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Synthesis

Social networks and the resilience of rural communities in the Global South: a critical review and conceptual reflections

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ABSTRACT. In the last decades, a growing scholarship has outlined the crucial role of social networks as a source of resilience. However, with regard to the Global South, the role of social networks for the resilience of rural communities remains an under-researched and underconceptualized issue, because research remains scattered between different strands and has rarely been integrated from a resilience perspective. To provide common ground for the exchange between disciplines and to identify steps towards a more comprehensive social network perspective on the resilience of rural communities in the Global South, we present a systematic review of contemporary case studies from three strands of research: (i) natural resource management, (ii) agricultural innovation, and (iii) social support. Although studies in each strand have their own particular strengths and weaknesses in addressing aspects of the resilience of rural communities in the Global South, they all share a static view of the outcomes of social networks, tend to emphasize structure over agency, and neglect spatial dimensions of social relations. To address these challenges, we propose a translocal social network perspective on resilience that views rural communities as being embedded in social networks that connect people and facilitate the flow of resources, information, and knowledge between places.

Key Words: *Global South; migration; resilience; rural communities; social networks; translocality*

INTRODUCTION

Rural communities can be understood as vulnerable social-ecological systems (SES) that need to build resilience to withstand internal and external stresses from social, economic, and political changes (Adger 2000, Wilson et al. 2013). It has been argued that many aspects of adaptive capacity reside in social networks (Adger 2003) and that these are a crucial source of resilience (Folke et al. 2005, Folke 2006, Berkes and Ross 2013). This applies in particular to rural communities in the Global South, where often a lack of access to resources, knowledge, and functioning institutions is a major obstacle to sustainable development (Etzold et al. 2012). However, although investigations into the role of social networks is growing at a fast pace, it remains scattered across different strands of research, with related but separate research agendas (Videras 2013). With this paper, we provide a systematic review of current case studies from three of these strands, addressing different aspects relevant to the resilience of rural communities. By analyzing how case studies conducted between 2000 and 2015 conceptualize and operationalize social networks, we level the ground for the exchange between disciplines. Concluding we identify prospects for more fruitfully employing a social network perspective in investigating the resilience of rural communities in the Global South.

During the last decades, resilience has emerged as a key concept across disciplines for investigating responses to changes in human and ecological systems (Folke et al. 2010), resulting in a variety of ways in which resilience is understood, investigated, and applied (Downes et al. 2013). From a concept originally concerned with the persistence of ecological systems in the context of external disturbances (Holling 1973), resilience has developed through a concept underlining the role of adaptive capacity for navigating coupled SES (Gunderson and Holling 2002, Berkes et al. 2003) to one emphasizing the transformation of SES in the face of global change (Walker et al. 2004, Folke 2006, Folke et al. 2010). Attention has thus widened from the ecological to include also the social dimensions of resilience (Adger 2000, Cote and Nightingale 2012). This comprises, for example, human agency, social learning, and the skills and capacities of social actors to cope with, adapt to change, and facilitate transformation (Folke et al. 2010, Moore and Westley 2011, Berkes and Ross 2013, Keck and Sakdapolrak 2013, Skerratt 2013, Cretney 2014, Ifejika Speranza et al. 2014).

Similar to resilience, the concept of social networks has been applied in a wide range of sciences from the social to the physical (Borgatti et al. 2009, Scott 2011). Intermediating between micro and macro levels, the investigation of social networks is expected to provide answers to central challenges pertinent in sustainability science, such as promoting social learning, linking knowledge with action, and enhancing collective action (Henry and Vollan 2014). Social networks have been shown to foster the capacity to buffer, adapt to, and shape change (Moore and Westley 2011) by providing resources needed to cope with external stresses and disturbances (Adger 2003), and fostering humans' ability to initiate social innovations and act collectively (Folke et al. 2005, Newman and Dale 2005, More and Westley 2011). Against this background, resilience scholars are increasingly embracing the study of social networks as a promising way to operationalize social-ecological systems research (Janssen et al. 2006, Bodin et al. 2011, 2014, Bodin and Tengö 2012).

In general, a social network perspective refuses individualistic explanation of human behavior and places emphasis on the study of the relations between individuals and the structure of these relationships (Emirbayer and Goodwin 1994, Wassermann and Faust 1994, Fuhse and Mützel 2010). However, there is no uniform theoretical explanation as to why and how the structure of social relations matters (Borgatti et al. 2009, Fuhse and Mützel 2010), which has resulted in various conceptualizations and operational approaches toward social network research.

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Probably the most common and intuitive conception of social networks is as "pipes" (Podolny 2001), connecting various actors through flows of resources, information, or knowledge (Borgatti et al. 2009). Another popular conception is that of networks as "social capital" (Bourdieu 1986, Coleman 1988, Portes 1998, Putnam 2000, Woolcock and Narayan 2000). In essence, the concept of social capital addresses the value of social connectedness (Borgatti and Foster 2003) in terms of competitive advantages (Burt 2000) derived from resources embedded in social structure (Lin 1999). Finally, the conception of networks as a "form of coordination," as opposed to other principles of coordination such as market or hierarchy (Powell 1990), emphasizes the deliberative character of social networks and their potential to facilitate collective action, self-organization, and cross-scale coordination (Schneider et al. 2003, Olsson et al. 2004, Folke et al. 2005, Carlsson and Sandström 2008, Newig et al. 2010).

With regard to the operationalization, three approaches to social networks can be distinguished: metaphorical, descriptive, and structurally explicit (Bodin et al. 2011). In general, studies following metaphorical approaches treat networks as binary variables, which either do or do not exist, whereas studies following descriptive approaches distinguish key properties of networks, such as size, density, or strength of ties. In contrast, studies following structurally explicit approaches draw on formally defined methods of social network analysis (SNA) to analyze structural patterns of social relations derived from relational data.

Although recent years have witnessed major advances in employing a social network perspective in research on SES in general (Bodin and Prell 2011), the role of social networks for the resilience of rural communities is still under-researched and underconceptualized. An increasing number of studies are applying a social network perspective in addressing diverse issues such as, for example, the diffusion of sustainable agricultural practices (Conley and Udry 2001, Bandiera and Rasul 2006, Isaac 2012), the exchange of financial and material support in times of need (Cassidy and Barnes 2012, Scheffran et al. 2012, Islam and Walkerden 2014), and collective action regarding the sustainable management of natural resources (Tompkins et al. 2002, Crona and Bodin 2006, Ramirez-Sanchez and Pinkerton 2009). However, findings from these studies have rarely been integrated from a resilience perspective because contrasting conceptualizations and operationalization of social networks are hindering the exchange between disciplines. Moreover, a systematic synthesis of current research on social networks in rural communities in the Global South is lacking, as are conceptual reflections about implications for future research on the resilience of rural communities.

To close this gap, we present a systematic review of case studies from three different strands of research: (i) natural resource governance, (ii) agricultural innovation, and (iii) social support. Although studies in these strands do not necessarily refer to the concept of resilience in explicit and theoretically founded ways, we opt for a review of studies from these strands because they provide examples of how a social network perspective can be applied in addressing different aspects relevant to the resilience of rural communities in the Global South. For example, research on governance networks provides insights into how social networks facilitate collective action of stakeholders and the navigation and transformation of management systems; research on agricultural innovation networks reveals how social networks facilitate learning between farmers about improved agricultural crops and practices and therefore foster purposeful adaptation to changing conditions; and research on social support networks addresses the role of social networks as a means for households and communities to cope with changes by providing access to resources in times of need.

Although investigating related things, research in each strand is rooted in a different disciplinary background and hence tends to look at social networks from a different perspective. For example, research in the strand of natural resource governance is influenced by environmental management and SES research and hence focuses on social networks as a means of improving collaboration between stakeholders; research in agricultural innovation is informed by agricultural and development economics and hence perceives networks as a means of improving knowledge diffusion and social learning between farmers; and research on social support networks is shaped by vulnerability and disaster risk research and hence is primarily concerned with networks as a livelihood strategy of households and communities. Accordingly, studies from each strand tend to conceptualize and operationalize social networks differently.

By systematically analyzing how studies across these three strands conceptualize and operationalize social networks, this review aims at critically discussing the viability of current social network research and intends to reflect conceptual implications for future research. In the following sections, we outline the analytical framework and present the findings of our review. Based on this, we discuss strengths and weaknesses of each strand in addressing different aspects of resilience. Finally, we conclude by proposing a translocal social network perspective as a conceptual framework for future research on social networks and the resilience of rural communities in the Global South.

METHODS

To allow scientific studies with different research designs to be compared, we performed a systematic literature review (Petticrew and Roberts 2006). We applied a stepwise research procedure, starting with a search of ISI Web of Knowledge and Science Direct using the terms "social network," "resilience," and "rural community." Based on this preliminary sample, we included key terms related to the three strands of literature we aimed to address, such as "natural resource governance," "agricultural innovation," and "social support." To ensure comprehensibility, we decided on an additional open research approach including, inter alia, case studies that were frequently cited by previously identified sample studies. We restricted the research to peer-reviewed articles published in English between 2000 and 2015 and excluded all nonempirical articles and articles not related to the domain of rural development and only selected case studies from the Global South, based on the categories "low-income countries" and "middle-income countries" (World Bank 2016). We analyzed the final sample derived from this research procedure according to how studies (a) conceptualize and (b) operationalize social networks. Besides this, we (c) summarized for each strand key findings that related to aspects of the resilience of rural communities in the Global South.

Table 1. Categories applied for the literature review.

	Category applied:	Questions addressed:
a) Conceptualization	a.(1) Conceptual framing	Is resilience addressed explicitly or implicitly? How are social networks and resilience framed?
	a.(2) Network variable	Are social networks treated as dependent or independent variables?
	a.(3) Network narrative	What is the underlying conception of social networks?
b) Operationalization	b.(1) Network approach	What operational approach does the study follow?
	b.(2) Network definition	What are the social relations of interest? Who are the actors and what are the relevant scales of interaction?
	b.(3) Network analysis	On what network level does the analysis focus? What network characteristics are addressed?
c) Key findings		What key findings can be summarized regarding the question of how social networks relate to aspects relevant to the resilience of rural communities?

To analyze how social network research is conceptualized (a), we applied the following categories (see Table1):

a.(1) Conceptual framing: With this category, we indicate whether studies address resilience implicitly or explicitly, and how they frame social networks and resilience.

a.(2) Network variable: This category indicates whether studies treat social networks as an independent or dependent variable. Studies treating networks as an independent variable focus on how the structure of social relations impacts social behavior. If the focus is on why people are linked in a particular way, networks are treated as a dependent variable (Bodin and Crona 2009, Henning et al. 2012).

a.(3) Network narrative: We choose this category to address underlying theoretical assumptions about how networks make a difference. This includes the conception of social networks as "pipes" (Podolny 2001), as "social capital" (Bourdieu 1986, Coleman 1988, Putnam 2000), and as a "form of coordination" (Powell 1990).

To analyze how social network research is operationalized (b), we applied the following categories:

b.(1) Network approach: In line with Bodin et al., we distinguished between metaphorical approaches, descriptive approaches, and structurally explicit approaches (Bodin et al. 2011).

b.(2) Network definition: This category refers to the definition of actors and the social relations of interest between them (Wassermann and Faust 1994), e.g., farmers, households, or institutions and the exchange of material support, information, or knowledge; as well as to the definition of the scale of interaction (Prell 2011), e.g., cooperation between different levels at different administrative or geographical scales.

b.(3) Network analysis: With this category, we indicate on which network level the analysis focuses, e.g., the individual actor, the subgroup, or the network level (Bodin and Crona 2009, Bodin and Prell 2011), and which specific characteristics are highlighted, e.g., actor, tie, or structural characteristics or network context (Entwisle et al. 2007, Doreian and Conti 2012).

General categories were used to be able to account for a broad spectrum of case studies. In reality, categorization is not a clear-cut process, and studies could be attributed to more than one category. Hence, except for the network approach, we allowed multiple nominations, for example, a combination of network narratives. At the same time, we took into account that categories might not be applicable in all cases. For example, a study following a metaphorical approach might not be explicit about the network level or characteristics addressed.

RESULTS

Sixty case studies were selected for in-depth analysis: 22 studies from strand (i) natural resource governance, 17 studies from strand (ii) agricultural innovation, and 21 studies from strand (iii) social support. In the following, we present an overview of how these studies conceptualize and operationalize social networks and summarize key findings for each strand. We refer to general characteristics of each strand and highlight particular case studies only where they are needed to illustrate differences in the conceptualization and operationalization of social networks. Detailed information on each case study is provided in Appendix 1.

Strand (i): Natural resource governance

Research in this strand is concerned with the question of how social networks affect the ability to adaptively manage natural resources. The case studies deal with issues, ranging from climate policy (Moeliono et al. 2014) to water and dryland management (Stein et al. 2011, Sundstrom et al. 2012, de Villiers et al. 2014, Nuno et al. 2014, Mannetti et al. 2015) and coastal area management (Tompkins et al. 2002, Crona and Bodin 2006, 2010, Bodin and Crona 2008, Ramirez-Sanchez and Pinkerton 2009, Gelcich et al. 2010, Marín and Berkes 2010, Cohen et al. 2012, Marín et al. 2012, 2015, Cárcamo et al. 2014, Pietri et al. 2015).

Network conceptualization

Conceptual framing: Social networks are conceptualized as key factors for understanding collective action and learning in SES. Even if studies do not explicitly refer to resilience, they conceptualize social networks as central to the management of natural resources. Particular studies draw on concepts such as adaptive comanagement and hence implicitly refer to the resilience of SES (Marín and Berkes 2010, Stein et al. 2011, Moeliono et al. 2014, Apgar et al. 2015, Mannetti et al. 2015).

Network variable: Studies predominantly focus on the structure of social relations and their impact on management outcomes, treating social networks as an independent variable, though there

are exceptions that take into account factors impacting social networks, such as ecological (Ramirez-Sanchez and Pinkerton 2009), economic (Rico García-Amado et al. 2012), and political changes (Ireland and Thomalla 2011, Sundstrom et al. 2012).

Network narrative: Underlying most studies is the conception of networks as a "form of coordination," either focusing particularly on the communication and knowledge flows between resource users at the community level (Crona and Bodin 2006, 2010), or with an emphasis on formal organizational networks (Gelcich et al. 2010, Stein et al. 2011, Cohen et al. 2012, Cárcamo et al. 2014, Moeliono et al. 2014, Nuno et al. 2014, Pietri et al. 2015). Furthermore, several studies refer to social networks as a structural feature of "social capital." In this way, they either explain the performance of particular organizations (Marín and Berkes 2010, Marín et al. 2012) and individual actors (Ramirez-Sanchez and Pinkerton 2009, Rico García-Amado et al. 2012) or investigate the potential of collective action for conflict resolution (Sanginga et al. 2007) and disaster risk recovery (Ireland and Thomalla 2011, Marín et al. 2015).

Network operationalization

Network approach: Structurally explicit approaches, and in particular the application of SNA techniques, are characteristic of most studies in this strand, however, there are also studies that refer to social networks in metaphorical terms, treating networks as an binary variable (Tompkins et al. 2002, Sanginga et al. 2007, Gelcich et al. 2010, Sundstrom et al. 2012).

Network definition: The social relations emphasized involve information, knowledge exchange, and collaboration between resource users and stakeholders. Network boundaries are defined with reference to management systems with a limited set of stakeholders and with clear ecological, geographical, or administrative boundaries. Whereas social ties in most cases are perceived as facilitating exchange and mutual understanding, few studies point to the restrictive potential of social ties (Marín and Berkes 2010, Marín et al. 2012). Several studies explicitly address cross-scale interactions between various political and administrative stakeholders (Tompkins et al. 2002, Gelcich et al. 2010, Stein et al. 2011, Cohen et al. 2012, Cárcamo et al. 2014, Marín et al. 2015).

Network analysis: The focus of research comprises the network, the subgroup, and the individual level, whereby the focus of analysis is on structural network characteristics such as density, centrality, or fragmentation. Common tie characteristics are those of importance, frequency, or intensity. Several studies distinguish between bonding, bridging, and linking ties (Sanginga et al. 2007, Bodin and Crona 2008, Ramirez-Sanchez and Pinkerton 2009, Stein et al. 2011, Cohen et al. 2012, Marín et al. 2012, 2015, Sundstrom et al. 2012, Cárcamo et al. 2014, Apgar et al. 2015). Few studies highlight the influence of network context (Tompkins et al. 2002, Rico García-Amado et al. 2012, Sundstrom et al. 2012) or actor characteristics, such as leadership or socioeconomic power (Bodin and Crona 2008, Crona and Bodin 2010) to explain agency or lack thereof.

Key findings

Studies identify heterogeneity, cross-scale interaction, network density, and actor centrality as key factors influencing the resilience of governance networks. For the latter two factors, dense and centralized networks with strong bonding ties are shown to be effective in managing simple tasks (Rico García-Amado et al. 2012), while fragmented networks are shown to limit communication and hence adaptive capacity (Cárcamo et al. 2014, Mannetti et al. 2015). Furthermore, for successful transformation toward sustainable governance, studies indicate the need for decentralized and heterogeneous networks that entail bridging ties between administrative and institutional scales of management (Gelcich et al. 2010, Cohen et al. 2012, Marín et al. 2012, 2015) and, in particular, the need for brokers who facilitate collaboration between these scales (Stein et al. 2011, Cárcamo et al. 2014, Moeliono et al. 2014, Nuno et al. 2014, Pietri et al. 2015). Studies elaborating on possible reasons for inertia in governance processes reveal homogeneity among centrally positioned opinion-leaders as a potential barrier to collective action (Crona and Bodin 2006, 2010, Bodin and Crona 2008, Ramirez-Sanchez and Pinkerton 2009, Moeliono et al. 2014, Mannetti et al. 2015). Social capital based on linking ties (Marín et al. 2012) and flexible arrangements with changing roles and responsibilities are suggested as better suited to meeting the challenges of adaptive management (Apgar et al. 2015). Particular findings show that, successful governance networks can enhance resilience to natural disasters (Marín et al. 2015), but favorable structures alone might not be sufficient to promote proactive resilience building if resource users are excluded from formal institution building (Ramirez-Sanchez and Pinkerton 2009).

Strand (ii): Agricultural innovation

Research in this strand is concerned with processes of social learning in the context of rural transformation. The case studies reviewed, for example, range from acceptance of improved crop varieties (Bandiera and Rasul 2006, Van den Broeck and Dercon 2011, Tatlonghari et al. 2012, Thuo et al. 2014) through the implementation of sustainable and risk-mitigating agricultural practices (Mazzucato and Niemeijer 2000, Conley and Udry 2001, Isaac et al. 2007, 2014, Matuschke and Qaim 2009, Arora 2012, van Rijn et al. 2012, Matouš et al. 2013, Wossen et al. 2013) to the use of modern information and communication technologies (Butt 2015).

Network conceptualization

Conceptual framing: In contrast to studies in the other two research strands, the majority of literature in this strand does not address resilience explicitly. However, from a development economics' perspective, studies perceive of social networks as factors shaping social learning and adaptive changes in the context of agrarian change, and hence implicitly address aspects relevant to resilience. A system's perspective is rare, although there are attempts to embed it in the context of innovation systems (Spielman et al. 2011, Arora 2012, Isaac 2012). A few studies link agricultural innovation with adaptive management (Isaac et al. 2007) or conceptualize social networks as a form of social memory contributing to resilience (Isaac et al. 2014).

Network variable: The majority of studies focus on the outcomes of networks—here the adoption of agricultural practices or technologies—treating social networks as an independent variable. Studies that address the impact of external changes on social network structure are the exception (Mazzucato and Niemeijer 2000, Arora 2012, Isaac et al. 2014, Butt 2015).

Network narrative: Underlying most studies is the conception of networks as pipes through which "flows" of information, knowledge, and advice are transferred and circulated between

actors. Less frequently, social networks are conceptualized as social capital, explaining differences in adaptation processes between different groups of farmers (Hoang et al. 2006, Tatlonghari et al. 2012, van Rijn et al. 2012).

Network operationalization

Network approach: In this strand, descriptive approaches predominate, characterized by an emphasis on econometric methods. A smaller number adopt structurally explicit approaches using methods of SNA (Isaac et al. 2007, 2014, Arora 2012, Spielman et al. 2011, Isaac 2012). Few studies adopt metaphorical approaches (Mazzucato and Niemeijer 2000, Butt 2015).

Network definition: The most frequently investigated social relation is information and advice sharing between farmers and external actors such as extension staff and NGOs (Arora 2012, Matouš et al. 2013, Wossen et al. 2013). Challenging the assumption that the village level is suitable for defining the reference group for social learning, specific studies compare innovation networks between different study sites, and highlight the role of information exchanges between villages (Mazzucato and Niemeijer 2000, Conley and Udry 2001, Matuschke and Qaim 2009, Isaac et al. 2014) and rural and urban areas (Isaac 2012, Wossen et al. 2013).

Network analysis: In contrast to studies in the governance strand, the dominant level of observation is not that of the network or subgroup but that of the individual farmer. For analysis, descriptive studies predominantly focus on actor and tie characteristics. Actor characteristics addressed include, for example, farm size, wealth, experience, gender, ethnicity, and geographic location, whereas tie characteristics addressed include kinship and friendship relations. The latter are referred to as strong or bonding ties (Van den Broeck and Dercon 2011, Tatlonghari et al. 2012), while relations to external actors and institutions are referred to as weak or bridging ties (Wossen et al. 2013, Thuo et al. 2014). Structurally explicit studies focus on structural measures for explaining information diffusion, such as network density and fragmentation, as well as on actor centrality for identifying brokers of agro-ecological knowledge (Isaac et al. 2007, 2014, Isaac 2012). Network context is addressed by a few studies highlighting the roles played by institutions (Hoang et al. 2006, Spielman et al. 2011, Arora 2012), information technologies (Butt 2015), or migration (Isaac et al. 2014).

Key findings

Studies do not explicitly elaborate on the link between network features and resilience. However, they identify key factors influencing social learning and decision-making processes and hence provide insights into adaptive processes crucial for the resilience of SES. In this regard, studies highlight actor and tie characteristics rather than network structure. Challenging the simple assumption that having more actors in a network increases the likelihood of adopting new technologies, studies reveal that decisions are based on imperfect knowledge and are oriented toward the experience and adoption behavior of network members (Conley and Udry 2001, Matuschke and Qaim 2009, Wossen et al. 2013), and are often subject to strategic considerations (Bandiera and Rasul 2006). Regarding tie characteristics, two groups of studies can be distinguished. The first group identifies social and geographical proximity as conducive to information diffusion: Strong and homophilous ties, for example kinship ties, are shown to facilitate information diffusion (Bandiera and Rasul 2006, Hoang et al. 2006, Matuschke and Qaim 2009, Van den Broeck and Dercon 2011, Tatlonghari et al. 2012). In contrast, the second group of studies emphasizes the role of bridging and linking ties between diverse actors from civil society, public extensions, and the private sector, which provide farmers with access to external sources of information and experiences (Arora 2012, van Rijn et al. 2012, Matouš et al. 2013, Wossen et al. 2013, Isaac et al. 2014, Thuo et al. 2014). Within this group, particular studies highlight geographical factors. First, ties to geographically distant actors increase the likelihood that farmers will gain access to new information (Wossen et al. 2013), and second, experiences gained from farming in different agro-ecological settings can help to build social memory (Isaac et al. 2014). With regard to network structure, those studies applying structurally explicit approaches argue that, unlike governance, innovation requires sparse but efficient networks with a few central actors acting as brokers between formal and informal networks (Isaac et al. 2007, 2014, Isaac 2012). Particular studies point to the critical roles played by elite actors linking external actors and the community, and the danger of reproducing power imbalances through external interventions (Hoang et al. 2006, Spielman et al. 2011, Arora 2012).

Strand (iii): Social support

Research in this strand focuses on reciprocity between rural households as a way of pooling scarce resources and as a means of household risk management. Case studies reviewed include, for example, work on social networks as part of rural livelihood strategies (Kadigi et al. 2007, Torkelsson 2007, Nygren and Myatt-Hirvonen 2009, Ekblom 2012, Rindfuss et al. 2012, Goulden et al. 2013, Baird and Gray 2014), recovery from climate risks (Bosher et al. 2007, Rotberg 2010, Islam and Walkerden 2014, 2015), climate-change adaptation (Scheffran et al. 2012), and sustainable resource management (Downey 2010, Zimmerer 2014, Abizaid et al. 2015, Katikiro et al. 2015, Orchard et al. 2015).

Network conceptualization

Conceptual framing: The majority of studies in this strand conceptualize social networks as a source of resources supportive to the resilience of rural households and communities. Even studies not explicitly addressing resilience share the conceptualization of networks as coping strategy in times of need (Kadigi et al. 2007, Torkelsson 2007, Nygren and Myatt-Hirvonen 2009, Rindfuss et al. 2012, Gallego and Mendola 2013, Lyle and Smith 2014, Abizaid et al. 2015, Katikiro et al. 2015) and hence refer to particular aspects of resilience. Unlike studies focusing on governance and innovation, studies on social support more frequently take a community perspective conceiving of social networks as a means for communities to deal with external shocks and risks (Cassidy and Barnes 2012, Ekblom 2012, Baird and Gray 2014, Islam and Walkerden 2014, 2015).

Network variable: Studies tend to focus on the outcomes of social networks and therefore treat social networks as an independent variable. However, there are also studies treating social networks as a dependent variable, emphasizing how social support networks are influenced by the impact of socioeconomic factors, such as livelihood diversification (Baird and Gray 2014, Orchard

et al. 2015), gender (Torkelsson 2007), caste influence (Bosher et al. 2007), and migration (Scheffran et al. 2012, Gallego and Mendola 2013, Zimmerer 2014).

Network narrative: Most studies in this strand refer to the notion of networks as social capital explaining differences in the vulnerability of households due to their different embeddedness. Unlike literature on agricultural innovations and governance, few studies in this strand build on the notion of networks functioning as pipes for the exchange of different types of support (Rindfuss et al. 2012, da Costa et al. 2013, Zimmerer 2014, Abizaid et al. 2015, Katikiro et al. 2015) or as a form of coordination (Downey 2010).

Network operationalization

Network approach: In comparison to the other two strands, this strand is characterized by a more equal presence of all three operational approaches. Descriptive approaches, characterizing social networks according to the nature of the ties involved, account for the majority. Metaphorical approaches that refer to either the existence or the decline of social networks as an explanatory variable of resilience are more frequent than in other strands (Kadigi et al. 2007, Ekblom 2012, Scheffran et al. 2012, da Costa et al. 2013, Zimmerer 2014, Katikiro et al. 2015). Structurally explicit approaches, drawing on methods of SNA (Downey 2010, Cassidy and Barnes 2012, Lyle and Smith 2014, Abizaid et al. 2015, Orchard et al. 2015) are more frequent than in the strand of agricultural innovation but less frequent than in the governance strand.

Network definition: The dominant social relation of interest is the exchange of material, financial, and emotional support between rural households at the village level. Studies tend to concentrate on the village level (Cassidy and Barnes 2012, Islam and Walkerden 2014, Lyle and Smith 2014, Abizaid et al. 2015), though there are also studies emphasizing the role of social ties that extend beyond the community (Ekblom 2012, Rindfuss et al. 2012, Scheffran et al. 2012, Gallego and Mendola 2013, Islam and Walkerden 2015, Orchard et al. 2015).

Network analysis: The main level of analysis is that of the individual, in this case, households, whereas structurally explicit studies also give attention to the network level (Cassidy and Barnes 2012, Lyle and Smith 2014). Frequently addressed characteristics include tie reciprocity and tie strength, the latter being operationalized either as bonding ties of kinship and bridging ties of neighborhood and friendship (Islam and Walkerden 2014, 2015), or as bonding ties within the community and bridging ties to actors outside the community (Rotberg 2010, Baird and Gray 2014, Islam and Walkerden 2014, 2015, Orchard et al. 2015). Compared to other strands, there is a stronger focus on network context, including social institutions and socioeconomic changes (Torkelsson 2007, Nygren and Myatt-Hirvonen 2009, Baird and Gray 2014, Katikiro et al. 2015, Orchard et al. 2015). Structurally explicit studies focus on structural characteristics such as density, hierarchy, and the centrality of particular households (Downey 2010, Cassidy and Barnes 2012, Lyle and Smith 2014, Orchard et al. 2015).

Key findings

Regarding the coping aspect of social networks, several studies emphasize the importance of strong ties of reciprocity and trust at the community level (Kadigi et al. 2007, da Costa et al. 2013, Goulden et al. 2013, Katikiro et al. 2015) or, more specifically, to the combination of strong and weak ties (Rotberg 2010, Islam and Walkerden 2014, 2015). Particular studies point to the importance of temporal dynamics by revealing that the composition and viability of bridging and bonding ties is not fixed but changes over time (Baird and Gray 2014, Islam and Walkerden 2014). Network transitions from traditional support systems to diversified market-oriented networks are shown to have ambiguous implications for community resilience. For example, transitions might foster the capacity to cope with high-incidence/low-severity impacts, while at the same time reduce the ability to manage low-incidence/high-severity shocks (Baird and Gray 2014, Orchard et al. 2015). With regard to actor characteristics, studies show that gender and socioeconomic status determine access to and ability to utilize social networks (Bosher et al. 2007, Torkelsson 2007, Cassidy and Barnes 2012, Rindfuss et al. 2012, Abizaid et al. 2015). Taking into account network structure, some studies conclude that more central households are more resilient because they can access more resources (Cassidy and Barnes 2012, Lyle and Smith 2014). Dense networks are shown to have higher redundancy and hence better opportunities to mobilize resources and act collectively, while larger and less redundant networks might yield greater returns (Orchard et al. 2015). Taking into account the effect of external factors on support networks, a small group of studies indicates the effects of migration either on participation in community networks (Gallego and Mendola 2013), or on livelihoods and resilience in the places of origin (Ekblom 2012, Rindfuss et al. 2012, Scheffran et al. 2012).

DISCUSSION

This review of case studies on the role of social networks in the Global South extends beyond disciplinary boundaries. Its categorization system permits the different strands to be compared and thus allows similarities, differences, and blind spots to be revealed. This opens up the opportunity to critically assess the viability of a social network perspective for addressing the resilience of rural communities in the Global South as well as to discuss implications for future research.

Strengths, weaknesses, and challenges of current social network research in the Global South

Strand (i): Natural resource governance

Approaching social networks from a systems perspective, this strand addresses the capacity of social networks to navigate the transformation of SES toward sustainable resource use and resilience. A particular strength of this approach lies in linking social network patterns with particular resilience features (Newman and Dale 2005, Janssen et al. 2006). Against this background, studies provide instructions for strengthening the resilience of governance systems; they offer opportunities to identify cross-scale mismatches and barriers in governance processes (e.g., Crona and Bodin 2006, Stein et al. 2011, Moeliono et al. 2014, Nuno et al. 2014), to recognize potential change agents (e.g., Crona and Bodin 2010, Cárcamo et al. 2014, Moeliono et al. 2014), to design more sustainable governance regimes (e.g., Gelcich et al. 2010, Cohen et al. 2012, Marín et al. 2012, 2015, Pietri et al. 2015). In doing so, they can draw on the elaborated toolkit of SNA, which is increasingly applied not only in the context of resource governance in the Global South but around

the globe (Bodin and Prell 2011). Particularly promising in this regard is the application of SNA for disentangling coupled SES and for investigating the alignment of social and ecological structures and processes (Bodin and Tengö 2012, Bodin et al. 2014, Roldán et al. 2015).

Structurally explicit approaches, as applied in most studies, have their drawbacks, however. Formal assessment of network structure requires clearly defined network boundaries (Scott 2013), a methodological restriction in the context of dynamic rural societies. As well, the focus on definable management systems tends to ignore particularities of resource governance in the Global South, such as social, economic, and political conditions impacting the livelihoods, needs, and rationalities of stakeholders. Another drawback stems from the underlying assumption that exchange and communication between various actors inevitably increases understanding and the willingness to act collectively (Schneider et al. 2003, Carlsson and Sandström 2008, Newig et al. 2010). This collaborative bias tends to downplay conflicts underlying many current resource management issues in the Global South (McNeish 2010), in particular the role of power asymmetries (Crona and Bodin 2010). A technical and apolitical understanding of governance is problematic because it portrays resource conflicts as a manageable task involving the modification of network patterns (Zimmer and Sakdapolrak 2012, Scott 2015). In the same way, any argument that SNA can be used as a tool to improve governance processes and hence contribute to resilience runs the risk of reducing resilience building to a mere technical challenge (Scott 2015).

Instead of assuming that favorable network patterns will "lubricate the machinery of natural resource governance" (Crona and Hubacek 2010), more attention should be paid to the skills, means, and motivation of centrally positioned actors to promote new ideas and prompt collective action (Crona and Bodin 2010, Moore and Westley 2011). A critical approach to governance ought to address the question of what mode of social-ecological interactions promotes specific governance systems and whose resilience this might foster or impede (Cretney 2014). This would also entail a stronger emphasis on the social and historical context of resource governance in the Global South.

Strand (ii): Agricultural innovation

In contrast to the system perspective of the governance strand, this strand adopts an actor-based perspective on the capacity of social networks to promote adaptive capacity through social learning and the adoption of technology in the context of agrarian change. Its strength lies in accounting for a variety of actor and tie characteristics (e.g., Conley and Udry 2001, Bandiera and Rasul 2006, Tatlonghari et al. 2012, Thuo et al. 2014) as well as social, political, and religious factors (e.g., Mazzucato and Niemeijer 2000, Matouš et al. 2013). Building on descriptive approaches utilizing sophisticated econometric methods, studies in this strand are less restricted by defining boundaries and are more conscious of the relevance of relations that cross geographic scales (e.g., Matuschke and Qaim 2009, Isaac 2012, van Rijn et al. 2012, Wossen et al. 2013, Isaac et al. 2014). Although studies do not explicitly address the links between social networks and resilience, they provide valuable information about how sustainable innovations, and hence adaptive capacity, can be promoted by research, development, and policy. (e.g., Hoang et al. 2006, Spielman et al. 2011, Van den Broeck and Dercon 2011).

Although the descriptive approaches offer greater flexibility in the network definition than structurally explicit approaches, they are limited in their ability to assess network structure. Furthermore, using network proxies such as group membership involves methodological problems. First, farmers might adopt or choose group membership because of unobserved individual characteristics or hidden variables. Second, the behavior of the group might influence the individual, who in turn might influence the group (Manski 1993). Ways of circumventing these problems have been suggested (Bandiera and Rasul 2006, Matuschke and Qaim 2009). However, these adjustments do not account for the simplistic conceptualization of networks as pipes, which tends to oversimplify decision-making processes in rural contexts. This omission is of particular relevance because work on social contagion (Burt 1987) suggests that social actors align their behavior with reference not only according to directly available information but also according to perceived norms and roles regarding their positions within a given network structure (Burt 1987, Grabher 2006). Of further concern is the strand's bias toward economic explanations of decision making, which downplay the roles of social, political, and environmental aspects in mediating the social and economic values of innovations.

Seen from a systemic perspective, a major factor that stands in the way of understanding resilience is the strand's focus on decisions at the individual level. Understanding how social networks facilitate or impede the adoption of more sustainable agricultural practices is a major, but not a sufficient, basis upon which to make claims about the resilience of SES (Carpenter et al. 2001). As a way forward, studies that approach innovation networks from a systems' perspective (Spielman et al. 2011, Isaac 2012) and link them to concepts such as adaptive management and social memory (Isaac et al. 2014) might be instructive in addressing multiscale interactions and positioning them in social, political, and cultural contexts (Atwell et al. 2008).

Strand (iii): Social support

This strand provides insights into the ways in which households employ their social networks as a strategy to cope with and recover from risks. Its strengths lie in providing a community perspective on household coping strategies and in employing a multimethod mix comprising quantitative and qualitative aspects of social networks. This combination offers the flexibility to take into account actor, tie, and network characteristics, as well as the impact of network context such as social institutions (e.g., Bosher et al. 2007, Torkelsson 2007, Nygren and Myatt-Hirvonen 2009) and socioeconomic changes (e.g., Baird and Gray 2014, Zimmerer 2014, Katikiro et. al 2015, Orchard et al. 2015). Furthermore, in contrast to the strands of governance and innovation research, studies in this strand more explicitly account for the temporal dynamics of social networks (e.g., Rindfuss et al. 2012, Goulden et al. 2013, Islam and Walkerden 2014), and hence provide a more nuanced understanding of how the resilience of rural households evolves in the context of rural transformation (Rigg 2006).

One particular issue of concern, however, stems from reducing social networks to "assets" that households have at their disposal. A tendency to reiterate tautological assumptions about the positive role of social capital (Nygren and Myatt-Hirvonen 2009) is particularly prevalent in metaphorical approaches that consider the mere existence of networks. This is a one-sided perspective, because networks are not necessarily solely beneficial but may

also exclude actors from community resources and reinforce dependencies and differences between the actors (Bohle 2006, Torkelsson 2007, Steinbrink 2009). Furthermore, networks are not always readily available but involve time and resources to maintain (Nygren and Myatt-Hirvonen 2009, Lyle and Smith 2014), and their effectiveness might be limited by risks faced by its members (Gallego and Mendola 2013). Accordingly, participation in community networks is an ambiguous proxy for resilience, not least because it excludes those who cannot afford to be part of the network (Torkelsson 2007, Cassidy and Barnes 2012). Another drawback of studies in this strand is their tendency to conceive of social networks as consisting of strong bonding ties as relations of reciprocity and trust. Indeed, a bias toward reciprocal ties neglects the fact that norms of reciprocity, in particular between close family and kin, can exert high social pressure, and hence weak ties might be prioritized when seeking support (Nygren and Myatt-Hirvonen 2009).

In terms of the resilience of rural communities, it is not only problematic to confuse social proximity with the degree of support but also problematic to narrowly focus on the community level as the primary level of social interaction. Studies taking into account the impact of external actors on the resilience of rural households (e.g., Islam and Walkerden 2014, 2015) are providing important insights on the impact of external factors but might not be sufficient to address the mobility of rural livelihoods in the Global South (Ellis 2003, Rigg 2006). Rather studies should shift attention toward social ties spanning different locations to address coping capacity in an increasingly connected world (Scheffran et al. 2012).

General challenges

Besides the strengths and weaknesses of each research strand, our review also identifies general challenges: current case studies on the role of social networks tend to provide a static view of network outcomes, emphasize structure over agency, and neglect the spatial dimensions of social relations. A general challenge that has to be met by future social network research in the Global South is the tendency to abstract social structure from network context (Entwisle et al. 2007). Indeed, the majority of studies focus on the outcomes of networks rather than on the question of how social networks evolve in the context of change (Baird and Gray 2014). In most cases, studies addressing the impact of external drivers such as socioeconomic and political factors are following metaphorical or descriptive approaches and thus tend to remain silent about impacts in terms of network structure. Structurally explicit approaches that could provide these insights often fail to make sense of network context. Building on heuristic assumptions about how structural patterns are related to resilience features (Bodin et al. 2006, Janssen et al. 2006), studies following an analytical explicit approach tend to make general judgments about "trade-offs" between structural features and the "right mix" of ties instead of addressing the quality of ties for particular purposes (Videras 2013) and identifying contextual aspects of social interaction (De Nooy 2013). Moreover, studies tend to focus on the assessment of networks at a given point in time. In dynamic contexts, such as that of rural transformation, however, assessing "network snapshots" (Ernstson et al. 2008) is not sufficient to make causal claims about resilience in the long term (Bodin and Prell 2011). This applies in particular when taking into account that SES evolve through adaptive cycles (Gunderson and Holling 2002) and that changing systems configurations might require different social networks (Downey 2010, Goulden et al. 2013). Studies using long-term panel surveys might overcome this challenge but are time and resource consuming (Rindfuss et al. 2012).

A much-discussed issue in network research is its inability to address the dialectical relationship between social structure and agency (Crona et al. 2011). This problem arises in the majority of our sample studies, which implicitly or explicitly build on the assumption that the presence of favorable networks is sufficient to ensure agency, here the ability to identify and enact solutions to sustainable development challenges (Newman and Dale 2007). However, addressing only one part of the iterative cycle between social processes and social structure (Bodin and Prell 2011) fails to make sense of the mechanisms through which social relations are reproduced and configured over time (Emirbayer and Goodwin 1994). Treating social structure "as is" (Bodin and Prell 2011:365) does not reflect how that structure evolves through communicative processes (Fuhse and Mützel 2010, Ingram et al. 2014) and neglects the critical role played by the means, skills, and motivation of particular social actors who "make things happen" (Crona et al. 2011:53) and, in particular, how they create social networks conducive to resilience (Moore and Westley 2011).

Finally, a further bias of current network research is its tendency not to take the spatial dimensions of social networks seriously. Indeed, most studies reviewed adopt a network-centric perspective, with a one-sided conception of horizontal and frictionless social "spaces of flows" (Jessop et al. 2008:391). In general, spatial assumptions underpinning social inquiries should be treated with caution (Jessop et al. 2008) to avoid falling into the trap of determinism. In the context of the Global South, where mobility and multiple connections between rural and urban areas are the norm rather than the exception (Ellis 2003, Steinbrink 2009), a spatially blind form of social network research, however, risks losing sight of significant determinants of rural livelihoods. Migration is a major strategy for livelihood diversification (Rigg 2006, World Bank 2011) and climate change adaptation (Black et al. 2011) and hence should be accounted for in studies addressing the role of social networks for the resilience of rural communities (Rindfuss et al. 2012, Scheffran et al. 2012, Gallego and Mendola 2013, Isaac et al. 2014).

Although all three challenges could apply to networks research in general, we argue that they are of particular concern for understanding the role of social networks for the resilience of rural communities in the Global South. Current social network research, with its static focus on network outcomes and its inability to take social agency sufficiently into account, is ill suited to addressing temporal and spatial dynamics in factually highly mobile societies (Ellis 2003, Rigg 2006). Furthermore, it provides an ahistorical perspective on social networks that tends to mask the political nature and colonial history of resource conflicts (McNeish 2010).

Toward a translocal social network perspective

Against the backdrop of these challenges, we envisage a social network perspective on resilience that takes into account the complexity and dynamics of rural livelihoods in an increasingly connected world. As a means to this end, we propose integrating research on social networks and resilience with the concept of translocality (Greiner and Sakdapolrak 2013*a*).

The concept of translocality addresses the increasing connectedness of daily life, which is inter alia facilitated by multiple forms of mobility, including everyday movements, and seasonal and long-term migration (Brickell and Datta 2011). By emphasizing the simultaneous embeddedness of social actors in translocal networks spanning different locales, translocality combines the socio-spatial dimensions of both place and social networks (Jessop et al. 2008). It thereby challenges dichotomous geographical conceptions such as space/place, rural/urban, and core/periphery (Steinbrink 2009, Greiner and Sakdapolrak 2013*b*). Instead of conceiving of migration as a singular and unidirectional movement of people, translocality highlights the importance of migration-induced feedback processes between areas of origin and destination. This includes the circulation and flows of ideas, symbols, knowledge, and practices between mobile and nonmobile actors through translocal social networks (Greiner and Sakdapolrak 2013*a*). Hence, embeddedness in these translocal networks determines the availability of and access to resources and therefore has the potential to strengthen the resilience of its actors (Scheffran et al. 2012, Sakdapolrak 2014).

Accordingly, the notion of translocal resilience points to the role of translocal networks in conditioning the capacity of particular actors, households, and communities to cope with and adapt to changes, transform livelihoods, and explore alternative modes of social-ecological interaction (Sakdapolrak 2014, Sakdapolrak et al. 2016). These capacities in turn impact the means and opportunities to shape and utilize translocal networks. In other words, translocal networks are both preconditions and outcomes of the resilience of rural communities. By acknowledging that different capacities at individual, household, and community level are not necessarily complementary but might compete with each other, the notion of translocal resilience places particular emphasis on the role of social norms and power asymmetries in negotiating and defining desirable resilience outcomes. In other words, it provides a "situated" approach to resilience that broadens the scope of research toward including the processes and social relations that support resilience (Cote and Nightingale 2012).

A translocal network perspective, we claim, holds promise for addressing the challenges faced by current research on social networks and resilience in the Global South. First, by integrating the socio-spatial dimensions of networks and place, a translocal network perspective shifts the research focus from locally bound entities, such as the village, a region, or a management area, to the connectedness between actors at different places, while, at the same time, emphasizing the role of spatiality in social networks. Second, by taking into account mutual feedback processes between areas of origin and destination, it facilitates a dynamic understanding of complex rural transformations that cannot be understood by focusing on locally bound networks only. Third, it draws attention to the dialectic relationship between social structure and agency by revealing how capacities of resilience are related to daily practices of mobile and nonmobile actors in utilizing and shaping their networks. In doing so, it has the potential to contribute to a resilience research "of fine nuances," in the sense of Bourdieu, which takes into account economic and social power relations from the local to the global level (Deffner et al. 2014). Finally, a translocal network perspective would be suited to overcoming the apolitical tendencies of both resilience and network theory through reassessing resilience and social networks from a critical sciences perspective (Scott 2015).

CONCLUSION

This review provides a systematic overview on the conceptualization and operationalization of social networks across three strands of research and a discussion of their strengths and weaknesses in addressing aspects of the resilience of rural communities in the Global South. Research on governance networks, rooted in SES research, predominantly conceptualizes social networks as a form of coordination in the context of management system transformation. With its bias toward methods of formal network analysis, studies are powerful in providing insights into how networks can facilitate cross-scale adaptive management and how structural patterns relate to key system features relevant for the resilience of SES. However, because of methodological constraints, studies are limited to clearly identifiable management systems and tend to underestimate the role of human agency and power asymmetries. Contrastingly, research on innovation networks, informed by development economics, centers around the conception of social networks as pipes of information exchange required for the adaptation to changing conditions. Econometric methods provide opportunities for assessing a wide range of factors relevant, for example, to the purposeful changes of crops and practices; however, they remain descriptive in nature and vague with regard to the impact of these changes on resilience on higher levels. Studies on social support, rooted in vulnerability and disaster research, address the role of social networks as a means of coping with shock. By conceptualizing social networks as social capital, studies in this strand help to broaden the scope of vulnerability and livelihoods research. However, they tend to focus on social networks as assets at the community level thereby omitting the role of migration-induced feedback processes between areas of origin and destination.

Opportunities for sharpening and developing future research agendas include inter alia a critical approach to governance networks that reconsiders the role of actors' differential agency and power asymmetries; an integration of actor- and systems-based approaches to agricultural innovation networks; and finally a shift away from stressing reciprocal and trusting relations at the community level toward addressing support networks spanning multiple locales in the context of mobility and social, economic, and political changes. More specifically, the review points to central challenges to be met in future research on social networks and resilience in the Global South. These particularly include the tendency of current network research to focus on network outcomes and the difficulties involved in assessing network dynamics, an overemphasis of network structure while undertheorizing the role of agency in shaping and reproducing social networks, and the tendency to neglect spatial dimensions of social relations despite the highly mobile character of many rural societies.

To address these challenges, we propose linking future research with the concept of translocality. A translocal social network perspective on the resilience of rural communities addressing embeddedness in and connectedness between places shifts the focus of research from bounded entities toward the connections between places; it takes into account the dynamic

interrelationship between structure and agency and provides a multidimensional conception of social relations. Hence, it offers a framework well suited to the complexity of rural-urban realities in the Global South.

Responses to this article can be read online at:
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Appendix 1

List of sample studies selected for in-depth analysis.

A1.1: Strand i: Natural resource governance

Authors	Research interest	Conceptualization			Operationalization				Key findings
		Conceptual framing	Network variable	Network narrative	Network approach	Network definition	Network analysis		
							Network level	Network characteristics	
Apgar et al. 2015	Understand underlying social dynamics at play in social-ecological systems in indigenous territories of Panama.	*Explicit reference to resilience:* Social networks as dynamic and informal web of interactions which foster adaptation and transformation, and hence resilience of social-ecological systems.	Independent: Influence of networks on adaptive capacity of social-ecological systems.	Social capital: Social networks as part of social capital helping to understand the value of bridging links across different groups, communities, and scales.	Descriptive: Reflection-groups made up of leaders and scholars engaged in iterative discussion cycles in an indigenous territory.	Social relation: formal / informal information exchange. Actors: community members and leaders involved in natural resource governance. Scale: regional / indigenous territory + linkages to external actors.	Subgroup: local governance groups Individual: brokers between subgroups.	Tie: bridging ties connecting brokers between groups, and to outside actors.	Changing roles of leaders prevent the network from becoming vulnerable to the loss of hubs and bridging links. Cultural practices facilitating leadership development and social networking are critical for enabling both adaptation and transformation.
Bodin and Crona 2008	Assess community social capital and identify potentially influential actors in a Kenyan coastal village. Assess if lack of community social capital and leadership may explain the lack of collective action.	*Implicit reference to resilience:* Social networks as a factor fostering or hindering collective action towards sustainable resource management.	Independent: Influence of social networks on collective action.	Social capital: Characteristics of social networks as a factor of social capital.	Structurally explicit: Complete village / household survey and key informant interviews in a coastal village. SNA: total network.	Social relation: personal support, knowledge exchange, gear lending. Actors: fishermen (household heads) in the village. Scale: local / village.	Subgroup: occupational and relational groups. Individual: brokers between subgroups.	Actor: tribe, occupation, perception of resource status. Tie: ratio of bonding / bridging ties. Structure: density, centrality.	Unwillingness to report rule-breaking due to strong social capital. Homogeneity among key individuals leading to poor recognition. Brokers can block information flows and act as social barriers to transformation. Resilience depends on the impact of central actors on decision making processes.
Cárcamo et al. 2014 †	Investigate the structure and properties of inter-organizational social networks involved in the use and management of natural resources in a	*Implicit reference to resilience:* Structural properties of social networks influence co-management ar-	Independent: Influence of networks on management outcome.	Form of coordination: Social networks as a formal form of inter-organizational communication / collabo-	Structurally explicit: Document analysis, stakeholder analysis, and questionnaire with organizational representatives	Social relation: information, collaboration. Actors: representatives of organizations / institutions.	Network: governance network. Individual: cross-scale brokers.	Actor: organizational type, administrative level, perception, homophily. Tie: importance, frequency, bridging	Missing cross-scale interaction in co-management networks potentially hampers adaptive capacity and resilience of social-ecological systems. Centrally positioned actors could act as

	coastal marine ecosystem in Chile.	rangements which foster adaptive capacity and resilience of social-ecological systems.		ration.	involved in the management of the marine protected area. SNA: total network.	Scale: local - national governance system.		ties (between scales) Structure: density, diameter, average path length, centrality.	bridging stakeholders.
Cohen et al. 2012	Understand the potential of social networks to facilitate coordination and learning among management actors involved in the marine resource management in Solomon Islands.	*Implicit reference to resilience:* Social networks as factor of adaptive co-management facilitating coordination and learning among management actors.	Independent: Influence of networks on natural resource governance outcome.	Form of coordination: Social networks as purposeful formed relations between different actors fostering collective action.	Structurally explicit: Qualitative interviews, and questionnaire with representatives of organizations involved in the governance of marine resources. SNA: total network.	Social relation: formal / informal knowledge exchange, collaboration. Actors: agencies and organizations. Scale: local - international governance system.	Network: governance network. Individual: bridging organizations or institutions.	Actor: organization type, scale of operation, preference for learning. Tie: intensity (strong / weak), bridging ties (between scales). Structure: density, centrality.	Cross-scale communication transcending formal governance systems facilitates coordination and learning. A trade-off exists between facilitating flows of knowledge between various levels and promoting learning on local level.
Crona and Bodin 2006	Investigate if a lack of collective action to remedy unsustainable use of fishery resources may be attributed to the structures of the social networks in a Kenyan coastal village.	*Implicit reference to resilience:* Social networks as factor determining successful implementation of community based co-management.	Independent: Influence of networks on collective action towards the co-management of common-pool resources.	Form of coordination: Networks of stakeholder communication as means of mobilizing and maintaining co-management.	Structurally explicit: Complete village household survey, and semi-structured interviews with household heads in a coastal village. SNA: total network.	Social relation: information and knowledge exchange. Actors: resource users in the village. Scale: local / village.	Network: community management network. Subgroup: occupational and relational groups.	Actor: occupation, tribe. Tie: density of inner / in-between group ties. Structure: centrality, fragmentation (in subgroups).	Communication is mainly defined by occupational groups. Restricted communication between groups in social networks and missing incentives for brokers to act impede the successful implementation of community based management.
Crona and Bodin 2010	Investigate if the examination of power relations and knowledge sharing networks in a Kenyan coastal village can explain why a community has not initiated collective action.	*Implicit reference to resilience:* Power relations within social networks as factors that can facilitate or prevent societies from transforming governance of natural resources towards resilience.	Independent / Dependent: Influence of network structure on collective action. Influence of power relations on social network structure.	Form of coordination: Social networks of knowledge exchange and power relations as factors impacting consensus building in resource management.	Structurally explicit: Complete village / household survey, and semi-structured interviews with household heads in a coastal village. SNA: total network.	Social relation: knowledge exchange, gear lending. Actors: resource users in the village. Scale: local / village.	Network: knowledge, and gear lending network. Subgroups: occupational and relational groups. Individual: opinion leaders.	Actor: gender age, tribe, occupation, perception of key individuals. Structure: degree centrality.	Opinion leaders, characterized by centrality in knowledge and gear lending networks, show little recognition and willingness to change resource use, because of capital invested in gear equipment. Opinion leaders can act as barrier to change.
de Villiers et al. 2014	Determine whether particular decision making frameworks promote adaptive capacity. Explore social capital amongst land managers in South Africa applying methods of SNA.	*Explicit reference to resilience*: Social networks facilitating social learning and innovation as a key to enhancing adaptive capacity and resilience of rangeland management.	Independent: Impact of social networks on social learning and innovation.	Social capital: Social networks as structural component of social capital alongside cognitive social capital (norms and trust).	Structurally explicit: Interviews with households involved in land management in Eastern Cape Province. SNA: total network (constructed from ego-networks).	Social relation: seeking advice and calling in times of problems. Actors: households in the region. Scale: regional / provincial governance system.	Subgroups: groups of adopters / non-adopters.	Actor: adopting behavior. Tie: type of ties (friendship, kinship). Structure: size, density.	Social learning networks in form of study groups support both the structural components (i.e. networks facilitating information sharing and decision-making) and cognitive components of social capital (i.e. trust and shared values). Building social networks as a foundation for strong social capital is essential for strengthening adaptive capacity of local communities.

Gelcich et al. 2010 †	Explore social, political, and ecological aspects of the transformation in Chile's coastal marine resource governance, from 1980 to today.	*Explicit reference to resilience:* Social networks as a vehicle to promote transformation and resilience building in natural resource governance.	Independent: Influence of social networks on natural resource management.	Form of coordination: Social networks as purposefully created governance networks.	Metaphorical: Review and synthesis of secondary sources on the transformation of a marine management system in Chile.	Social relation: communication Actors: resource users, scientists, organizations / institutions involved in the management of marine resources. Scale: local - national governance system. Temporal scale: 1980 until today.	Network: national governance network.	Tie: tie strength (strong / weak), bridging ties (between different scales). Context: facilitating policies.	The ability to network knowledge from local to national level through preexisting strong social networks provided critical elements for the transformation of the governance system towards resilience.
Ireland and Thomalla 2011	Explore the role of collective action in building adaptive capacity in Nepal and Thailand, with particular attention to the role of social networks.	*Explicit reference to resilience:* Social networks as factor facilitating community collective action for resilience building.	Independent: Influence of networks on collective action for adaptation to environmental risks.	Social capital: Social networks as a component of social capital facilitating collective action.	Metaphorical: Two case studies from Nepal and Thailand. Semi-structured interviews, vulnerability analysis, and participatory multi-stakeholder assessment.	Social relation: communication, information and knowledge exchange. Actors: community activists and collectives involved in reducing vulnerability to social and environmental risks. Scale: *(not specified)*	Individual: motivated leaders.	Actor: leadership. Tie: tie strength. Context: local government influence.	Collective action is robust if it builds on existing social network, and if strong and motivated individuals with good social networks take leadership. Local government can impede collective action.
Mannetti et al. 2015	Examine the issues of social capital, leadership, and traditional knowledge in South Africa and Botswana and explore how they contribute to collective action at the community level.	*Implicit reference to resilience:* Adaptive co-management systems as formed of social networks of actors involved in implementing rules and regulations on resource use.	Independent: Influence of social networks on adaptive management.	Form of coordination: Networks facilitate access to information required for promoting adaptive co-management systems.	Structurally explicit: Semi-structured interviews with bushmen involved in natural plant use from six farms belonging to the community. SNA: total network.	Social relation: seeking advice and discussing knowledge. Actors: bushmen in the community. Scale: local / community.	Network: knowledge network, collaboration network, dependency network. Subgroups: relational groups.	Actors: demographic factors (gender, age, length of residence), self-perceived level of knowledge. Structure: density, degree, dyads / triads, fragmentation, group cohesion.	Gender and the length of time an individual has been part of the community are barriers to knowledge acquisition (knowledge transfer occurs primarily between men). Homogeneity among key players is likely to reduce communities' ability to synthesize new knowledge. Low levels of ties among members of the network, higher fragmentation and overall low network cohesion hamper the opportunities for collective action.
Marín and Berkes 2010 †	Assess the Chilean shellfish co-management system from an organizational network perspective including networks of actors, the functions of these actors, and fishers' perceptions about Chile's co-management arrangement.	*Implicit reference to resilience:* Co-management as alternative form of governance that is comprised of multiple and complex social networks.	Independent: Influence of networks on management outcome.	Form of coordination: Social networks as formal arrangements between complex sets of actors.	Structurally explicit: Focus groups, in-depth interviews, and questionnaire with representatives of fishery associations in two administrative regions. SNA: total network (two-mode).	Social relation: facilitation, hindrance of co-management. Actos: small-scale fisher associations, public or private counterparts. Scale: local - national governance system.	Subgroup: functional groups in hindering and facilitating networks.	Tie: positive and negative ties (hindering / facilitating). Structure: centrality.	Studies of co-management should not focus only on collaborative (or facilitating), but also on hindering relationships. Highly centralized governance systems hamper participation of grassroots organizations. More autonomy and ability to use existing linking social capital between local organizations and actors at other scales would provide an opportunity to experiment and learn.

Marín et al. 2012 †	Assess the multifunctional relationships of small-scale artisanal fisher associations and explore the role of bridging and linking social capital for co-management of coastal benthic resource systems in Chile.	*Implicit reference to resilience:* Social networks linking actors at different levels promote performance of natural resource management and well-being.	Independent: Influence of social networks on economic performance of fisher associations.	Social capital: Investment in social relations pay-back in form of enhanced opportunities and capacities.	Structurally explicit: Semi-structured interviews with representatives of fisher associations in two administrative regions. SNA: ego-network.	Social relation: facilitation and hindrance of co-management. Actors: small-scale fisher associations, public or private counterparts. Scale: local – national governance system-	Subgroups: social capital groups.	Actor: co-management performance . Tie: bridging ties (between groups at the same level), linking ties (between groups at different levels). Structure: centrality	Best performing fisher associations are those with higher levels of linking and bridging social capital. Policy regulations and instruments should promote vertical and horizontal relationships.
Marin et al. 2015 †	Investigate if and how social capital – in combination with the levels of damage and geographic isolation – determines fishing organizations' ability to recover and innovate in response to a tsunami disaster.	*Explicit reference to resilience:* Social networks are an internal factor of social-ecological systems. Social networks promote capacity to respond to risks and adapt to change and hence – in combination with external factors – determine community resilience.	Independent: Impact of social capital / linking ties on the recovery trajectories of fishing communities	Form of coordination / Social capital: Social networks as purposeful developed networks for co-management of natural resources. Social capital as resources embedded in social structure / as linking ties providing resources and support from other places.	Structurally explicit: Panel study including semi-structured interviews with representatives, fisher associations, and regional officials in a coastal region before and after a tsunami. SNA: ego-network.	Social relation: facilitating relationships for the development of collaborative management. Actors: fishery authorities, researchers and consultants, buyers and traders. Scale: local - national governance system Temporal: 2008 and 2013.	Subgroups: groups of fisher organizations with different social capital, external factors, and trajectories.	Ties: linking ties (cross-scale ties to external actors). Structure: centrality	Higher levels of linking social capital are correlated with more positive post-tsunami trajectories. Social networks developed for co-management can facilitate disaster recovery. However, social capital changes over time and post disaster trajectories are also influenced by external factors (amount of damage and geographical isolation). This fact implies that relying only on social relations is a limited strategy for community recovery.
Moeliono et al. 2014	Analyze patterns of information exchange related to REDD+ policy networks in Indonesia. Help to identify potential barriers to the transformational change needed to implement REDD+.	*Implicit reference to resilience:* Adaptive management of social-ecological systems requires networks fostering the combination of local knowledge, cross-scale coordination, and social learning.	Independent: Influence of network structure on information exchange and governance outcome.	Form of coordination: Governance networks as purposefully created networks of inter-organizational linkages.	Structurally explicit: Semi-structured interviews with representatives of organizations involved in REDD+ Indonesia. SNA: total network.	Social relation: regular exchange of information. Actors: organizations from academic, private, and public sector. Scale: national - international governance system.	Network: governance network. Subgroups: relational groups. Individual: brokers.	Actor: number of employees, headquarter locations, membership in organizations. Structure: centrality, subgroup fragmentation.	Homophily and power generate a network that lacks the integration between diverse groups. Power asymmetries can hinder effective and inclusive governance. Brokers able to connect different clusters of information seeking will be crucial for effective and inclusive management.
Nuno et al. 2014	Analyze the multiple roles played by different institutions in the management system of the Serengeti and describe the interactions between different actor types.	*Explicit reference to resilience:* Social networks as a means to characterize collaborations and social relationships facilitating conservation and promoting resilience of governance.	Independent: Influence of social networks on management outcome.	Form of coordination: Management systems as networks of organizations involved in resource management.	Structurally explicit: Scenario building, institutional analysis, and semi-structured interviews with representatives of organizations responsible for the regulation of resource use in the Serengeti. SNA: total network.	Social relation: advice and support aiming to influence policy or implementation interventions. Actors: resource management organizations. Scale: local - regional governance system.	Network: governance network (including policy and implementation network). Individual: brokers / bridging actors.	Tie: frequency Structure: edge connectivity, density, mean geodesic distance, centrality.	Management networks center on very few individuals. These individuals are important in bridging across conservation arenas and therefore are able to potentially affect the resilience of governance structures. Understanding the complexity of behavior of key actors within management institutions is important for implementation of sustainable management.

Pietri et al. 2015	Examine the major patterns of information exchange among individuals of the Coral Triangle Initiative and evaluate impacts on information sharing. Consider implications for strengthening network sustainability, capacity building, and learning.	*Explicit reference to resilience:* Learning networks are building on social capital which can help fostering resilience and achieving social and environmental goals.	Independent: Influence of social networks on capacity building and learning.	Form of coordination / Social capital: Governance networks as purposefully designed networks for promoting social capital through social learning and capacity building.	Structurally explicit: Qualitative key informant interviews and standardized (electronic) survey with representatives of organizations involved in the Coral Triangle Initiative. SNA: total network.	Social relation: seeking information with regard to coral reef management issues. Actos: organizations and partner countries participating in marine protected area management. Scale: national - international governance system.	Network: governance network. Individual: coordinators.	Actor: organizational affiliation, nationality, brokerage types. Ties: scores, ratio of internal / external links. Structure: density, centralization, fragmentation.	A decentralized network structure with redundancy of ties indicates potential resilience to changes in leadership and membership. Conservation learning networks have the ability to bridge cultural divides and promote social learning. A strong coordinator and continuing efforts to support information sharing and learning are crucial to the network's strength and sustainability.
Ramirez-Sanchez and Pinkerton 2009 †	Examine the effect of resource scarcity on the bonding, bridging, and linking social-capital patterns of fishers' information-sharing networks in coastal communities in Chile.	*Explicit reference to resilience:* Social capital patterned by social networks of trust can enable or constrain collaborative arrangements and collective action and therefore impact the resilience of social-ecological systems governance.	Dependent: Influence of resource scarcity on social networks and the production and distribution of social capital	Social capital: Social relations as means of supporting fishers' adaptive responses to resource fluctuations, external shocks, and other uncertainties.	Structurally explicit: Survey questionnaire and key informant interviews in six communities in the municipality. SNA: total network.	Social relation: trustworthy information on the state and location of fish. Actors: fishers in the community, fishers in other communities. Scale: local / community + linkages between communities.	Subgroup: social capital groups.	Tie: bonding ties (within a group) bridging ties (between groups in the same community), linking ties (between communities). Structure: fragmentation, subgroups. Context: resource scarcity.	Social networks are activated and deactivated during transitions in fish abundance. Presence of linking ties as indicator of the extent to which fishers adopt geographic mobility as a coping strategy to deal with resource scarcity. Although fishers have adaptive capacity for dealing with fish fluctuations, they have little or no proactive resilience to address the decline of resources.
Rico García-Amado et al. 2012	Understand social capital, decision-making, and collective action in forest-based common pool resource management in Chiapas, Mexico.	*Explicit reference to resilience* Social networks of trust, reciprocal exchanges, norms, and sanctions are positively related to collective action required for resilient common pool governance.	Independent / Dependent: Impact of social networks on productive activities and conservation of forest resources. Impact of market requirements on social network structure.	Social capital / Form of coordination Norms and social networks as factors of social capital and collective action for resource management.	Structurally explicit: Observations and semi-structured household interviews with all household heads in the local administrative unit. SNA: total network.	Social relation: work-related demand of assistance. Actors: households and public or private actors. Scale: local / administrative unit + external linkages.	Network: management networks (i.e. palm / coffee). Subgroups: crop / producer groups.	Actor: tenure, cash income, group affiliation. Structure: centrality, cluster and subgroups, hierarchy. Context: market changes and requirements.	Market requirements shape networks Organic coffee commercialization is the main source of bridging ties that have resulted in more connectivity and resilience. Despite power asymmetries and internal conflicts, the local network facilitates an effective management of common pool resources. Institution-building is required, because highly centralized networks may not be appropriate for governing social-ecological systems in the long term.
Sanginga et al. 2007	Examine the role, strengths, and limits of social capital in managing conflicts over the use and management of natural resources in Uganda.	*Implicit reference to resilience:* Social networks facilitate coordination and cooperation for mutually beneficial collective action and help to manage	Independent: Influence of social networks on resource management and conflict resolution.	Social capital: Social networks as assets upon which people rely to manage natural resources and resolve conflicts.	Metaphorical: Interviews with farmers in 16 villages in one district.	Social relation: linkages, membership in formal / informal associations *(not specified)*. Actors: farmers in the village, farmers from other villages.	*(not specified)*	Tie: bonding ties (between members of the same group), bridging ties (between different groups), and linking ties (connecting actors of different status).	Farmers use several social capital mechanisms for managing conflicts. A combination of social, economic, and political factors has undermined the ability of local bonding mechanisms to manage conflicts. Bridging capital has a relatively higher

		natural resources and to resolve conflicts.				Scale: local / community + linkages between communities.		Context: social, economic, and political factors.	capacity to resolve conflicts.
Stein et al. 2011	Empirical mapping of collaborative social networks between actors that either directly or indirectly influence water flows in the Mkindo catchment in Tanzania.	*Implicit reference to resilience:* Social networks matter for the adaptive co-management of natural resources.	Independent: Influence of social networks on governance outcome.	Form of coordination: Governance networks consisting of formal and informal relations between political, social, and economic organizations and institutions.	Structurally explicit: Questionnaire and semi-structured interviews with stakeholders in the catchment area (including leaders in four villages). SNA: total network.	Social relation: funding, information and knowledge exchange, collaboration. Actors: organizations and institutions involved in water management. Scale: local - regional governance system.	Network: governance network. Individual: influential actors.	Structure: density, centralization, group analysis.	Village leaders play a crucial role in linking otherwise disconnected actors but are not integrated in the management system. Instead of imposing top-down institutional arrangements, it is more promising to build on existing social structures.
Sundstrom et al. 2012	Examine how ranch privatization and settlement of individual Maasai households have affected traditional livestock herding and social capital mechanisms of Maasai livestock herders in Kenya.	*Implicit reference to resilience:* In the context of insecure tenure rights over land and natural resources, trusted long-term social networks can enforce property rights and sustain natural resources.	Independent / Dependent: Social networks as a mechanism to ensure access to natural resources. Impact of rangeland privatization on social networks.	Social capital: Social ties among networks members generating collective well-being.	Metaphorical: Narrative interview, group discussions in the area of a former ranch.	Social relations: customary relations, reciprocal use of land and resource. Actors: Masaai community members. Scale: local / village + external linkages.	Individual: particular herders.	Ties: bonding ties (among kin and friends), bridging ties (to actors outside the community). Context: rangeland privatization.	Land subdivision has altered customary social networks and resource governance. Individuals can generate new social capital mechanisms based on a combination of bonding and bridging ties. Bridging ties reaching outside the community can help to shape the transition to commercial livestock practices and take advantage of development opportunities.
Tompkins et al. 2002	Investigate the role of institutional networks for integrated and inclusive coastal-zone management in Trinidad and Tobago.	*Implicit reference to resilience:* Social networks and the ability of its social actors to combine information and resources outside the local sphere of institutions are important means by which integrated and inclusive management are maintained.	Independent / Dependent: Influence of social networks on inclusive resource management. Influence of legislation and regulation on social networks.	Form of coordination: Governance as facilitated by networks of institutions at various scales:	Metaphorical: Semi-structured interviews and participatory workshops with representatives of coastal resource management institutions.	Social relation: institutional relations relied on for the realization of essential interests. Actors: institutions involved in the management of coastal resources. Scale: local - international governance system.	*Network:* spaces of dependency (between localized organizations), spaces of engagement (between local stakeholders and external interests).	Context: institutional setup / legislation and regulations.	Cross-scale networks may permit an institutional shift towards more integrated and inclusive approaches. There are winners and losers in any strengthening of networks for the co-management of resources. Thus there is a need to understand the institutional form of networks facilitating inclusive decision making at various scales.

† We included studies from Chile, despite its high-income status, in order to take account of representative studies.

A1.2: Strand ii: Agricultural innovation

Authors	Research interest	Conceptualization			Operationalization				Key findings
		Conceptual framing	Network variable	Network narrative	Network approach	Network definition	Network analysis		
							Network level	Network characteristics	
Arora 2012	Study farmers' participation in knowledge circulation in the context of a participatory project on agro-ecological methods in rural India.	*Implicit reference to resilience:* Agricultural innovation as a way out of indebtedness and resource depletion necessitates dyadic user-producer interactions which are embedded in wider knowledge networks between heterogeneous actors.	Independent / Dependent: Impact of social networks on adoption of agro-ecological methods. Influence of institutions on network structure.	Pipe: Knowledge networks constituted by circuits of knowledge exchange.	Structurally explicit: Complete village survey in a rural community. SNA: total network.	Social relation: problem solving knowledge in the face of agricultural pest attacks. Actors: farmers and external actors (experts, NGOs, input supplier). Scale local / village + external linkages.	Subgroup: learning circles.	Actor: caste, occupational group (farmer, NGO, private sector), experience of pest attack, adoption of sustainable practices. Tie: number of links. Structure: centrality, analysis of closed circles. Context: institutions / political influence.	Resource persons at the local level act as brokers between the development agency and its beneficiaries. Few farmers involved in knowledge circuits are "elite" farmers in the village who derive their influence from a number of relational and experiential factors that are hinged on formal and informal institutions. Knowledge is produced and interpreted within a set of unequal power relations.
Bandiera and Rasul 2006	Explore the role of family and friendship networks on the adoption of a new crop in Mozambique.	*Implicit reference to resilience:* Adoption of new agricultural technologies as an important route out of poverty. Farmers learn how to cultivate a new crop from the choices of others tied together in strong social networks.	Independent: Influence of social networks on adoption behavior.	Pipe: Social networks as conduit for the diffusion of information about new crops.	Descriptive: Household survey, key informant interviews in nine villages. Econometric modeling / analysis.	Social relation: information seeking on sunflower cultivation. Actors: farmers in the village, friends, and kin in other villages. Scale: local / village + linkages between villages.	Individual: farmers.	Actor: adopting status, relational group (kin, family neighbor), labor and agricultural tools, exposure to risk (food insecurity), cashew cultivation, participation in NGO activities, demographic data, migration status. Structure: network size.	The probability that a farmer adopts a new technology is increasing with the number of adopters in his network when there are few, and decreasing when there are many informed farmers. Adoption decisions are more correlated within family and friends than religion-based networks, and uncorrelated among individuals of different religions.
Butt 2015	Examine the political, economic, ecological, and socio-spatial contexts and the relevance of mobile phone use among pastoralists in Kenya.	*Implicit reference to resilience:* Technology as main driver of a social group's ability to adapt to rapidly changing social, political, economic, and environmental conditions.	Dependent: Impact of mobile phone use on communication networks related to herding.	Pipe: Social networks as conduit for the exchange of information.	Metaphorical: Qualitative ethnographic research in the study site.	Social relation: enquiring information about herding related issues. Actors: herders. Scale: local / study site	Individual: herders.	Tie: kinship, clan membership.	Information sharing among pastoralists using mobile phones transcends social groups. It is not a question of kinship or clan membership but of how well herders know each other. Instead, exchange is more likely to be mediated by daily practices of herding in response to social, political and environmental conditions.

Conley and Udry 2001	Explore agricultural technology adoption in Ghana with a focus on communication networks.	*Implicit reference to resilience:* Learning about technologies in social networks as a central feature of the transformation of farming systems in the context of economic development.	Independent: Impact of social networks on the adoption of agricultural practices.	Pipe: Social networks as conduit for the exchange of information on agricultural techniques.	Descriptive: Household survey in four clusters of villages. Econometric modeling.	Social relation: advice about farming, communication about input / output levels. Actors: farmers in the village and farmers in other villages. Scale: local / villages + linkages between villages.	Individual: farmers.	Actor: plot level data on input and output, knowledge on input / output level of other farms. Structure: density.	Information is not freely available to all farmers but channeled through sparse networks and is often imperfect. Farmers orient their behavior to the behavior of other farmers they communicate with. Communication links are not based solely on geographic proximity but expand beyond the village level. Farmers do not engage in optimal learning behavior. Instead, they use simple rules of thumb to guide their behavior when innovating.
Hoang et al. 2006	Explore how social networks function as assets for individuals and households and how they influence access to information and benefits from research and development in rural areas of North Vietnam.	*Implicit reference to resilience:* Village communities as heterogeneous entities constituted by complex networks of social relationships. Social networks as a means of accessing information from research and development.	Independent: Influence of social networks information access.	Social capital: Social networks as important intangible component of individuals' or households' asset-portfolios.	Descriptive: Semi-structured interviews with household representatives in one rural village. SNA: total network (but no explicit analysis of network structure).	Social relation: discussing, advice seeking regarding agricultural issues and practices. Actors: households in the community, external actors (other households, extension, research). Scale: local / village + linkages to external actors.	Network: discussion / advice network, kinship network.	Actor: relational category, gender, socio-economic status. Tie: kinship, neighborhood / friendship ties. Context: political influence.	Differences in socio-economic status and social connections through kinship, friendship, and neighborhood networks act as significant determinants of access to information. Close relatives are most trusted and hence followed. Most discussion regarding agricultural matters takes place at home / at the village level. Network analysis can avoid reinforcing existing unequal power relations and can enable research and development interventions to reach the individuals and households in greatest need.
Isaac et al. 2007	Investigate the structural arrangements of informal communication networks by examining advice seeking in the cocoa agroforestry of Ghana.	*Implicit reference to resilience:* Access to knowledge is essential for community based adaptive management. Farmers who lack the means to acquire farming knowledge from formal sources rely on information within their informal social networks.	Independent: Influence of social structure on the adoption of agroforestry management practices.	Pipe: Social networks as informal conduits for the transfer of knowledge on agricultural practices.	Structurally explicit: Household interviews in four communities in Ghana. SNA: total network.	Social relation: informal advice on farming practices. Actors: famers in four communities, external actors (farmers, extension, and institutions). Scale: local /community + linkages to external actors.	Network: community advice network. Individual: central / bridging farmers.	Actor: socio-demographic data, origin (in / outside the community), level of involvement, and level of imitation. Structure: density, centrality	Social proximity does not control the formation of informal advice structures. Advice networks are sparse networks with a core-periphery structure. Few central actors acting as bridging between formal and informal networks. Central farmers are active in community activities. Hence promotion of community involvement may strengthen informal networks.
Isaac 2012	Investigate information network structures within the agrarian environment in order to understand the barriers to, and development of	*Implicit reference to resilience*: The structure of social networks connecting a variety of agrarian actors is fundamental	Independent: Impact of social structure on effectiveness of farm management.	Pipe: Social networks as conduit for the exchange of agrarian knowledge and	Structurally explicit: Semi-structured interviews with farmers and members of organizations in two geographically sepa-	Social relation: advice on the management of agrodiversity on cocoa farms. Actors: famers, external actors (ex-	Network: farmers' personal innovation networks. Individual: farmers.	Actor: adoption rate of agroforestry practices. Tie: number of ties, farmer-to-farmer ties, organizational ties.	The increase of organizational ties is related to a decrease of network density in personal producer networks as they replace producer-to-producer ties. Producers with ties to organizations are likely to be positioned in more sparse and

	effective farm management, specifically the management of agrodiversity in Ghana.	to the adoption of innovations and influences the advancement or weakening of sustainable farm management.		information	rate rural areas. SNA: ego-networks.	tension, NGOs). Scale: local / community + linkages to external actors.		Structure: size, density, triad analysis.	efficient information networks as identified by a low level of redundant ties correlated to higher reported on-farm agrodiversity. Unlike common-pool resource management which requires dense networks, exchange of complex information requires diffuse but efficient social networks.
Isaac et al. 2014	Investigate the role of migrant farmers in agricultural information networks and explore implications on the adoption of pro-environmental management practices in Ghana.	*Explicit reference to resilience*: Environmentally induced migration as a livelihood strategy shaping agricultural information networks and therefore the sustainable management of agroecosystems and the resilience of the region of destination.	Dependent: Influence of migration on social networks and their ability to promote the adoption of environmental management practices.	Pipe: Networks as conduit for the exchange of knowledge on agricultural practices.	Structurally explicit: Famer interviews in three rural communities. SNA: total network (constructed from ego-networks).	Social relation: exchanging and seeking information on agricultural practices. Actors: farmers in the community and farmers in other communities. Scale: local / community + linkages between communities.	Network: agricultural communication network. Individual: farmers (brokers).	Actor: settlement categories, origin and location, demographic data, land tenure, adaptive practice, brokerage roles. Tie; tie-frequency between communities. Structure: size, centrality, cohesion. Context: migration.	Cohesion of the communication network is dependent on a few strategic bridging ties initiated by migrant farmers. Migrant farmers have larger networks, act as brokers between socially and spatial distant groups, and tend to apply pro-environmental agricultural methods. This can be conceptualized as social-ecological memory. Migrant farmers are potential agents of innovation and adaptive management.
Matouš et al. 2013	Explore the roles of social networks and extension networks for the adoption of resource conserving practices among Ethiopian farmers.	*Implicit reference to resilience:* Farmers' decisions are influenced by other farmers and the nature of social relationships. Informal networks can play a larger role in the protection of natural resources than formal institutions.	Independent: Influence of social networks on the adoption of agricultural techniques.	Pipe: Networks as conduit for the exchange of information.	Descriptive: Household survey and semi-structured interviews with local extension staff in three villages in three agro-ecological zones. Econometric analysis.	Social relation: information exchange on resource conserving agricultural techniques. Actors: households in the village and external actors (extension staff). Scale: local / village + linkages to external actors.	Individual: farmers. Network: community information network.	Actor: wealth, ethno-religious group, knowledge about resource conserving practices, geographic location. Tie: internal / external ties. Structure: size, density.	Farmers living close to the village center, with big land, bigger overall networks, and same ethnicity are more likely to be included in the extension system. Same religion and ethnicity between farmers and extension staff increases likelihood of learning from extension. Farmers with larger networks are more likely to know an extension agent but those are receptive to extension are those who are less socially connected.
Matuschke and Qaim 2009	Examine the impact of social networks on the adoption of modern seed technologies among smallholder farmers in rural India.	*Implicit reference to resilience:* Social networks impact the adoption of agricultural innovations and contribute to increased agricultural productivity and reduced poverty.	Independent: Influence of social networks on social learning and technology adoption.	Pipe: Networks as a conduit enabling interaction and knowledge exchange between farmers.	Descriptive: Household interviews in seven villages in four rural districts. Econometric modeling / analysis.	Social relation: regularly talking about agricultural decisions. Actors: farmers in the village and external actors (farmers, extension staff). Scale: local / village, linkages between villages + linkages to external actors.	Individual: farmers.	Actor: education, experience, farm size, caste, adoption behavior. Tie: ties of kinship and friendship. Context: village adoption rate, distance to input dealer / market.	Social networks do not necessarily incidence with village boundaries. Hence, relying on village level adoption rates underestimates social network effects. Communication takes place along homophilious rather than along heterogeneous lines. The behavior of members in the individual network has bigger impact as their characteristics.

Mazzucato and Niemeijer 2000	Explore the role of social institutions in guiding decisions regarding the use of technologies drawing on a case study from Eastern Burkina Faso.	*Implicit reference to resilience:* In order to understand farmers' decision making regarding soil and water conservation technologies, it is fundamental to understand local institutions. These institutions require investments in form of gift-giving and exchanges to build relationships.	Independent / Dependent: Influence of social networks on soil and water conservation. Influence of socio-economic changes on traditional social networks.	Pipe: Social networks as conduit for the exchange of technologies, information, resources, and gifts.	Metaphorical: Interviews and observations in two villages over a three-year period.	Social relation: reciprocal exchange of labor, varieties, technology, and land. Actors: farmers in the village, farmers in other villages. Scale: local / village + linkages between villages.	*(not specified)*	Context: socio-economic changes (increasing market integration).	Mixing of market and social aspects has led to changing use and composition of networks. Networks extending beyond the village level are used to access a repertoire of resources and technologies. This has increased the ability to adapt to changes. Technologies are more attractive if they help maintain existing networks (lending qualities of a technology). Intervention should not only focus on technologies but on how farmers' abilities to network can be increased.
Spielman et al. 2010	Examine how Ethiopian smallholders innovate, how their social networks contribute to innovation processes, and how they are influenced by policies and market factors.	*Implicit reference to resilience:* The way how smallholders innovate and improve their livelihoods is under constant change. Innovation systems comprise actors linked by networks of knowledge and others exchanges.	Independent: Influence of social networks on innovation adoption.	Pipe: Networks as a conduit for the exchange of information, inputs, and credit within the innovation system.	Structurally explicit: Household interviews, focus group discussions, and semi-structured interviews with key actors in 10 case study locations. SNA: total network.	Social relation: exchange of knowledge, inputs, credit, finance, price and market information. Actors: actors of the innovation system: farmers, extension staff, private and public sector representatives. Scale: local – national innovation system.	Network: national innovation system. Individual: brokering organizations.	Actor: socio-economic / demographic data, adoption behavior, group affiliation (private sector, NGO, extension, etc.). Tie: bridging links. Structure: centrality, coreness, cliques, and structural holes. Context: political influence.	Heterogeneous and integrated networks provide farmers with greater livelihood options. Interconnected public organizations play a central role, while market and civil society actors play only a peripheral role. Public extension and administration exert a strong influence over smallholder networks. By crowding out market-based and civil society actors the public sectors potentially limits beneficial innovation processes.
Tatlonghari et al. 2012	Investigate the structure of information exchange among male and female farmers involved in a project on participatory variety selection in Laos and Indonesia.	*Implicit reference to resilience:* Social capital in form of social networks among farmers can enhance the adoption of sustainable resource practices and can promote food security and income generation.	Independent: Impact of social networks on the adoption of new seeds.	Social capital: Social networks can serve as a form of social capital, and hence are an important intangible component of individuals' and households' asset portfolios.	Descriptive: Household surveys in two study villages in Laos and Indonesia. Econometric modeling / analysis.	Social relation: exchange of information on seeds. Actors: friends, family members, external actors (formal institutions). Scale: local / village + linkages between communities + linkages to external actors.	Subgroup: groups of kinship / friendship.	Actor: gender of the respondent, age, years in school, household size, area cultivated, number of relatives, membership in organizations, and access to extension services and social institutions. Structure: size of subgroups.	Farmers are strongly influenced by their kin and friends. Having more relatives increases the likelihood of having a big network. Information opportunities of men and women vary in terms of exposure to and control of information. Men tend to have larger networks than women. Gender should be accounted for when investigating the determinants of social networks.
Thuo et al. 2014	Examine the effects of social network factors on information acquisition and adoption of new seed varieties among groundnut farmers in Uganda and Kenya.	*Implicit reference to resilience:* Social networks play a key role for social learning, and hence the adoption of new agricultural practices.	Independent: Influence of social networks on information acquisition and the adoption of new seeds.	Pipe Networks as a conduit for the exchange of information.	Descriptive: Household interviews in two study sites. Econometric modeling / analysis.	Social relation: discussing groundnut matters, support towards better productivity. Actors: farmers and external actors (extension staff, input	Individual: farmers.	Actor: socioeconomic / demographic data, location, gender. Tie: tie strength, bonding / bridging ties (internal or external sources of infor-	Information flows in social networks are strong among farmers with similar characteristics. Particular weak ties to external support (research, extension etc.) influence information acquisition but not necessarily adoption. As well, gender and geographic location determine information

						supplier, and researchers) Scale: local / village + linkages to external actors.		mation).	acquisition.
Van den Broeck and Dercon 2011	Explore the role of social networks as facilitators of information flows and social externalities of banana production in a Tanzanian village.	*Implicit reference to resilience:* Social networks facilitating information flows and "learning from others" between farmers.	Independent: Influence of social networks on information flows and social externalities of banana production.	Pipe: Networks as a conduit for the exchange of information flows.	Descriptive: Full village / household census in one village. Econometric analysis.	Social relation: advice seeking and information exchange related to banana production. Actors: farmers in the village. Scale: local / village.	Individual: farmers.	Actor: social roles (kinship, neighborhood and membership in self-reported insurance groups). Tie: tie strength (internal / external ties).	Social learning is imperfect and requires strong networks such as kinship networks. Being part of a larger kinship network or living closer to other famers suppresses the likelihood of having outside information sources. In order to obtain biggest social externalities those farmers should be addressed belonging to different kinship groups.
van Rijn et al. 2012	Explore the relation between different forms of social capital and agricultural innovations for a sample of African countries.	*Implicit reference to resilience:* Agricultural innovation is an important factor for economic growth and development. Structural social capital of the poor can fosters the adoption of new agricultural technologies.	Independent: Influence of social networks on agricultural innovation.	Social capital: Social networks as structural capital (bonding-, and bridging social capital).	Descriptive: Household survey and village survey in seven African countries. Assessment of an adaptation index and social capital indicators. Econometric modeling / analysis.	Social relation: connections between households at village national level *(not specified)*. Actors: households in the village and external actors *(not specified)*. Scale: local / village + linkages to external actors.	Subgroups: social capital groups.	Actors: level of education, experience of the household in farming, household wealth. Tie: bonding ties (between kin), bridging ties (linkages across groups). Context: presence of mobile phone networks, schooling facilities and water resources.	Participation in wider networks that extend beyond the local village correlates with more innovation. This could be due to enhanced information or better access to resources. Participation in horizontal (intra-community) networks does not appear to be significantly correlated with innovations.
Wossen et al. 2013	Examine how the structure and size of networks affect social learning and farmers' decision to adopt sustainable resource management practices.	*Implicit reference to resilience:* Social networks as a central determinant of the adoption of new technologies. Networks reduce exposure to risks and are essential in enhancing agricultural productivity and food security.	Independent: Impact of structure and size of social networks on adoption decisions.	Pipe: Networks as a conduit for the exchange of information from different sources.	Descriptive: Analysis of existing survey material from villages in 140 districts. Econometric modeling / analysis.	Social relation: exchange of information, learning about new technologies. Actors: farmers, external actors (extension, public / private institutions). Scale: local / village + linkages to external actors.	Individual: farmers.	Actor: social roles (kin, friends, neighbors) educational level, age, plot location, distance from the peer, distance of network members relative to each other. Tie: kinship- / friendship ties, neighborhood ties. Network: number of ties (size).	Social network size and type of ties (e.g. kinship) play a significant role in enhancing the adoption of natural resource management practices. Adoption of new natural resource management practices is more frequent among farmers whose plot is located next to adopters ("learning by watching"). Distance between network members has a positive effect on the adoption of new technologies. External sources of information such as extension play a crucial role in enhancing the adoption of resource management practices.

Table A1.3: Strand iii: Social support

Authors	Research interest	Conceptualization			Operationalization				Key findings
		Conceptual framing	Network variable	Network narrative	Network approach	Network definition	Network analysis		
							Network level	Network characteristics	
Abizaid et al. 2015	Employ an analytic approach for the study of labor sharing networks among peasant households in the Peruvian Amazon.	*Implicit reference to resilience:* Social relations shape peasant resource use and livelihood security in rural areas. Labor exchange as a strategy to cope with seasonal labor shortage and cash limitations.	Independent: Influence of kinship networks and household structure on the availability of labor exchange.	Pipe: Social networks as source of labor support in times of labor shortage.	Structurally explicit: Observation, focus groups discussions with key informants, and complete household / village census in a mountain village. SNA: total network.	Social relation: exchange of labor. Actors: households in the village. Scale: local / village.	Network: village labor sharing network. Subgroup: kinship / gender groups.	Actor: household affiliation, gender, income, assets, and land use. Tie: ties between women / men, kinship ties, tie intensity.	Structure and flows of labor within the network are shaped by how households are connected through relational networks at personal and group level. Participation in and access to cooperative labor is markedly unequal. Women's personal networks play an important role in the mobilization of cooperative labor. Cooperative labor is not always reciprocal in the short term.
Baird and Gray 2014	Investigate the influence of livelihood diversification on traditional support networks in terms of bonding and bridging ties in Maasai communities in northern Tanzania.	*Explicit reference to resilience:* Traditional social networks of exchange and reciprocity are critical components of household security, disaster relief, and household resilience in rural areas. Social networks are evolving in response to household diversification.	Dependent: Influence of income diversification on networks of traditional inter-household exchanges.	Social capital: Social networks as important component of social capital. Different networks confer different types of social capital on their members.	Descriptive: Semi-structured group interviews and household survey in six communities. Livelihood diversification index. Regression analysis.	Social relation: exchanges of resources between households (loans, restocking, and gifts). Actors: households in the community. Scale: local / community.	Individual: households.	Actors: socio-economic / demographic data, church participation, perception of household exchanges. Ties: number and content of exchanges, bonding and bridging ties.	The transition of risk management holds several implications for the growth, development, and resilience of households and communities. Reducing household exchanges might reduce the ability to act collectively. Diversified households may be able to better manage high incidence / low severity shocks but may be less well prepared to manage low incidence / high severity shocks. Declining inter-household exchanges (bonding ties) releases resources that could be invested in household diversification (bridging ties).
Bosher et al. 2007	Explore key factors determining who has assets, who can access public facilities, who has political connections, and who has supportive social networks for coping with environmental risk in coastal communities in Andhra Pradesh, India.	*Explicit reference to resilience*: Social networks provide social capital that can bolster the resilience of the poor and vulnerable to environmental risks.	Independent / Dependent: Influence of social networks on the resilience of poor households. Caste influence on access to social networks.	Social capital: Social networks as component of social capital providing access to resources that can substitute other capitals and enhance resilience.	Descriptive: Key informant interviews, household interviews, and sociograms in eight coastal villages. Vulnerability index. Descriptive statistics.	Social relation: connections to NGOs, CBOs and family members. Actors: households, CBOs, external actors (NGOs, politicians). Scale: local / village + linkages to external actors.	Individual: households.	Actor: caste, vulnerability index. Tie: tie type, tie strength (internal / external).	Caste is a decisive factor determining the access to particular supportive networks. The poor and powerless castes (those with poor access to political social networks) are dependent on their informal social networks. These networks are typically accessed via the involvement with NGOs.

Cassidy and Barnes 2012	Explore the relationship between household connectivity and household resilience to shocks such as illness, crop damage, and livestock diseases in a rural community in Botswana.	*Explicit reference to resilience*: Social networks as a strategy of vulnerable rural households to deal with external and internal stresses and shocks and to increase their resilience.	Independent: Influence of network structure on household resilience to environmental risks / economic stress.	Pipe / Social capital: Social networks as a conduit for the exchange of resources. Social networks as one aspect of social capital.	Structurally explicit: Focus group and complete household survey in a rural village. Household resilience index. SNA: total network.	Social relation: exchange of information, labor, food, or money in times of stress. Actors: households in the village. Scale: local / village.	Network: village support network. Individual: households.	Actor: socio-economic and demographic data, resilience index (including wealth, livelihood diversity, household capitals). Structure: centrality.	Households that are better connected have higher resilience, because of higher redundancy and reach of ties into different subsets of the community. Unequal distribution of capitals is correlated with unequal distribution of connectivity. Already marginalized households are less connected.
da Costa et al. 2012	Understanding household food security and, inter alia, the role of food exchange in Timor-Leste.	*Explicit reference to resilience:* Social networks as a coping strategy for rural households and as a contribution to resilience of agricultural systems to climatic risks.	Independent: Influence on social networks on household food security.	Pipe: Social networks as conduit for the reciprocal exchange of food.	Metaphorical: Review based on national household survey / consumption study.	Social relation: reciprocal gifting of food. Actors: households. Scale: *(not specified)*	*(not specified)*	Tie: reciprocity of food exchanges.	The gifting of food between neighbors and members of extended families functions as 'delayed reciprocity' whereby the gift is returned at a later date when the household that has received the gift has a surplus or when other households experience shortage.
Downey 2010	Examine the influence of labor exchange networks on the socio-ecological resilience of rural Mayan communities in Belize and identify relevant network properties.	*Explicit reference to resilience:* Labor exchange networks contribute to village cohesion and adaptive management, and therefore to community resilience in the context of socio-economic and environmental changes.	Independent: Influence of social networks on the resilience of rural communities / social-ecological systems.	Pipe / Form of coordination: Social networks as conduit for the exchange of labor and information. Networks as a form of managing resource use.	Structurally explicit: Analysis of historical land uses and complete household census in five study villages. SNA: total network.	Social relation: exchange of labor for clearing and planting fields. Actors: households in the village. Scale: local / village.	Network: village labor exchange network.	Actor: field size, crops planted, and productivity. Tie: ratio of reciprocated / unreciprocated ties. Structure: group size, hierarchy.	Labor networks not only increase a farmer's ability to coordinate large labor groups, they also enhance learning and adaptation. Increasing reciprocity rates can increase production, whereas decreasing reciprocity can help protecting shared resources from overuse. Resilience is not increased by developing fragile institutional hierarchies to protect common resources, but by the connective properties of networks.
Ekblom 2012	Assess vulnerability and resilience in rural communities in South Mozambique from a historical perspective, including the role of social networks.	*Explicit reference to resilience*: Resilience as the capacity of a society to respond to and recover from adverse conditions. Social networks as a livelihood strategy affecting the capacity to cope with vulnerabilities.	Independent: Influence of social networks on resilience / vulnerability of rural communities.	Pipe: Social networks as conduit for the exchange of resources.	Metaphorical: Semi-structured interviews with key informants and household interviews in a rural commune. Geological data and pollen analysis.	Social relation: kinship ties, labor exchange, information sharing, remittances. Actors: households in the commune, external actors (*not specified*). Scale: local / commune + national / international linkages. Temporal scale: 700 AD until today.	Individual: households.	Ties: internal / external linkages. Context: commercialization of natural resources use, trade, and migration.	Household exchange as an important strategy for buffering risks. Livelihood strategies are institutionalized in society and are examples of the capacity to build resilience. In particular social networks spanning places have long historical continuities. Strategies for reducing vulnerability in the short term can inhibit the capacity to build resilience in the long term.

Gallego and Mendola 2013	Investigate how labor migration in poor developing settings impacts social support networks and cooperative arrangements in migrant-sending communities in South Mozambique.	*Implicit reference to resilience:* Social networks and migration are crucial household strategies for mobilizing a range of economic resources. Mobility provides both the households and the local network with potential access to uncorrelated income sources.	Dependent: Influence of migration (remittances) on social networks in the origin of migration.	Social capital: Social networks as a key source of information and resources, ultimately influencing economic performance.	Descriptive: Household survey in 42 communities in four rural districts. Econometric modeling / analysis.	Social relation: informal mutual support, advice seeking from relevant persons, formal group membership. Actors: households in the community, migrating household members. Scale: local / community + linkages to migrants.	Individual: households.	Actor: socioeconomic / demographic data, migration, remittances, perception of / reason for community participation. Context: migration, community level characteristics.	Households with successful migrants (i.e. those receiving remittances or return migration) engage more in community-based social networks. Income risks and participation constraints may limit both access to and effectiveness of social networks. Thus higher income stability through remittances or strong family migration ties may decrease participation costs and increase household commitment at the community level.
Goulden et al. 2013	Examine the role of social capital and livelihood diversification strategies for adaptation to climate variability.in dynamic lakeshore social–ecological systems in Uganda	*Explicit reference to resilience:* Social networks as livelihood strategy supporting adaptation to climate variability and promoting resilience throughout the adaptive cycle of the coupled social-ecological system.	Independent: Influence of social networks on the resilience of social-ecological systems	Social capital: Social networks as relations between people that facilitate productive activities.	Descriptive: Household survey, focus group discussions, and key informant interviews in two villages. Regression analysis.	Social relation: advice seeking regarding climate events, group participation. Actors: households in the village and external actors (organizations and institutions). Scale: local / village + linkages to external actors. Temporal scale: 1950s to mid-2000s.	Individual: households.	Tie: type and strength of ties (bonding, bridging, linking).	Households adapt to climate variability by concurrent, spatial and temporal diversification of livelihoods, and by drawing on social capital. However, these sources of resilience are not sufficient in all circumstances. The availability of adaptation options varies according to the different stages in the adaptive cycle of the social-ecological system. Bridging and linking social capital are important for collective action and state responses. Policies should promote strong social capital within and between social groups.
Islam and Walkerden 2014	Investigate the role of bonding and bridging relationships for community resilience to climate events in coastal villages in Bangladesh.	*Explicit reference to resilience:* Social networks of bonding and bridging ties play a central role in household resilience and disaster recovery.	Independent: Influence of social networks on household resilience to climatic risks.	Social capital: Social networks (bonding and bridging ties) as element of social capital facilitating coordination and cooperation for mutual benefit.	Descriptive: Focus groups, meetings with NGOs and key informants, and household surveys in two coastal villages. Descriptive statistics.	Social relation: support (emotional, food, shelter, cash, labor, etc.). Actors: households in the community, external actors (NGOs). Scale: local / community + linkages to external actors. Temporal scale: Weeks / months after the event.	Individual: households.	Actor: socio-economic / demographic data, household assets. Tie: bonding ties (household members + in-law households), bridging ties (neighbors and close friends).	Effected households draw heavily on their bonding and bridging relationships to face the immediate crisis. Bridging ties (neighbors and friends) break down after some time due to conflict and resource constraints. For longer-term recovery support through linking social networks is needed. Distribution of support is not equal: NGOs favor their borrowers and local governments favor members of their political party.

Islam and Walkerden 2015	Examine how social capital promotes household disaster recovery in coastal villages in Bangladesh, in particular linking social networks with NGOs.	*Explicit reference to resilience:* Linking social networks – the links between households and external organizations – form an important part of disaster resilience and recovery.	Independent: Influence of social networks on household resilience to climatic risks.	Social capital: Social networks as an aspect of social capital, facilitating coordination and cooperation for mutual benefit.	Descriptive: Focus groups, meetings with NGOs and key informants, and household surveys in two coastal villages. Descriptive statistics.	Social relation: links to formal organizations, advice seeking, material and financial relief, livelihood assistance. Actors: households in the community, external actors (NGOs). Scale: local / community + linkages to external actors.	Individual: households.	Actor: socio-economic / demographic data, household assets. Tie: linking ties to organizations.	Linking ties to NGOs provide support but at the same time catalyze relief dependency, because they focus on relief rather than preparedness.
Kadigi et al. 2007	Assess the spatial dynamics and determinants of livelihood capital, vulnerability, and coping strategies for poor agrarian households in Tanzania, including the role of social networks.	*Implicit reference to resilience:* Social capital in form of social networks of trust and reciprocity provides opportunities for poor households to cope with water scarcity.	Independent: Influence of social networks on the ability of households to pursue different livelihood activities.	Social capital: Social networks as aspect of social capital: Networks provide an informal framework for information sharing and collective decision-making and have direct impact on other types of capital.	Metaphorical: Household survey in different sample villages in the upper and lower catchment. Descriptive statistics.	Social relation: information sharing and collective decision making, labor sharing. Actors: households. Scale: *(not specified)*	Individual: households.	Context: climate related shocks, market / income opportunities, access to resources and institutions.	Collective labor arrangements, traditional ceremonies, and informal group membership crosscut social strata and result in higher levels of social capital for poor households. Nevertheless, households critically depend on existing institutional arrangements and mechanisms.
Katikiro et al. 2015	Describe how perceived changes in a fishery system such as declining fish stocks, market failures, and the loss of important species may strengthen or weaken sociocultural patterns in a fishing community in Tanzania.	*Implicit reference to resilience:* Traditional networks (based on kinship and friendship) provide opportunities for mutual help, solidarity, and social exchange. Hence, social networks constitute a critical safety net for poor households.	Dependent: Impact of ecological changes, market changes, and in-migration on patterns of social exchange.	Pipe: Social networks a means to access resources and support.	Metaphorical: Semi-structured interviews, focus group discussions, and life-history interviews in five coastal villages. Descriptive statistics.	Social relation: mutual support. Actors: households in the community. Scale: local / village.	Network: mutual support networks.	Tie: bonding ties (based on kinship / friendship). Context: decline of resources, market integration, in-migration.	Informal social relations have become loose and changeable due to perceived ecological changes and the influx of people without a fishing culture background. This has led to an erosion of mutual help, solidarity, and social exchange. However, few primary bonds such as family and clan networks have managed to survive and even flourish within new situations.
Lyle and Smith 2014	Explore the linkages between participation in community collective activities and access to adaptive support networks in a Peruvian highland community.	*Implicit reference to resilience:* Adaptive support networks play a prominent role in alleviating social and environmental stressors. One reason for collective benefits from social networks is that those who	Dependent: Influence of community participation on access to social support networks.	Social capital : Participation in community activities as an investment in social networks facilitating access to support and resources.	Structurally explicit: Observation, archival data, and household interviews in an Andean village. SNA: total network. Regression analysis.	Social relation: agricultural support (e.g. watching herds, providing advice on animal husbandry). Actors: households in the village. Scale: local / village.	Network: village support network. Individual: households.	Actor: household health and composition, herd size, participation in community activities. Tie: reciprocity. Structure: degree centrality. Context: geographic	Participation in collective action can convey information about qualities of fellow community members that are not easily observable otherwise. Cooperative households have better reputations and have larger support networks (and better household health). As well, mean distance from other households and per capita herd size are significant predictors of network size.

		contribute more receive reputational benefits, whereas those who contribute less incur reputational costs.						location.	
Nygren and Myatt-Hirvonen. 2009	Analyze the diverse ways in which peasant households in Honduras struggle to earn their living and cope with distress amid globalization.	*Implicit reference to resilience:* Social networks play an ambiguous role in shaping the opportunities and constraints of poor households to cope with poverty.	Dependent: Factors influencing the viability and reproduction of social networks.	Social capital: Social networks providing access to resources for coping with distress.	Descriptive: Observation, participation, ethnographic interviews, and semi-structured households interviews in all seven villages of the region.	Social relation: labor exchange, money lending, remittances, market connections. Actors: households, and external actors (intermediaries, politicians, and NGOs). Scale: local / village + linkages to external actors.	Individual: households.	Actor: household assets, household composition, life-history. Context: political-economic processes and institutional mechanisms shaping rural livelihoods.	Social networks are not a "capital" or "asset" that poor always can draw from. Rather networks are based on dynamic and negotiated transactions that cannot be mechanically stored or accumulated. Networks are not necessarily available and free of charge but are based upon complex norms of reciprocity. Cultivation of networks requires time, effort and money which the poor peasants lack. Instead, social networks tend to reinforce the existing differences.
Orchard et al. 2015	Assess the association between aquaculture, livelihoods, and social networks in coastal communities of North Vietnam.	*Explicit reference to resilience:* Aspects of resilience reside in the social networks of natural resource dependent communities: They facilitate access to livelihood resources in order to respond to change and increase the ability of communities to self-organize.	Independent / Dependent: Influence of aquaculture on social networks. Influence of social networks on the resilience of local communities.	Social capital: The structure and function of social networks is a crucial aspect of social capital enabling people to act together, and to pursue shared benefits.	Structurally explicit: Household survey in three coastal communities. Livelihood diversity index. SNA: total network (constructed from ego-networks).	Social relation: communication about mangrove system related issues. Actors: households, external market actors. Scale: local / village + linkages to external actors.	Network: mangrove communication network. Individual: households.	Actor: income, mangrove dependency, livelihood diversity. Tie: bonding / bridging ties. Structure: centrality, efficiency, effective size, and constraint. Context: market integration.	Economic transition alters mangrove system governance through the increasing influence of market mechanisms on the structure of social networks. Traditional dense social networks (bonding capital) are replaced by larger and less dense networks extending the village level (bridging capital). By reducing redundancy and connectedness market integration negatively impacts the capacity of communities to buffer the loss of ties and to self-organize. This way, market integration impacts community resilience.
Rindfuss et al. 2012	Examine the role of family networks at places of origin and destination on migrants' exchanges with family members in northeast Thailand.	*Implicit reference to resilience:* Migrant remittances are a crucial source for livelihoods in less developed countries. Migrants are embedded in a complex and changing web of social obligations among close family / kin and obligations in the area of destination.	Independent: Influence of family social networks on migrants' remittance behavior.	Pipe: Networks as a conduit for exchanging and facilitating flows of support.	Descriptive: Complete village / household census in all villages of a rural district. Migrant interviews (in destination areas). Regression analysis.	Social relation: transfer of money, labor and goods. Actors: households in the village and other villages in the district, migrants in destination areas. Scale: regional / district + linkages between villages and destination areas. Temporal scale: from 1984 to 1994.	Individual: households.	Actors; age, gender, education, occupation, migrant destination, household size. Tie: ties to spouses, children, and parents.	Intra-family exchanges are influenced by marital status of the migrant, the presence of children and parents in the household of origin, and by having siblings depart from it. The location of the spouse is of relevance as well.

Rotberg 2010	Investigate if and how social networks and key individuals contribute to rural adaptability to climate related risks in Bangladesh.	*Explicit reference to resilience:* Key individuals in formal and informal social networks can lead communities to adaptive action and can increase communities' resilience / capacity to cope with the impacts of climate changes.	Independent: Influence of networks and key individuals within them on the ability of households and communities to adapt.	Social capital: Social networks as a source of coping and adaptation to climate related risks.	Descriptive: Focus group, interviews, and semi-structured interviews in a coastal village in Bangladesh.	Social relation: asking for support in times of flood, and general assistance. Actors: households, external actors (organizations, NGOs). Scale of interaction: local + linkages to external actors. Temporal scale: seasonal / annual.	Individual: key individuals in the village (brokers).	Actor: education, gender, age, employment, origin of migration, trust and respect (attributed by the community). Ties: tie strength strong / weak ties and type (internal / external).	Key individuals are important for social network functioning. Key individuals that are trusted and respected serve as mobilizer and brokers and hence promote capacity to cope and to adapt. Formal and informal linkages with NGOs provide opportunities for income generation and the strengthening of networks. Social capital is bolstered when embedded in a network of reciprocal social relations. Combination of strong and weak ties leads to more resilient and adaptable communities.
Scheffran et al. 2012	Investigate opportunities for framing migration as a contribution to climate adaptation by drawing on case studies from the Sahel region.	*Explicit reference to resilience:* Communities and migrants are active agents who shape their livelihoods under changing conditions. Migration creates social capital that can foster resilience in the communities of origin.	Independent: Influence of social networks on climate change adaptation in areas of destination.	Social capital: Networks promote capabilities of migrants and provide access to resources that enrich capitals available at origin of migration.	Metaphorical: Review of three case studies from Western Sahel region.	Social relation: remittances, innovation and knowledge transfer. Actors: households and migrants in areas of destination. Scale: local - international migration system.	Network: migration network.	*(not specified)*	Migrant social networks can help building social capital and fostering social resilience in the communities of origin. Migration networks trigger innovations across regions by transferring knowledge, technology, remittances and other resources. Hence migration could increase the flexibility, diversity, and creativity of communities in addressing climate stress and could open new pathways for co-development.
Torkelsson 2007	Analyze the role that gender plays in the distribution and productivity of social network ties in a rural village in Ethiopia.	*Implicit reference to resilience:* Social networks provide access to bonded and bridged social resources and therefore offer opportunities to confront poverty and vulnerability.	Dependent: Influence of gender on the distribution and productivity of network ties.	Social capital: Social networks provide access to social resources that can be exchanged into other capitals.	Descriptive: Semi-structured household interviews, discussions, and observations in a rural village. Document analysis.	Social relation: participation in formal / informal institutions. Actors: households in the village, external actors (formal organizations). Scale: local / village + linkages to external actors.	Individual: households.	Actor: gender. Tie: bonding ties, bridging ties (access to formal institutions), linking ties (contact to external institutions, e.g. NGOs). Context: social norms, social institutions.	Men and women have different access to social networks. It is shown that the poorest and most vulnerable are those excluded from social networks. Networks of women revolve around bonding ties at local level and lack bridging ties to formal institutions (because of limited mobility and time constraints).
Zimmerer 2014	Examine agrobiodiversity in smallholder cultural landscapes with the goal of offering new insights into management and policy options for the resilience-based in-situ conservation in Bolivia.	*Explicit reference to resilience:* Migration alters social networks central to in-situ conservation of agro-diversity and hence impacts social ecological resilience.	Dependent: Influence of migration on social networks.	Pipe: Livelihood networks connecting various groups through the exchange of information and influence.	Metaphorical: Survey on land use and livelihood activities (including migration and social networks) in a highland region.	Social relation: kinship, social relations between livelihood groups *(not specified)*. Actors: livelihood groups. Scale: (*not specified)*	*(not specified)*	Context: migration.	Social networks of migration related livelihood groups are powerfully shaped through international and national migration, while at the same time supporting agrobiodiversity use and in-situ conservation.