2010	Examine the relationship between livelihood recovery and social capital to help improve disaster response at the community level in Sri Lanka.	Implicit reference to resilience: Micro-social capital (linkages within communities, relationship of trust and norms during recovery) may help the process of disaster recovery.	Dependent: Networks are the product of various social structures.	Social capital: Social networks provide the structural component of social capital.	Descriptive: Household surveys, using World Bank social capital tool. Regression analysis.	Social relation: Mutual support networks. Actors: Households / Community-based organisations. Scale: Local / community.	Individual: Community members Subgroup: Community-based organisations.	Actor: Group affiliation (community-based organisations). Tie: Reciprocity, trust. Context: During reconstruction programmes.	Formal community networks, and the leadership and trusteeship of community-based organizations improve people's perceptions of livelihood recovery. Establishment of new organisations after an event which involve semi-forced participation can create negative social capital. Disaster aid needs to consider seriously the social factors and power structure of the community during the reconstruction stage.

Yandong, 2010	Role of social networks during and after a disaster as a conduit of social capital in China.	Implicit reference to resilience: Social networks play an important role in reducing risk during and after a disaster by facilitating the flow of information, as well as providing various types of support and help to maintain the mental health of victims. These all contribute to improving and increasing the speed of recovery.	Independent: Influence of social networks on recovery from a disaster.	Social capital / pipes: Social networks providing support, information, and knowledge after an earthquake, which realises the benefits of social capital.	Descriptive: Post-Wenchuan Earthquake Rapid Needs Assessment (household). Social network basic attributes: Chinese version of position generation - 'spring festival network', no. of people contacted (baseline); change since earthquake. Ordinary Least Squares regression.	Social relation: recovery, support (mental and physical), and information. Actors: Individual. Scale: Individual; regional.	Individual: Respondents.	Actor: Age, health, network change, income. Tie: Support, information. Structural characteristics: Size of network, composition of network (number of relatives in network), deterioration of networks, and new members.	Majority of disaster victims are rescued by their social network members. Social networks played an indispensable role in facilitating information flows in disaster affected areas. A more heterogeneous network is better for getting new information. Social networks played a supplementary role (to governmental assistance) in providing support to victims. Social networks are very important in maintaining the mental health of disaster victims. The bigger the network, the better the psychological outcomes. Dense and homogeneous networks are good for providing emotional support.
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<p>Tobin et al, 2014</p>	<p>Modeling the impact of personal networks on community resilience in Ecuador and Mexico.</p>	<p>Explicit reference to resilience: Social networks may enhance individual and group recovery from hazard exposure and ultimately enhance community resilience.</p>	<p>Dependent: Chronic exposure to ongoing disaster may influence social network structures, which in turn may shape individuals' abilities to adapt to the hazardous conditions.</p>	<p>Form of coordination: How people are connected, how they support each other and how individuals play different roles within a network can significantly impact decision-making and eventual outcomes.</p>	<p>Structurally explicit: Questionnaires, interviews and focus groups in 6 communities (4 in Ecuador, 2 in Mexico). Socio-demographic survey for basic community characteristics. Wellbeing survey for one participant per household. Social Network Analysis (SNA): Wellbeing</p>	<p>Social relation: Emotional closeness, support (social, personal, financial or material), interaction with others within their network. Actors: Community members. Scale: Local / community.</p>	<p>Individual: Personal networks</p>	<p>Actor: Individual attributes (sex, age, socioeconomic status, ethnicity). Tie: Bonding and bridging ties. Structural characteristics: Classification of networks into four types of tight/closed, extended, subgroups, and sparse.</p>	<p>Disaster recovery is impacted by social network type and these networks play different roles depending on the prevailing conditions in the community. Medium density, sub-group networks with good bridging or connectivity to different sub-groups were better adapted to the demands of disasters and evacuations than those with denser networks and limited bridging. Sparse or open/weak networks may not have sufficient social influence to act in emergency situations and are often more vulnerable and show lower levels of wellbeing. Networks with close ties provide greater support mechanisms fostering reciprocal relationships amongst their contacts, reporting more sharing of resources. Conflicting results regarding the</p>
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					participants, 45 contacts, 25 of which selected for attribute and relation analysis.				<p>role of density.</p> <p>Geographic distance was negatively correlated with frequency and strength of contact.</p> <p>Structure of relations is indeed important for disaster recovery but mechanisms depend on context.</p> <p>Must consider to a degree to which network structure is a product of the hazards themselves.</p>
Byg & Herslund, 2016	Investigate the use of social capital in the form of social ties to increase livelihood diversity and decrease vulnerability in Nepal.	<p>Implicit reference to resilience:</p> <p>Adaptation - the ability to adjust to a disturbance, take advantage of opportunities and to cope with the consequences of transformations, usually for climate</p>	<p>Independent:</p> <p>Social ties can be used to access resources which can help people make use of opportunities and deal with change.</p>	<p>Pipes:</p> <p>Benefits of social networks include the ability to provide individual or groups with access to resources (material as well</p>	<p>Descriptive:</p> <p>Household questionnaire, interviews, and focus groups in three areas (lowland, mid-hills and the Himalaya).</p>	<p>Social relation: Information sharing; labour sharing.</p> <p>Actors: Households in the communities / Individuals</p>	<p>Individual: Households / personal.</p>	<p>Actor: Location type</p> <p>Tie: Different types of ties for different purposes.</p> <p>Context: Information on climate changes, agriculture, jobs and business opportunities i.e. livelihood changes.</p>	<p>People made use of a mix of ties that could be classified as strong and weak - but it is difficult to maintain clear distinctions between the two.</p> <p>Distinguish between the existence of ties and the resources which become available through them.</p> <p>Some ties were used in some situations but not in others.</p> <p>Personal ties were used to obtain</p>

		change but can be applied to other kinds of changes. The adaptive capacity of a system is influenced by factors including social capital.	Not only the number and kind of ties, but also the situations in which different ties can be used and for what purposes.	as information) and enable group action.		Scale: Local / Community			information, references and sometimes loans. Within the villages, people were very reluctant to cooperate and share resources or information with each other. Sharing only took place among the closest relations or with people situated elsewhere. Location influenced access to markets, jobs and enterprises despite social contacts. Diversification reduces levels of vulnerability at the household level.
Guarnacci, 2016	Social networks and community resilience in post-disaster and -conflict Indonesia.	Explicit reference to resilience: The ability of a community to absorb the negative impacts of a disaster, The capability to adapt and transform	Independent: Social networks give rise to social capital which becomes an asset for communities to use in	Social capital: Value arises from social networks, which is a crucial resource for engaging in rescue activities, facilitating	Structurally explicit: Semi-structured interviews. SNA: Whole network, with attributes, using	Social relation: Social support (close ties); information / materials (weak ties) Actors: Individuals.	Individual: Community members. Network: Community network.	Actor: Impact of disaster, ethnicity, religion, gender, urban vs rural. Tie: Betweenness centrality (gatekeeper role), modularity. Context: Impact of	Affected communities are not uniform entities since survivors' personal characteristics such as ethnicity, religion and gender contribute to create different social circles. Need to give consideration to the smaller closely knitted subgroups. SNA used to identify central players who have fundamental

		depends on the structure of social networks which varies according to the strength of ties, the social position of key actors and the nature of information and resources exchanged among them.	disaster response.	evacuation, acquiring information about policies, enhancing household-level disaster preparedness and improving community-based disaster risk management.	name generator approach.	Scale: Local/ community and linkages to external actors.		Indian Ocean tsunami in 2004.	role to help victims in dealing with crises and without whom the buffering capacity of the community is deeply altered. Community resilience is also fostered through the help and resources channelled by regional and global players, including religious and ethical organisations located outside the local area.
Sanyal and Routray, 2016	Examining social capital as a resource to help reduce disaster risk for communities, applying findings from empirical studies to the Sundarbans.	Implicit reference to resilience: Social capital plays an important role in the disaster management cycle, reducing risk within communities and helping them to survive by	Independent: Social networks and social associations are considered as the basic social units to respond to disasters.	Social capital: Social networks as source of social capital. Different networks confer different types of social capital on their members.	Descriptive: Field survey, key informant interviews, focused group discussions in one community. Secondary data collected on role of social	Social relation: Connections within and between community groups, collective decision making, and links to formal organisations.	Individual: Community members Subgroup: Community groups	Actor: Group affiliation (age, employment, gender, religion, caste). Tie: Bonding, bridging, and linking. Context: Participation within community activities leading to recovery. Exclusion due	Social capital plays an important role throughout the disaster management cycle. The network at the community level is crucial for the survival of the overall community. Huge role to play in strengthening capacities at the community level for better risk reduction. Similar culture and religious institutions act as de-facto

		providing support and insurance when infrastructure and disaster management institutions fail.	Networks categorised into the three types of social capital.	Each type of social capital has a specific role within the disaster management cycle.	resources in past emergency situations.	Actors: Community groups. Scale: Local / community.		to environmental and political issues.	community centres. Might be different drivers of social capital across countries, but there is a lot of similarity in the way social capital works in the event of a disaster. Social capital and the experience of dealing with adversities is vital for remote communities. The efficiency and effectiveness of activities can be influenced positively by the use of the traditional structure of the community rather than creating new ones. Just the top-down approach can seriously hamper and damage how social capital acts as a resource for reducing the risk of and responding to disasters.
Schramski, 2017	Using SNA at the household level to assess the role of social networks	Explicit reference to one component of community resilience:	Independent: Network capital improves a	Pipes: Social networks as a means of accessing and	Structurally explicit: Adaptive capacity index,	Social relation: resource exchange. Actors:	Individual: Households. Network: Community.	Tie: Exchange of food, water, wood, labour, information about diseases, money.	Exchanges of labour, money, and disease information are all related to adaptive capacity. Households that exhibit greater degree centrality in labour

	within adaptive capacity in rural South Africa.	Social networks can help households improve their adaptive capacity, one of the main features of community resilience.	household's capacity to conduct and engage with resource exchange that helps with adaptive capacity.	exchanging information, financial and material resources.	livelihood survey, ethnographic interviews. SNA: Personal, whole network.	Households. Scale: Local / community.		Structural characteristics: Betweenness centrality, degree centrality.	exchanges appear to have greater adaptive capacity, although the same cannot be said for their betweenness centrality. Natural resource exchanges are not necessarily associated with measures of adaptive capacity in a rural poor region of South Africa.
Chaudhury et al, 2017	Examine how bridging relations of rural communities with local actors impact their own bonding structures as well as their capacity to adapt in Ghana.	Implicit reference to resilience: The capacity of any individual or household to cope and adapt to threats largely depends on their personal networks, attributes, livelihoods and capital bases.	Independent: Strong networks are essential for improving everyone's adaptive typical.	Pipes: Relationships, network structures and networks positions are crucial to understanding the adaptive capacity of both households and the community, providing resources and knowledge.	Structurally explicit: Workshops, surveys, network mapping and semi-structured interviews. SNA: External relations of a community (bridging ties) - used to infer internal	Social relation: Links to outside actors. Actors: Individuals and local 'actors'. Scale: Local / community and links with local 'actors'.	Individual: Household / member. Network: Community.	Actor: Local actors by type of group. Tie: Number of links to overlapping local actors. Structure: Network size, network position (indegree centrality), density, degree centrality, betweenness centrality.	Social connections provide important resources and knowledge to build adaptive capacity. A household's capacity to adapt and its network position is linked, but it is difficult to be certain which way around this relationship works. Close relations with local actors improve responses to environmental change and associated problems, which can enhance household capability, influencing adaptive capacity. Drawing community networks

					relations (two-mode data). Adaptive capacity measures.				based on external relations helps gain a clearer picture of the community structure, centrality and stratification of households and the role and changing position of local actors and redundancy of networks.
Misra et al, 2017	Community networks before, during and after a disaster in West Bengal, how they changed, and their role in community resilience.	Explicit reference to resilience: Social capital and agency lead to collective action in the community at different phases of the disaster which enhances the resilience of households and the community itself.	Independent: The strength and effectiveness of social networks influence the ability of a community to cope with disaster events.	Social capital / Form of coordination: Agency is realized through the existence of agents in the network who mobilize social capital to produce a sustained flow of resources i.e. social networks work together by encouraging agency as well	Structurally explicit: Focus group discussions. SNA: Whole network - measure cohesiveness to determine social capital; identify key players based on structural position in community social network.	Social relation: Aid and support, contact. Actors: Individuals and households in the community. Scale: Local / community.	Individual: Household. Network: Community.	Actor: Background variables, institutional affiliation. Tie: Number of ties, network density, average degree and network centralization (including degree centrality, closeness centrality, betweenness centrality). Context: Changing over different phases.	Importance of network structure and different central node/s in the networks that evolved over time. In the early phase of the disaster, most of the searching and rescuing endeavours came from endogenous social network ties of the community. In the aftermath, networks assumed different forms and featured different key actors. Networks facilitated the flow of information and external support, to maintain the daily life of the victims. The underlying perspective in disaster research, which claims

				<p>as providing the resources used by that agency.</p>	<p>Resilience measured by index adapted from FAO, using income, food security and other variables.</p>					<p>that communities are important collective units, is clearly evident in the findings presented here. Networks played an important role in reducing the risk during and after disaster. The change in these networks in different phases of the disaster constitutes an important scope of further studies. Social networks, along with community leaders and local administration, can be used during and after the occurrence of disasters to make effective interventions. Failing to understand this network and local culture may endanger the disaster-hit communities badly. The analysis of social networks in the context of a disaster may illustrate the interactions within and between community networks, which itself can</p>
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									improve situational awareness, as well as enhance planning and optimise resource allocation. All of these are essential for improving disaster preparedness, response and recovery efforts, and community resilience.
Patel and Gleason, 2018	Association between social cohesion and resilience in urban slums in Haiti.	Explicit reference to resilience: Social cohesion (rather than networks) may enable a wider array of resources drawn for greater cooperation, sharing and help in times of stress, conferring greater resilience on communities to disasters.	Independent: Social cohesion is a positive factor in community resilience, playing an important compensatory role, particularly when all other systems of support fail.	Form of coordination: The presence of social cohesion features (e.g. organisation, trust, norms and networks) can improve the efficiency of society by facilitating coordinated actions.	Descriptive: Population survey, developed from focus group discussions, to gain information for four main indicators. Social cohesion index developed from neighbourhood cohesion index.	Social relation: Trust, wellbeing, collective action. Actors: Individual, community. Scale: Local / community.	Individual: Community members. Network: Community.	Actor: Socio-economic / demographic data, time in community, time in house.	Social cohesion helps drive resilience, highlighting the importance of considering social cohesion in all programs and policies aimed at improving resilience and disaster risk reduction. Decision makers should not make assumptions about individual, demographic or other factors that may be assumed to enhance resilience or focus resources solely those, including social resilience. Social cohesion may compensate for weaknesses in a wide variety

					Community resilience, using Communities Advancing Resilience Toolkit.				of factors that lead to reduced resilience and increased risk.
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